Guide

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Cisco Catalyst Wireless Group Based Policy Guide

Introduction

About Cisco Catalyst Wireless

Cisco Catalyst Wireless is the next generation of Enterprise wireless network powered by Catalyst 9800 Wireless controller and Catalyst Access Points.

Based on Cisco IOS XE operating system, the Catalyst 9800 (C9800) is built from the ground up for intent-based networks to deliver on the next wave of wireless innovations and to address the new requirements coming from emerging standards like Wi-Fi 6, Wi-Fi 6E and Wi-Fi 7 in the near future.

Cisco Catalyst 9800 Series Wireless controllers integrate fifteen years of Cisco RF excellence with a modern, scalable, and programmable operating system to create the best-in-class wireless network. Together with Catalyst Access Points, Cisco Catalyst Center and Cisco Spaces it provides the next generation of wireless experience and addresses the enterprise evolving and growing digitization needs.

About Group-Based Policy (GBP)

Group-Based Policy, or software defined segmentation, simplifies the management and provisioning of network access control using groups to classify network traffic and enforce security policies. Traffic classification is not based purely on IP address but based on endpoint identity and context enabling policy change without network redesign. A centralized policy management platform (e.g., Cisco Identity Services Engine) gathers advanced contextual data about who and what is accessing your network, uses security group tags (SGTs) to define roles and access rights and then pushes the associated policy to your network devices such as switches, routers, security platforms and the C9800 (and access points when appropriate). This provides better visibility through richer contextual information and allows an organization to be better able to isolate threats and accelerate remediation, reducing the impact and costs associated with a potential breach.

Group-Based Policy technology is embedded within network switches, routers, wireless infrastructure and firewalls and is defined by three primary concepts: classification, propagation, and enforcement.

When users/endpoints connect to the network, they are authenticated using methods such as 802.1X, MAC authentication bypass (MAB), web authentication or passive authentication. Network authorization follows, which entails classifying the user or endpoint's IP address into a group leveraging rich contextual information such as identity, LDAP group membership, location, access type for example. After the user or endpoint's IP address is classified into an SGT group, network devices either enforce traffic flows based on those group assignments directly or propagate the classification information towards another network device assigned to be an enforcement point.

If the classification information needs to be propagated from one device to another, then hardware or software methods can be utilized by the C9800. The hardware method supported is known as inline tagging where the assigned SGT is inserted into the Cisco Meta-Data (CMD) field in the L2 frame of every packet sent by the user/endpoint, so propagated in the data-plane. The software method supported is called Security Group Tag Exchange Protocol (SXP) and is propagated in the control-plane.

Wherever enforcement occurs, the dynamically downloaded policy dictates whether the traffic should be permitted or denied. Full CTS provisioning and network device enrollment with ISE is required for the C9800 to enforce traffic based on the group assignments.

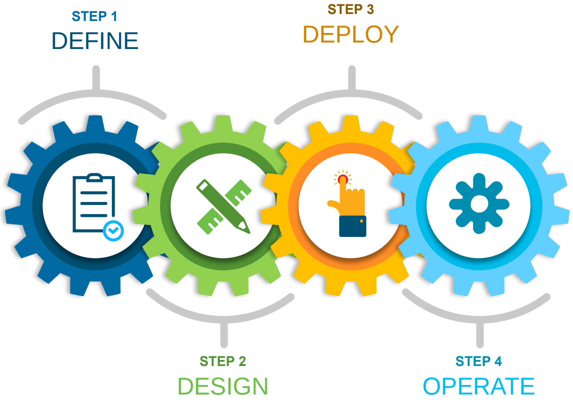
Some terms to be familiar with are CTS and TrustSec. CTS stands for 'Cisco Trusted Security' and is an acronym typically used in the IOS-XE CLI when configuring or showing Group-Based Policy commands. Commands using this acronym will be used throughout this document. TrustSec is a brand name created by Cisco to name the whole technology using Security Group Tags (SGTs). The brand name has now officially been released by Cisco and the term ‘Group-Based Policy’ is more often used now. However, the term TrustSec still resides in some ISE GUI pages.

There are some new functions required to implement the Group-Based Policy technology, but subsequently the effort for adds, moves and changes is dramatically reduced once deployed.

About This Guide

This guide provides technical guidance on deploying the C9800 wireless controller with Group-Based Policy (GBP) segmentation technology. As well as providing advice on best practices, the guide covers design topics, deployment configurations and how to get the most out of the technology operation.

Figure 1. **Guide Workflow**



This guide is intended to provide technical guidance to design, deploy and operate the C9800 controller across an environment incorporating GBP. It focuses on the incremental steps to enable the functionality and shows the configuration necessary to handle various use-cases.

This guide contains four major sections:

- The Define section defines the problem being solved with the C9800 employing GBP and provides information about the use-cases covered.
- The Design section highlights the typical deployment topologies and any important considerations.
- The Deploy section provides information about various procedures and configurations to deploy the solution along with recommended best practices.
- The Operate section shows how to verify segmentation is in place and how endpoints in a WLAN can be blocked from communicating with other endpoints in the same WLAN, in different WLANs or endpoints which are connected to the network using wired connectivity.

What is covered in this document?

Group-Based Policy C9800 controller deployments with APs in Local and Flex Connect mode in a standalone controller deployment or in a Foreign – Anchor scenario.

Other C9800 deployment guides can be found here: https://community.cisco.com/t5/networking-knowledge-base/cisco-en-amp-c-validated-design-and-deployment-guides/ta-p/3777320

What is not covered in this document?

Full C9800 configuration – it is assumed the general configuration of the controller is understood and in place: SSIDs have been defined, APs have joined to the C9800, and clients can connect to the wireless network. This guide purely covers the additional GBP features and related configuration. SD-Access fabric enabled wireless is not covered, please refer to the SD-Access Wireless Deployment Guide: (https://www.cisco.com/c/dam/en/us/td/docs/cloud-systems-management/network-automation-and-management/dna-center/deploy-guide/cisco-dna-center-sd-access-wl-dg.pdf).

Define

Group-Based Policy (GBP) operation with the Cisco AireOS controller products has been well documented over the years. The introduction of the C9800 controller brought about additional capabilities more in line with the Cisco switches and routers as they share the same IOS-XE Operating System. One such feature is enforcement on the platform itself whereas AireOS WLCs only facilitated enforcement on the access points or on other network devices. All the C9800 capabilities related to GBP are covered in this document.

The C9800 controller was introduced with IOS-XE release 16.10 but this guide refers to 17.9.x as the officially supported train. The aim of this document is to not only detail the GBP functions but prove the operations through documented test results.

To enforce traffic on the C9800 platform, full CTS provisioning and network device enrollment is required. This entails downloading a protected access credential (PAC) from ISE plus data within what is called the environment-data which includes the Network Device SGT, the TrustSec server list, a list of all the SGTs within ISE as well as associated timers.

Occasionally there is a misunderstanding of the GBP operation that full CTS provisioning and network device enrollment is required to classify endpoints and to propagate that information off-platform. The first use-case covered is to prove that this is not the case. Use-cases included are as follows:

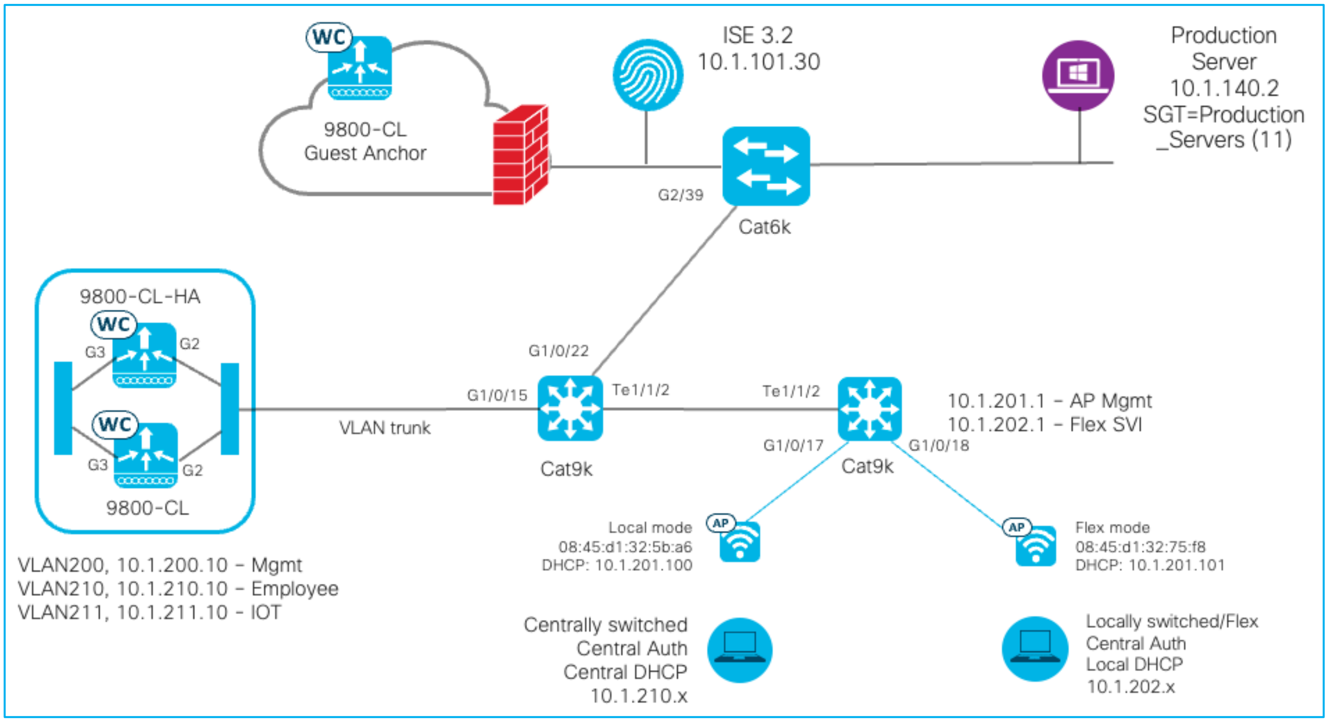
- ISE dynamic SGT assignment
- C9800 propagating SGT off-platform using SXP and inline tagging (using Cisco Meta-Data (CMD) in L2 frame)
- C9800 Default SGT Assigned via Policy Profile and Enforcing Off-Platform
- CTS Provisioning and C9800 enrollment with ISE
- ISE Change of Authorization (CoA) and SSH for SGT and Device SGT Create/Update/Delete
- East-West policy enforcement (wireless to wireless)
- North-South policy enforcement (wired to wireless), using SXP, CMD, IP:SGT and Subnet:SGT
- North-South Enforcement with Wireless Client Using Default SGT Assigned via Policy Profile
- C9800 dealing with classification order of precedence
- ISE CoA and SSH for Policy
- Monitor Mode
- C9800 and AP in Flex Mode, SXP and CMD transmitted and received by the AP
- C9800 using HTTPS for SGT and policy download (rather than RADIUS)
- C9800 handling SGT functions for HA operation

- C9800 and SGT operation in Foreign and Anchor scenario
- Logging capability of SGACL hits
- SGT information within NetFlow records

Design

Topology

Unless indicated otherwise, the use-cases in this document are proven using the following topology:

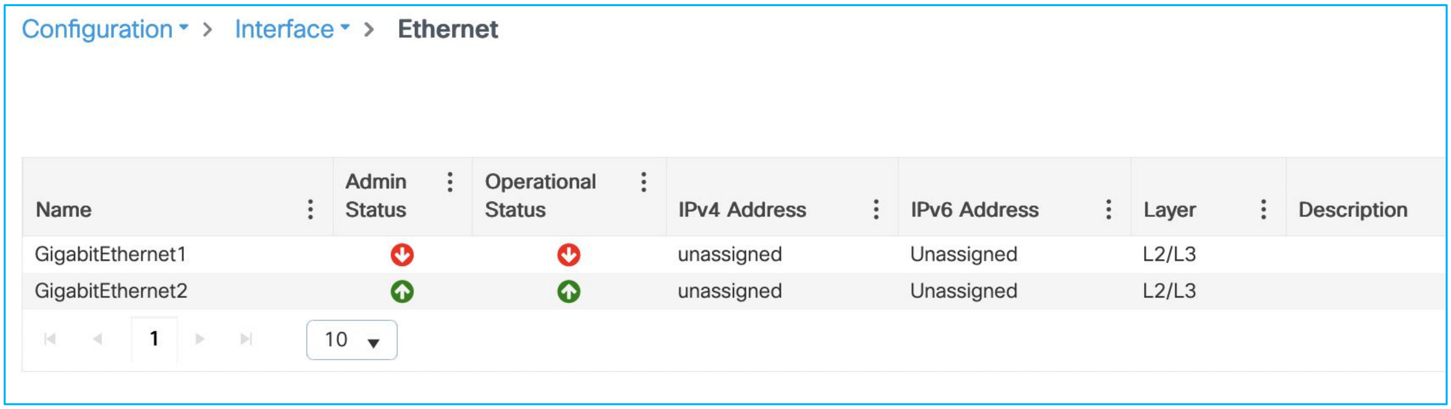


In some use-cases, inline tagging is enabled on the C9800 uplink interface to the interconnected Cat9k switch. As stated previously, inline tagging allows the source SGT to be inserted into the Cisco Meta-Data (CMD) field of the L2 frames of every packet transmitted. If the C9800 uplink interface is configured to use inline tagging, then the interface on the interconnected device must also have inline tagging enabled (Cat9k on the left, interface G1/0/15 in this topology). If another device were inserted between the C9800 and Cat9k (a firewall for example), then the connected interfaces on that FW must also support inline tagging.

The same is true for the connectivity between the AP's and their interconnected Cat9k, some use-cases enable inline tagging here in flexconnect mode.

Initial C9800 Setup

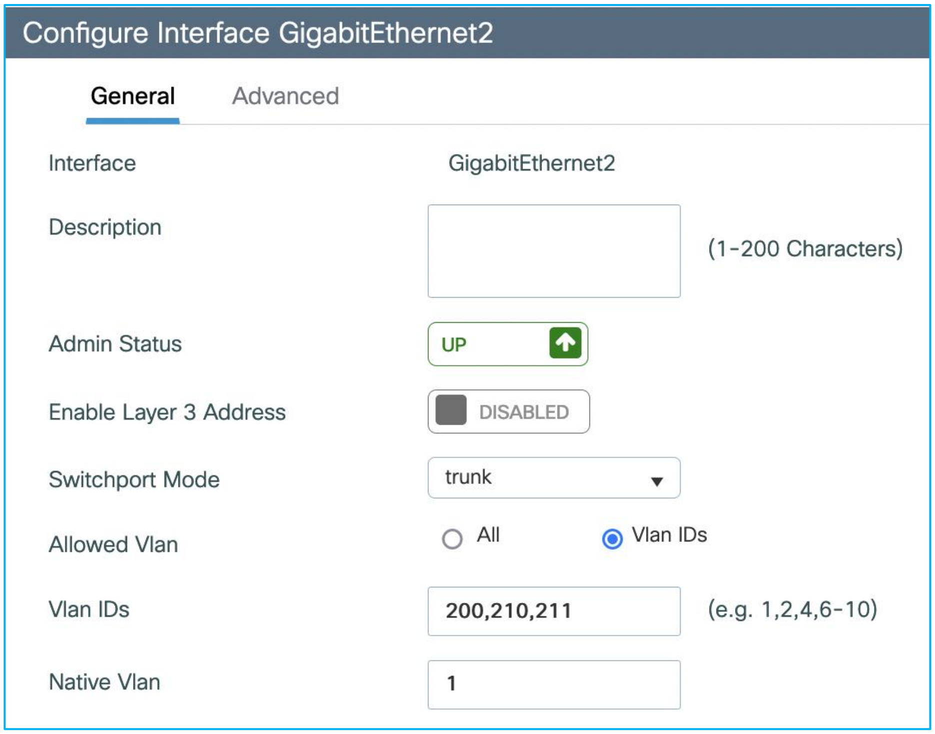
In this guide, the C9800 Cloud version (C9800-CL) is mostly used, and the Gigabit Ethernet 2 (G2) is configured as the uplink interface. Of course, customers may use a port-channel or any other uplink interfaces available on the virtual or physical appliances. The following shows a trunk deployed on the uplink interface:



Configuration ▾ > Interface ▾ > Ethernet

Name	Admin Status	Operational Status	IPv4 Address	IPv6 Address	Layer	Description
GigabitEthernet1	⬇	⬇	unassigned	Unassigned	L2/L3	
GigabitEthernet2	⬆	⬆	unassigned	Unassigned	L2/L3	

GigabitEthernet2 details:



Configure Interface GigabitEthernet2

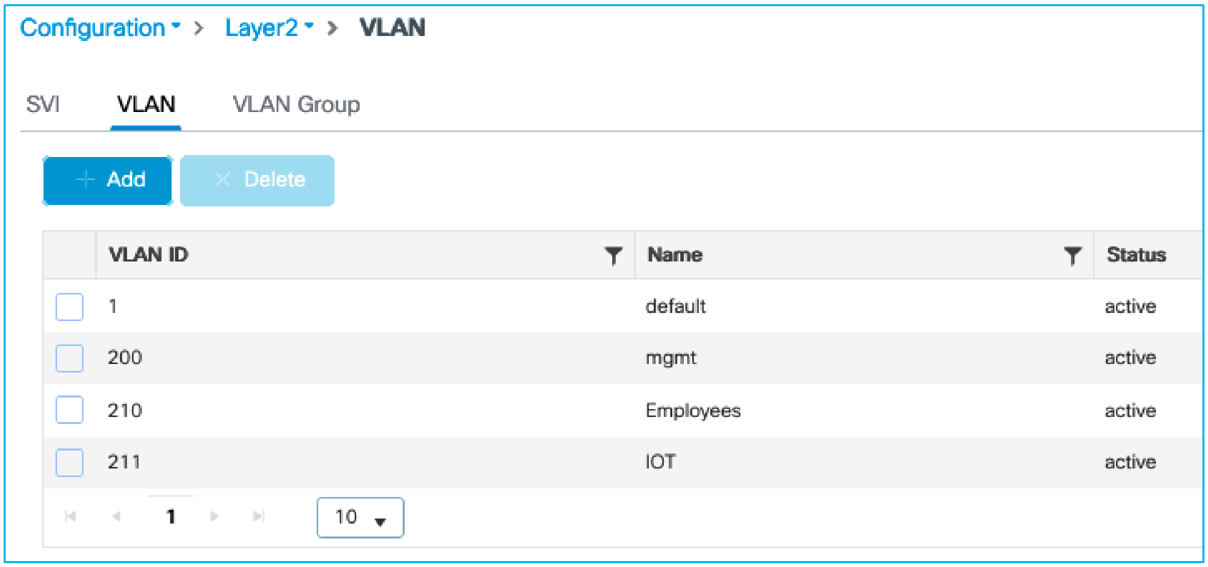
Interface	GigabitEthernet2	
Description		(1-200 Characters)
Admin Status	UP ⬆	
Enable Layer 3 Address	DISABLED	
Switchport Mode	trunk ▾	
Allowed Vlan	○ All ● Vlan IDs	
Vlan IDs	200,210,211	(e.g. 1,2,4,6-10)
Native Vlan	1	

VLANs added:

VLAN 200 used for Management

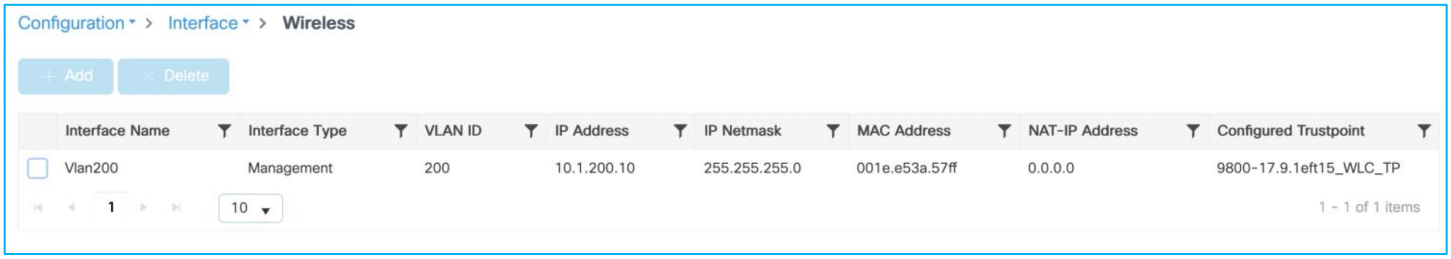
VLAN 210 used for Employees

VLAN 211 used for IOT



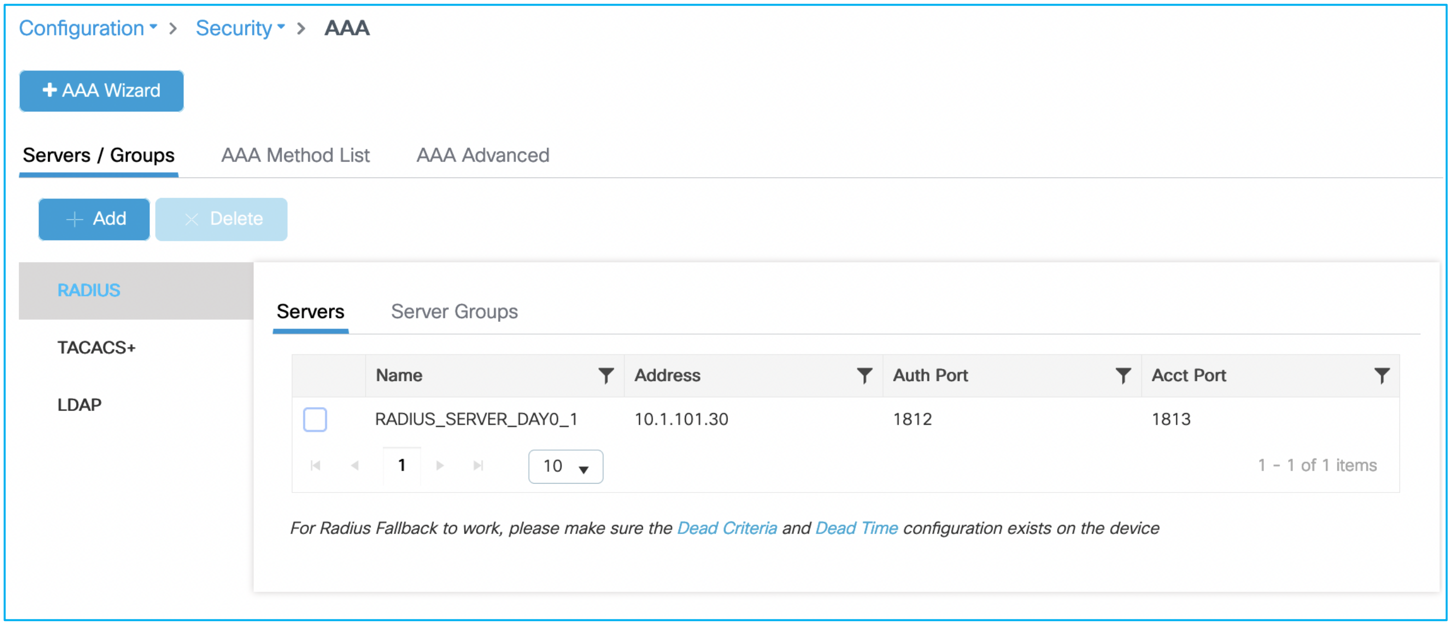
	VLAN ID	Name	Status
□	1	default	active
□	200	mgmt	active
□	210	Employees	active
□	211	IOT	active

Wireless Management Interface:



	Interface Name	Interface Type	VLAN ID	IP Address	IP Netmask	MAC Address	NAT-IP Address	Configured Trustpoint
□	Vlan200	Management	200	10.1.200.10	255.255.255.0	001e.e53a.57ff	0.0.0.0	9800-17.9.1eft15_WLC_TP

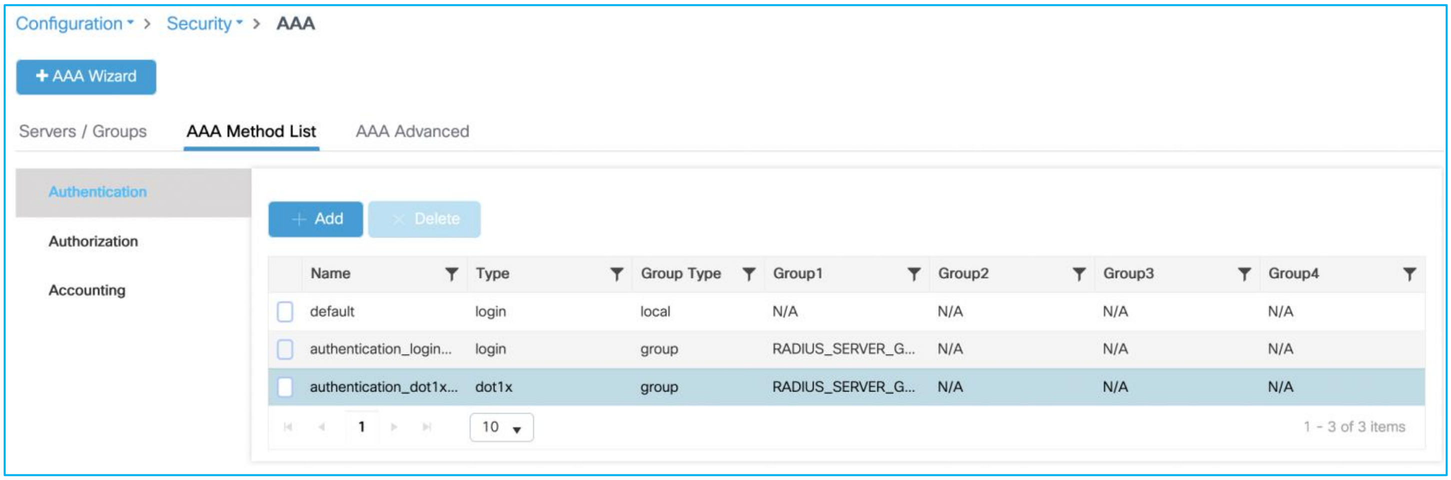
AAA Configuration:



	Name	Address	Auth Port	Acct Port
□	RADIUS_SERVER_DAY0_1	10.1.101.30	1812	1813

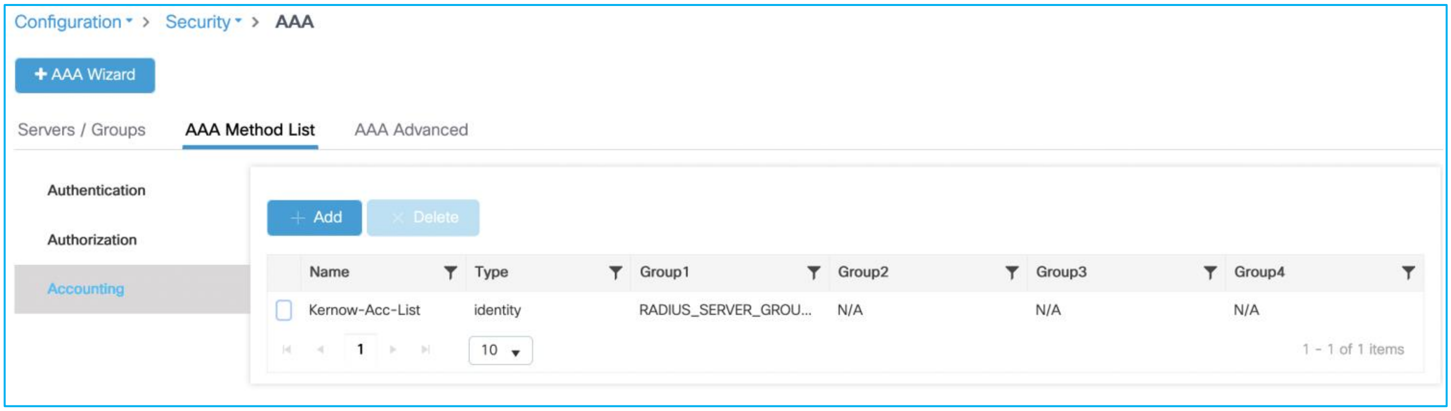
For Radius Fallback to work, please make sure the Dead Criteria and Dead Time configuration exists on the device

AAA Method List > Authentication:



	Name	Type	Group Type	Group1	Group2	Group3	Group4
□	default	login	local	N/A	N/A	N/A	N/A
□	authentication_login...	login	group	RADIUS_SERVER_G...	N/A	N/A	N/A
□	authentication_dot1x...	dot1x	group	RADIUS_SERVER_G...	N/A	N/A	N/A

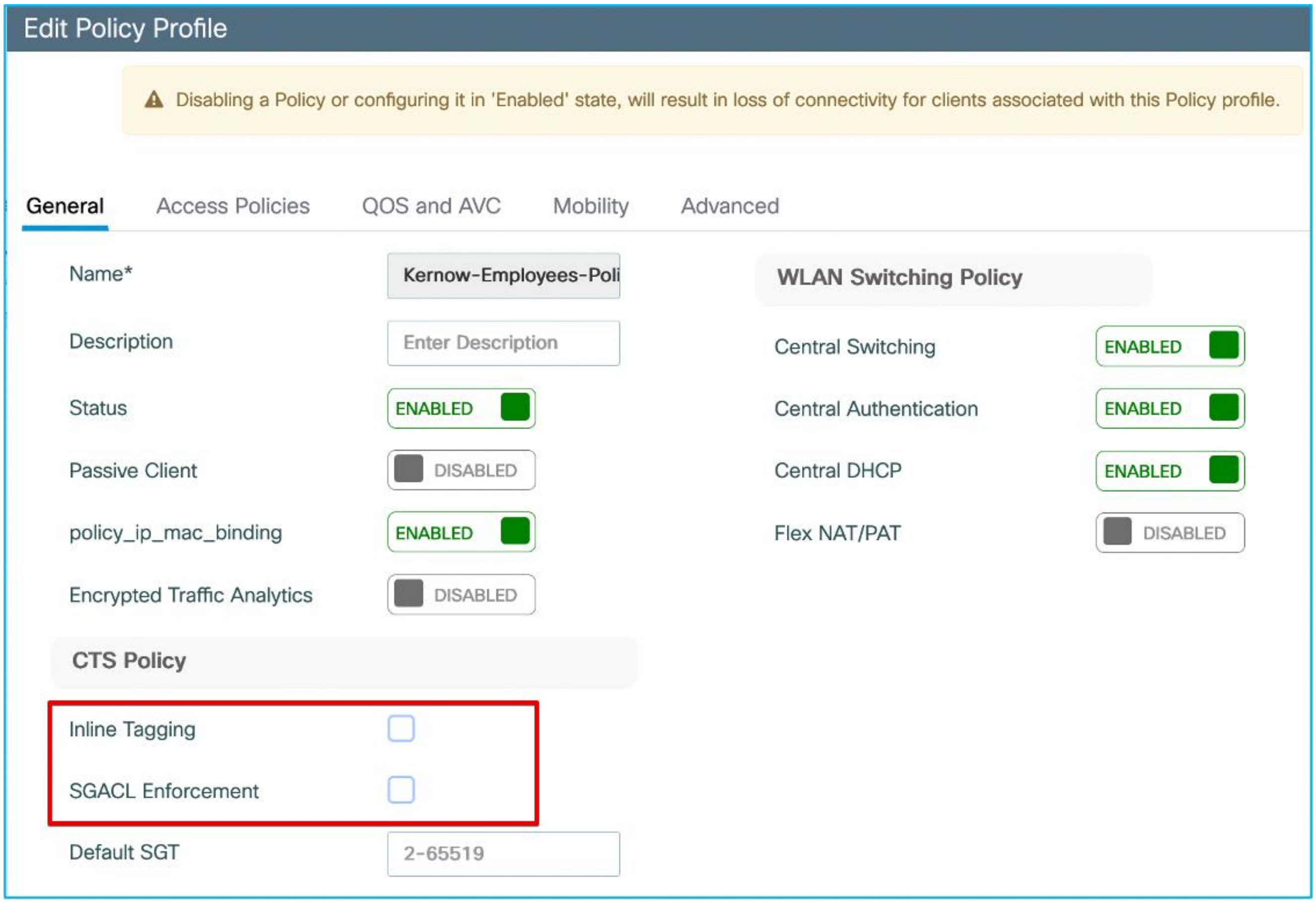
AAA Method List > Accounting:



	Name	Type	Group1	Group2	Group3	Group4
□	Kernow-Acc-List	identity	RADIUS_SERVER_GROU...	N/A	N/A	N/A

The initial stage of this guide covers the case where there is no inline tagging or SGACL enforcement set on the Policy Profiles. These options are explained and set when appropriate later in the guide.

An example policy profile General tab follows for the Employees for central switching:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*	Kernow-Employees-Poli
Description	Enter Description
Status	ENABLED
Passive Client	DISABLED
policy_ip_mac_binding	ENABLED
Encrypted Traffic Analytics	DISABLED

CTS Policy

Inline Tagging	□
SGACL Enforcement	□
Default SGT	2-65519

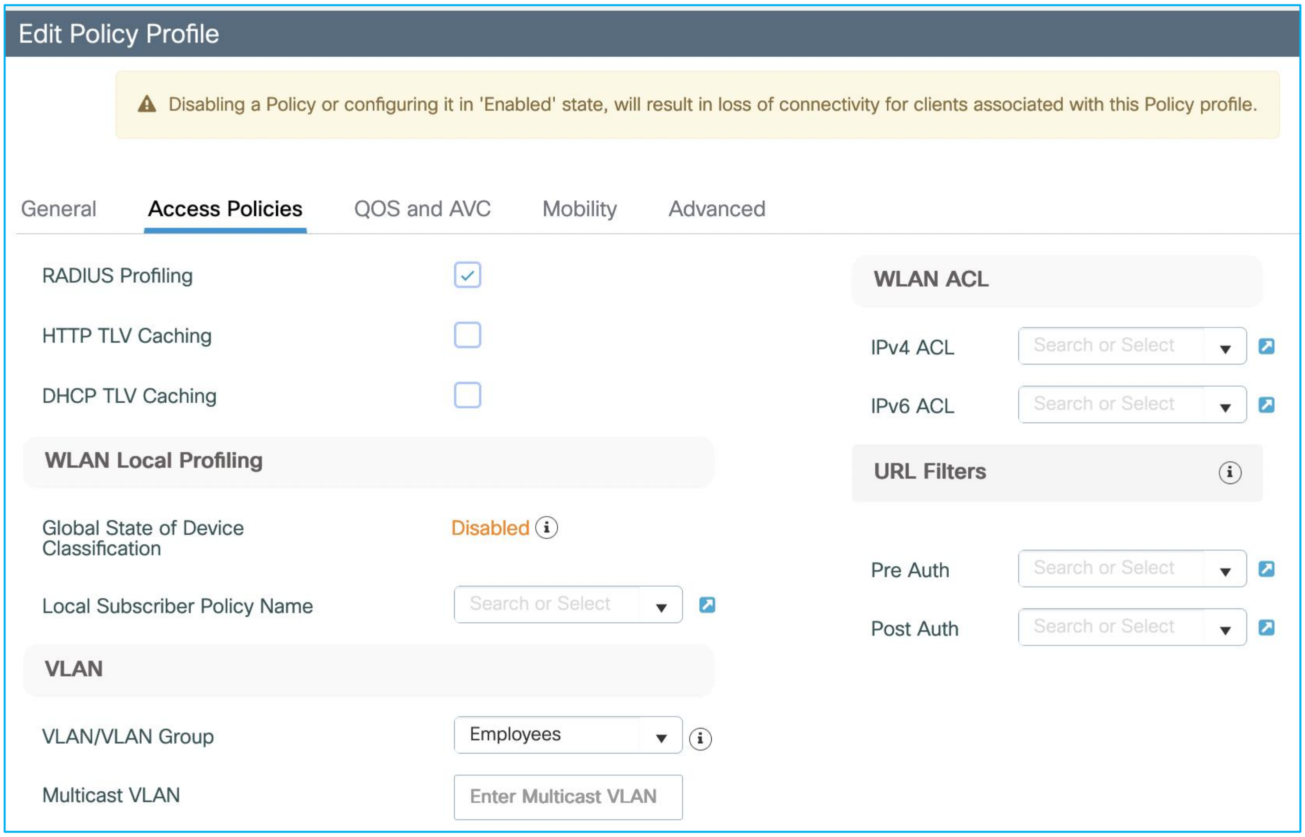
WLAN Switching Policy

Central Switching	ENABLED
Central Authentication	ENABLED
Central DHCP	ENABLED
Flex NAT/PAT	DISABLED

Note: For the equivalent policy profile for FlexConnect local switching deployment, both Central Switching and Central DHCP are disabled.

The Employees VLAN is defined within the Access Policies tab of the Employees Policy Profile, along with enabling RADIUS Profiling.

Configuration > Tags & Profiles > Policy > Employees Policy profile > Access Policies:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

RADIUS Profiling ☑

HTTP TLV Caching □

DHCP TLV Caching □

WLAN Local Profiling

Global State of Device Classification: Disabled ⓘ

Local Subscriber Policy Name: Search or Select

VLAN

VLAN/VLAN Group: Employees ⓘ

Multicast VLAN: Enter Multicast VLAN

WLAN ACL

IPv4 ACL: Search or Select

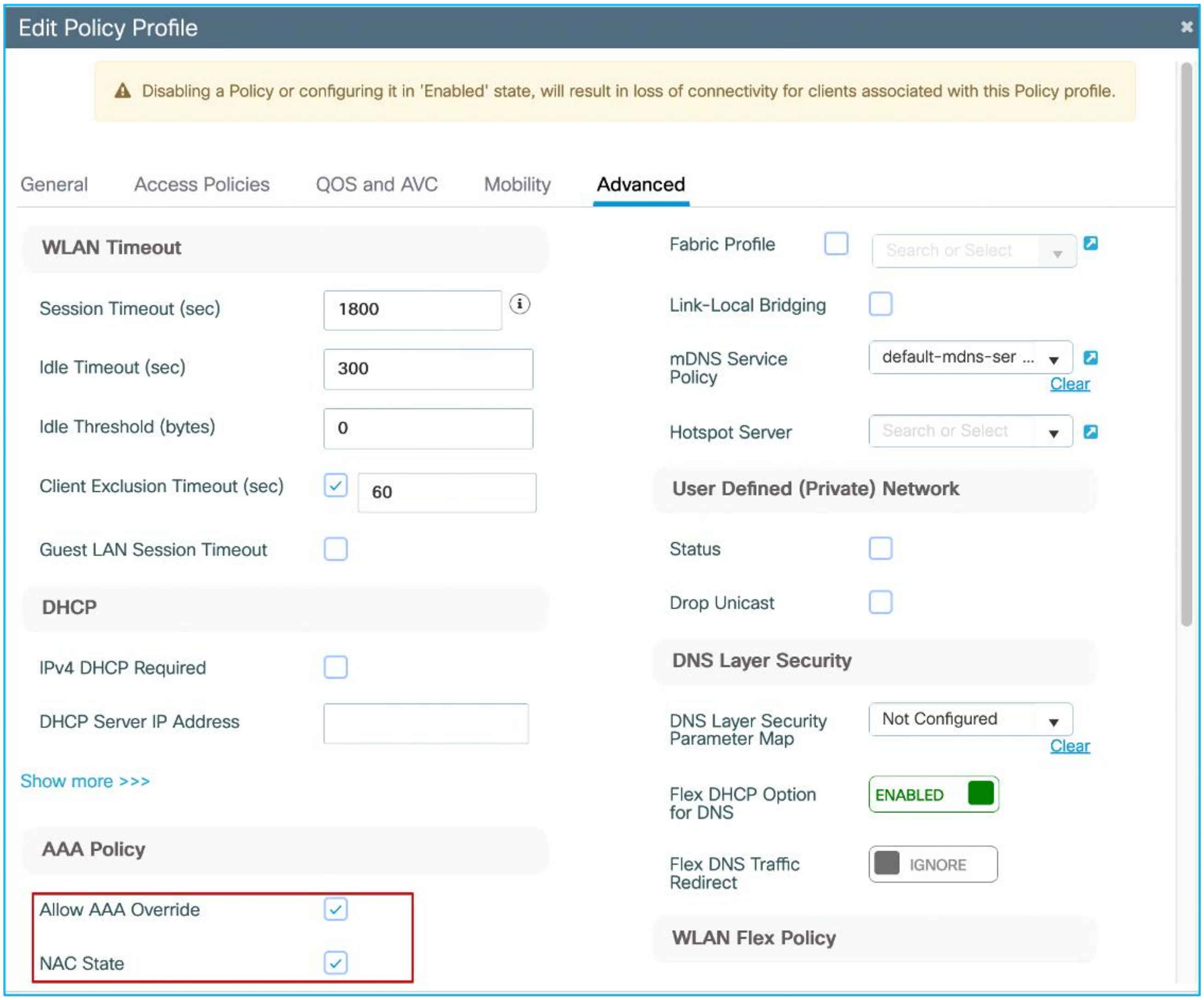
IPv6 ACL: Search or Select

URL Filters ⓘ

Pre Auth: Search or Select

Post Auth: Search or Select

Configuration > Tags & Profiles > Policy > Employees Policy profile > Advanced has AAA override and NAC state enabled, this is to successfully receive the SGT assigned by ISE in the Authorization Reply:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

WLAN Timeout

Session Timeout (sec)	1800
Idle Timeout (sec)	300
Idle Threshold (bytes)	0
Client Exclusion Timeout (sec)	☑ 60
Guest LAN Session Timeout	□

DHCP

IPv4 DHCP Required	□
DHCP Server IP Address	

Show more >>>

AAA Policy

Allow AAA Override	☑
NAC State	☑

Fabric Profile	□ Search or Select
Link-Local Bridging	□
mDNS Service Policy	default-mdns-ser ... Clear
Hotspot Server	Search or Select

User Defined (Private) Network

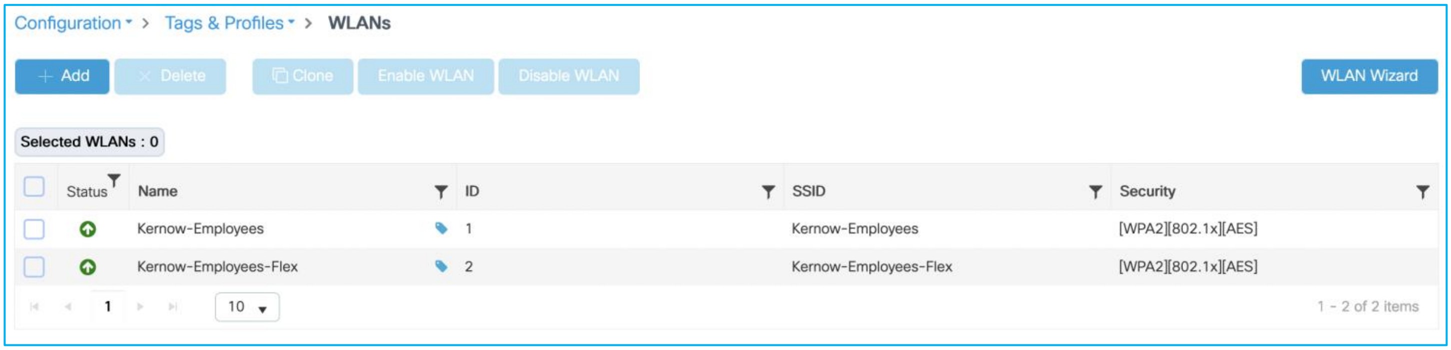
Status	□
Drop Unicast	□

DNS Layer Security

DNS Layer Security Parameter Map	Not Configured Clear
Flex DHCP Option for DNS	ENABLED
Flex DNS Traffic Redirect	IGNORE

WLAN Flex Policy

WLANs are setup and ready for Employees for use in central switching mode as well as FlexConnect local switching:



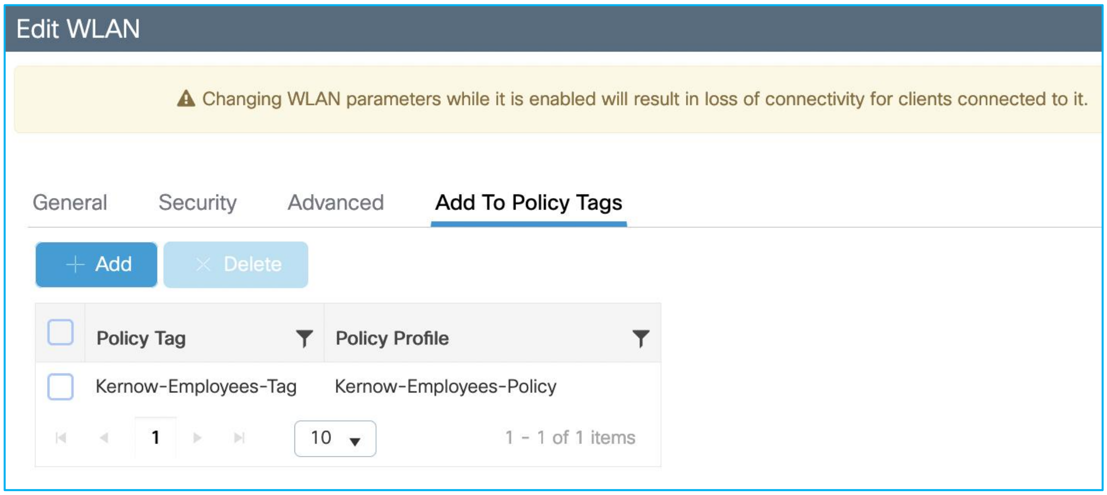
Configuration > Tags & Profiles > WLANs

Selected WLANs : 0

□	Status	Name	ID	SSID	Security
□	●	Kernow-Employees	1	Kernow-Employees	[WPA2][802.1x][AES]
□	●	Kernow-Employees-Flex	2	Kernow-Employees-Flex	[WPA2][802.1x][AES]

1 10 1 - 2 of 2 items

WLAN ‘Add to Policy Tags’ tab, links the Policy Tag with the Policy Profile:

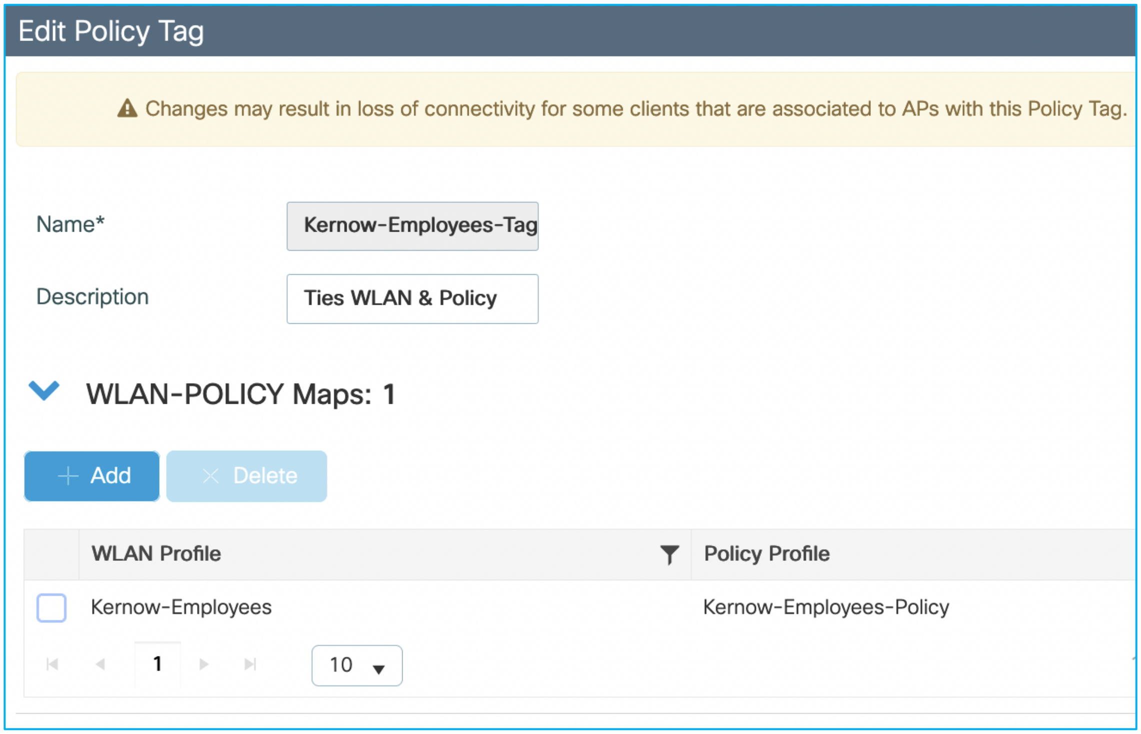


Edit WLAN

⚠ Changing WLAN parameters while it is enabled will result in loss of connectivity for clients connected to it.

□	Policy Tag	Policy Profile
□	Kernow-Employees-Tag	Kernow-Employees-Policy

Under Configuration > Tags & Profiles > Tags, Policy Tag links WLAN Profile with Policy Profile:



Edit Policy Tag

⚠ Changes may result in loss of connectivity for some clients that are associated to APs with this Policy Tag.

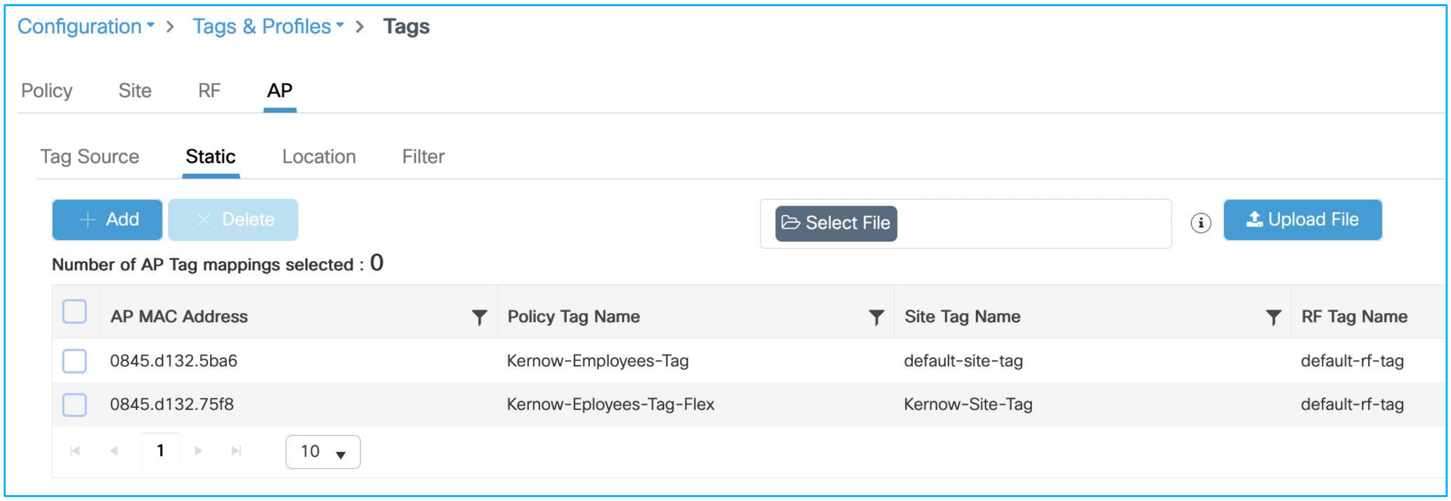
Name* Kernow-Employees-Tag

Description Ties WLAN & Policy

WLAN-POLICY Maps: 1

	WLAN Profile	Policy Profile
□	Kernow-Employees	Kernow-Employees-Policy

Under Configuration > Tags & Profiles > Tags, the APs are statically assigned to the appropriate Policy Tag (Site Tag becomes more relevant for SGT purposes in Flex mode):



Number of AP Tag mappings selected : 0

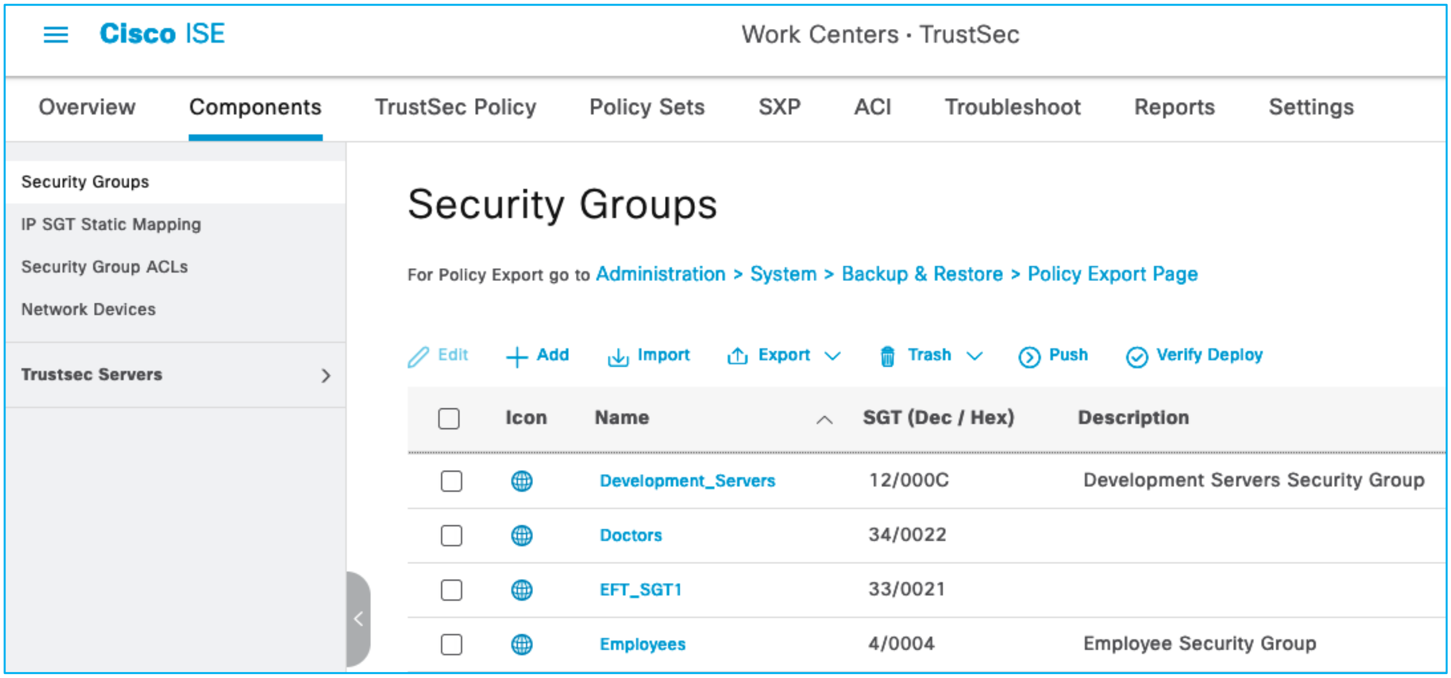
□	AP MAC Address	Policy Tag Name	Site Tag Name	RF Tag Name
□	0845.d132.5ba6	Kernow-Employees-Tag	default-site-tag	default-rf-tag
□	0845.d132.75f8	Kernow-Eployees-Tag-Flex	Kernow-Site-Tag	default-rf-tag

Note: RF tags and Site tags for central mode use the default tags, but in a live deployment these would be leveraged as per your design.

Initial ISE Setup

ISE has SGTs, SGACLs, Policies and C9800 Network Device entries already added and Authorization Rules already setup:

SGTs:

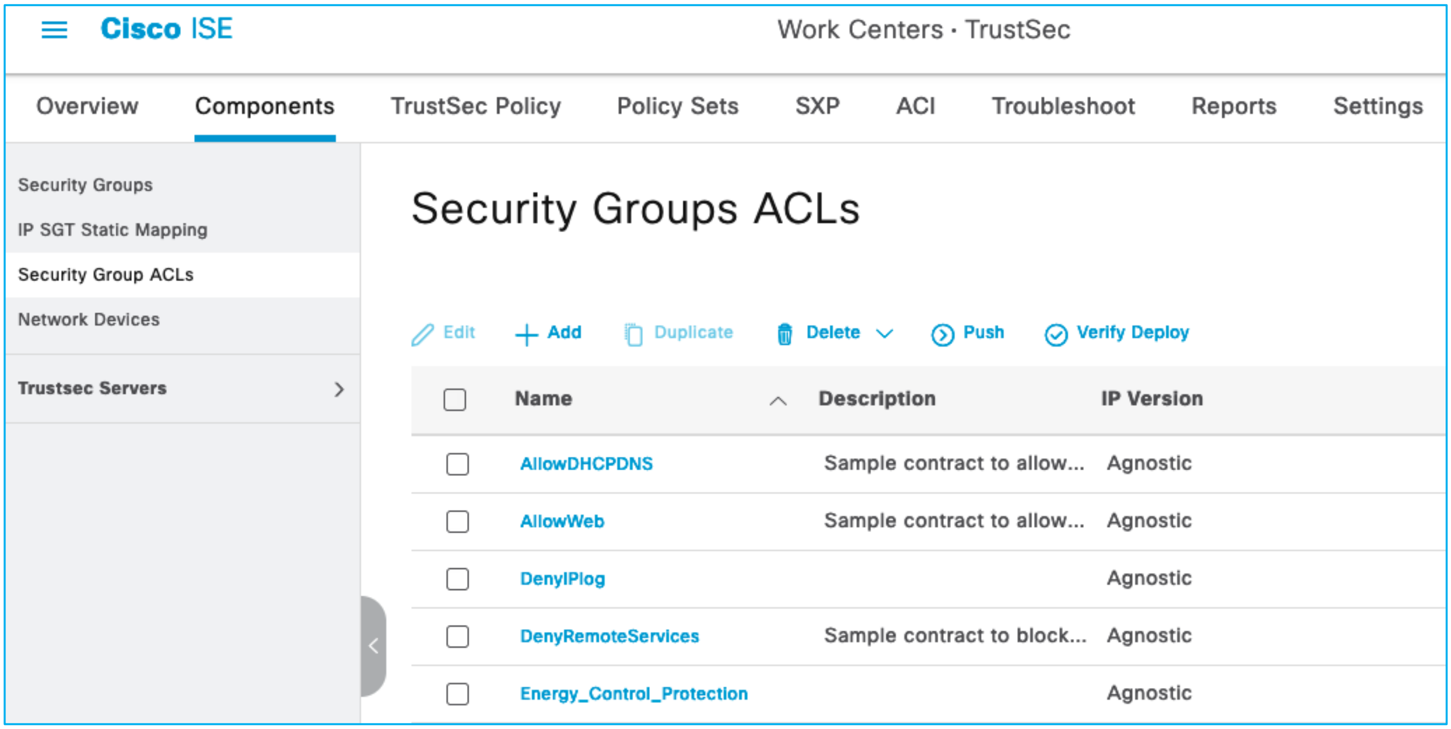


Security Groups

For Policy Export go to Administration > System > Backup & Restore > Policy Export Page

□	Icon	Name	SGT (Dec / Hex)	Description
□	🌐	Development_Servers	12/000C	Development Servers Security Group
□	🌐	Doctors	34/0022	
□	🌐	EFT_SGT1	33/0021	
□	🌐	Employees	4/0004	Employee Security Group

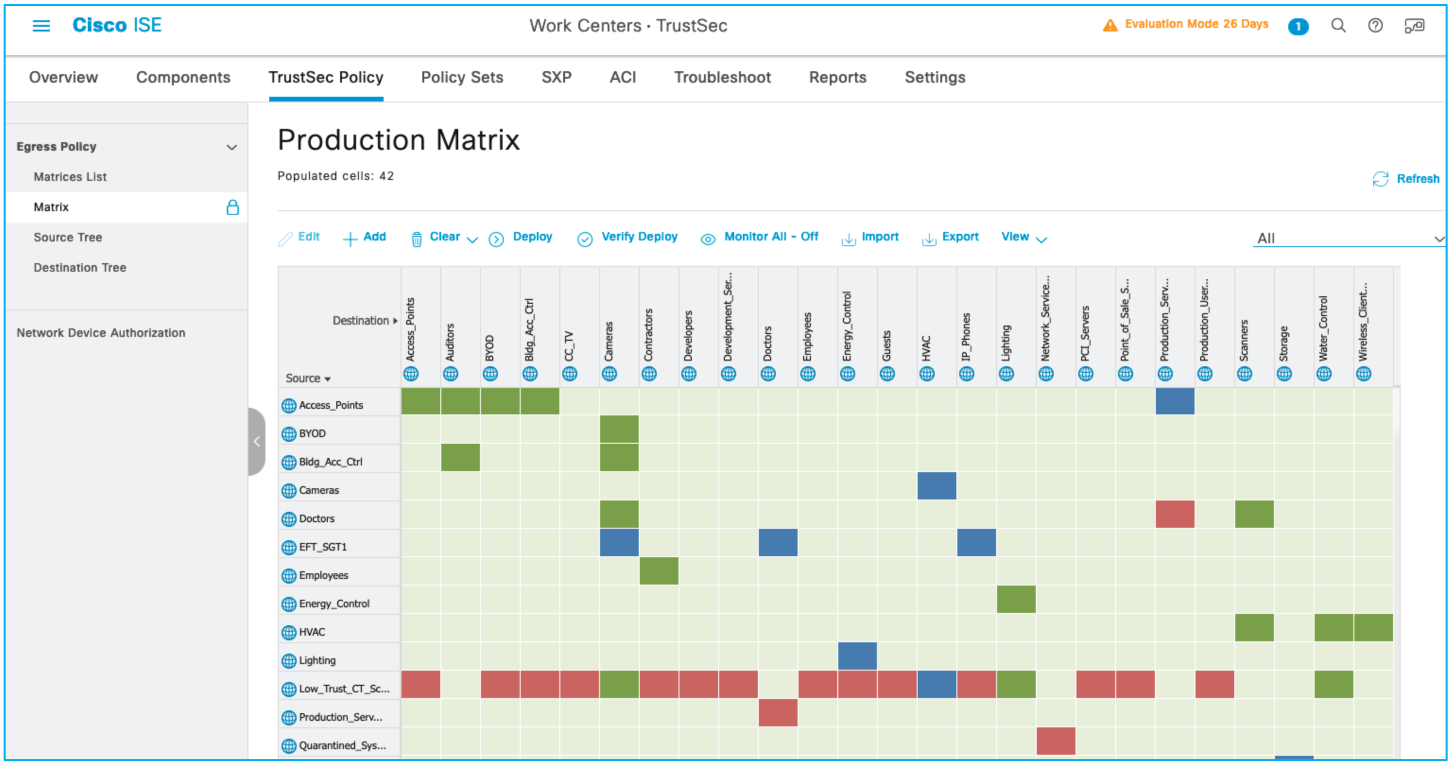
Security Group ACLs (SGACLs):



Security Groups ACLs

□	Name	Description	IP Version
□	AllowDHCPDNS	Sample contract to allow...	Agnostic
□	AllowWeb	Sample contract to allow...	Agnostic
□	DenyIPlog		Agnostic
□	DenyRemoteServices	Sample contract to block...	Agnostic
□	Energy_Control_Protection		Agnostic

Policy Matrix (some changes are implemented within the document):

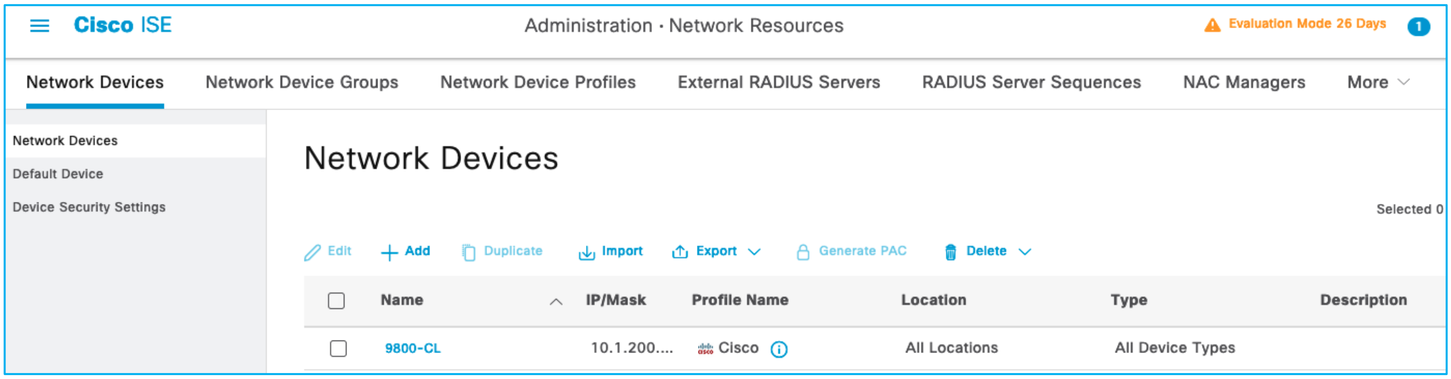


Production Matrix

Populated cells: 42

Source \ Destination	Access_Points	Auditors	BYOD	Bldg_Acc_Ctrl	CC_TV	Cameras	Contractors	Developers	Development_Ser...	Doctors	Employees	Energy_Control	Guests	HVAC	IP_Phones	Lighting	Network_Service...	PCI_Servers	Point_of_Sale_S...	Production_Serv...	Production_User...	Scanners	Storage	Water_Control	Wireless_Client...
Access_Points	🟩	🟩	🟩	🟩																🟦					
BYOD						🟩																			
Bldg_Acc_Ctrl		🟩				🟩																			
Cameras														🟦											
Doctors						🟩														🟥		🟩			
EFT_SGT1						🟦				🟦					🟦										
Employees							🟩																		
Energy_Control																🟩									
HVAC																						🟩		🟩	🟩
Lighting												🟦													
Low_Trust_CT_Sc...	🟥		🟥	🟥	🟥	🟩	🟥	🟥	🟥		🟥	🟥	🟥	🟦	🟥	🟩		🟥	🟥		🟥			🟩	
Production_Serv...										🟥															
Quarantined_Sys...																	🟥								

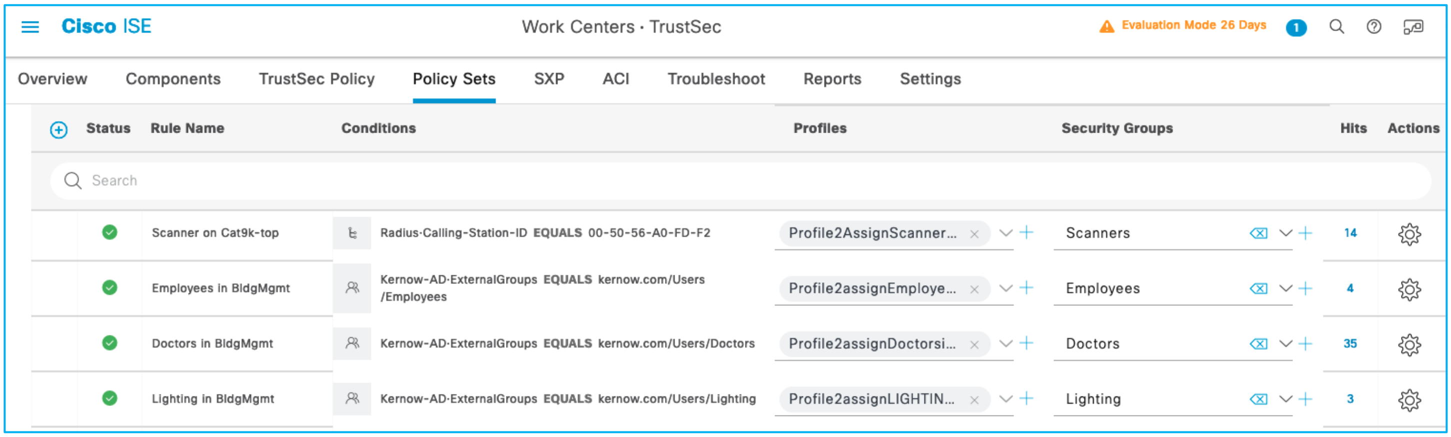
Network Devices:



Network Devices

□	Name	IP/Mask	Profile Name	Location	Type	Description
□	9800-CL	10.1.200....	Cisco	All Locations	All Device Types	

Authorization Rules:

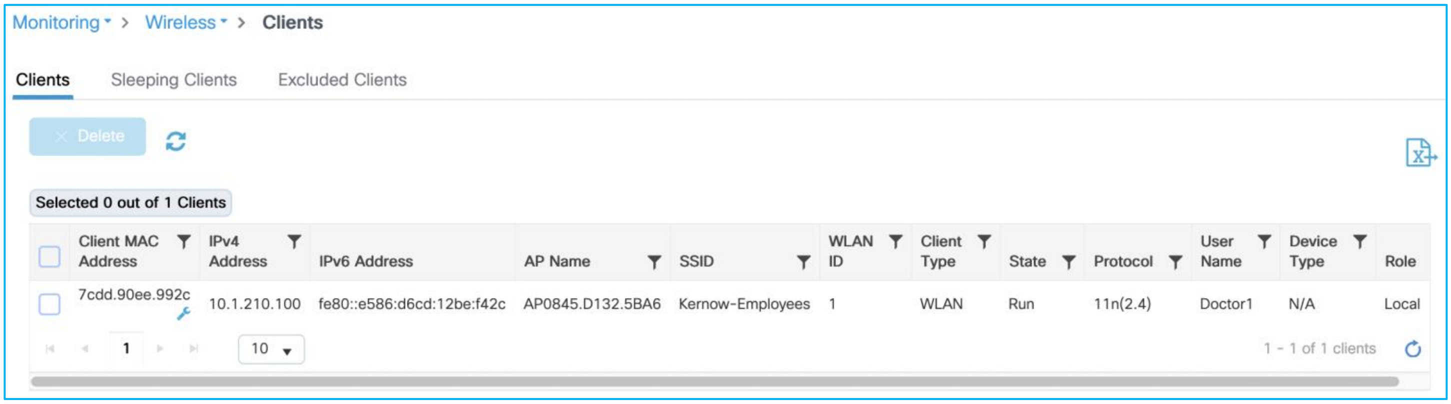


Status	Rule Name	Conditions	Profiles	Security Groups	Hits	Actions
✓	Scanner on Cat9k-top	Radius·Calling-Station-ID **EQUALS** 00-50-56-A0-FD-F2	Profile2AssignScanner...	Scanners	14	⚙
✓	Employees in BldgMgmt	Kernow-AD·ExternalGroups **EQUALS** kernow.com/Users /Employees	Profile2assignEmploye...	Employees	4	⚙
✓	Doctors in BldgMgmt	Kernow-AD·ExternalGroups **EQUALS** kernow.com/Users/Doctors	Profile2assignDoctorsi...	Doctors	35	⚙
✓	Lighting in BldgMgmt	Kernow-AD·ExternalGroups **EQUALS** kernow.com/Users/Lighting	Profile2assignLIGHTIN...	Lighting	3	⚙

Deploy

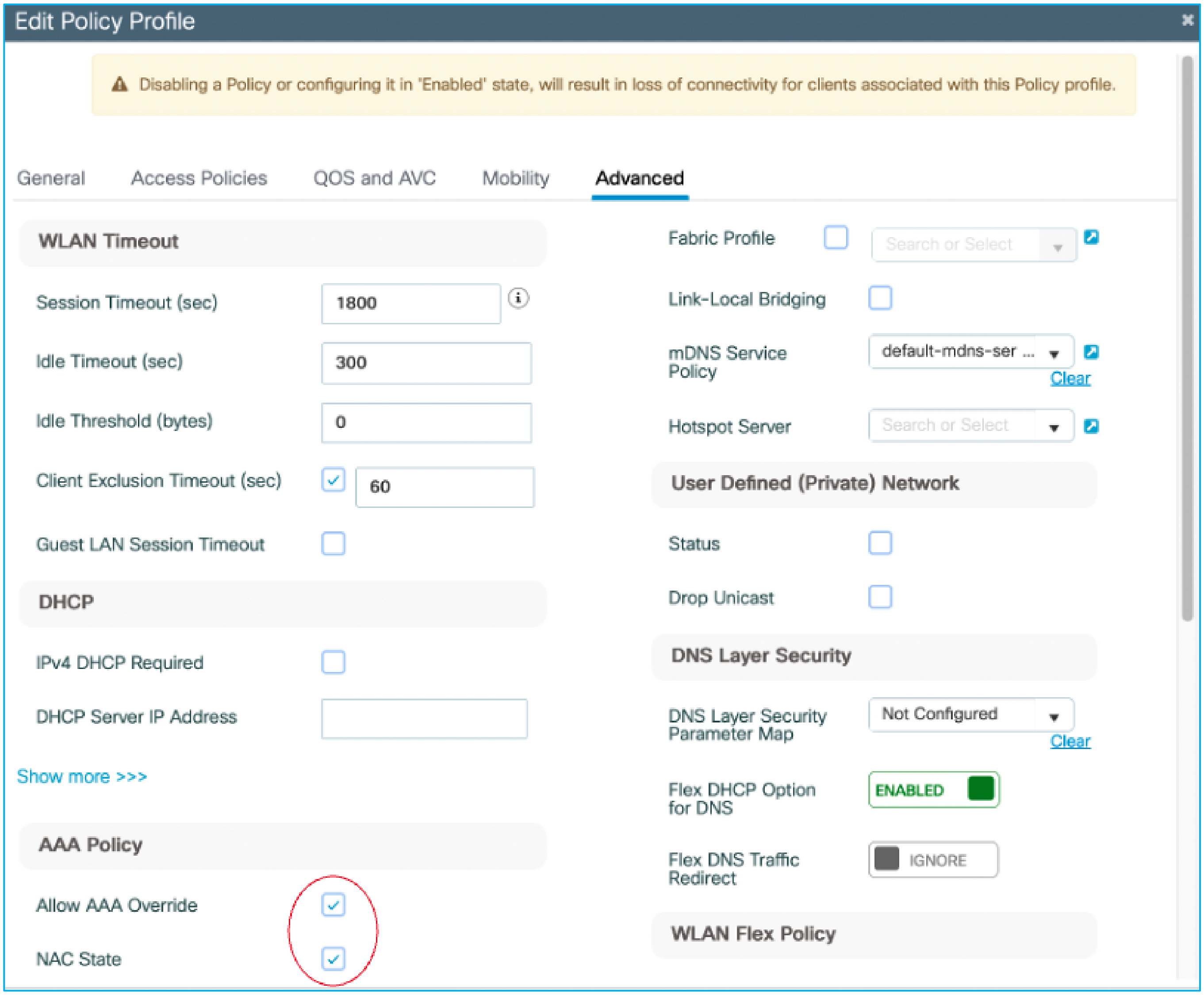
Dynamically Assigning SGT to Wireless Client from ISE (Without CTS Provisioning/C9800 Enrollment)

This use-case is to show an SGT can dynamically be assigned from ISE to a wireless client without the C9800 controller first having to go through CTS provisioning and device enrollment. This CTS provisioning and device enrollment is where the network device itself authenticates with ISE and downloads a protected access credential (PAC) and the environment-data containing the SGTs, TrustSec server list, Network Device SGT and timers. This allows the C9800 to enforce policy. So, without the C9800 controller being setup to download this TrustSec enrollment information, connect and authenticate a wireless client and assign an SGT from ISE authorization:



□	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	7cdd.90ee.992c	10.1.210.100	fe80::e586:d6cd:12be:f42c	AP0845.D132.5BA6	Kernow-Employees	1	WLAN	Run	11n(2.4)	Doctor1	N/A	Local

To ensure the C9800 controller accepts the assigned SGT from ISE within the authorization reply, enable both 'Allow AAA Override' and 'NAC State' within the used Policy Profile (Advanced Tab) on the C9800:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

WLAN Timeout

Session Timeout (sec) 1800

Idle Timeout (sec) 300

Idle Threshold (bytes) 0

Client Exclusion Timeout (sec) ☑ 60

Guest LAN Session Timeout □

DHCP

IPv4 DHCP Required □

DHCP Server IP Address

Show more >>>

AAA Policy

Allow AAA Override ☑

NAC State ☑

Fabric Profile □ Search or Select

Link-Local Bridging □

mDNS Service Policy default-mdns-ser ... Clear

Hotspot Server Search or Select

User Defined (Private) Network

Status □

Drop Unicast □

DNS Layer Security

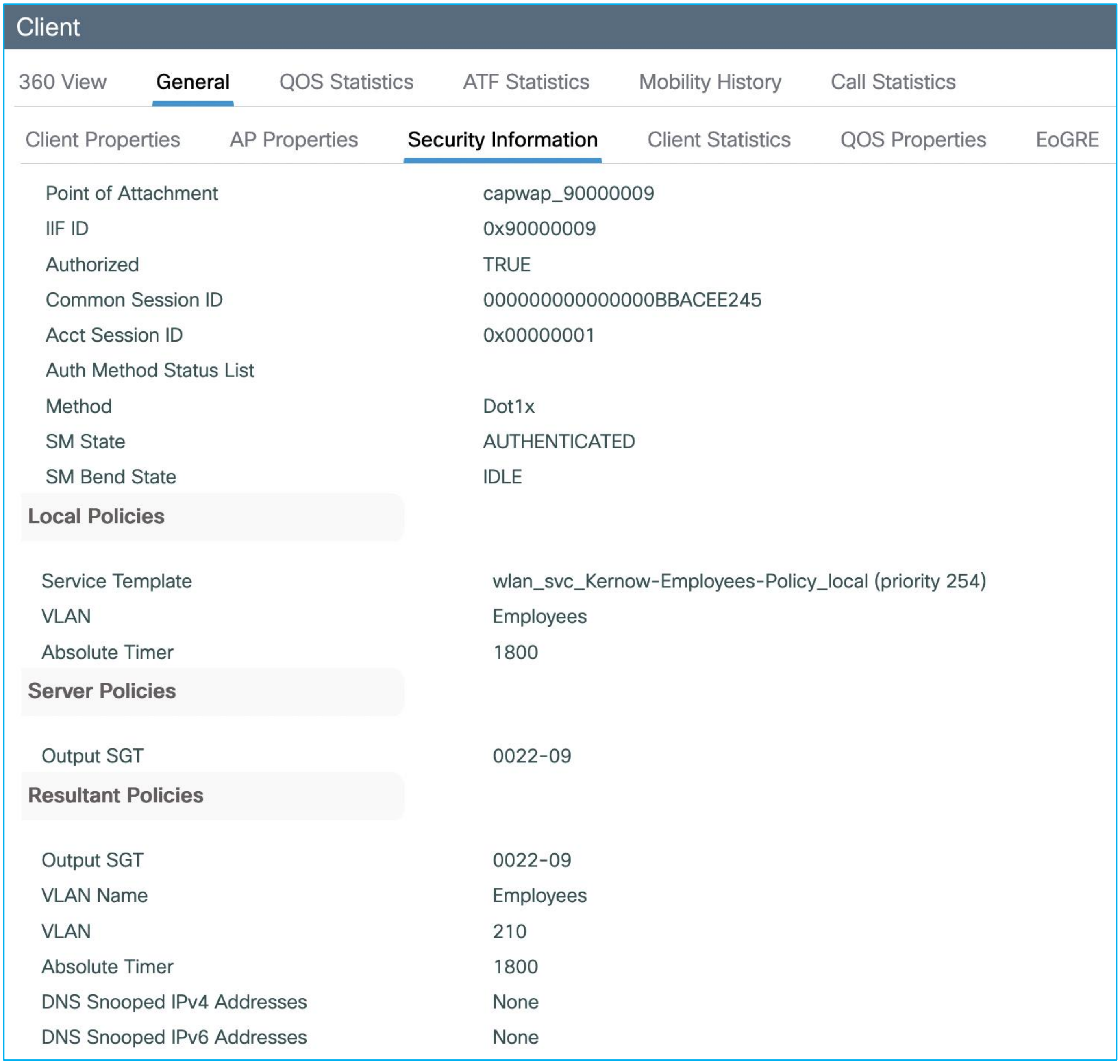
DNS Layer Security Parameter Map Not Configured Clear

Flex DHCP Option for DNS ENABLED

Flex DNS Traffic Redirect IGNORE

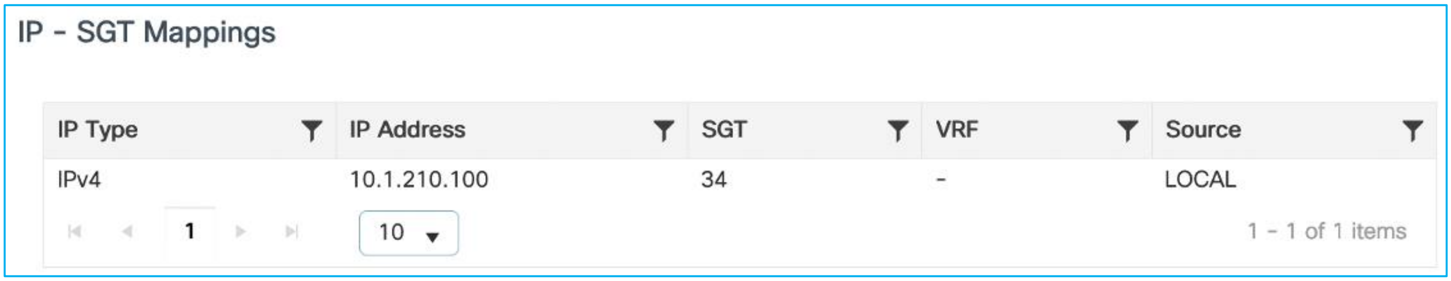
WLAN Flex Policy

The assigned SGT can be seen in the C9800 controller under Client details > General > Security Information (see 'Output SGT' in the capture below), and this example shows SGT for Doctors, number of 22 (this is HEX i.e., decimal is 34):



Point of Attachment	capwap_90000009
IIF ID	0x90000009
Authorized	TRUE
Common Session ID	000000000000000BBACEE245
Acct Session ID	0x00000001
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE
Local Policies	
Service Template	wlan_svc_Kernow-Employees-Policy_local (priority 254)
VLAN	Employees
Absolute Timer	1800
Server Policies	
Output SGT	0022-09
Resultant Policies	
Output SGT	0022-09
VLAN Name	Employees
VLAN	210
Absolute Timer	1800
DNS Snooped IPv4 Addresses	None
DNS Snooped IPv6 Addresses	None

The mapping also appears under Monitoring > General > TrustSec, where it's shown in decimal format:


IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.100	34	-	LOCAL

So, without CTS Provisioning and Network Device Enrollment, an SGT can still be assigned to wireless clients and used to classify wireless traffic. Subsequently, that classification can be sent off-platform for enforcement elsewhere.

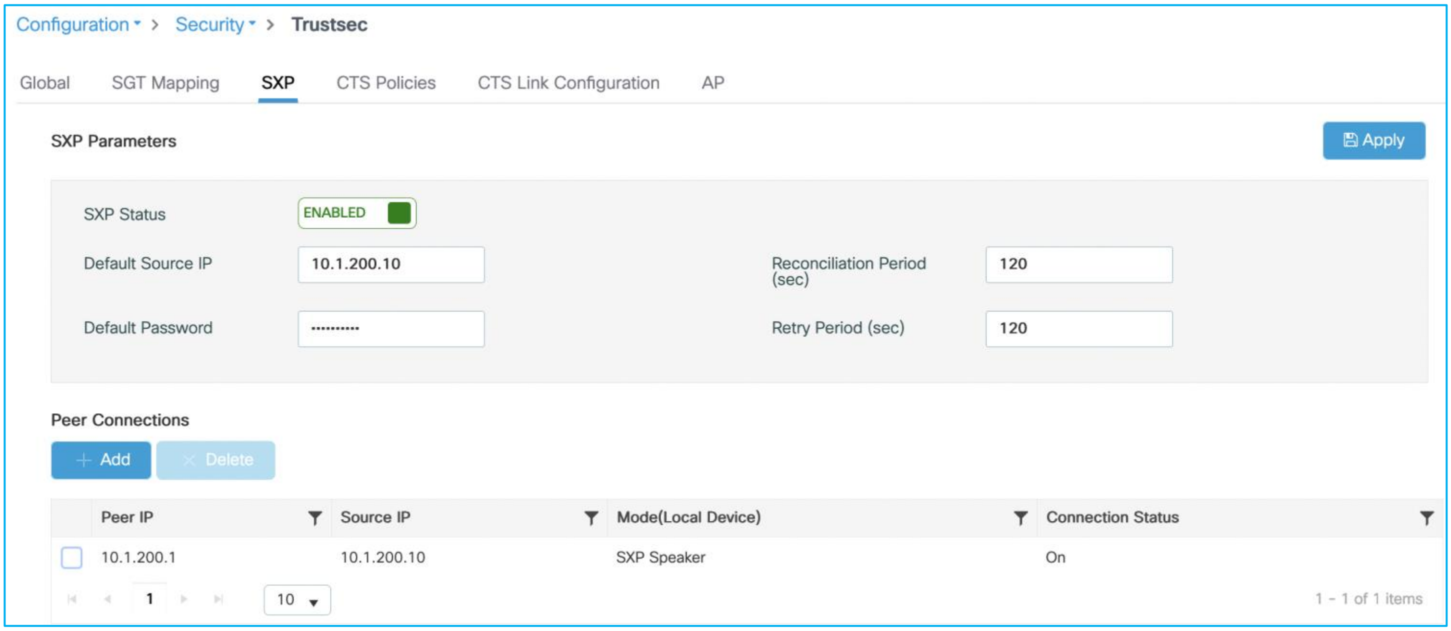
It is best practice to only configure or enable functions if needed. There is no need to enable full CTS Provisioning and Network Device Enrollment if it is not required (for example, if enforcing off-platform).

C9800 Propagating Client SGT and Enforcing Off-Platform (Without CTS Provisioning/C9800 Enrollment)

Propagating Using SXP and Enforcing Off-Platform

This use-case is to use the C9800 controller as an SXP Speaker to send wireless dynamic IP:SGT mappings off-platform for another network device (Cat9k switch in this example) to carry out traffic enforcement.

Add SXP default parameters and SXP connection on C9800 (to Cat9k) to see if we can enforce from wireless endpoint to wired on the adjacent Cat9k:



SXP Parameters

SXP Status: ENABLED

Default Source IP: 10.1.200.10

Reconciliation Period (sec): 120

Default Password: ....

Retry Period (sec): 120

Peer Connections

Peer IP	Source IP	Mode(Local Device)	Connection Status
10.1.200.1	10.1.200.10	SXP Speaker	On

1 - 1 of 1 items

Note: There is no support of IPv6 based peer SXP connections (but the IPv4 based connections do support the propagation of IPv6 SGT bindings).

Configure the Cat9k end to match:

```
Kernow-Cat9300-b#show run | inc sxp
cts sxp enable
cts sxp default source-ip 10.1.200.1
cts sxp default password <pwd>
cts sxp connection peer 10.1.200.10 password default mode local listener hold-time 0 0
```

Show the state of the SXP connection on the Cat9k to see it’s up/On:

```
Kernow-Cat9300-b#show cts sxp connections brief
SXP              : Enabled
Highest Version Supported: 5
Default Password : Set
Default Key-Chain: Not Set
Default Key-Chain Name: Not Applicable
Default Source IP: 10.1.200.1
```

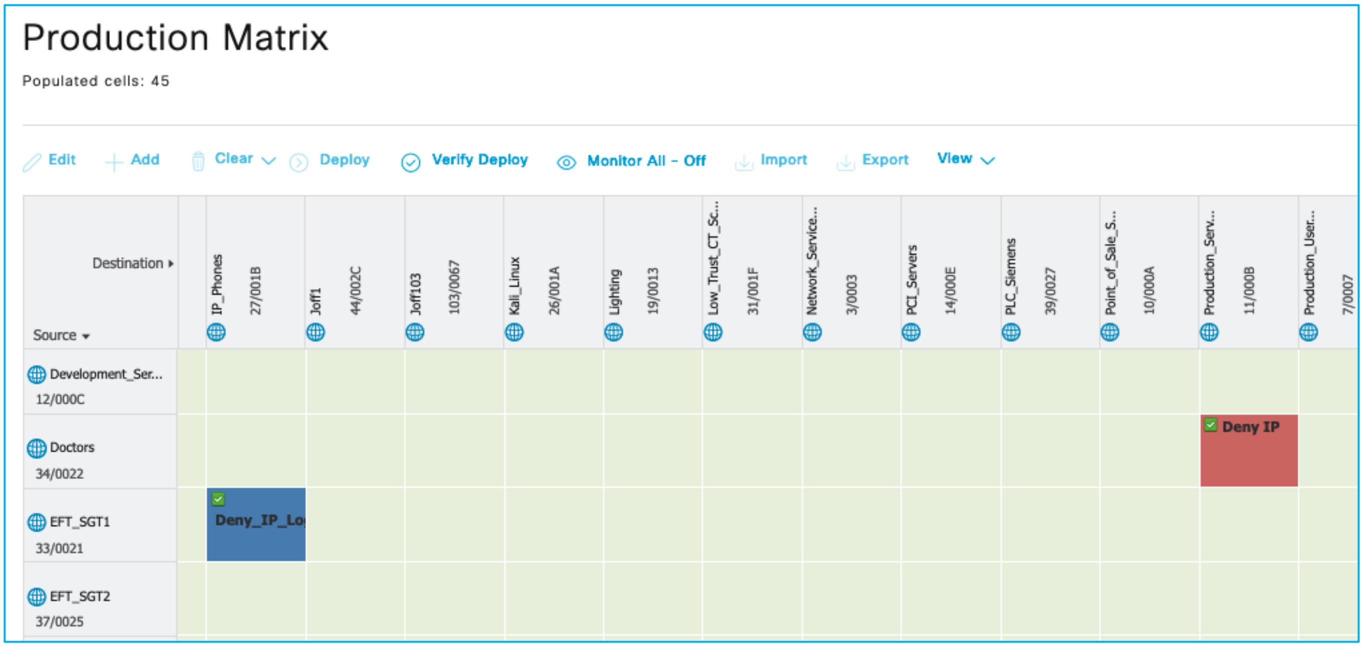
```
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
----------------------------------------------------------------------------------------
Peer_IP          Source_IP        Conn Status              Duration
----------------------------------------------------------------------------------------
10.1.200.10      10.1.200.1       On                       0:00:02:47 (dd:hr:mm:sec)
Total num of SXP Connections = 1
```

Cat9k receives the mapping from the C9800 via SXP ok. Have also added a static mapping for a DC server in the Cat9k:

cts role-based sgt-map 10.1.140.2 sgt 11 (where SGT 11 is production_servers):

```
Kernow-Cat9300-b#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
1.1.1.8                 2       INTERNAL
10.1.140.2              11      CLI                                <-Added via CLI
10.1.200.1              2       INTERNAL
10.1.210.1              2       INTERNAL
10.1.210.100            34      SXP                                <-From C9800 for wireless
client
10.1.211.1              2       INTERNAL
10.3.23.2               2       INTERNAL
10.4.25.2               2       INTERNAL
IP-SGT Active Bindings Summary
============================================
Total number of CLI      bindings = 1
Total number of SXP      bindings = 1
Total number of INTERNAL bindings = 6
Total number of active   bindings = 8
Active IPv6-SGT Bindings Information
IP Address                                  SGT     Source
================================================================
```

Added policy in ISE to deny traffic from Doctors SGT 34 to Production_Servers SGT 11:



Production Matrix

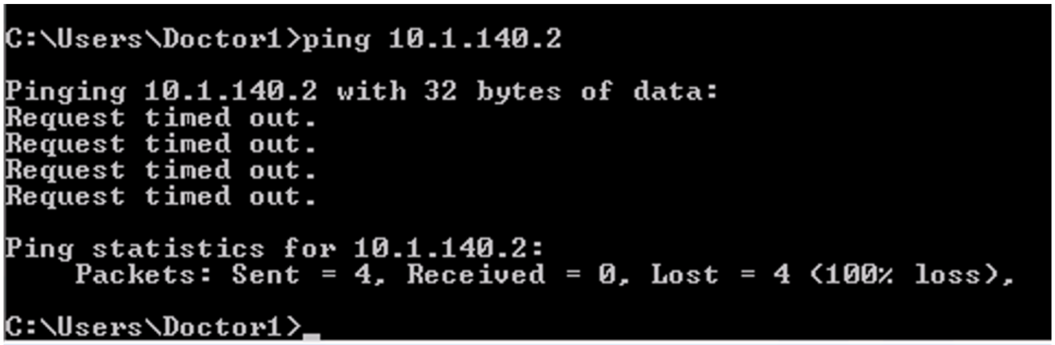
Populated cells: 45

Destination ▸ Source ▾	IP_Phones 27/001B	Joff1 44/002C	Joff103 103/0067	Kali_Linux 26/001A	Lighting 19/0013	Low_Trust_CT_Sc... 31/001F	Network_Service... 3/0003	PCI_Servers 14/000E	PLC_Siemens 39/0027	Point_of_Sale_S... 10/000A	Production_Serv... 11/000B	Production_User... 7/0007
Development_Ser... 12/000C												
Doctors 34/0022											✓ Deny IP	
EFT_SGT1 33/0021	✓ Deny_IP_Lo											
EFT_SGT2 37/0025												

The policy is retrieved by the Cat9k:

```
Kernow-Cat9300-b#show cts role-based permissions from 34
IPv4 Role-based permissions from group 34:Doctors to group 11:Production_Servers:
        Deny IP-00
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

Ping is denied from wireless client to the Production Server:



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\Doctor1>_
```

The enforcement can be seen to be carried out on the Cat9k switch:

```
Kernow-Cat9300-b#show cts role-based counters from 34
Role-based IPv4 counters
From    To      SW-Denied  HW-Denied  SW-Permitt HW-Permitt SW-Monitor HW-Monitor
34      11      0          4          0          0          0          0
```

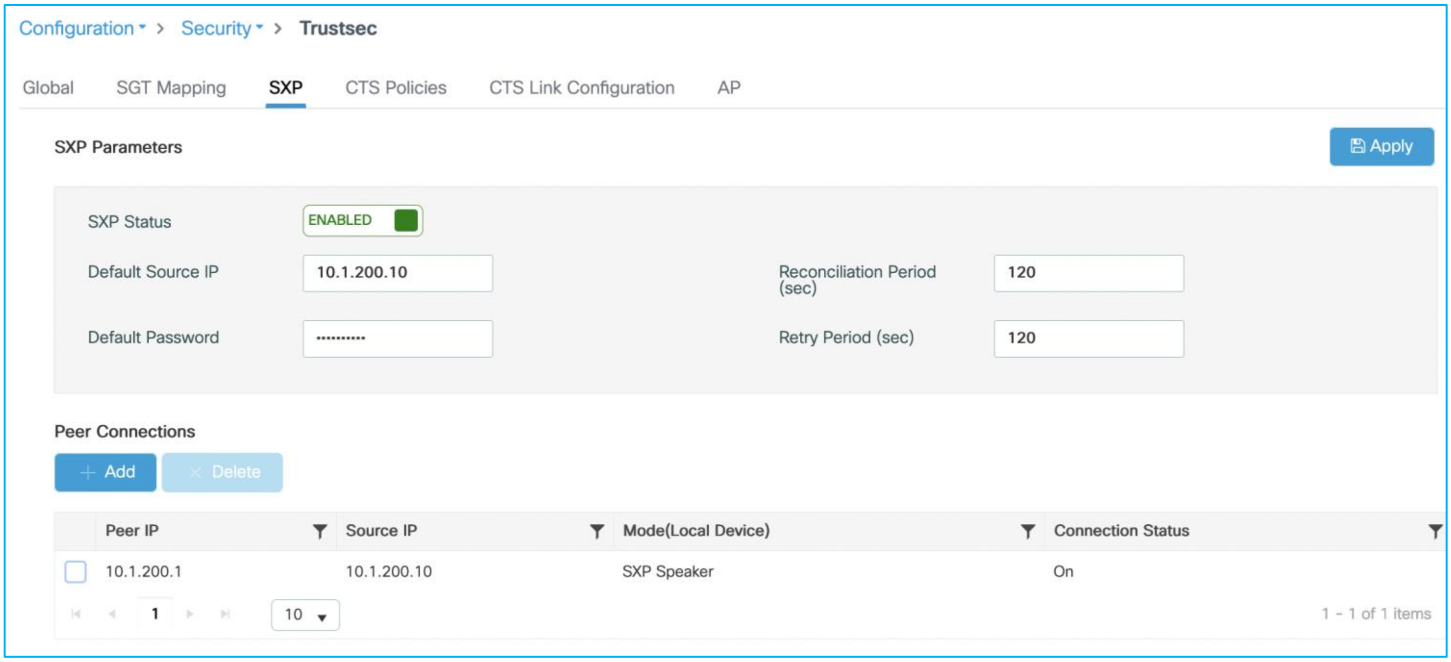
So, the C9800 propagates dynamic IP:SGT mappings via SXP to be enforced elsewhere.

A general rule-of-thumb or best practice is to use inline tagging where you can and SXP where you need to. Inline tagging operates at line rate and the SGT is handled in the data-plane without the need for extra control-plane mechanisms.

SXP Filters when Sending Off-Platform

Sometimes it may not be necessary to send all SXP mappings from the C9800 to another device. SXP filters exist to reduce the number of mappings sent, see the examples below. The SXP filters are supported only using the CLI, not the GUI/webui today.

C9800 setup with an SXP connection, sending mappings to north-bound Cat9k:



SXP Parameters

SXP Status: ENABLED

Default Source IP: 10.1.200.10

Default Password: ••••••••••

Reconciliation Period (sec): 120

Retry Period (sec): 120

Peer Connections

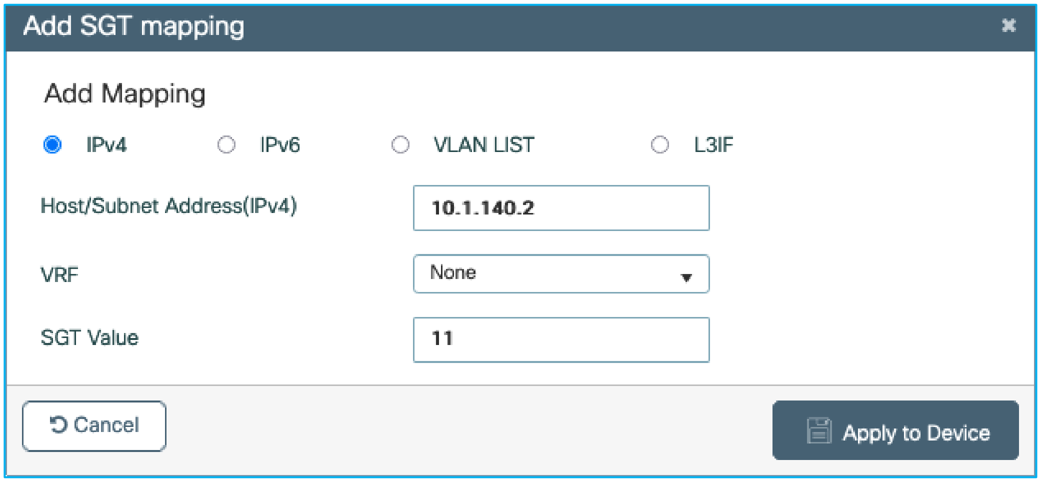
Peer IP	Source IP	Mode(Local Device)	Connection Status
10.1.200.1	10.1.200.10	SXP Speaker	On

1 - 1 of 1 items

Move the static mapping for the DC server added in the previous use-case from the Cat9k to the C9800. This is so that the Cat9k learns of this mapping via SXP from the C9800:

On the Cat9k: no cts role-based sgt-map 10.1.140.2 sgt 11 (where SGT 11 is production_servers).

On the C9800 at Configuration > Security > TrustSec > SGT Mapping, select Add and enter the following IP and SGT Value for adding an IPv4 static mapping:



Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

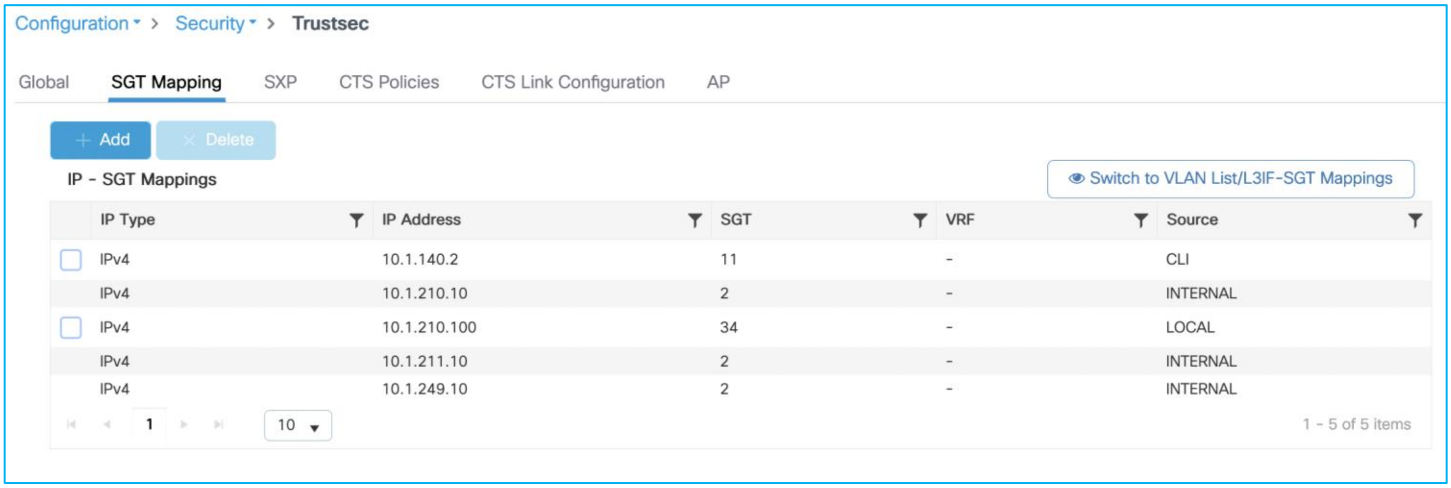
Host/Subnet Address(IPv4): 10.1.140.2

VRF: None

SGT Value: 11

Select ‘Apply to Device’.

Current IP:SGT mappings on the C9800:


Configuration ▾ > Security ▾ > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings

IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	10.1.140.2	11	-	CLI
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL
	IPv4	10.1.249.10	2	-	INTERNAL

The Cat9k is the receiving end of this SXP connection and SXP mappings:

```
Kernow-Cat9300-b#show cts sxp connections brief
 SXP              : Enabled
 Highest Version Supported: 5
 Default Password : Set
 Default Key-Chain: Not Set
 Default Key-Chain Name: Not Applicable
 Default Source IP: 1.1.1.8
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
-----------------------------------------------------------------------------------------
-------------------------------------
Peer_IP          Source_IP        Conn Status
Duration
-----------------------------------------------------------------------------------------
-------------------------------------
10.1.200.10      10.1.200.1       On
0:00:03:20 (dd:hr:mm:sec)
Total num of SXP Connections = 1
Kernow-Cat9300-b#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
1.1.1.8                 2       INTERNAL
10.1.140.2              11      SXP
10.1.200.1              2       INTERNAL
10.1.210.1              2       INTERNAL
10.1.210.10             2       SXP
```

```
10.1.210.100            34      SXP
10.1.211.1              2       INTERNAL
10.1.211.10             2       SXP
10.1.249.10             2       SXP
10.3.23.2               2       INTERNAL
10.4.25.2               2       INTERNAL
10.6.50.100             28      LOCAL
10.6.50.254             2       INTERNAL
IP-SGT Active Bindings Summary
============================================
Total number of SXP      bindings = 5
Total number of LOCAL    bindings = 1
Total number of INTERNAL bindings = 7
Total number of active   bindings = 13
Active IPv6-SGT Bindings Information
IP Address                                  SGT     Source
========================================================================
```

The following is building an SXP filter to stop sending SGT 2 (should stop sending 10.1.210.10, 10.1.211.10 and 10.1.249.10):

```
cts sxp filter-enable
!
cts sxp filter-list block-sgt2
 deny sgt 2
 permit sgt all             <-This is the default rule (otherwise denied)
!
cts sxp filter-group speaker speaker-to-Cat9k
 filter block-sgt2
 peer ipv4 10.1.200.1
```

Command to show the configuration along with filter hit counts:

```
9800-17.9.1#show cts sxp filter-group speaker detailed
Global Speaker Filter: Not configured
Filter-group: speaker-to-Cat9k
    Filter-name: block-sgt2
    Filter-rules:
        10 deny sgt 2 (0)
        20 permit sgt all (0)
    Total Matches: 0
    Default Deny Count: 0
    peer 10.1.200.1
```

On the C9800, carry out a ‘no cts sxp enable’ and then ‘cts sxp enable’ to refresh the table, result is the C9800 filter has denied 3 mappings from being sent to the Cat9k and permitted 2 mappings:

```
9800-17.9.1#show cts sxp filter-group speaker detailed
Global Speaker Filter: Not configured
Filter-group: speaker-to-Cat9k
    Filter-name: block-sgt2
    Filter-rules:
        10 deny sgt 2 (3)
        20 permit sgt all (2)
    Total Matches: 5
    Default Deny Count: 0
    peer 10.1.200.1
```

The Cat9k shows the new set of mappings i.e. only 2 mappings have been received from the C9800:

```
Kernow-Cat9300-b#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
1.1.1.8                 2       INTERNAL
10.1.140.2              11      SXP
10.1.200.1              2       INTERNAL
10.1.210.1              2       INTERNAL
10.1.210.100            34      SXP
10.1.211.1              2       INTERNAL
10.3.23.2               2       INTERNAL
10.4.25.2               2       INTERNAL
10.6.50.100             28      LOCAL
10.6.50.254             2       INTERNAL
IP-SGT Active Bindings Summary
============================================
Total number of SXP      bindings = 2
Total number of LOCAL    bindings = 1
Total number of INTERNAL bindings = 7
Total number of active   bindings = 10
Active IPv6-SGT Bindings Information
IP Address                                  SGT     Source
================================================================
```

The filter-list can include multiple entries and if a prefix plus an SGT are entered on the same entry then the operation is an OR:

```
cts sxp filter-enable
!
cts sxp filter-list block-prefix-OR-sgt
 deny ipv4 10.1.140.0/24 deny sgt 2
 permit sgt all
```

```
!
cts sxp filter-group speaker speaker-to-Cat9k
 filter block-prefix-OR-sgt
 peer ipv4 10.1.200.1
```

Taking the following mapping list on the C9800:

```
9800-17.9.1#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
10.1.140.2              11      CLI
10.1.210.10             2       INTERNAL
10.1.210.100            34      LOCAL
10.1.211.10             2       INTERNAL
10.1.249.10             2       INTERNAL
```

After the filter, the receiving Cat9k shows just the 1 entry learned from the C9800 over SXP (after blocking entries with prefix 10.1.140.0/24 OR SGT 2):

```
Kernow-Cat9300-b#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
1.1.1.8                 2       INTERNAL
10.1.200.1              2       INTERNAL
10.1.210.1              2       INTERNAL
10.1.210.100            34      SXP
10.1.211.1              2       INTERNAL
10.3.23.2               2       INTERNAL
10.4.25.2               2       INTERNAL
10.6.50.100             28      LOCAL
10.6.50.254             2       INTERNAL
```

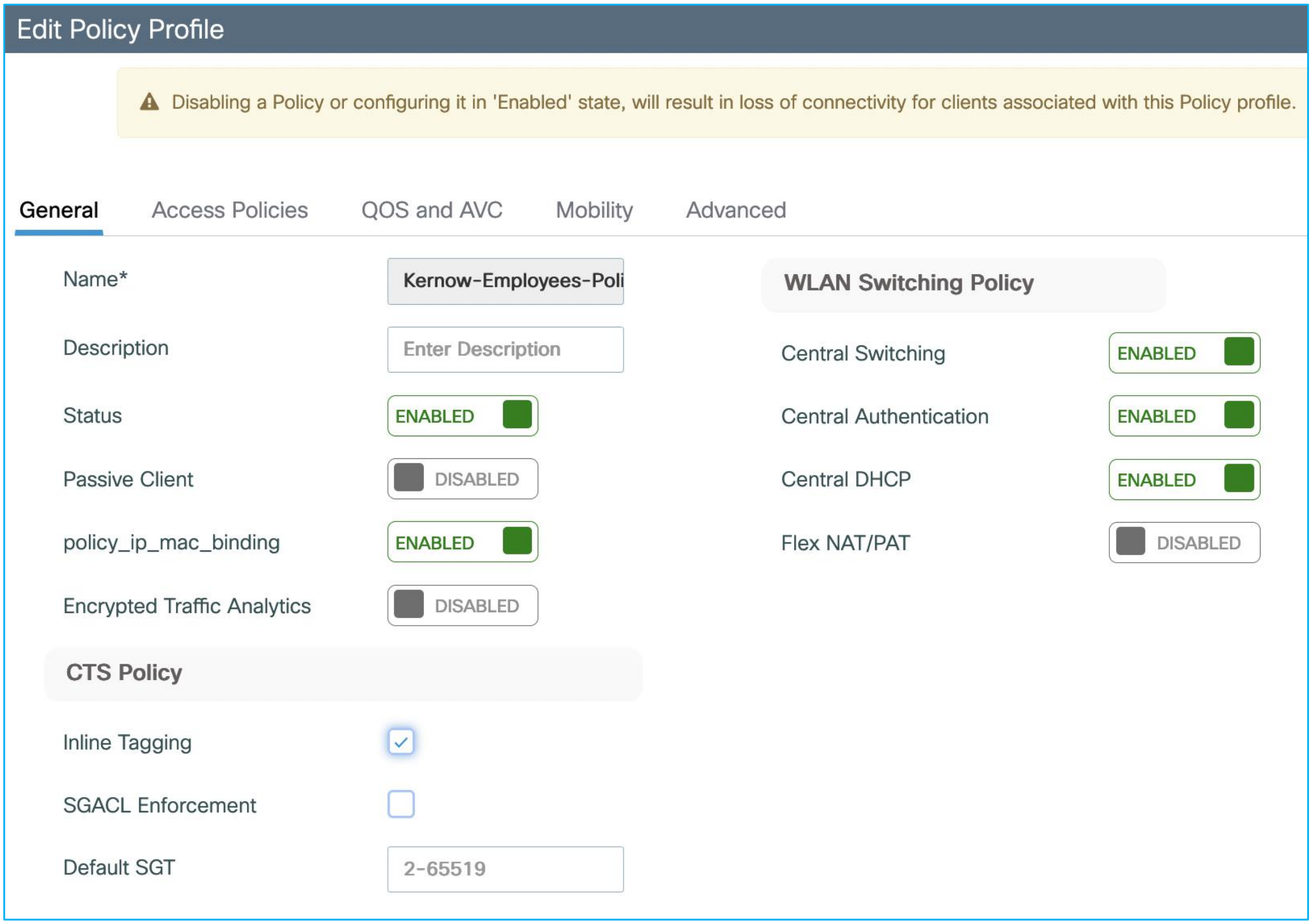
The conclusion is that SXP filtering works successfully when propagating mappings off-platform.

Propagating Using Inline Tagging (CMD) and Enforcing Off-Platform

We will show here that the client SGT can also be propagated via inline tagging for enforcement off-platform.

It would be best practice to utilize inline tagging over SXP in situations where it is supported.

Set inline tagging on C9800 first before setting it on the adjacent Cat9k interface. (We will set inline tagging on the policy profile first and prove later that this setting is in fact not used as it is the setting on the uplink which is actually used):



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name* : Kernow-Employees-Poli

Description : Enter Description

Status : ENABLED

Passive Client : DISABLED

policy_ip_mac_binding : ENABLED

Encrypted Traffic Analytics : DISABLED

CTS Policy

Inline Tagging : ☑

SGACL Enforcement : □

Default SGT : 2-65519

WLAN Switching Policy

Central Switching : ENABLED

Central Authentication : ENABLED

Central DHCP : ENABLED

Flex NAT/PAT : DISABLED

Inline tagging is enabled on the policy profile (seen via CLI) but not currently on the uplink G2:

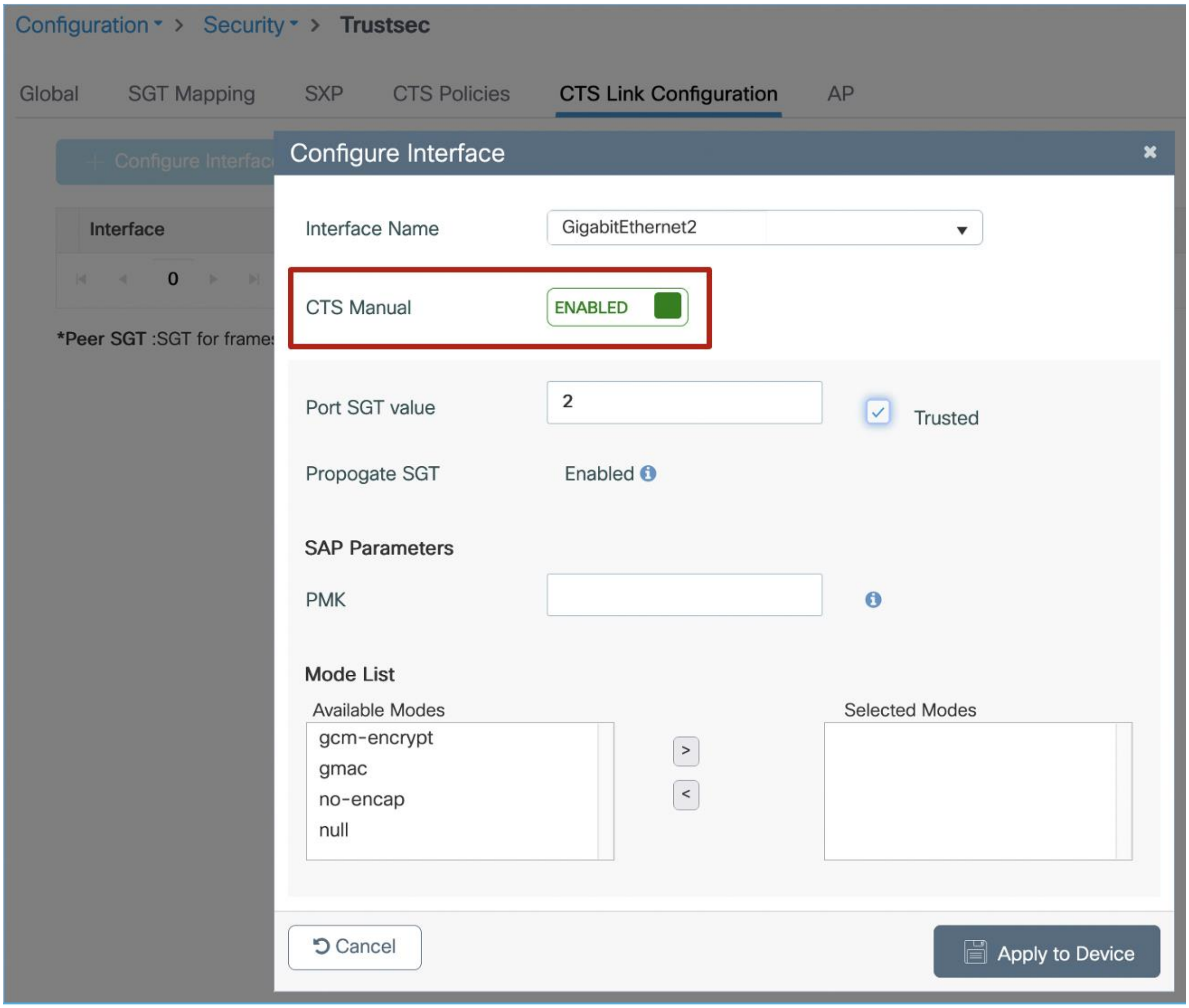
```
wireless profile policy Kernow-Employees-Policy
aaa-override
accounting-list Kernow-Acc-List
cts inline-tagging
nac
radius-profiling
vlan Employees
no shutdown
!
interface GigabitEthernet2
switchport trunk allowed vlan 200,210,211
switchport mode trunk
switchport nonegotiate
negotiation auto
no mop enabled
no mop sysid
```

```
end
```

Using monitor capture on the receiving Cat9k interface, we can see there is no CMD sent by the C9800:

```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:e3:f1
(04:6c:9d:1f:e3:f1)
    Destination: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        Address: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210          <-Cisco MetaData with SGT would be shown here
    Type: IPv4 (0x0800)
```

So, we have to enable CMD on the uplink interface (GigabitEthernet 2 in this example), under Configuration > Security > TrustSec > CTS Link Configuration:



Interface Name: GigabitEthernet2

CTS Manual: ENABLED

Port SGT value: 2 ☑ Trusted

Propogate SGT: Enabled

SAP Parameters

PMK:

Mode List

Available Modes: gcm-encrypt, gmac, no-encap, null

Selected Modes:

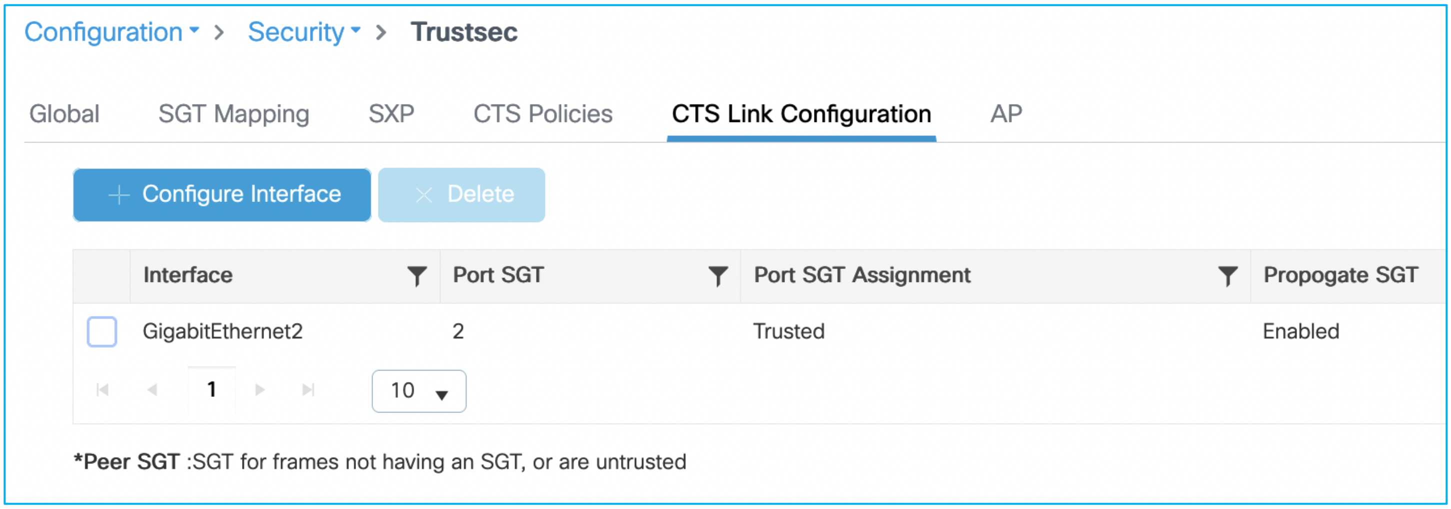
Note: It is best practice to assign TrustSec_Devices SGT 2 to network devices. Initial ISE configuration comes with TrustSec_Devices SGT 2 pre-added and assigned in the default rule of the Network Device Authorization table under Work Centers > TrustSec > TrustSec Policy > Network Device Authorization.

Note: SGT 2 within the 'Port SGT value' within the screen capture above, will be used in conjunction with the Trusted option as follows.

Note: If Trusted is not selected, then under the 'cts manual' configuration will be seen 'policy static sgt 2'. In this case, all traffic being received by the C9800 controller on this interface will not be trusted and will be classified with SGT 2.

Note: If Trusted is selected, then under the 'cts manual' configuration will be seen 'policy static sgt 2 trusted'. In this case, if there is no SGT in the CMD field being received, then classify the receiving traffic with SGT 2. In the case where the uplink is connected to a Cat9k, the Cat9k will always either send the assigned SGT of that traffic, or SGT 0/Unknown, both of which will be trusted by the C9800 controller. In this scenario, you will never see SGT 2 being assigned.

Once applied:



	Interface	Port SGT	Port SGT Assignment	Propogate SGT
□	GigabitEthernet2	2	Trusted	Enabled

***Peer SGT** :SGT for frames not having an SGT, or are untrusted

When applied, the inline tagging configuration can be seen to be implemented by checking CLI:

```
interface GigabitEthernet2
switchport trunk allowed vlan 200,210,211
switchport mode trunk
switchport nonegotiate
negotiation auto
cts manual
  policy static sgt 2 trusted
no mop enabled
no mop sysid
end
```

Now, manually set inline tagging on the Cat9k end of the link (shut / no shut is not required for a Cat9k):

```
interface GigabitEthernet1/0/15
switchport trunk allowed vlan 200,210,211
switchport mode trunk
switchport nonegotiate
cts manual
  policy static sgt 2 trusted
ip dhcp snooping trust
end
```

Using ‘monitor capture’ on the Cat9k G1/0/15 interface, it can be seen that SGT 34 is seen entering the Cat9k from the C9800 for traffic from the wireless client:

```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:e3:f1
(04:6c:9d:1f:e3:f1)
    Destination: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        Address: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
```

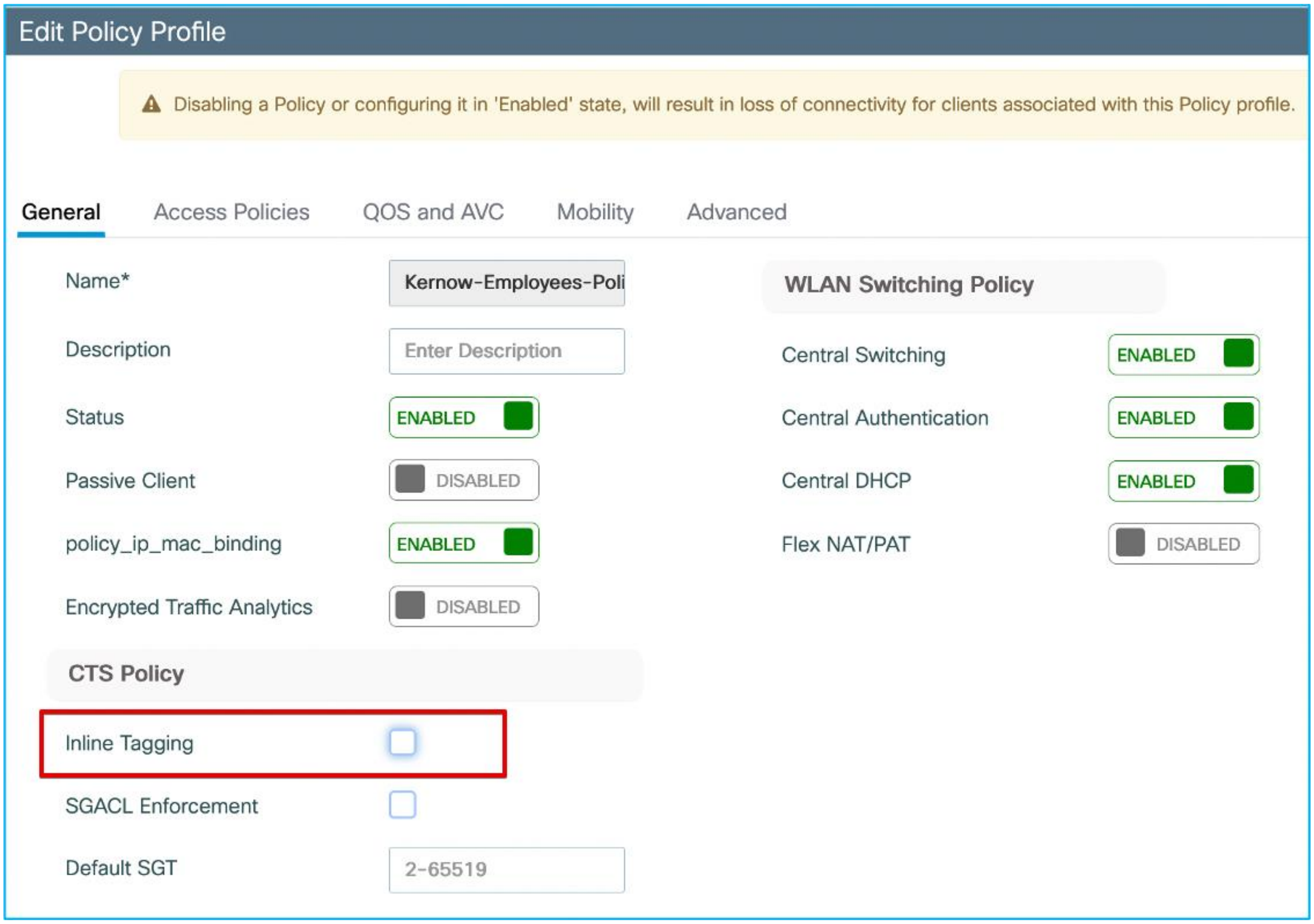
```
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 34
    Type: IPv4 (0x0800)
```

And this is enforced on the Cat9k:

```
Kernow-Cat9300-b#show cts role-based permissions from 34
IPv4 Role-based permissions from group 34:Doctors to group 11:Production_Servers:
        Deny IP-00
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
Kernow-Cat9300-b#show cts role-based counters from 34
Role-based IPv4 counters
From    To      SW-Denied  HW-Denied  SW-Permitt HW-Permitt SW-Monitor HW-Monitor
34      11      0          8          0          0          0          0
```

Note: When using ‘monitor capture’ on the C9k platforms to investigate inline tagging, the SGT is inserted on the wire after the monitor samples the traffic. This means that the inserted SGT will not be shown for traffic egressing the platform. It is best practice to use ‘monitor capture’ on the receiving device in order to see the SGT which was propagated on the wire.

Now, what happens if inline tagging is disabled from the policy profile?



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name* Kernow-Employees-Poli

Description Enter Description

Status ENABLED

Passive Client DISABLED

policy_ip_mac_binding ENABLED

Encrypted Traffic Analytics DISABLED

CTS Policy

Inline Tagging □

SGACL Enforcement □

Default SGT 2-65519

WLAN Switching Policy

Central Switching ENABLED

Central Authentication ENABLED

Central DHCP ENABLED

Flex NAT/PAT DISABLED

Inline is removed from the policy profile, as expected:

```
wireless profile policy Kernow-Employees-Policy

aaa-override

accounting-list Kernow-Acc-List

nac

radius-profiling

vlan Employees

no shutdown
```

But the client SGT is still propagated via inline tagging (CMD) to the Cat9k:

```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:e3:f1
(04:6c:9d:1f:e3:f1)

    Destination: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)

        Address: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)

        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)

        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)

    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)

        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)

        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)

        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 34
    Type: IPv4 (0x0800)
```

And it's still being enforced on the Cat9k:

```
Kernow-Cat9300-b#sh cts role counters from 34
Role-based IPv4 counters
From    To      SW-Denied  HW-Denied  SW-Permitt HW-Permitt SW-Monitor HW-Monitor
34      11      0          12         0          0          0          0
```

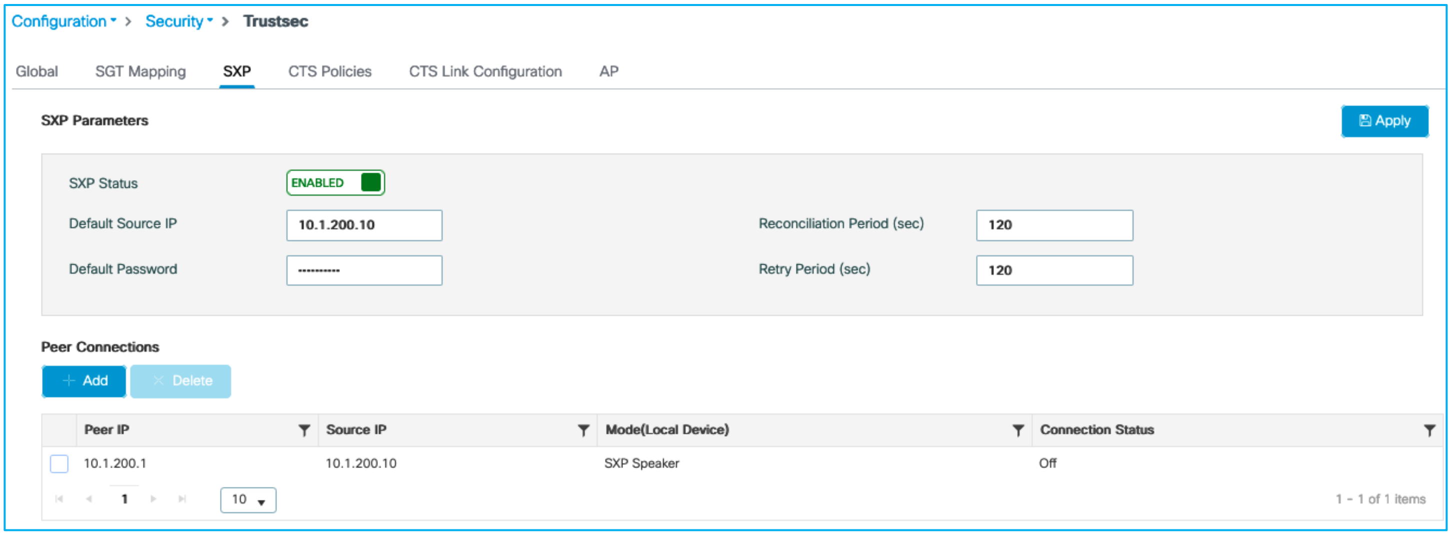
The setting of inline tagging on the policy profile is currently not used for this use-case, the SGT is propagated if set on the uplink interface. The use of the inline tagging setting on the policy profile will be introduced in a future release.

C9800 Static IP:SGT sent via SXP and Enforcing Off-Platform

If no SGT is dynamically assigned by ISE to a wireless client, statically assign an SGT to the IP of a client and propagate it via SXP to another platform for enforcement.

Remove inline tagging from C9800 to Cat9k in case that interferes with the results. Remove 'cts manual' config from Cat9k interface G1/0/15 and remove inline tagging from C9800 G2.

Check SXP default parameters and SXP connection from C9800 to Cat9k. On C9800, navigate to Configuration > Security > TrustSec > SXP:



SXP Parameters

SXP Status	ENABLED		
Default Source IP	10.1.200.10	Reconciliation Period (sec)	120
Default Password	··········	Retry Period (sec)	120

Peer Connections

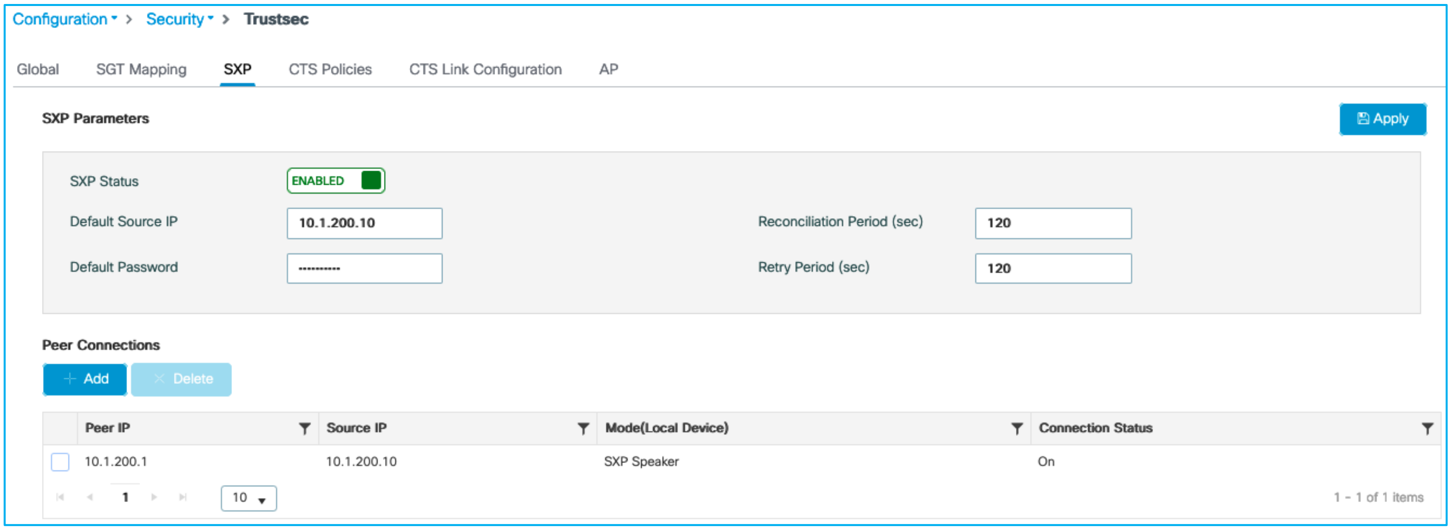
	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	10.1.200.1	10.1.200.10	SXP Speaker	Off

1   10   1 - 1 of 1 items

Connection of 'Off' as seen above, so check and re-enable SXP on the Cat9k peer:

```
Kernow-Cat9300-b#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Kernow-Cat9300-b(config)#cts sxp enable
Kernow-Cat9300-b(config)#cts sxp default source-ip 10.1.200.1
Kernow-Cat9300-b(config)#cts sxp default password xxx
Kernow-Cat9300-b(config)#cts sxp connection peer 10.1.200.10 password default mode local
listener
Kernow-Cat9300-b#show cts sxp connections brief
 SXP              : Enabled
 Highest Version Supported: 5
 Default Password : Set
 Default Key-Chain: Not Set
 Default Key-Chain Name: Not Applicable
 Default Source IP: 10.1.200.1
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
----------------------------------------------------------------------------------------
Peer_IP          Source_IP        Conn Status                  Duration
----------------------------------------------------------------------------------------
10.1.200.10      10.1.200.1       On                           0:00:00:59 (dd:hr:mm:sec)
Total num of SXP Connections = 1
```

C9800 now shows SXP connection as On:



SXP Parameters

SXP Status: ENABLED

Default Source IP: 10.1.200.10

Default Password: ----------

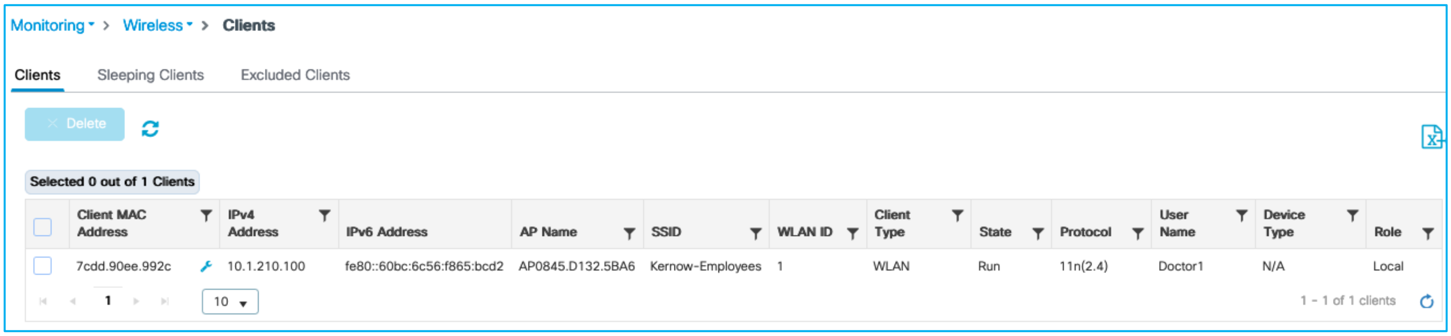
Reconciliation Period (sec): 120

Retry Period (sec): 120

Peer Connections

	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	10.1.200.1	10.1.200.10	SXP Speaker	On

Connect wireless client and do not assign an SGT from ISE:



Monitoring > Wireless > **Clients**

Clients | Sleeping Clients | Excluded Clients

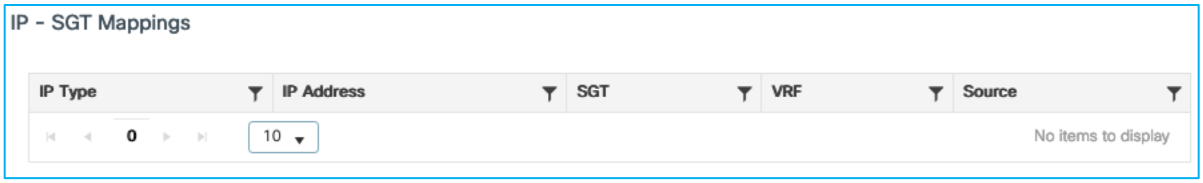
Delete

Selected 0 out of 1 Clients

	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	7cdd.90ee.992c	10.1.210.100	fe80::60bc:6c56:f865:bcd2	AP0845.D132.5BA6	Kernow-Employees	1	WLAN	Run	11n(2.4)	Doctor1	N/A	Local

1 | 10 | 1 - 1 of 1 clients

No dynamic IP:SGT mapping exists (Monitoring > General > TrustSec):

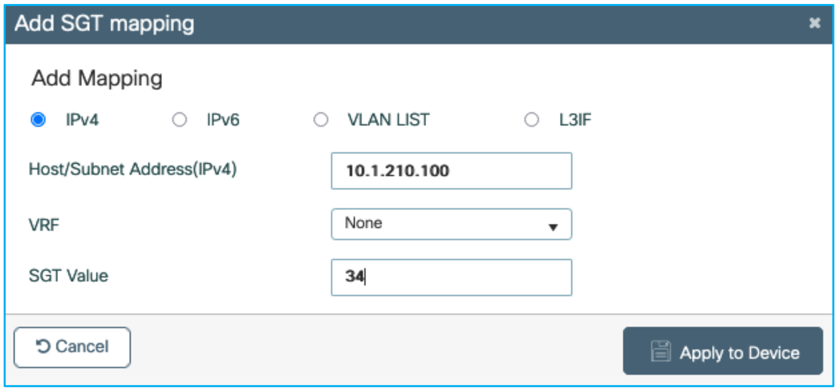


IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source

0 | 10 | No items to display

Add a static IPv4:SGT mapping in the C9800 under Configuration > Security > TrustSec > SGT Mapping. Click Add:



Add SGT mapping

Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

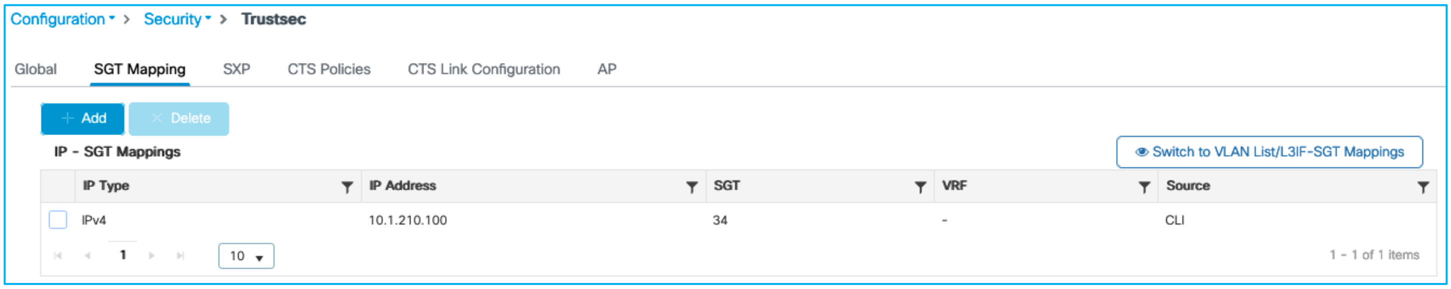
Host/Subnet Address(IPv4): 10.1.210.100

VRF: None

SGT Value: 34

Cancel | Apply to Device

This is applied successfully:



Configuration > Security > **Trustsec**

Global | SGT Mapping | SXP | CTS Policies | CTS Link Configuration | AP

+ Add | Delete

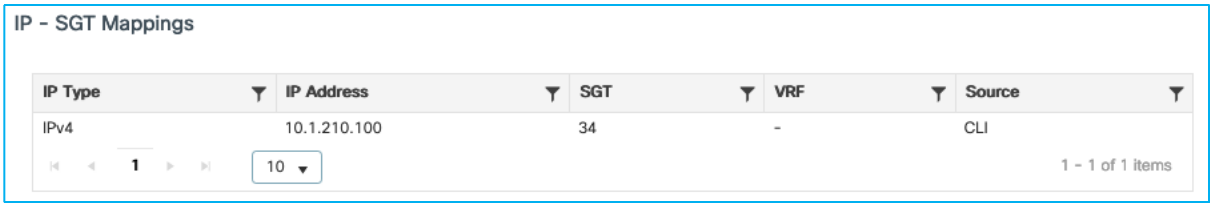
IP - SGT Mappings

Switch to VLAN List/L3IF-SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	10.1.210.100	34	-	CLI

1 | 10 | 1 - 1 of 1 items

Also seen under Monitoring > General > TrustSec:



IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.100	34	-	CLI

1 | 10 | 1 - 1 of 1 items

Check on the Ca9k whether this mapping has been received from the C9800 via SXP. It has:

```
Kernow-Cat9300-b#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
1.1.1.8                 2       INTERNAL
10.1.140.2              11      CLI
10.1.200.1              2       INTERNAL
10.1.210.1              2       INTERNAL
10.1.210.100            34      SXP
10.1.211.1              2       INTERNAL
10.3.23.2               2       INTERNAL
10.4.25.2               2       INTERNAL
IP-SGT Active Bindings Summary
============================================
Total number of CLI      bindings = 1
Total number of SXP      bindings = 1
Total number of INTERNAL bindings = 6
Total number of active   bindings = 8
Active IPv6-SGT Bindings Information
IP Address                                  SGT     Source
================================================================
```

Traffic from the wireless client to the Production Server is enforced successfully on the Cat9k due to this SXP mapping learned as a source from the C9800 and the destination mapping of the production server still being present from a previous use-case:

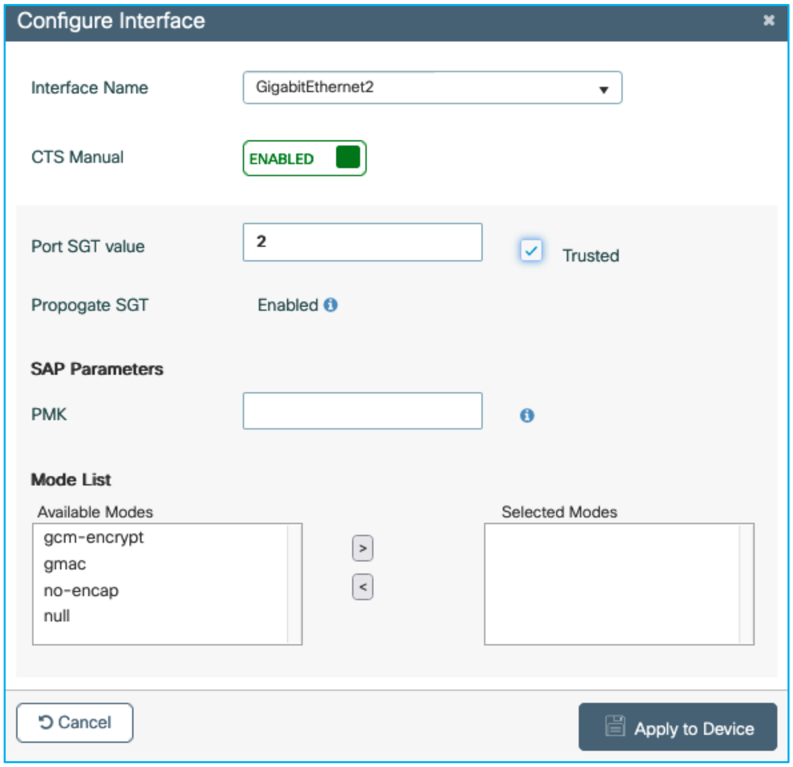
```
Kernow-Cat9300-b#show cts role-based permissions from 34
IPv4 Role-based permissions from group 34:Doctors to group 11:Production_Servers:
        Deny IP-00
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
Kernow-Cat9300-b#show cts role-based counters from 34
Role-based IPv4 counters
From    To      SW-Denied  HW-Denied  SW-Permitt HW-Permitt SW-Monitor HW-Monitor
34      11      0          28         0          0          0          0
```

So, an added static IP:SGT mapping on the C9800 does successfully get propagated via SXP to a northbound platform. However, you have to question the usefulness of this function. Why not just add the static mapping on the destination platform instead of using SXP from the C9800? Or how about using SXP from another device like ISE for example. It is good that the function works but it has limited practicality.

C9800 Static IP:SGT sent via Inline CMD and Enforcing Off-Platform (Not Supported)

If no SGT is dynamically assigned by ISE to a wireless client, statically assign an SGT to the IP of a wireless client and propagate it via CMD to another platform for enforcement. This is a capability supported by other types of network devices.

Ensure inline is set on the C9800 G2 interface – Navigate to Configuration > Security > TrustSec > CTS Link Configuration to configure the interface:



Interface Name: GigabitEthernet2

CTS Manual: ENABLED

Port SGT value: 2 ☑ Trusted

Propogate SGT: Enabled

SAP Parameters

PMK:

Mode List

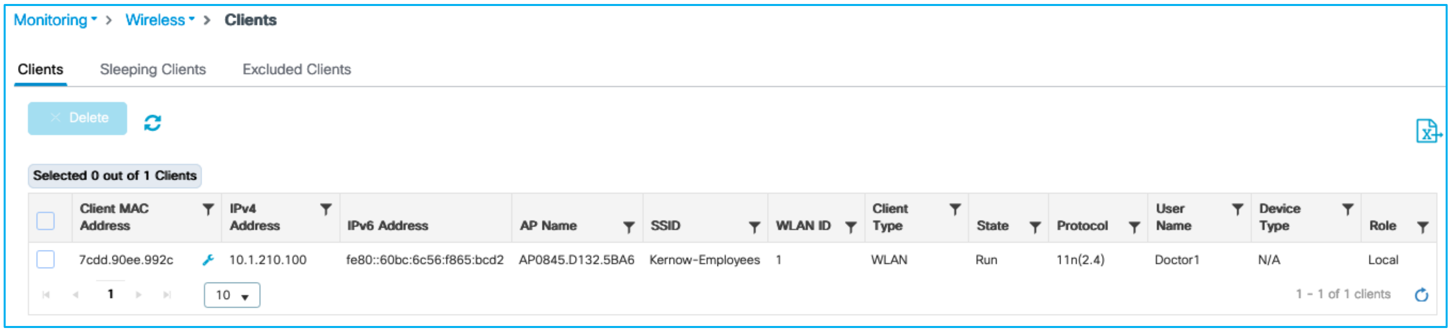
Available Modes: gcm-encrypt, gmac, no-encap, null

Selected Modes:

Also set inline tagging on the peer Cat9k interface G1/0/15:

```
interface GigabitEthernet1/0/15
 switchport trunk allowed vlan 200,210,211
 switchport mode trunk
 switchport nonegotiate
 cts manual
  policy static sgt 2 trusted
 ip dhcp snooping trust
end
```

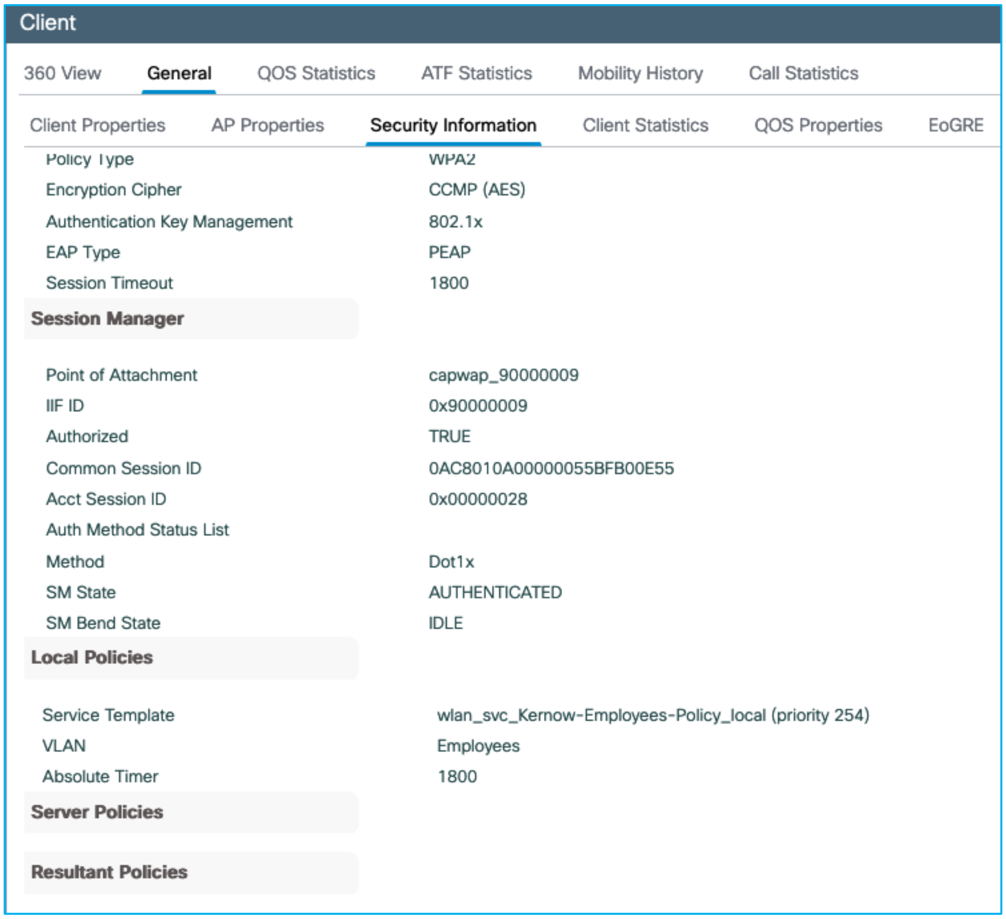
Authenticate wireless client but do not assign an SGT from ISE:



Selected 0 out of 1 Clients

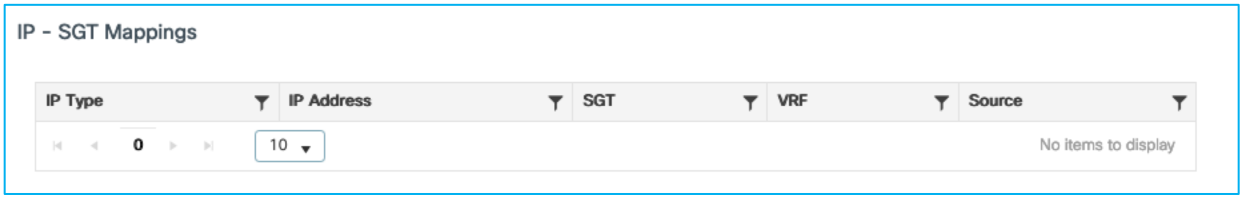
	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	7cdd.90ee.992c	10.1.210.100	fe80::60bc:6c56:f865:bcd2	AP0845.D132.5BA6	Kernow-Employees	1	WLAN	Run	11n(2.4)	Doctor1	N/A	Local

There’s no SGT assigned, as seen at the bottom of the following screen i.e. Server Policies is blank:



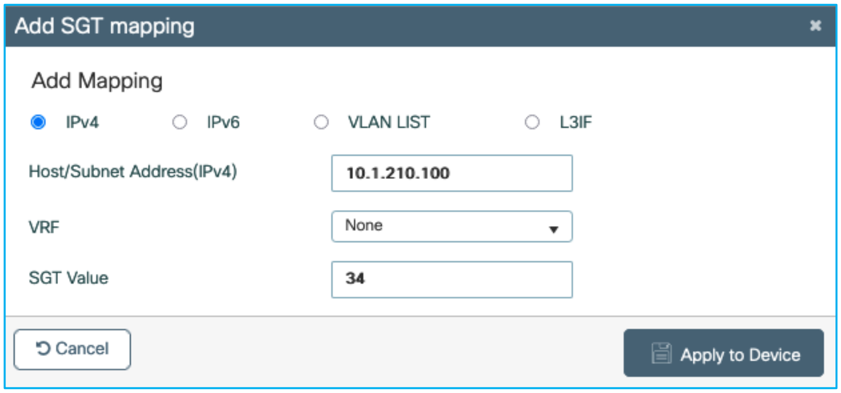
Policy Type	WPA2
Encryption Cipher	CCMP (AES)
Authentication Key Management	802.1x
EAP Type	PEAP
Session Timeout	1800
Session Manager	
Point of Attachment	capwap_90000009
IIF ID	0x90000009
Authorized	TRUE
Common Session ID	0AC8010A00000055BFB00E55
Acct Session ID	0x00000028
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE
Local Policies	
Service Template	wlan_svc_Kernow-Employees-Policy_local (priority 254)
VLAN	Employees
Absolute Timer	1800
Server Policies	
Resultant Policies	

Additionally, Monitoring > General > TrustSec on the C9800 shows no IP – SGT mappings:


IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source

Now, we'll set a static entry to assign SGT Doctors/34 to the client IP of 10.1.210.100. Navigate to Configuration > Security > TrustSec > SGT Mapping to add a new IPv4 entry:

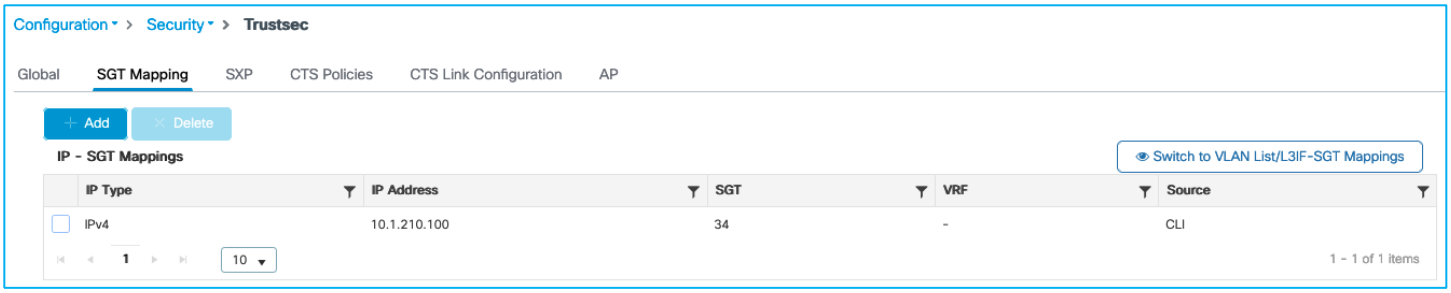

Add SGT mapping

Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

Host/Subnet Address(IPv4)	10.1.210.100
VRF	None
SGT Value	34

Once applied:

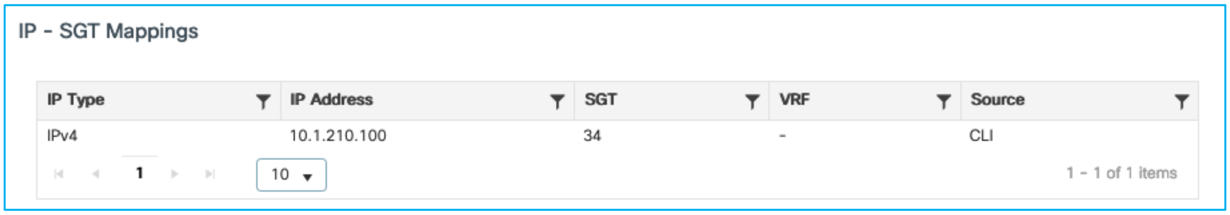

Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings
10

IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	10.1.210.100	34	-	CLI

1 - 1 of 1 items

Can also be seen via Monitoring > General > TrustSec



IP - SGT Mappings

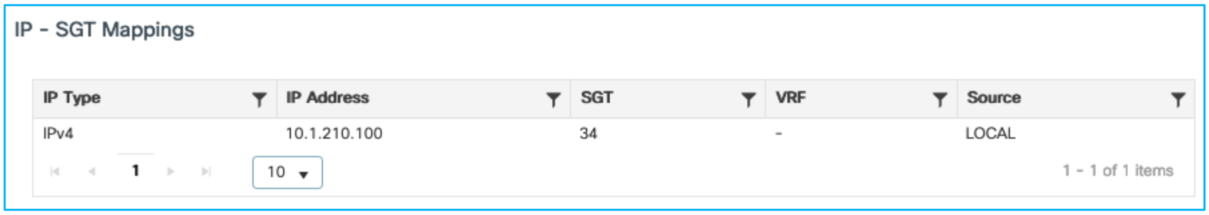
IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.100	34	-	CLI

1 - 1 of 1 items

When client traffic flows from C9800 to the Cat9k, the statically assigned SGT of 34 is NOT propagated to the Cat9k, as seen using a ‘monitor capture’ command on the Cat9k G1/0/15 interface:

```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:e3:f1
(04:6c:9d:1f:e3:f1)
    Destination: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        Address: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 0
    Type: IPv4 (0x0800)
```

Assign an SGT dynamically from ISE (just as a test); Update ISE authz rule to assign SGT 34 and re-auth the client. The dynamic SGT assigned (source as LOCAL in the table below) takes precedence over the static entry sourced from CLI:



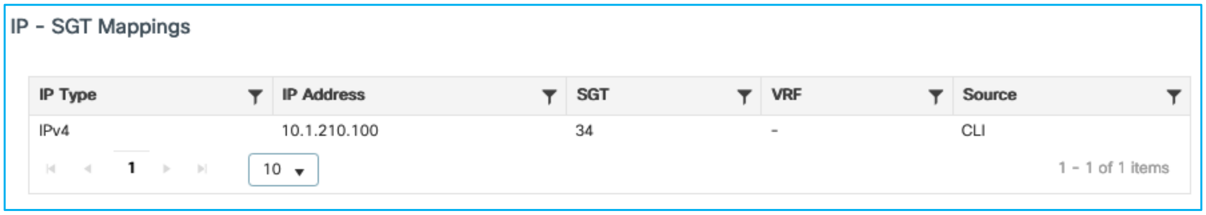
IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.100	34	-	LOCAL

SGT is sent to Cat9k in CMD field with the assigned dynamic SGT entry (source: LOCAL):

```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:e3:f1
(04:6c:9d:1f:e3:f1)
    Destination: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        Address: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 34
    Type: IPv4 (0x0800)
```

Again, remove dynamic SGT assignment from ISE leaving only the static entry:



IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.100	34	-	CLI

SGT received by the Cat9k is again 0 (not 34):

```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:e3:f1
(04:6c:9d:1f:e3:f1)
    Destination: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        Address: 04:6c:9d:1f:e3:f1 (04:6c:9d:1f:e3:f1)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 0
    Type: IPv4 (0x0800)
```

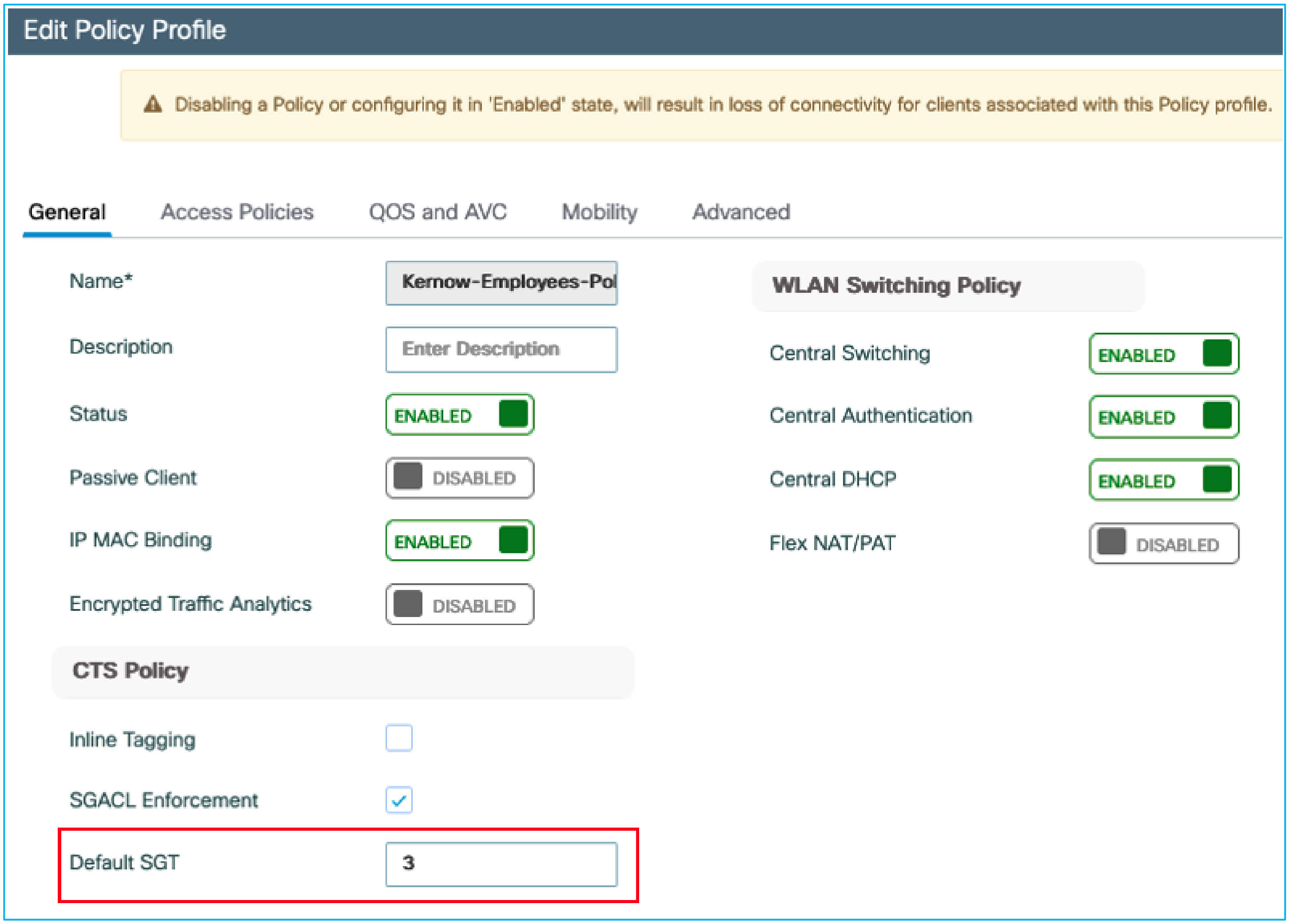
The conclusion is that a statically assigned IP:SGT mapping to a wireless client is not propagated via CMD across the uplink. The SGT must be dynamically assigned from ISE for this propagation to occur, or SXP can be used.

A DDTS has been opened for this use-case: CSCwd06879 C9800 wireless static IP to SGT mapping not inline tagged over uplink.

C9800 Default SGT Assigned via Policy Profile and Enforcing Off-Platform

The previous two use-cases covered static assignment of the IP:SGT on the C9800 and sending off-platform to be enforced elsewhere. There is another way to statically assign a default SGT to a wireless client and that is provided through the policy profile. Of course, all endpoints using that Policy Profile will be subject to being assigned that same SGT. If a wireless client is authenticated and dynamically assigned an SGT from ISE, then that will take precedence over the static/default assignment on the policy profile.

Set the ‘Default SGT’ on the policy profile to be 3 as an example:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*	Kernow-Employees-Pol
Description	Enter Description
Status	ENABLED
Passive Client	DISABLED
IP MAC Binding	ENABLED
Encrypted Traffic Analytics	DISABLED

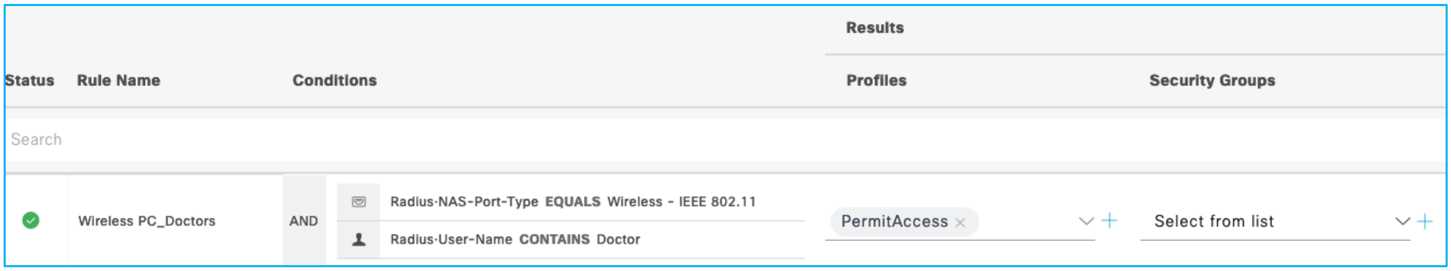
CTS Policy

Inline Tagging	☐
SGACL Enforcement	☑
Default SGT	3

WLAN Switching Policy

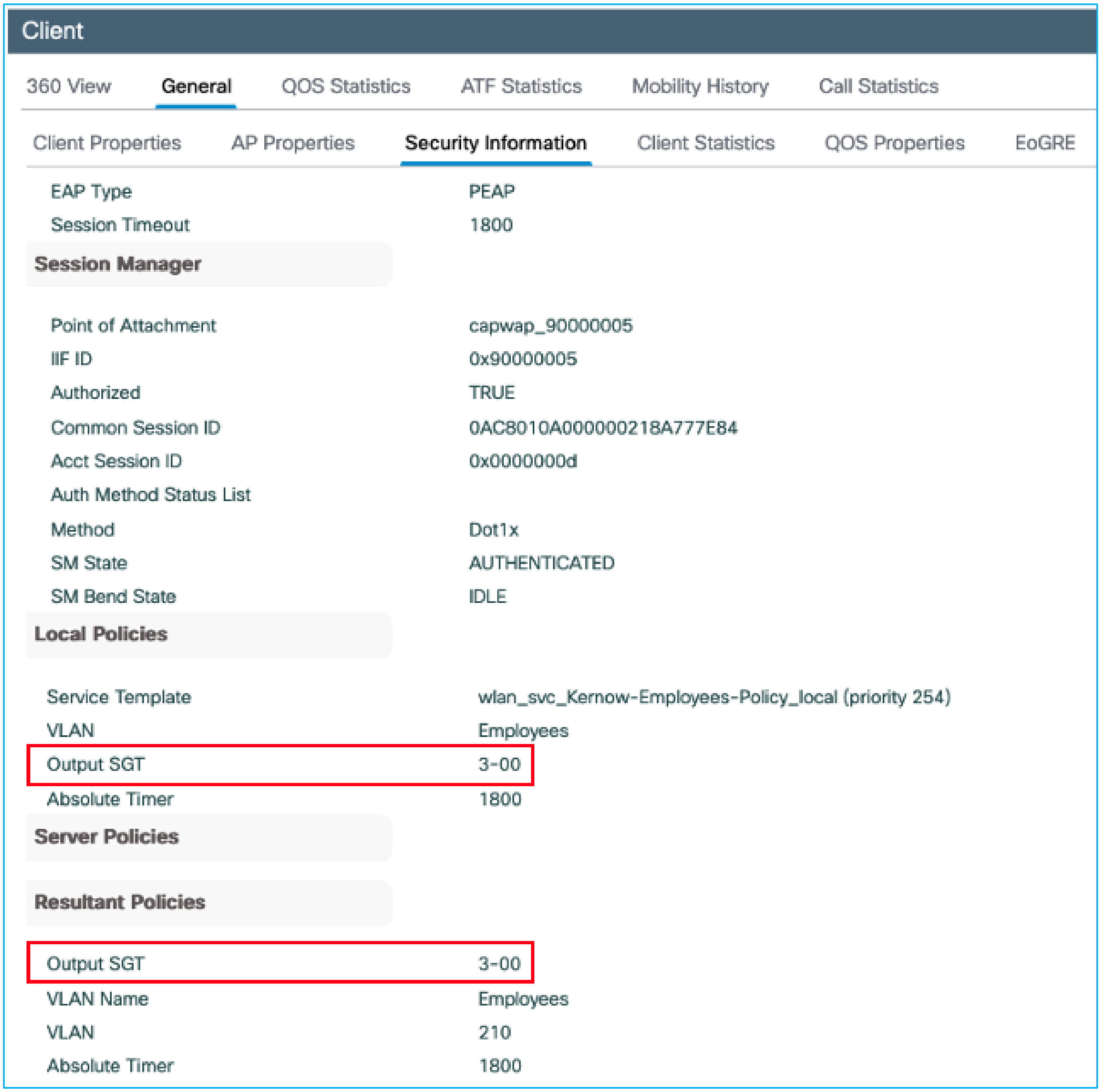
Central Switching	ENABLED
Central Authentication	ENABLED
Central DHCP	ENABLED
Flex NAT/PAT	DISABLED

Now, authenticate a wireless client but configure the ISE authorization policy to not assign an SGT.



				Results	
Status	Rule Name	Conditions		Profiles	Security Groups
✓	Wireless PC_Doctors	AND	Radius·NAS-Port-Type EQUALS Wireless - IEEE 802.11 Radius·User-Name CONTAINS Doctor	PermitAccess ×	Select from list

The client on the C9800 shows up as having the Default SGT assigned as configured in the Policy Profile. Navigate to Monitoring > Wireless > Clients > Select Client > General > Security Information, scroll down to see the two Output SGT entries:



EAP Type	PEAP
Session Timeout	1800

Session Manager

Point of Attachment	capwap_90000005
IIF ID	0x90000005
Authorized	TRUE
Common Session ID	0AC8010A000000218A777E84
Acct Session ID	0x0000000d
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE

Local Policies

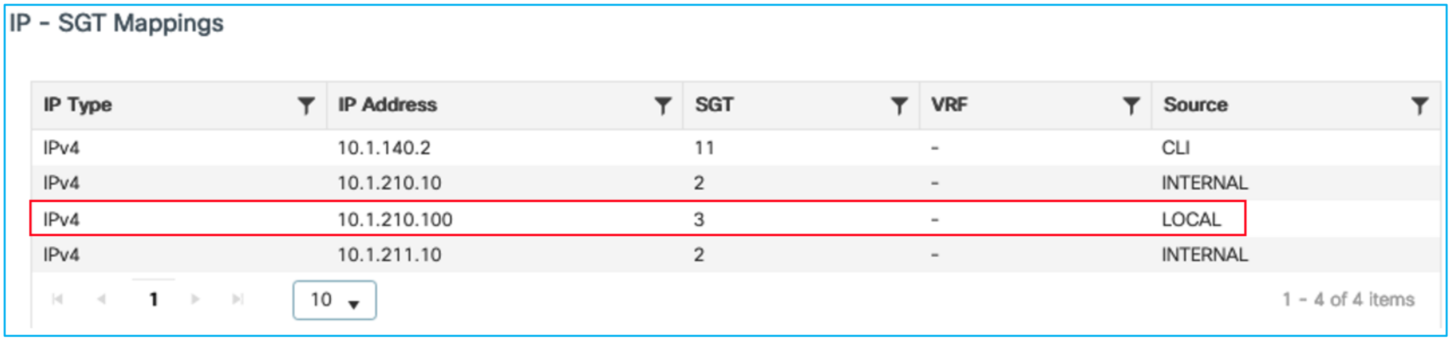
Service Template	wlan_svc_Kernow-Employees-Policy_local (priority 254)
VLAN	Employees
Output SGT	3-00
Absolute Timer	1800

Server Policies

Resultant Policies

Output SGT	3-00
VLAN Name	Employees
VLAN	210
Absolute Timer	1800

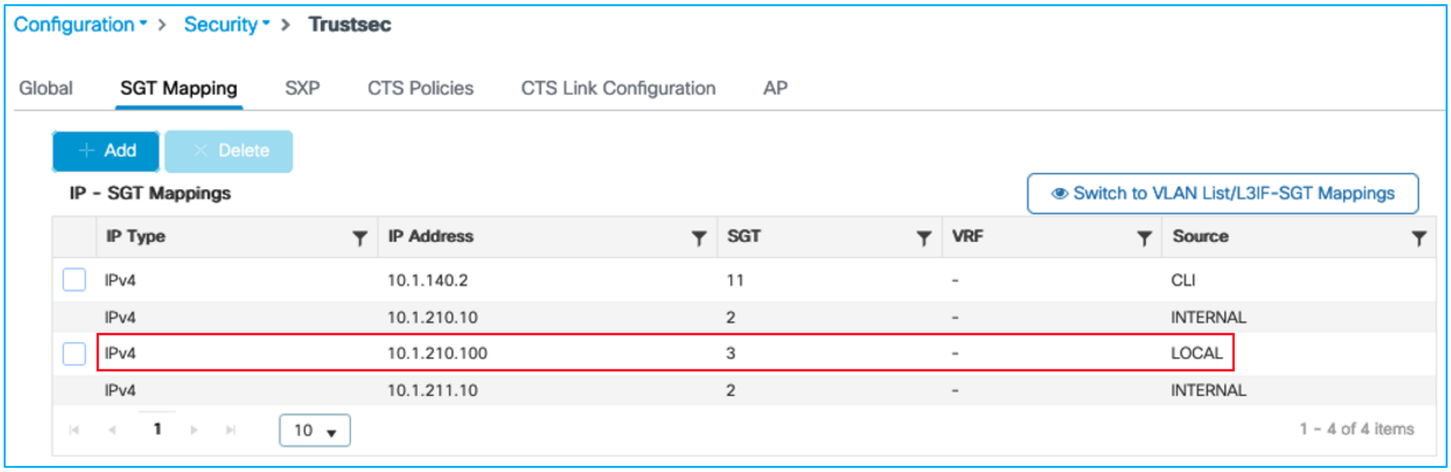
This assignment shows up under Monitoring > General > TrustSec:



IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.140.2	11	-	CLI
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	3	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL

Plus the assignment shows up in the Configuration > Security > TrustSec > SGT Mapping table:



IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	10.1.140.2	11	-	CLI
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	3	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

When traffic flows from the wireless client to a north-bound wired endpoint, this Default SGT is propagated successfully. Firstly showing the propagation via inline tagging (CMD) – showing the interesting snippet of a capture received on the adjacent Cat9k:

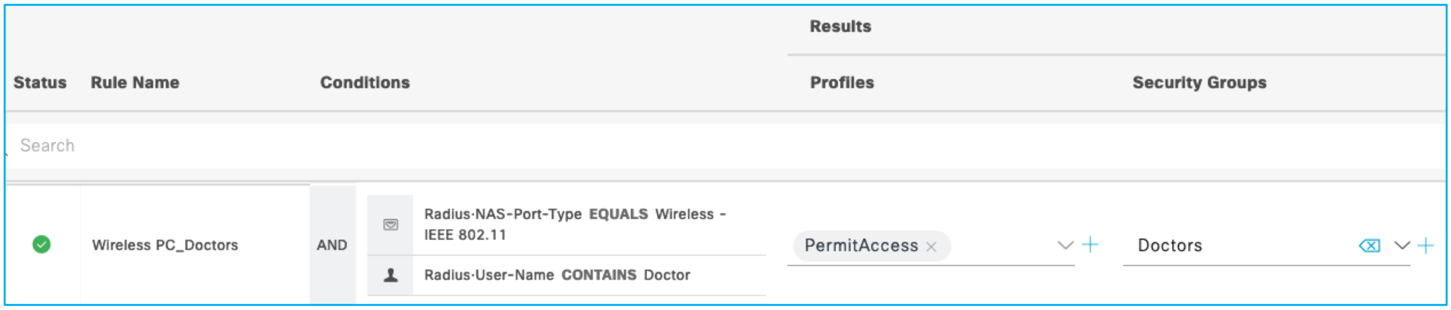
```
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:88:71
(04:6c:9d:1f:88:71)
    Destination: 04:6c:9d:1f:88:71 (04:6c:9d:1f:88:71)
        Address: 04:6c:9d:1f:88:71 (04:6c:9d:1f:88:71)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1101 0010 = ID: 210
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 3
    Type: IPv4 (0x0800)
```

Secondly, showing the mapping being received by the adjacent Cat9k over SXP:

```
Kernow-C9k-top#show cts role-based sgt-map 10.1.210.100
Active IPv4-SGT Bindings Information

IP Address              SGT     Source
```

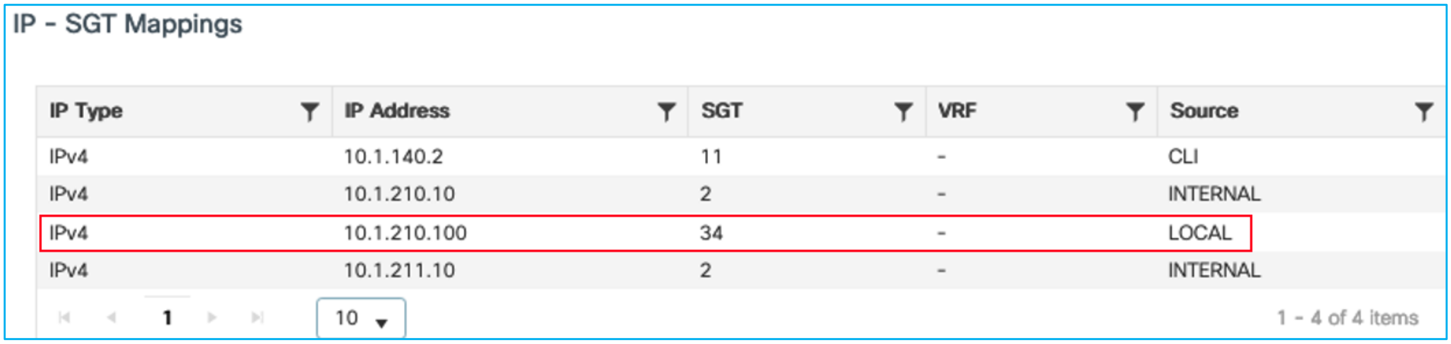
```
============================================
10.1.210.100            3       SXP
```

If ISE is then set to assign a dynamic SGT, it takes precedence. Set the SGT assignment within ISE back to SGT Doctors (SGT 34):



			Results	
Status	Rule Name	Conditions	Profiles	Security Groups
✓	Wireless PC_Doctors	AND Radius·NAS-Port-Type EQUALS Wireless - IEEE 802.11 Radius·User-Name CONTAINS Doctor	PermitAccess ×	Doctors

Re-auth the wireless client and recheck the assignment within the C9800, the dynamic assignment takes precedence over the Default SGT set in the Policy Profile:



IP - SGT Mappings

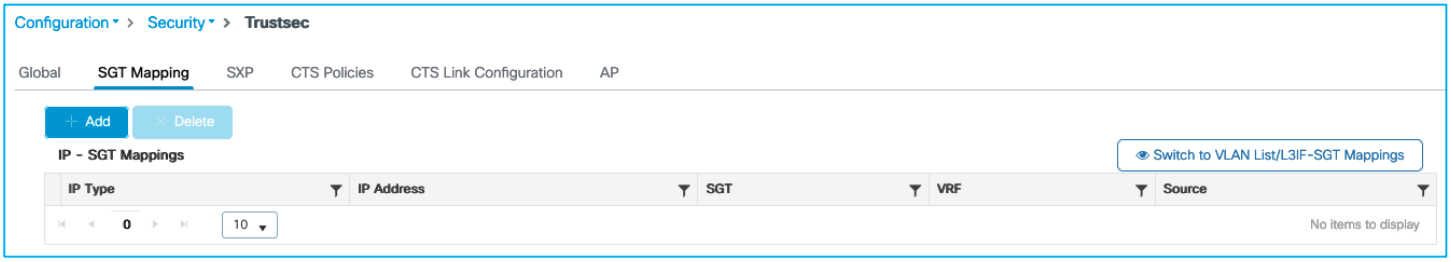
IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.140.2	11	-	CLI
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	34	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL

The conclusion is that setting the SGT in the Default SGT field within a Policy Profile is a great way to statically assign an SGT to be used by default if there is no dynamic assignment from ISE. The default assignment would be for all endpoints using that Policy Profile but any dynamic SGT assigned from ISE would take precedence.

C9800 SGT learned through VLAN:SGT static mapping, sent via SXP and enforcing Off-Platform (Not Supported)

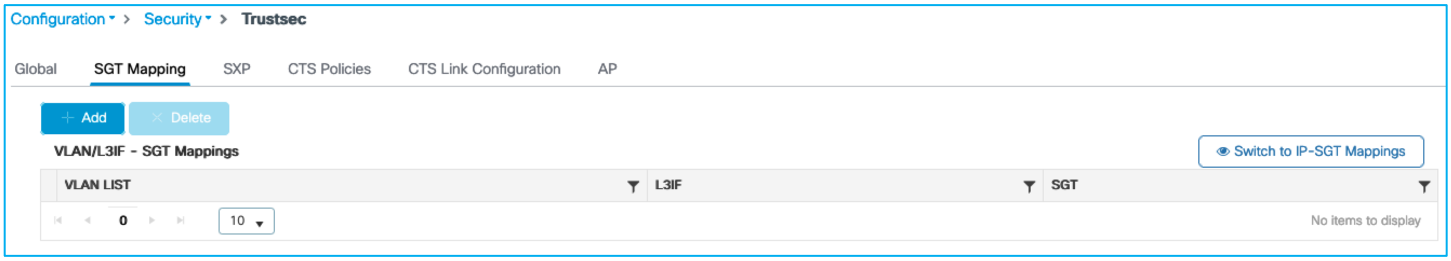
A static VLAN:SGT mapping is generally useful to learn of dynamic IP addresses assigned to endpoints on a VLAN and to assign an SGT to them. To learn the IP addresses, IP device tracking would need to be enabled. This use-case tests the functionality on the C9800 where IP addresses of wireless devices using an SSID would be tracked, assigned to a static SGT and propagated off-platform using SXP.

Do not assign SGT to client dynamically from ISE, assign static VLAN:SGT on C9800 instead. Navigate to Configuration > Security > TrustSec > SGT Mapping:



IP Type	IP Address	SGT	VRF	Source

Click on the ‘Switch to VLAN List/L3IF-SGT Mappings’ link near the right-hand side of the screen:

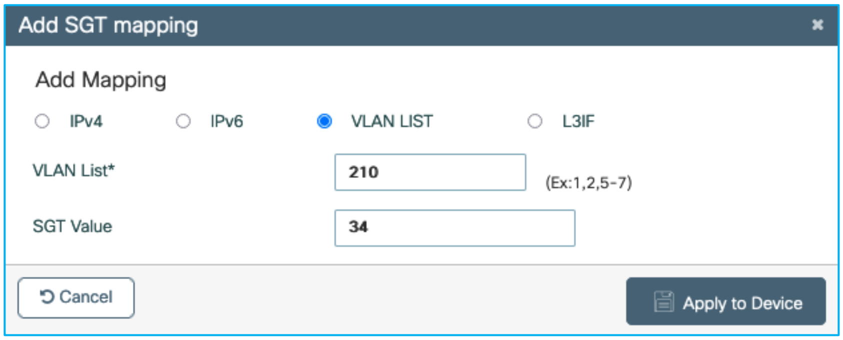


VLAN/L3IF - SGT Mappings

VLAN LIST	L3IF	SGT

0 10 ▾ No items to display

Click ‘Add’ and select VLAN LIST and enter vlan 210 with SGT 34:



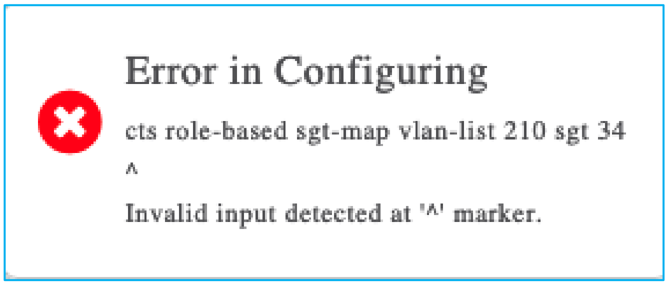
Add Mapping

○ IPv4 ○ IPv6 ● VLAN LIST ○ L3IF

VLAN List* 210 (Ex:1,2,5-7)

SGT Value 34

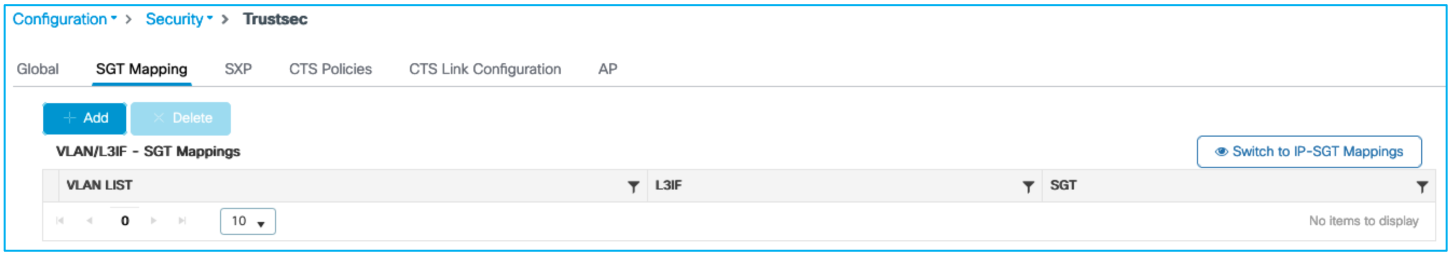
Click Apply:



Error in Configuring

cts role-based sgt-map vlan-list 210 sgt 34
^
Invalid input detected at '^' marker.

Nothing is entered into the table:



VLAN/L3IF - SGT Mappings

VLAN LIST	L3IF	SGT

0 10 ▾ No items to display

Using CLI on C9800, the command option does not exist:

```
9800-17.9.1(config)#cts role-based sgt-map ?
  A.B.C.D               IPv4 host address
  A.B.C.D/nn            IPv4 prefix <network>/<length>, e.g., 35.0.0.0/8
  X:X:X:X::X            IPv6 host address x:x::y
  X:X:X:X::X/<0-128>    IPv6 prefix <network>/<length> (x:x::y/<z>)
  host                  Host IP address
  vrf                   Select VPN Routing/Forwarding instance for the binding
```

VLAN:SGT static mapping is not supported on the C9800 controller.

The following DDTS was opened for this use-case CSCwd06900 C9800 wireless static VLAN to SGT mapping GUI provisioning generates error.

It has been decided to temporarily hide the option to 'Switch to VLAN List/L3IF-SGT Mappings' under Configuration > Security > TrustSec > SGT Mapping in ongoing releases. If either of the two features are required in the future, then the functionality can be investigated and re-introduced. The following DDTS was opened to hide the option:

CSCwd14077 C9800: Hide the option to switch to VLAN List and L3IF to SGT Mappings in SGT Mapping screen

C9800 CTS Provisioning and Device Enrollment

In order for the C9800 to carry out enforcement on-platform, it needs to download a Protected Access Credential (PAC) and the TrustSec Environment-Data from ISE.

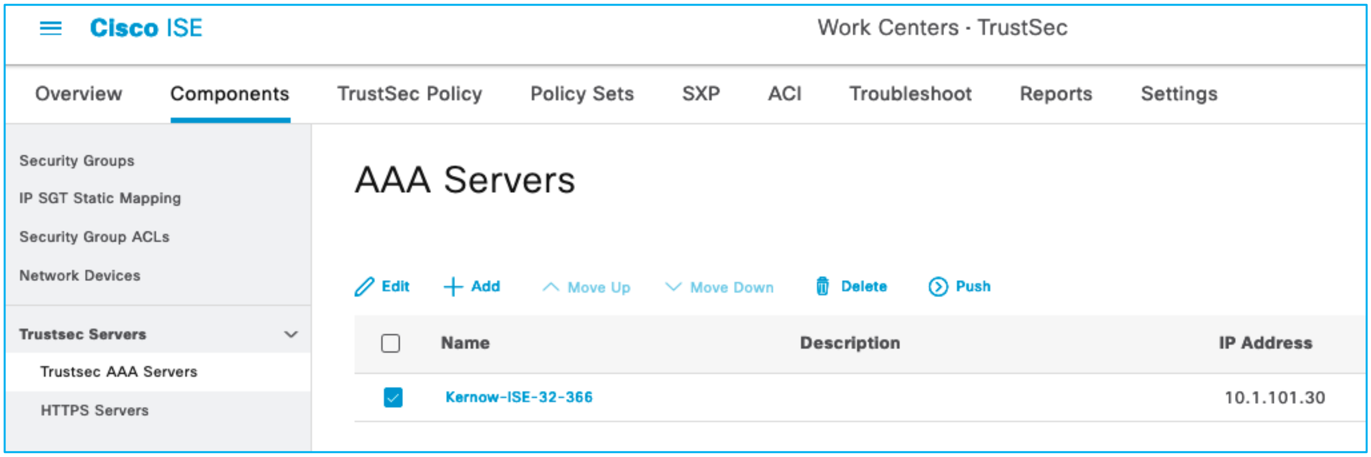
Environment-Data includes the following:

Policy server IP - the ISE instance that policy is requested from

Device SGT – the SGT assigned to internal interfaces of the C9800 itself

All SGT names with associated numbers

Within ISE, the ISE instance used for policy download requests is set at Work Centers > TrustSec > Components > TrustSec Servers > TrustSec AAA Servers:

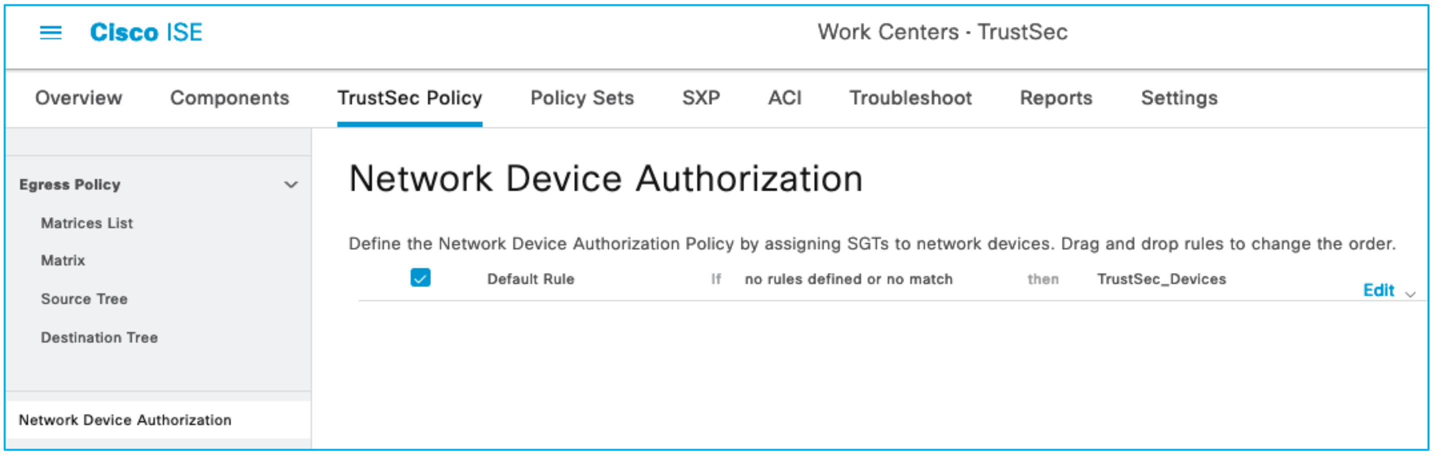


AAA Servers

□	Name	Description	IP Address
☑	Kernow-ISE-32-366		10.1.101.30

If there is only one ISE instance in your deployment, then this entry needs to be the Hostname and IP of your one ISE instance. If you have a distributed ISE deployment, then this Hostname and IP will be the ISE instance chosen to handle all policy downloads for the network devices. If multiple entries are added in this ISE table, then the network devices will always download policy from the 1st entry in the list unless that ISE instance is unreachable, in which case the 2nd entry in the table will be attempted. So, in normal operations, all network devices will download policy from the 1st entry in the list.

The Device SGT is also downloaded within the Environment-Data. Within ISE, the Device SGT is set at Work Centers > TrustSec > TrustSec Policy > Network Device Authorization:



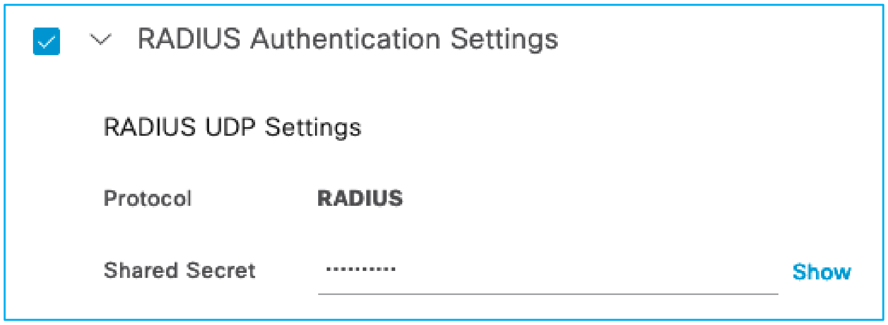
Network Device Authorization

Define the Network Device Authorization Policy by assigning SGTs to network devices. Drag and drop rules to change the order.

☑ Default Rule If no rules defined or no match then TrustSec_Devices Edit

When you first install ISE there is a pre-existing SGT called TrustSec_Devices which is assigned SGT 2. Best practice is to use this pre-existing SGT for assigning to all devices in the network within the GBP ‘domain’. Later releases of ISE pre-configure the Network Device Authorization table to assign TrustSec_Devices SGT 2 to all network devices requesting environment-data but check that SGT TrustSec_Devices is configured and not Unknown (SGT 0).

Note down some information from the ISE Network Device entry for the C9800. The network device entries can be found at Administration > Network Resources > Network Devices. The RADIUS password is important, note this down after pressing ‘Show’ to display the characters:



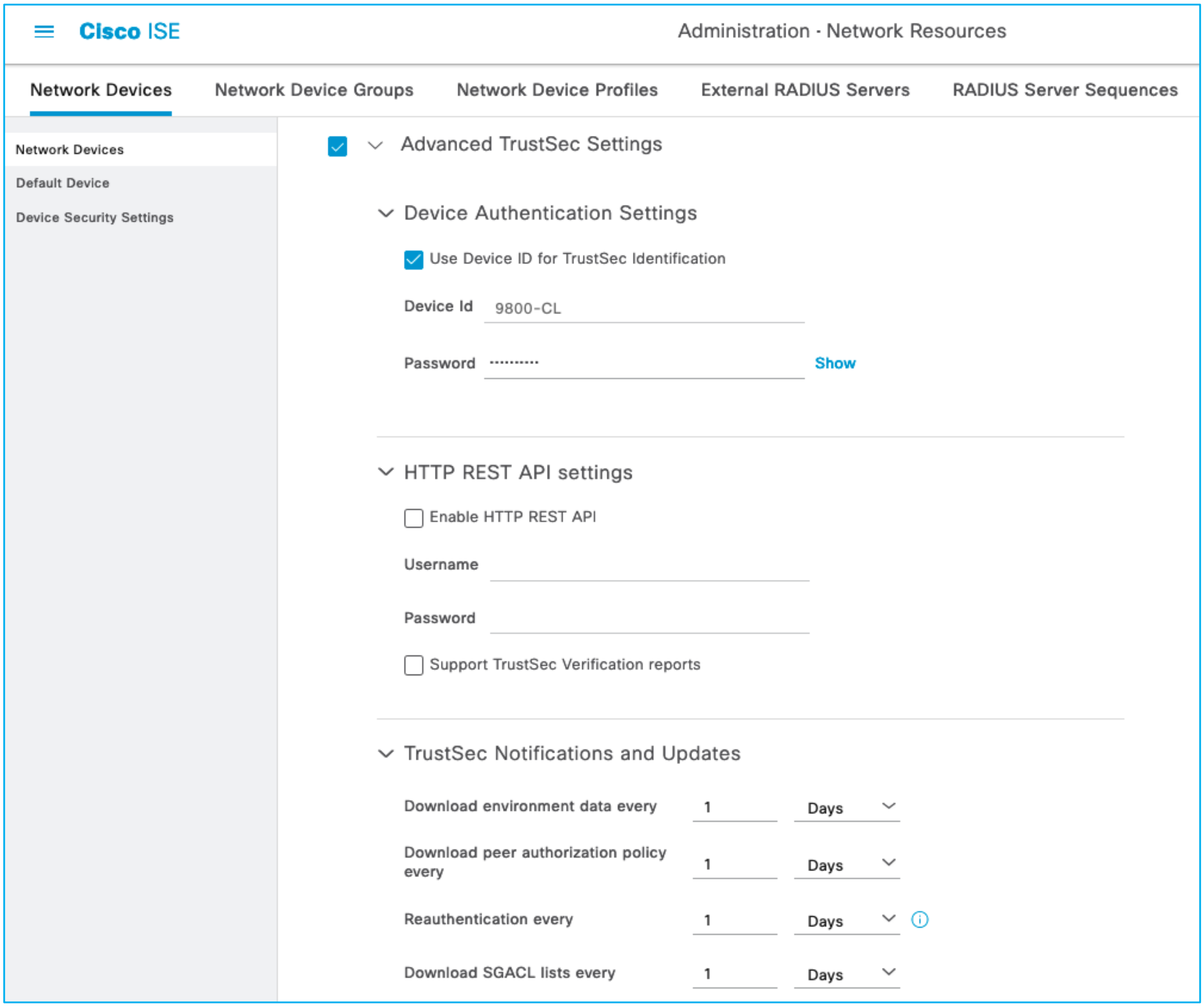
☑ RADIUS Authentication Settings

RADIUS UDP Settings

Protocol RADIUS

Shared Secret ···········

Scroll down to the ‘Advanced TrustSec Settings’ enabled with a Device ID entered with appropriate password, note these down:



☑ Advanced TrustSec Settings

Device Authentication Settings

☑ Use Device ID for TrustSec Identification

Device Id: 9800-CL

Password: ··········

HTTP REST API settings

□ Enable HTTP REST API

Username:

Password:

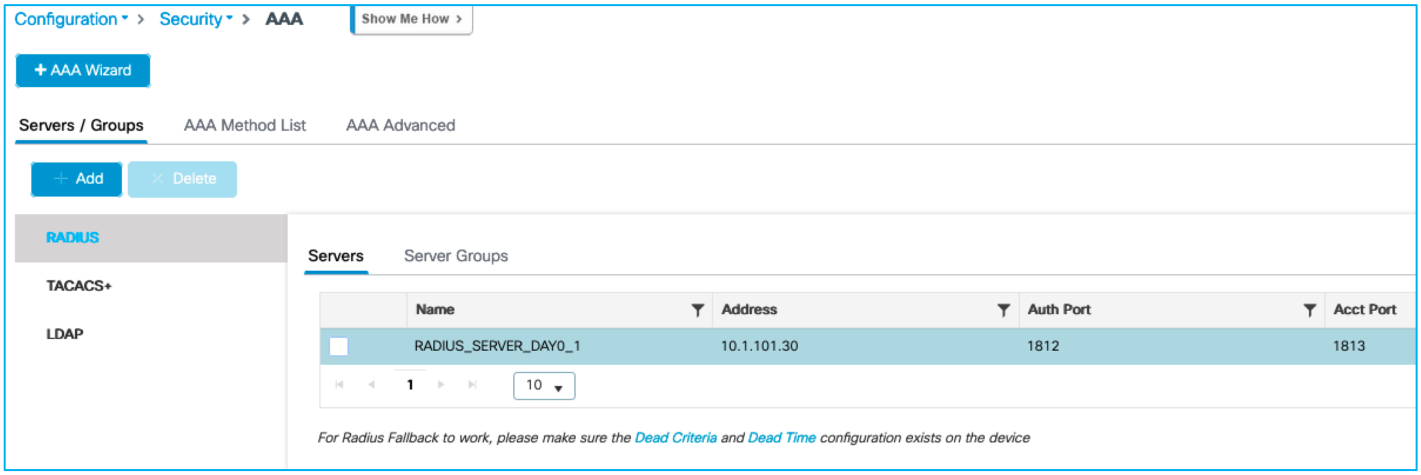
□ Support TrustSec Verification reports

TrustSec Notifications and Updates

Download environment data every	1	Days
Download peer authorization policy every	1	Days
Reauthentication every	1	Days
Download SGACL lists every	1	Days

Note: The PAC is automatically generated by ISE and downloaded to the network devices when requested.

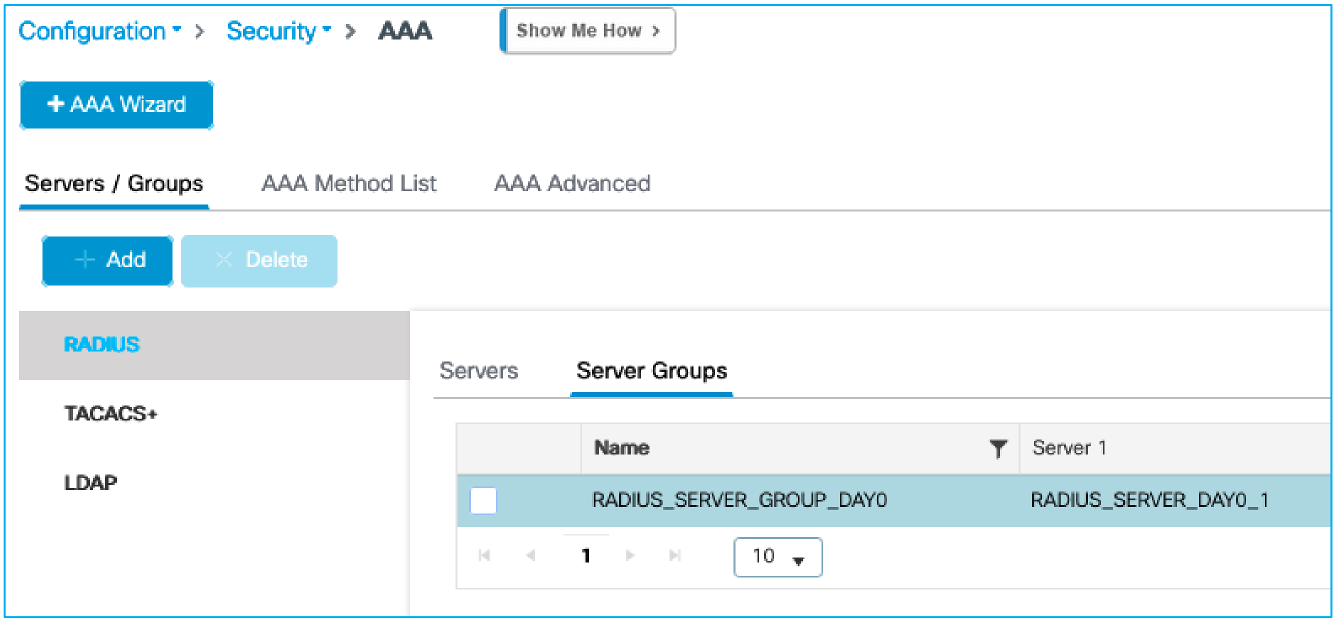
Then collect the information needed from the C9800 itself to setup CTS communications, navigate to Configuration > Security > AAA > Servers/Groups:



	Name	Address	Auth Port	Acct Port
□	RADIUS_SERVER_DAY0_1	10.1.101.30	1812	1813

For Radius Fallback to work, please make sure the Dead Criteria and Dead Time configuration exists on the device

Note the Server name and IP (RADIUS_SERVER_DAY0_1 and 10.1.101.30 in this example), then click on the Server Groups sub-menu:

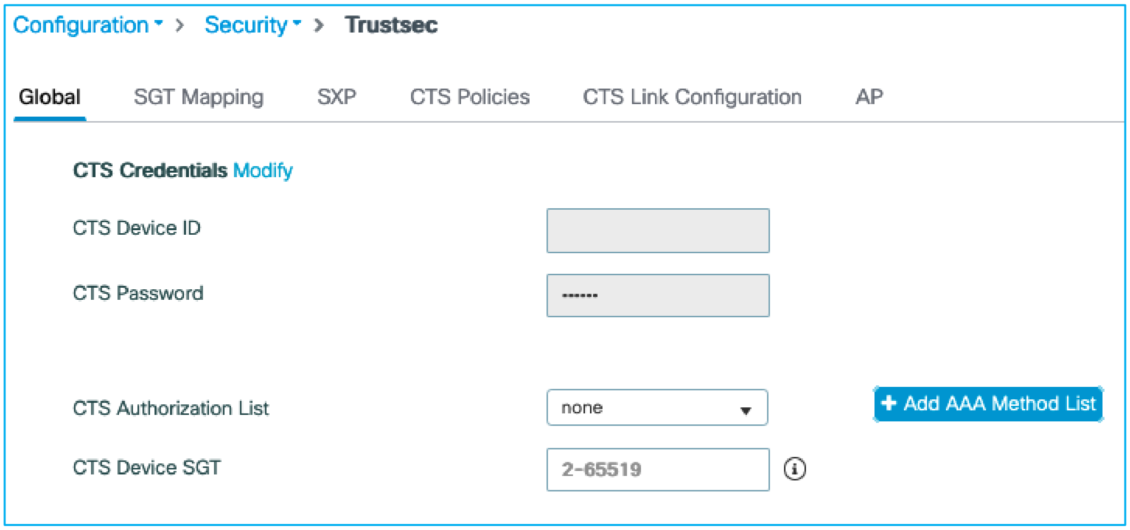


	Name	Server 1
□	RADIUS_SERVER_GROUP_DAY0	RADIUS_SERVER_DAY0_1

And note the Server Group name (RADIUS_SERVER_GROUP_DAY0 in this example).

Then, on the C9800, navigate to Configuration > Security > TrustSec > Global.

Firstly, set the CTS Authorization List, click on ‘Add AAA Method List’ as shown in blue here:



Configuration > Security > Trustsec

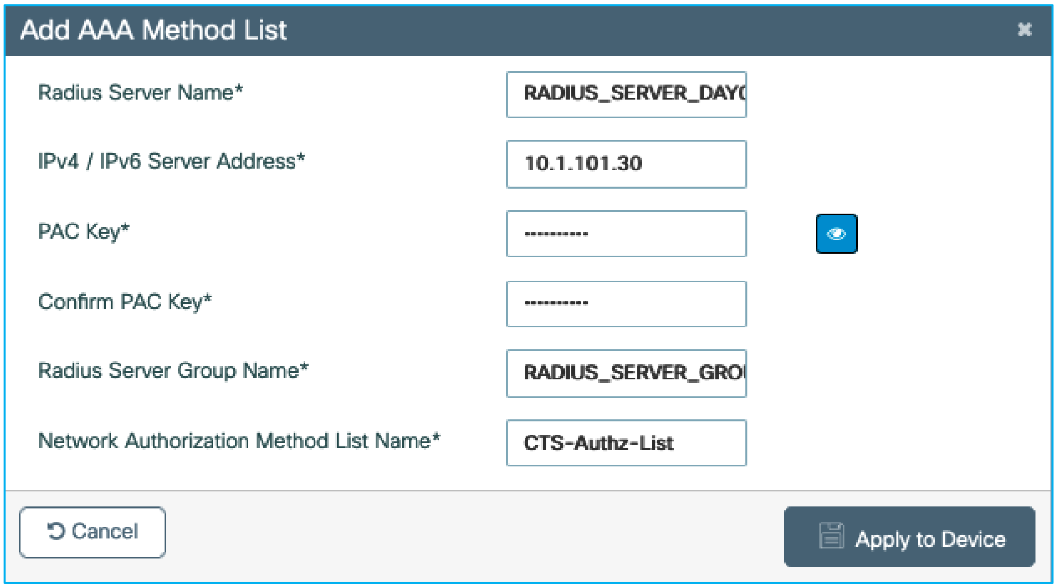
CTS Device ID:

CTS Password: ------

CTS Authorization List: none

CTS Device SGT: 2-65519

Enter the Server name, Server IP and Server Group name we copied above from the C9800, and the PAC key is the RADIUS password/shared secret that was entered into the ISE Network Device screen. The Network Authorization Method List Name can be a new name for example CTS-Authz-List:



Add AAA Method List

Radius Server Name*: RADIUS_SERVER_DAY(

IPv4 / IPv6 Server Address*: 10.1.101.30

PAC Key*: ----------

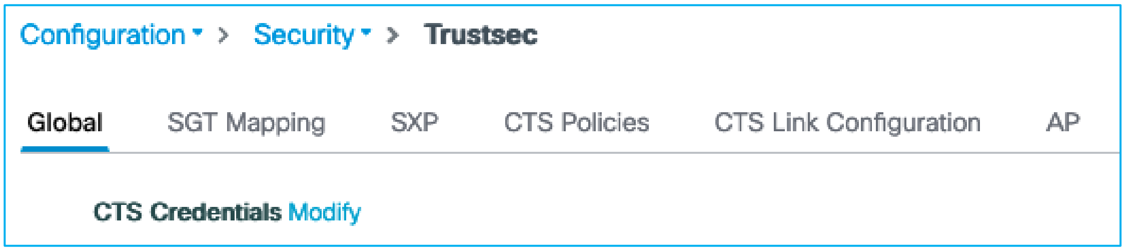
Confirm PAC Key*: ----------

Radius Server Group Name*: RADIUS_SERVER_GRO(

Network Authorization Method List Name*: CTS-Authz-List

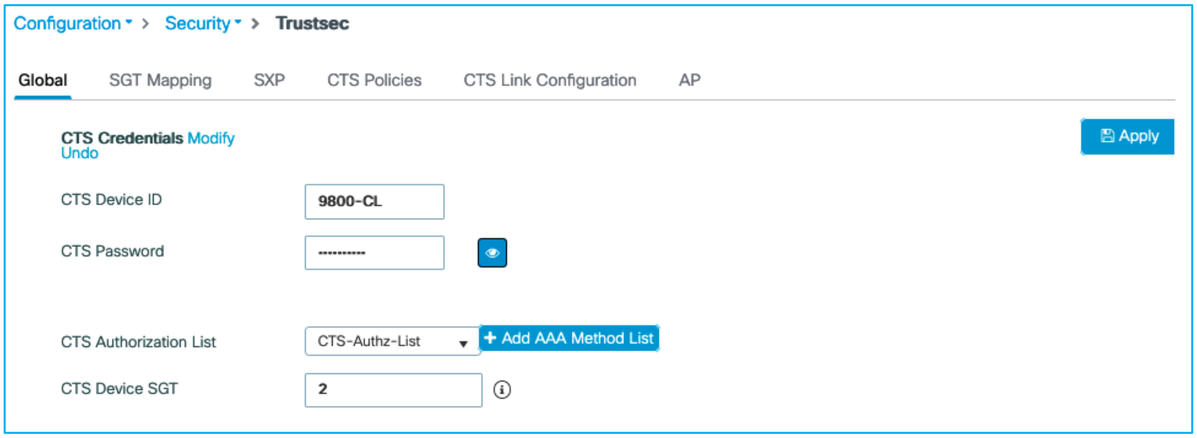
Click 'Apply to Device'.

Then, back on the Global tab, click the 'Modify' link to update the CTS Credentials settings:



Configuration > Security > Trustsec

Update the settings to coincide with the Device ID and associated password entered in ISE in the Advanced TrustSec Settings of the Network Device entry:



CTS Credentials Modify
Undo

CTS Device ID: 9800-CL

CTS Password: ----------

CTS Authorization List: CTS-Authz-List

CTS Device SGT: 2

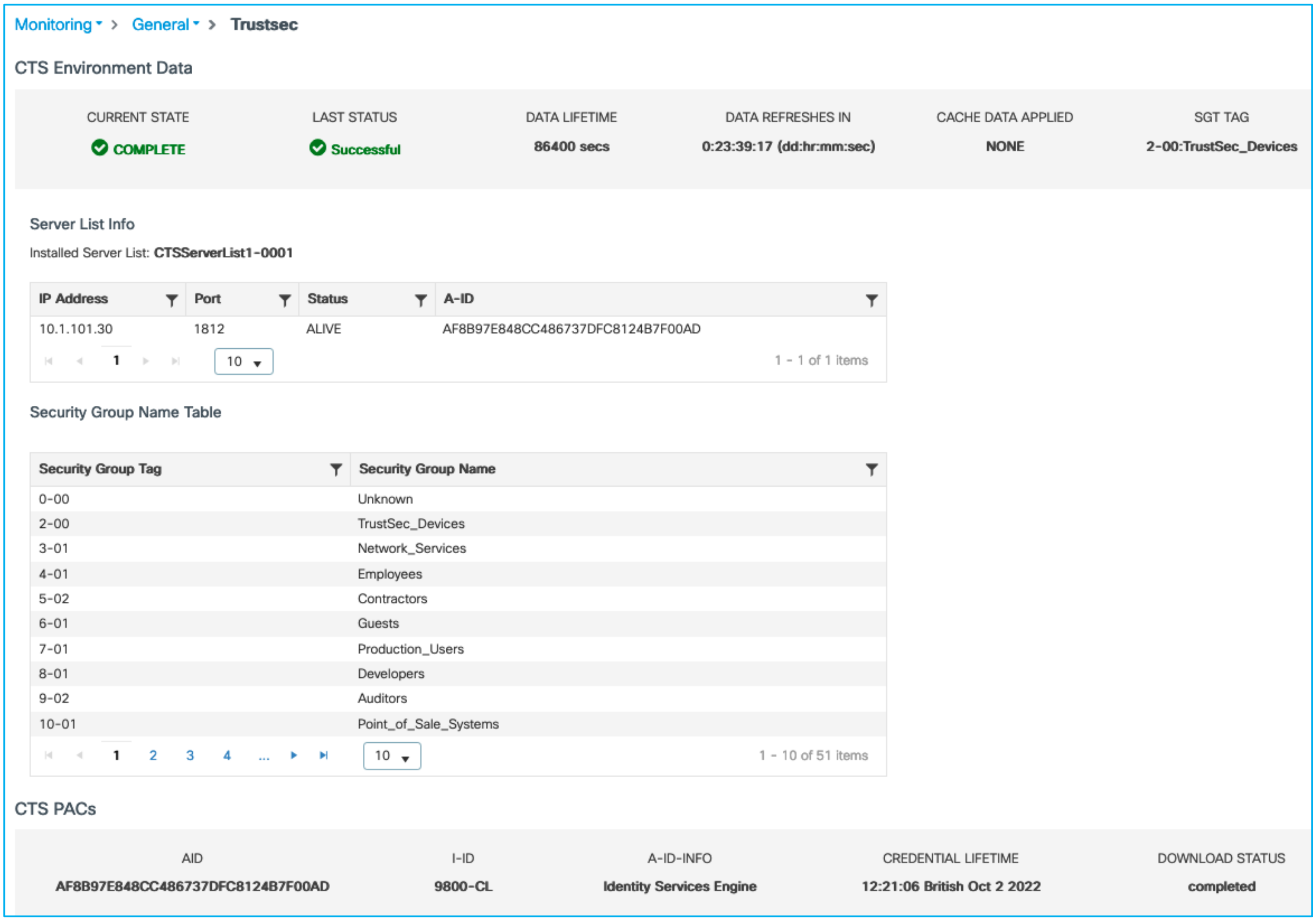
Click Apply.

An example of changes implemented in the C9800 are marked in blue below:

```
aaa group server radius RADIUS_SERVER_GROUP_DAY0
 server name RADIUS_SERVER_DAY0_1
!
aaa authentication login authentication_login_day0 group RADIUS_SERVER_GROUP_DAY0
aaa authentication dot1x authentication_dot1x_day0 group RADIUS_SERVER_GROUP_DAY0
aaa authorization network CTS-Authz-List group RADIUS_SERVER_GROUP_DAY0
aaa accounting identity Kernow-Acc-List start-stop group RADIUS_SERVER_GROUP_DAY0
!
cts authorization list CTS-Authz-List
cts sgt 2
!
aaa server radius dynamic-author
 client 10.1.101.30 server-key XXXX
!
radius server RADIUS_SERVER_DAY0_1
 address ipv4 10.1.101.30 auth-port 1812 acct-port 1813
 pac key xxxx
9800-17.9.1#show cts credentials
CTS password is defined in keystore, device-id = 9800-CL
```

Note: The procedure above modifies the existing RADIUS server config to include the PAC keyword. If two separate radius server configurations are desired (one without PAC for AAA and one with PAC for CTS operations) then that is also possible.

Once applied, navigate to Monitoring > General > TrustSec. A CTS PAC and the CTS Environment-Data should have been downloaded from ISE (with the Device SGT, Server List and Security Group Table):



Monitoring ▾ > General ▾ > **Trustsec**

CTS Environment Data

CURRENT STATE	LAST STATUS	DATA LIFETIME	DATA REFRESHES IN	CACHE DATA APPLIED	SGT TAG
✓ COMPLETE	✓ Successful	86400 secs	0:23:39:17 (dd:hr:mm:sec)	NONE	2-00:TrustSec_Devices

Server List Info

Installed Server List: **CTSServerList1-0001**

IP Address	Port	Status	A-ID
10.1.101.30	1812	ALIVE	AF8B97E848CC486737DFC8124B7F00AD

1 | 10 ▾ | 1 - 1 of 1 items

Security Group Name Table

Security Group Tag	Security Group Name
0-00	Unknown
2-00	TrustSec_Devices
3-01	Network_Services
4-01	Employees
5-02	Contractors
6-01	Guests
7-01	Production_Users
8-01	Developers
9-02	Auditors
10-01	Point_of_Sale_Systems

1 2 3 4 ... | 10 ▾ | 1 - 10 of 51 items

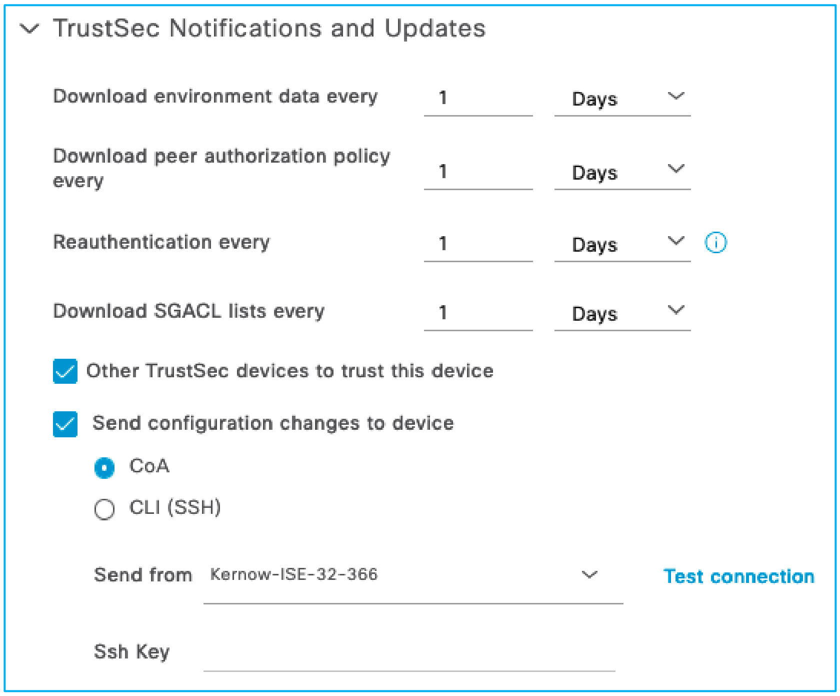
CTS PACs

AID	I-ID	A-ID-INFO	CREDENTIAL LIFETIME	DOWNLOAD STATUS
AF8B97E848CC486737DFC8124B7F00AD	9800-CL	Identity Services Engine	12:21:06 British Oct 2 2022	completed

If these have not been downloaded, then re-check the configuration and use the ISE Live Logs to determine if any errors are being displayed for the requests.

ISE initiating updates (via CoA or SSH) to C9800 for Environment-Data

For all the scenarios in this section, the protocol used for ISE to make change requests is configured in the ISE Network Device screen. In ISE, navigate to Administration > Network Resources > Network Devices, click on the C9800 entry. Scroll down to the Advanced TrustSec Settings section and then the TrustSec Notifications and Updates:



TrustSec Notifications and Updates

Download environment data every 1 Days

Download peer authorization policy every 1 Days

Reauthentication every 1 Days

Download SGACL lists every 1 Days

☑ Other TrustSec devices to trust this device

☑ Send configuration changes to device

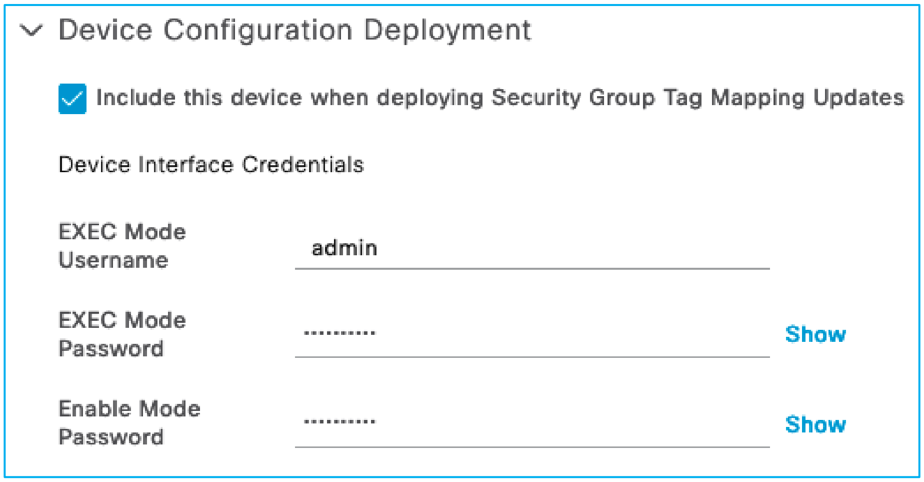
● CoA

○ CLI (SSH)

Send from Kernow-ISE-32-366

Ssh Key

See the setting to select ‘Send configuration changes to device’ using CoA or CLI (SSH). If CLI (SSH) is selected then the credentials ISE uses to log into the C9800 can be entered just below that in the screen, as shown here:



Device Configuration Deployment

☑ Include this device when deploying Security Group Tag Mapping Updates

Device Interface Credentials

EXEC Mode Username: admin

EXEC Mode Password: ....

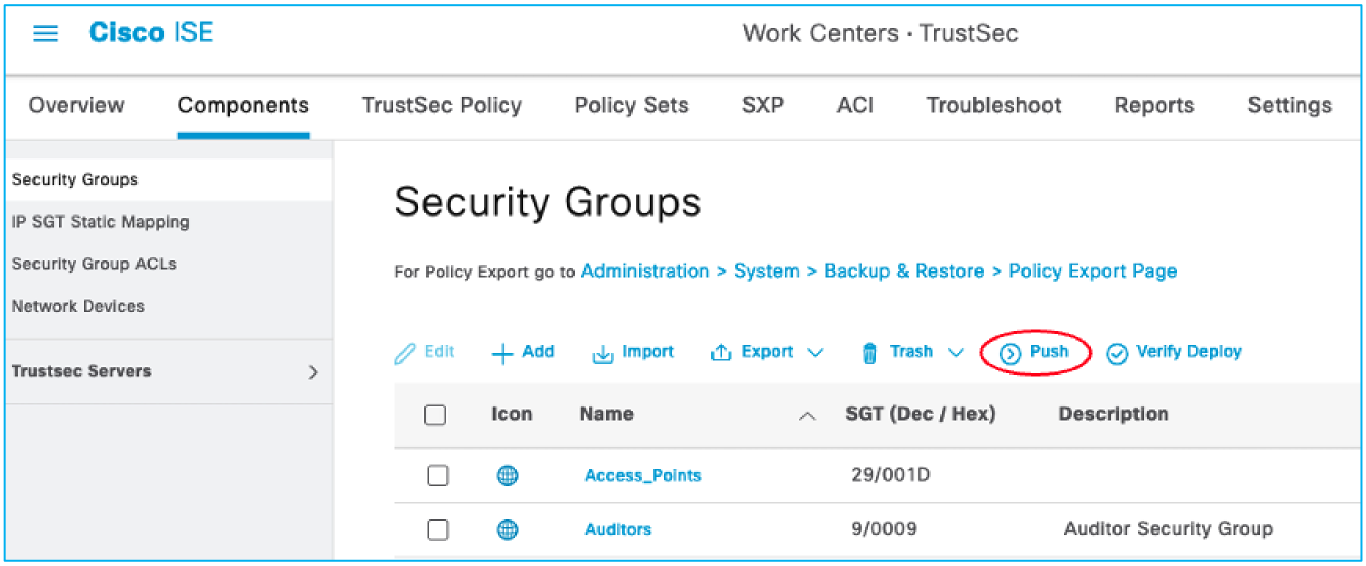
Enable Mode Password: ....

Generally, it is best practice to leave the setting as default i.e. use CoA for changes. It is common though for the ‘Send from’ option to be set as the ISE Policy Service Node (PSN) nearest the C9800.

In networks with a very large number of network devices and when several policy changes are made at the same time, it may be beneficial to change from using CoA to use SSH. The reason is that there is a CoA message sent from ISE per policy change for every network device, generating many messages. Using SSH sends just one message per network device informing the network device to refresh policy.

Adding SGT and pushing the change via CoA

With the ISE Network Device set to use CoA for instigating changes, add a new SGT in ISE (an example: A_New_SGT with SGT 40) and push the change (this Push option is at the top of the Security Group table, and this instigates the RADIUS CoA to implement the change on the C9800); see here:

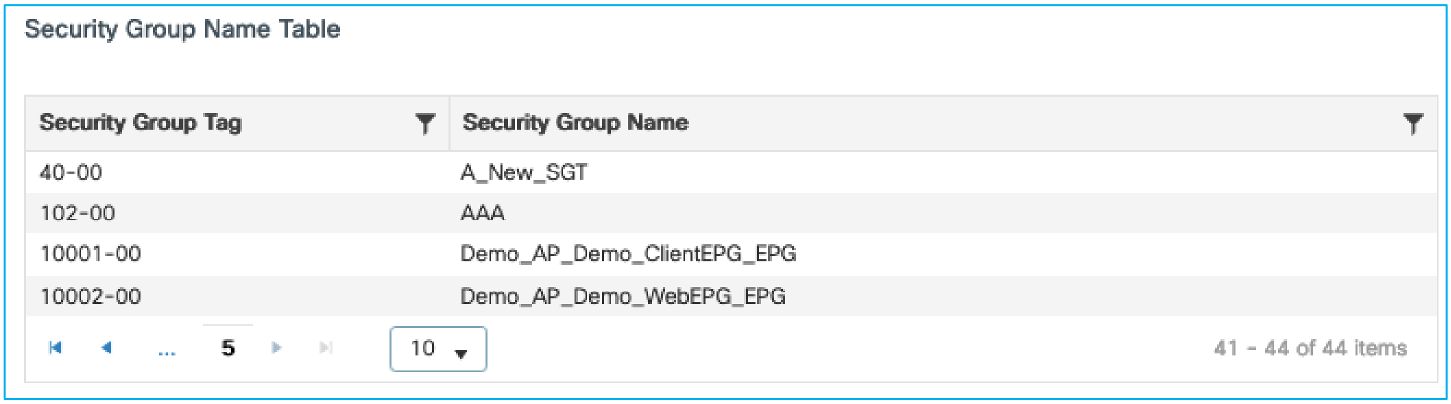


Security Groups

For Policy Export go to Administration > System > Backup & Restore > Policy Export Page

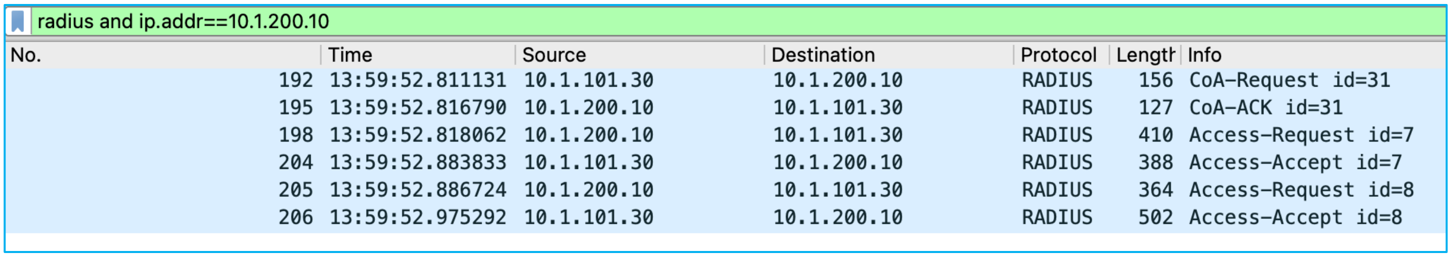
□	Icon	Name	SGT (Dec / Hex)	Description
□	🌐	Access_Points	29/001D	
□	🌐	Auditors	9/0009	Auditor Security Group

On the C9800, navigate to Monitoring > General > TrustSec, and go through the Security Group Name Table to find the newly added SGT:

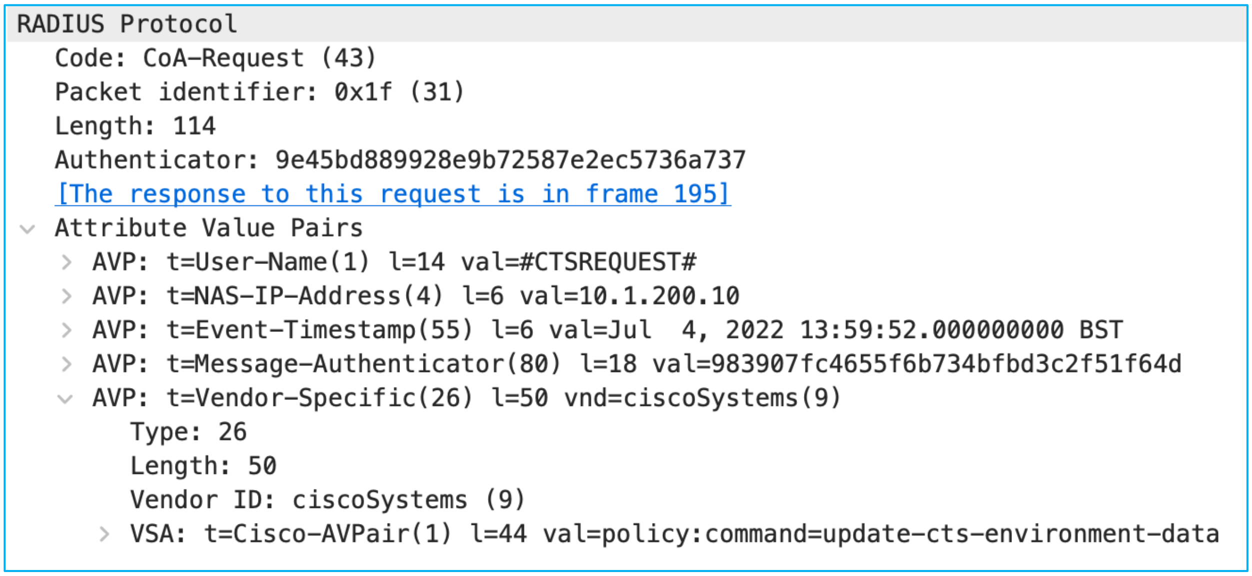

Security Group Name Table

Security Group Tag	Security Group Name
40-00	A_New_SGT
102-00	AAA
10001-00	Demo_AP_Demo_ClientEPG_EPG
10002-00	Demo_AP_Demo_WebEPG_EPG

A debug on ISE shows the CoA Request being sent to the C9800 to inform of a CTS Environment-Data update, plus the subsequent messages:

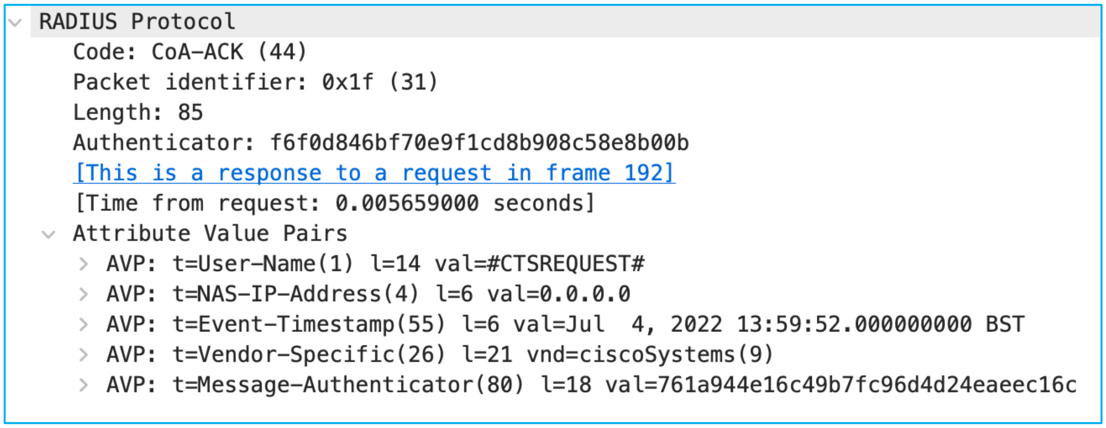

```
radius and ip.addr==10.1.200.10
No.                     Time             Source         Destination     Protocol  Lengtł Info
                    192 13:59:52.811131  10.1.101.30    10.1.200.10     RADIUS    156 CoA-Request id=31
                    195 13:59:52.816790  10.1.200.10    10.1.101.30     RADIUS    127 CoA-ACK id=31
                    198 13:59:52.818062  10.1.200.10    10.1.101.30     RADIUS    410 Access-Request id=7
                    204 13:59:52.883833  10.1.101.30    10.1.200.10     RADIUS    388 Access-Accept id=7
                    205 13:59:52.886724  10.1.200.10    10.1.101.30     RADIUS    364 Access-Request id=8
                    206 13:59:52.975292  10.1.101.30    10.1.200.10     RADIUS    502 Access-Accept id=8
```

CoA Request:



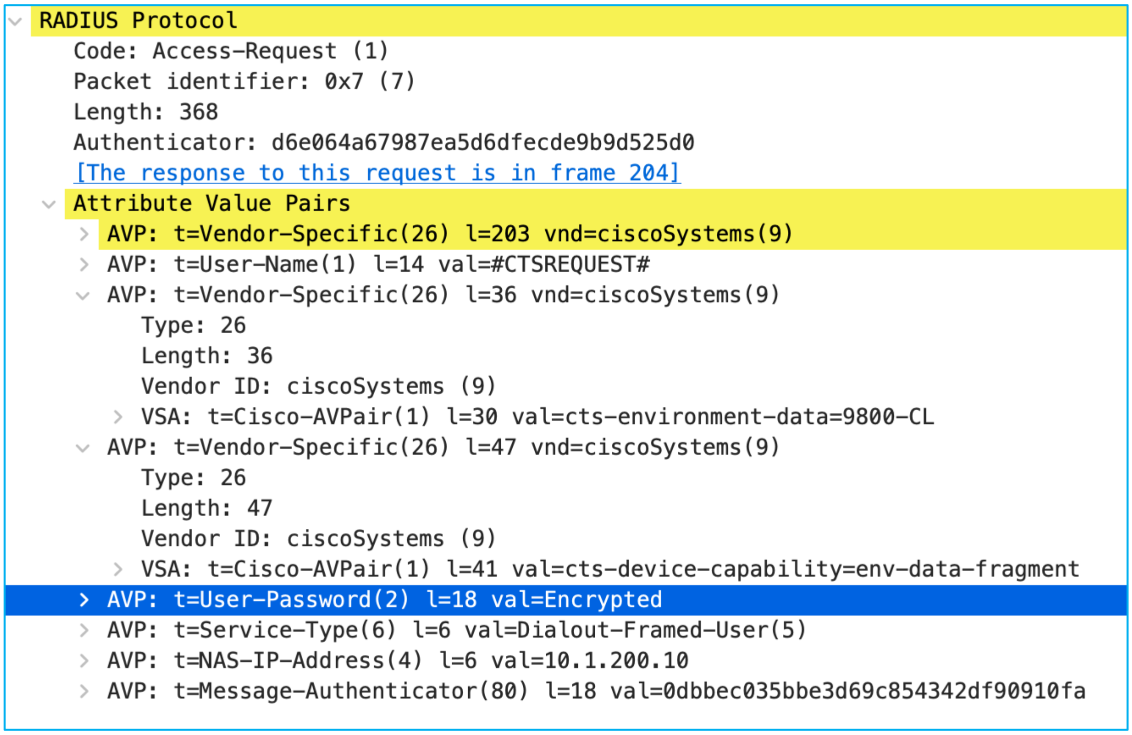
```
RADIUS Protocol
    Code: CoA-Request (43)
    Packet identifier: 0x1f (31)
    Length: 114
    Authenticator: 9e45bd889928e9b72587e2ec5736a737
    [The response to this request is in frame 195]
    Attribute Value Pairs
        AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
        AVP: t=NAS-IP-Address(4) l=6 val=10.1.200.10
        AVP: t=Event-Timestamp(55) l=6 val=Jul  4, 2022 13:59:52.000000000 BST
        AVP: t=Message-Authenticator(80) l=18 val=983907fc4655f6b734bfbd3c2f51f64d
        AVP: t=Vendor-Specific(26) l=50 vnd=ciscoSystems(9)
            Type: 26
            Length: 50
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=44 val=policy:command=update-cts-environment-data
```

CoA Ack:



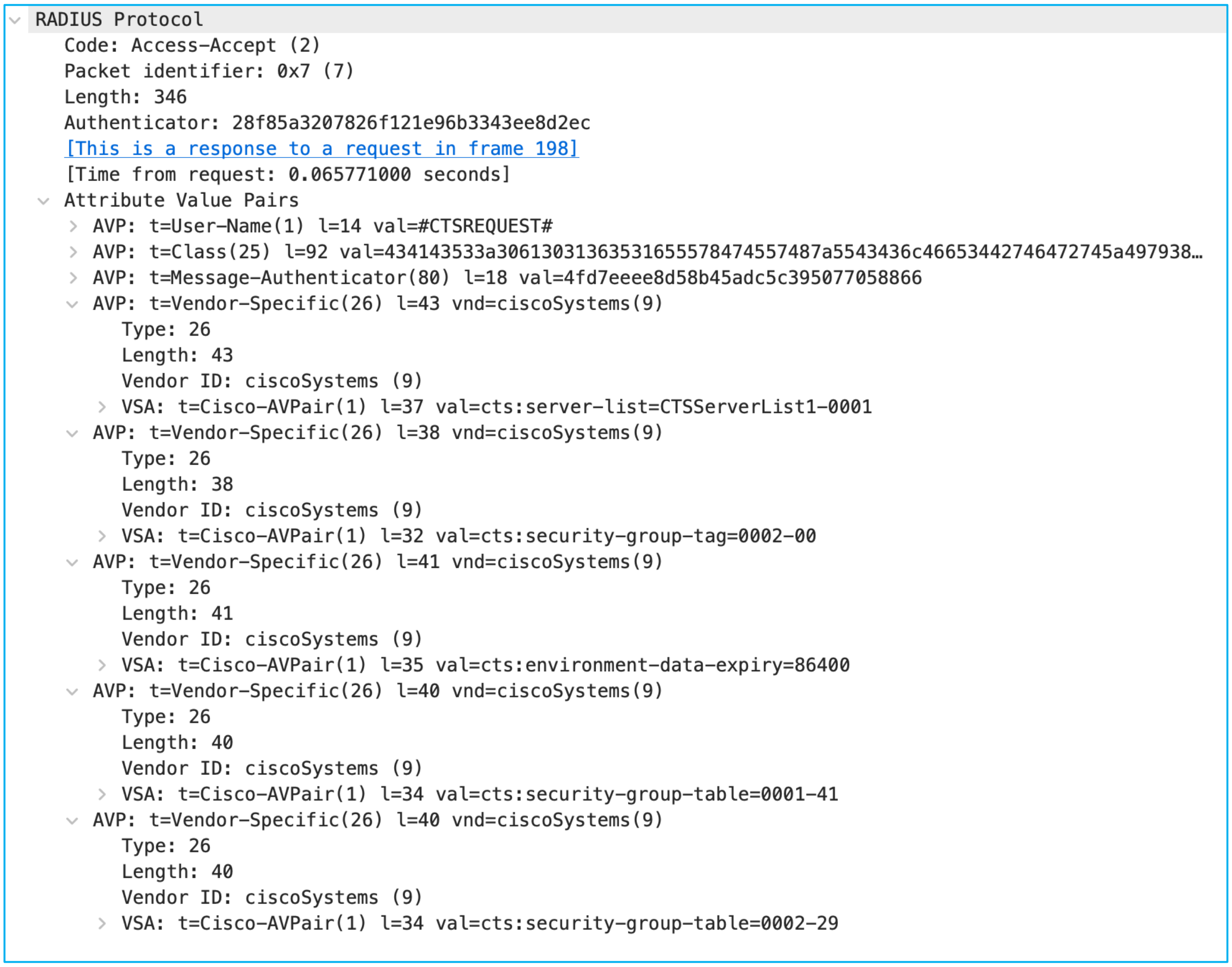
```
RADIUS Protocol
    Code: CoA-ACK (44)
    Packet identifier: 0x1f (31)
    Length: 85
    Authenticator: f6f0d846bf70e9f1cd8b908c58e8b00b
    [This is a response to a request in frame 192]
    [Time from request: 0.005659000 seconds]
    Attribute Value Pairs
        AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
        AVP: t=NAS-IP-Address(4) l=6 val=0.0.0.0
        AVP: t=Event-Timestamp(55) l=6 val=Jul  4, 2022 13:59:52.000000000 BST
        AVP: t=Vendor-Specific(26) l=21 vnd=ciscoSystems(9)
        AVP: t=Message-Authenticator(80) l=18 val=761a944e16c49b7fc96d4d24eaeec16c
```

The above CoA Request instigates the C9800 to send a RADIUS Request to download any change:



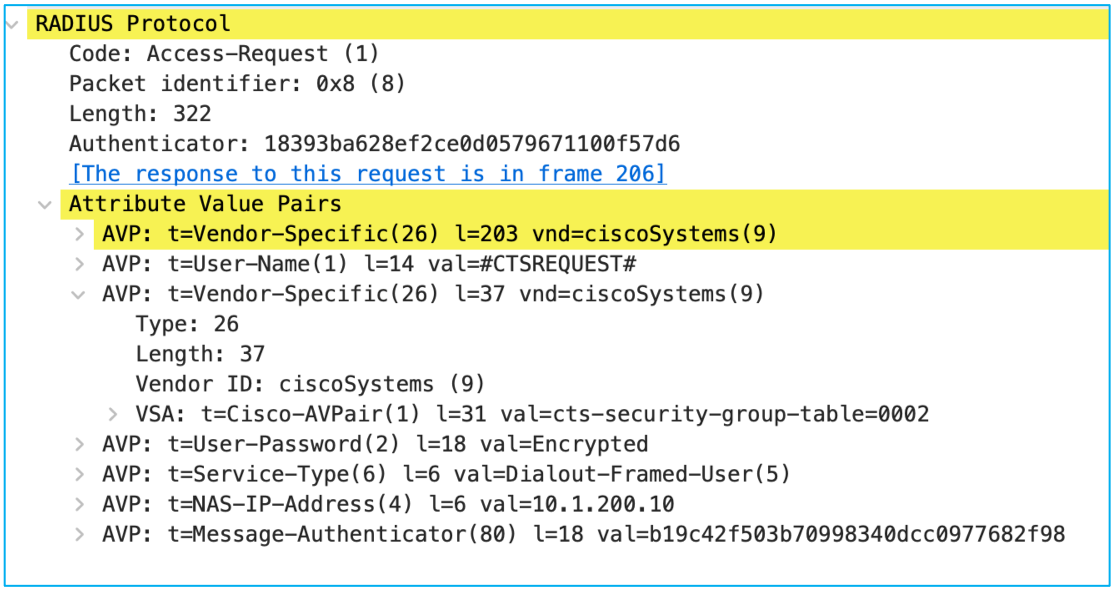
```
RADIUS Protocol
    Code: Access-Request (1)
    Packet identifier: 0x7 (7)
    Length: 368
    Authenticator: d6e064a67987ea5d6dfecde9b9d525d0
    [The response to this request is in frame 204]
    Attribute Value Pairs
        AVP: t=Vendor-Specific(26) l=203 vnd=ciscoSystems(9)
        AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
        AVP: t=Vendor-Specific(26) l=36 vnd=ciscoSystems(9)
            Type: 26
            Length: 36
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=30 val=cts-environment-data=9800-CL
        AVP: t=Vendor-Specific(26) l=47 vnd=ciscoSystems(9)
            Type: 26
            Length: 47
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=41 val=cts-device-capability=env-data-fragment
        AVP: t=User-Password(2) l=18 val=Encrypted
        AVP: t=Service-Type(6) l=6 val=Dialout-Framed-User(5)
        AVP: t=NAS-IP-Address(4) l=6 val=10.1.200.10
        AVP: t=Message-Authenticator(80) l=18 val=0dbbec035bbe3d69c854342df90910fa
```

Reply from ISE indicates there are two SGT tables, 0001 and 0002 along with associated version numbers. The SGT list is chopped up into manageable chunks to reduce the amount of data needing to be downloaded (hence this example shows 2 chunks, table 0001 and table 0002):



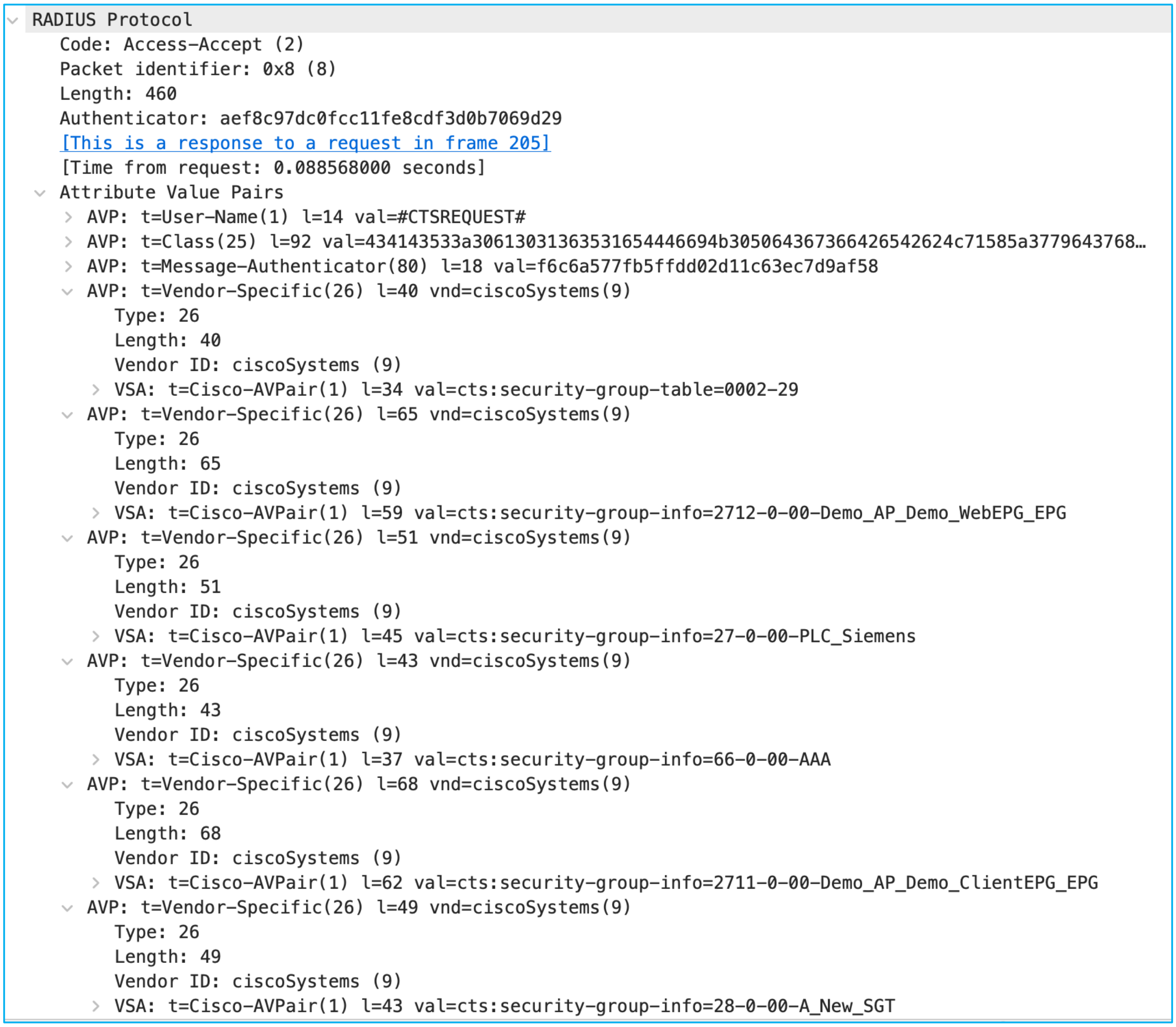
```
RADIUS Protocol
    Code: Access-Accept (2)
    Packet identifier: 0x7 (7)
    Length: 346
    Authenticator: 28f85a3207826f121e96b3343ee8d2ec
    [This is a response to a request in frame 198]
    [Time from request: 0.065771000 seconds]
    Attribute Value Pairs
        AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
        AVP: t=Class(25) l=92 val=434143533a30613031363531655578474557487a5543436c46653442746472745a497938…
        AVP: t=Message-Authenticator(80) l=18 val=4fd7eeee8d58b45adc5c395077058866
        AVP: t=Vendor-Specific(26) l=43 vnd=ciscoSystems(9)
            Type: 26
            Length: 43
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=37 val=cts:server-list=CTSServerList1-0001
        AVP: t=Vendor-Specific(26) l=38 vnd=ciscoSystems(9)
            Type: 26
            Length: 38
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=32 val=cts:security-group-tag=0002-00
        AVP: t=Vendor-Specific(26) l=41 vnd=ciscoSystems(9)
            Type: 26
            Length: 41
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=35 val=cts:environment-data-expiry=86400
        AVP: t=Vendor-Specific(26) l=40 vnd=ciscoSystems(9)
            Type: 26
            Length: 40
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=34 val=cts:security-group-table=0001-41
        AVP: t=Vendor-Specific(26) l=40 vnd=ciscoSystems(9)
            Type: 26
            Length: 40
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=34 val=cts:security-group-table=0002-29
```

The security-group-table 0001 shows a version of 41 (cts:security-group-table=0001-41) and this matches what the C9800 already internally has. So, no request is made to update any SGTs within table 0001. The version number for table 0002 (29) has been incremented since the C9800 last downloaded the list, so a request is made to download the new table 0002 list:



```
RADIUS Protocol
    Code: Access-Request (1)
    Packet identifier: 0x8 (8)
    Length: 322
    Authenticator: 18393ba628ef2ce0d0579671100f57d6
    [The response to this request is in frame 206]
    Attribute Value Pairs
        AVP: t=Vendor-Specific(26) l=203 vnd=ciscoSystems(9)
        AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
        AVP: t=Vendor-Specific(26) l=37 vnd=ciscoSystems(9)
            Type: 26
            Length: 37
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=31 val=cts-security-group-table=0002
        AVP: t=User-Password(2) l=18 val=Encrypted
        AVP: t=Service-Type(6) l=6 val=Dialout-Framed-User(5)
        AVP: t=NAS-IP-Address(4) l=6 val=10.1.200.10
        AVP: t=Message-Authenticator(80) l=18 val=b19c42f503b70998340dcc0977682f98
```

ISE replies with that new list including the new SGT that was recently added:



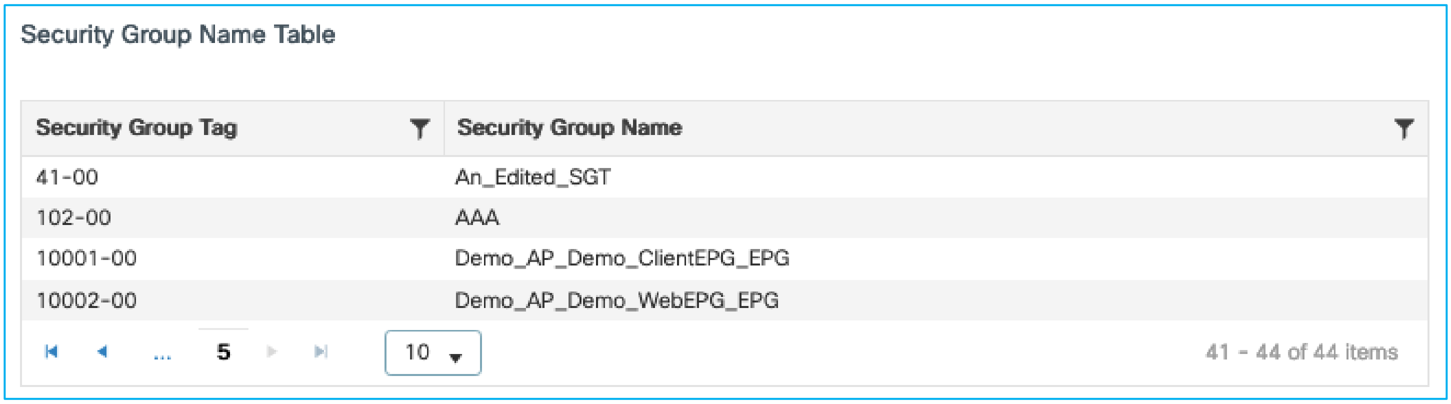
```
RADIUS Protocol
    Code: Access-Accept (2)
    Packet identifier: 0x8 (8)
    Length: 460
    Authenticator: aef8c97dc0fcc11fe8cdf3d0b7069d29
    [This is a response to a request in frame 205]
    [Time from request: 0.088568000 seconds]
  Attribute Value Pairs
      AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
      AVP: t=Class(25) l=92 val=434143533a30613031363531654446694b305064367366426542624c71585a3779643768…
      AVP: t=Message-Authenticator(80) l=18 val=f6c6a577fb5ffdd02d11c63ec7d9af58
      AVP: t=Vendor-Specific(26) l=40 vnd=ciscoSystems(9)
          Type: 26
          Length: 40
          Vendor ID: ciscoSystems (9)
          VSA: t=Cisco-AVPair(1) l=34 val=cts:security-group-table=0002-29
      AVP: t=Vendor-Specific(26) l=65 vnd=ciscoSystems(9)
          Type: 26
          Length: 65
          Vendor ID: ciscoSystems (9)
          VSA: t=Cisco-AVPair(1) l=59 val=cts:security-group-info=2712-0-00-Demo_AP_Demo_WebEPG_EPG
      AVP: t=Vendor-Specific(26) l=51 vnd=ciscoSystems(9)
          Type: 26
          Length: 51
          Vendor ID: ciscoSystems (9)
          VSA: t=Cisco-AVPair(1) l=45 val=cts:security-group-info=27-0-00-PLC_Siemens
      AVP: t=Vendor-Specific(26) l=43 vnd=ciscoSystems(9)
          Type: 26
          Length: 43
          Vendor ID: ciscoSystems (9)
          VSA: t=Cisco-AVPair(1) l=37 val=cts:security-group-info=66-0-00-AAA
      AVP: t=Vendor-Specific(26) l=68 vnd=ciscoSystems(9)
          Type: 26
          Length: 68
          Vendor ID: ciscoSystems (9)
          VSA: t=Cisco-AVPair(1) l=62 val=cts:security-group-info=2711-0-00-Demo_AP_Demo_ClientEPG_EPG
      AVP: t=Vendor-Specific(26) l=49 vnd=ciscoSystems(9)
          Type: 26
          Length: 49
          Vendor ID: ciscoSystems (9)
          VSA: t=Cisco-AVPair(1) l=43 val=cts:security-group-info=28-0-00-A_New_SGT
```

The SGT was successfully added to the C9800 using CoA.

Editing SGT and pushing the change via CoA

After adding SGT 40 above with the name A_New_SGT, both the name and number can be modified in ISE with a CoA being used to update the C9800. Edit the SGT in ISE at Work Centers > TrustSec > Components > Security Groups and change the name to An_Edited_SGT with a new number (example 41). Push the change from ISE.

Check in the C9800 at Monitoring > General > TrustSec, and go through the Security Group Name Table to find the newly edited SGT:



Security Group Name Table

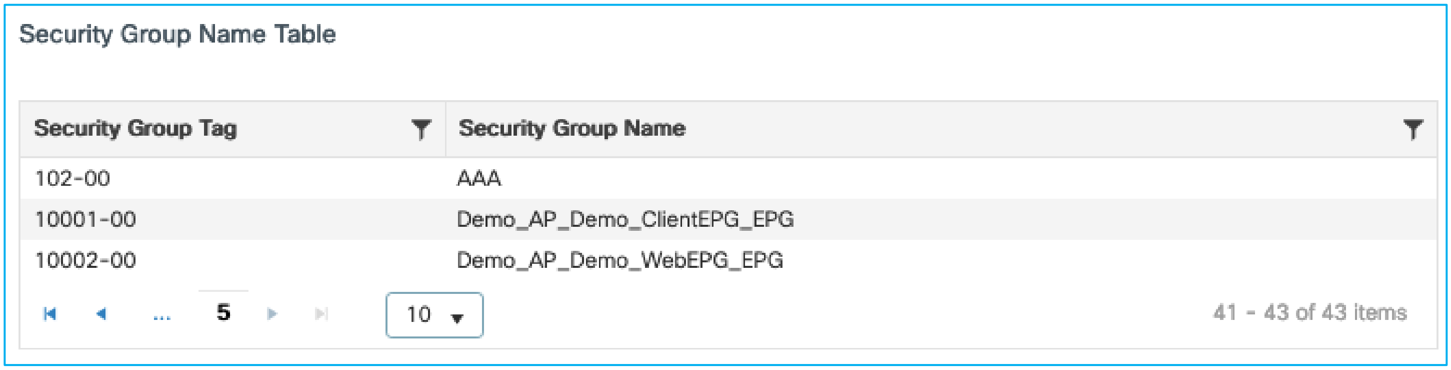
Security Group Tag	Security Group Name
41-00	An_Edited_SGT
102-00	AAA
10001-00	Demo_AP_Demo_ClientEPG_EPG
10002-00	Demo_AP_Demo_WebEPG_EPG

Both the SGT name and number were successfully updated on the C9800 using CoA.

Deleting SGT and pushing change via CoA

Delete that last SGT with name An_Edited_SGT in ISE at Work Centers > TrustSec > Components > Security Groups. Push the change to network devices.

Check in the C9800 at Monitoring > General > TrustSec, and go through the Security Group Name Table to see that An_Edited_SGT has been deleted:



Security Group Name Table

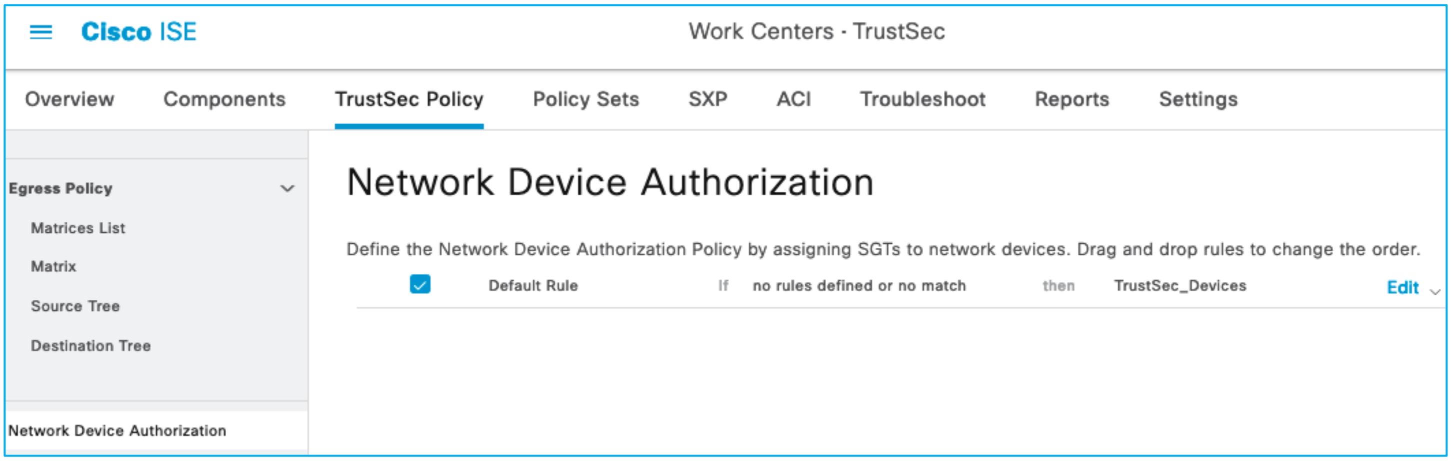
Security Group Tag	Security Group Name
102-00	AAA
10001-00	Demo_AP_Demo_ClientEPG_EPG
10002-00	Demo_AP_Demo_WebEPG_EPG

The SGT was successfully deleted on the C9800 using CoA.

Editing Device-SGT and pushing change via CoA

If a specific rule is added in ISE to assign a different Device SGT to the C9800, then that is honored by using CoA.

In ISE, add a specific rule at Work Centers > TrustSec > TrustSec Policy > Network Device Authorization:

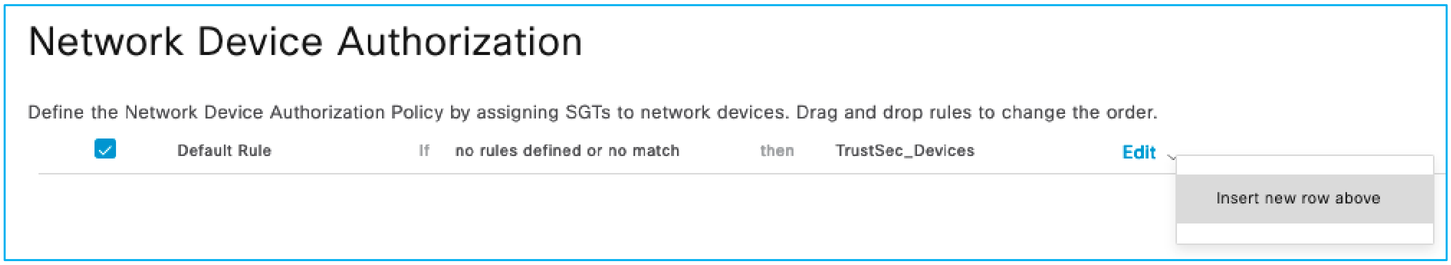


Network Device Authorization

Define the Network Device Authorization Policy by assigning SGTs to network devices. Drag and drop rules to change the order.

☑ Default Rule If no rules defined or no match then TrustSec_Devices

Click the down arrow next to Edit and insert a new rule:

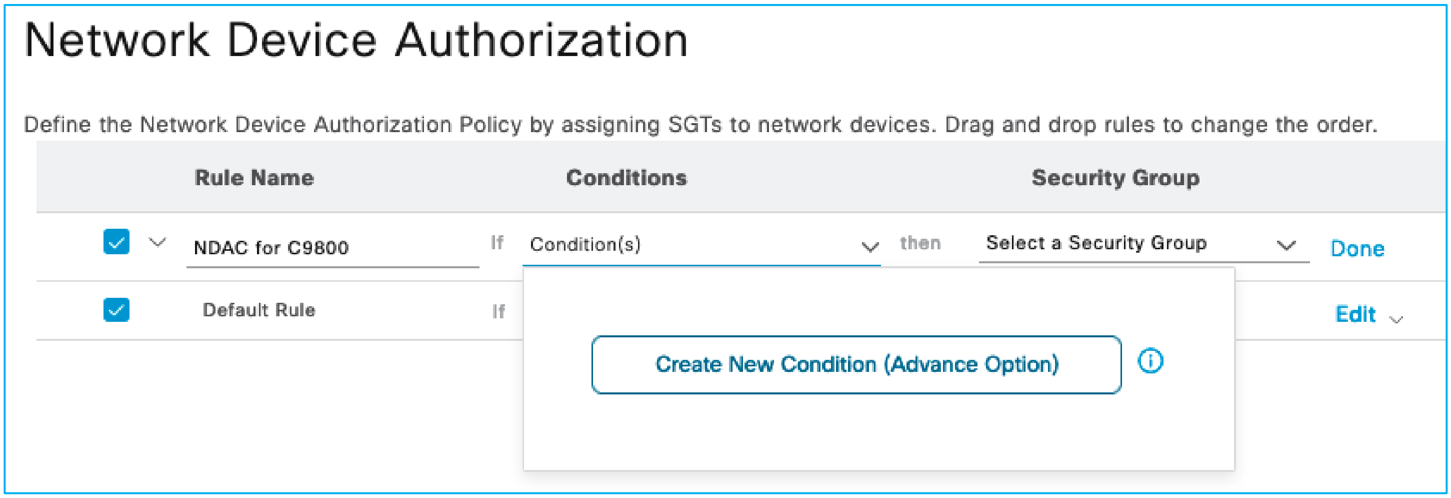


Network Device Authorization

Define the Network Device Authorization Policy by assigning SGTs to network devices. Drag and drop rules to change the order.

☑ Default Rule If no rules defined or no match then TrustSec_Devices

Provide a new rule name and click on the Condition(s) field.

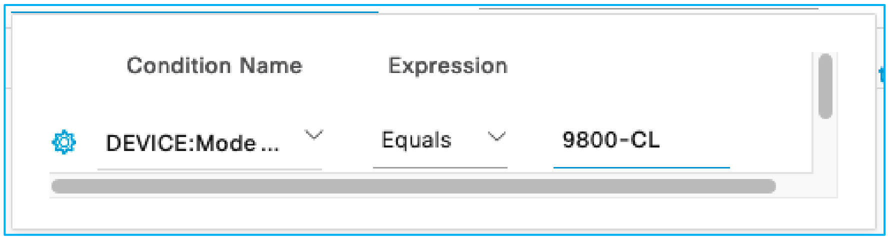


Network Device Authorization

Define the Network Device Authorization Policy by assigning SGTs to network devices. Drag and drop rules to change the order.

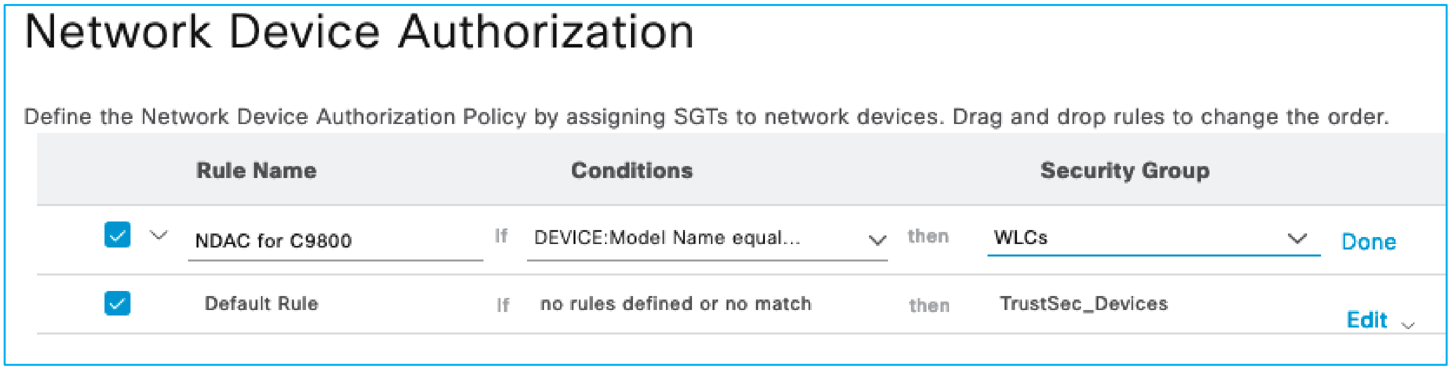
	Rule Name		Conditions		Security Group
☑	NDAC for C9800	If	Condition(s)	then	Select a Security Group
☑	Default Rule	If			

Create a new condition – for example, if the C9800 Network Device entry in ISE has the Model Name entered as ‘9800-CL’, then use that as a condition in this new rule. Click ‘Select Attribute’ and choose Model Name, then under Expression use equals with 9800-CL in the matching criteria:



Condition Name	Expression	
DEVICE:Mode ...	Equals	9800-CL

Click Done, then select Edit to add an SGT to be assigned when this condition is matched. E.g. one has been added in this system called WLCs (SGT 40):



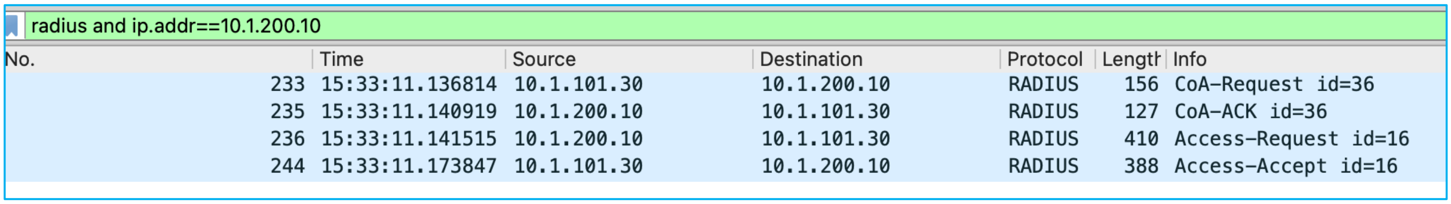
Network Device Authorization

Define the Network Device Authorization Policy by assigning SGTs to network devices. Drag and drop rules to change the order.

	Rule Name		Conditions		Security Group	
☑	NDAC for C9800	If	DEVICE:Model Name equal...	then	WLCs	Done
☑	Default Rule	If	no rules defined or no match	then	TrustSec_Devices	Edit

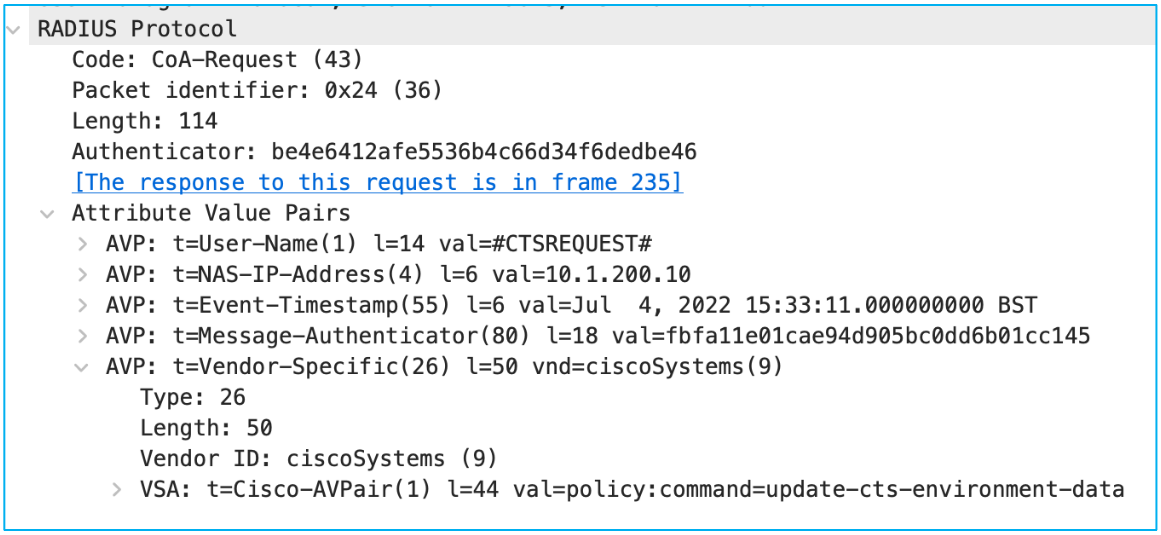
Click Done then Save. To the right of the Save option, click ‘Push’ to instigate a CoA message to inform the C9800 that a change to the Device SGT has occurred.

A wireshark capture shows the interaction:



```
radius and ip.addr==10.1.200.10
No.   Time             Source        Destination   Protocol  Length  Info
233   15:33:11.136814  10.1.101.30   10.1.200.10   RADIUS    156     CoA-Request id=36
235   15:33:11.140919  10.1.200.10   10.1.101.30   RADIUS    127     CoA-ACK id=36
236   15:33:11.141515  10.1.200.10   10.1.101.30   RADIUS    410     Access-Request id=16
244   15:33:11.173847  10.1.101.30   10.1.200.10   RADIUS    388     Access-Accept id=16
```

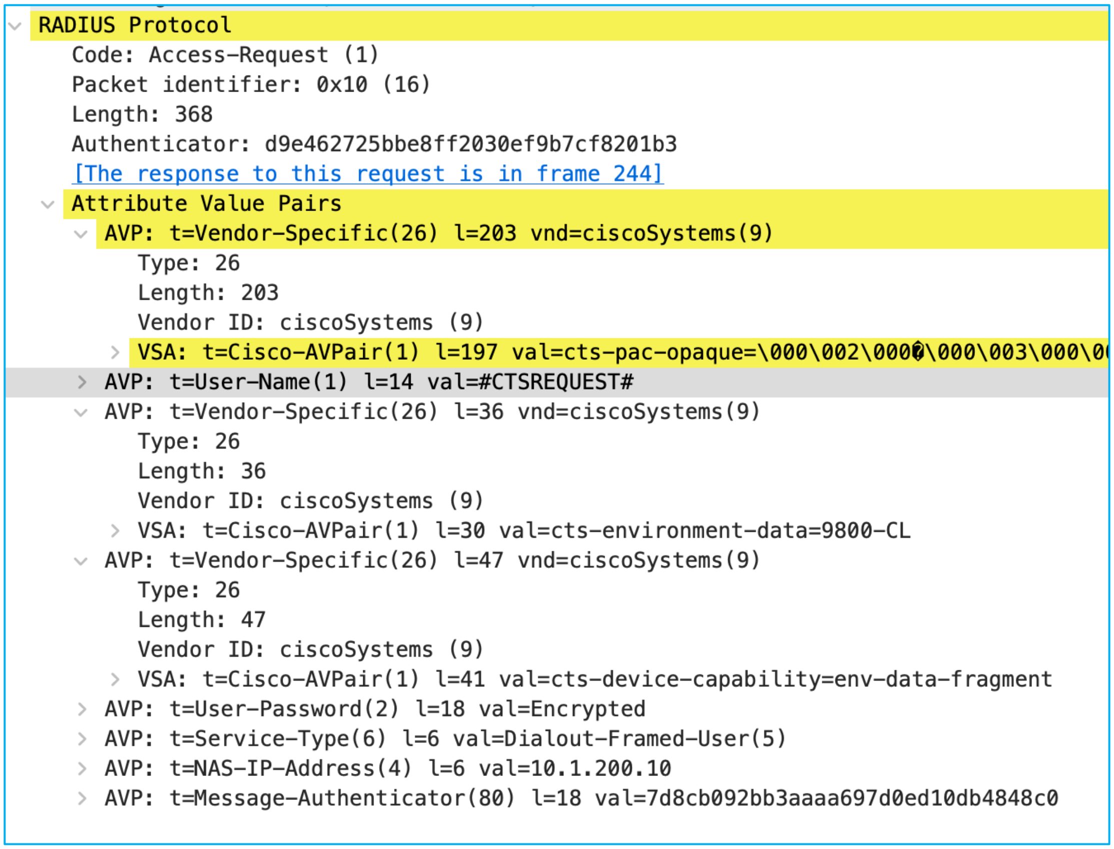
ISE sends a RADIUS CoA to inform of the Environment-Data change:



```
RADIUS Protocol
    Code: CoA-Request (43)
    Packet identifier: 0x24 (36)
    Length: 114
    Authenticator: be4e6412afe5536b4c66d34f6dedbe46
    [The response to this request is in frame 235]
    Attribute Value Pairs
      AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
      AVP: t=NAS-IP-Address(4) l=6 val=10.1.200.10
      AVP: t=Event-Timestamp(55) l=6 val=Jul  4, 2022 15:33:11.000000000 BST
      AVP: t=Message-Authenticator(80) l=18 val=fbfa11e01cae94d905bc0dd6b01cc145
      AVP: t=Vendor-Specific(26) l=50 vnd=ciscoSystems(9)
          Type: 26
          Length: 50
          Vendor ID: ciscoSystems (9)
        VSA: t=Cisco-AVPair(1) l=44 val=policy:command=update-cts-environment-data
```

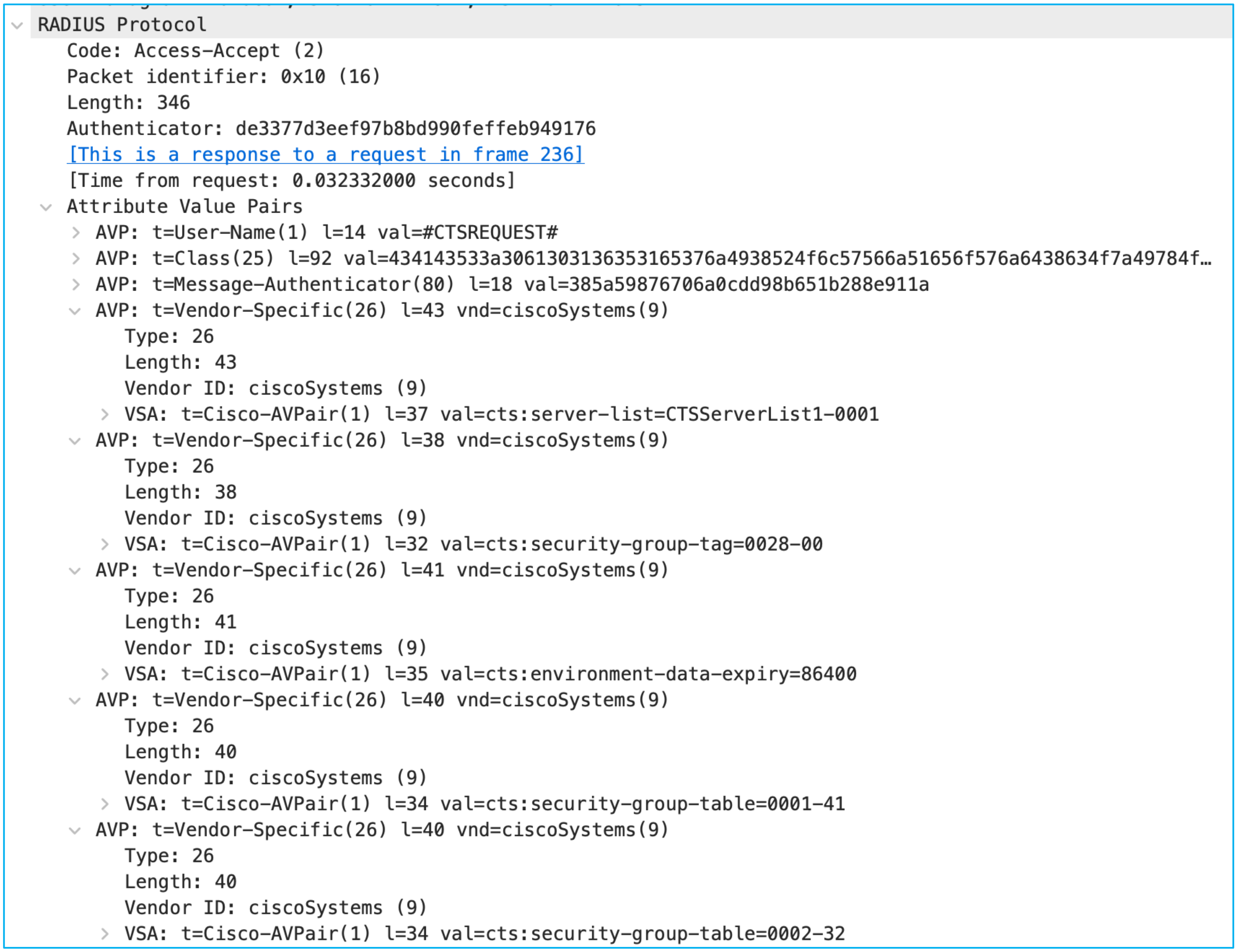
The C9800 acknowledges the CoA.

The C9800 then requests the updated Environment-Data table:



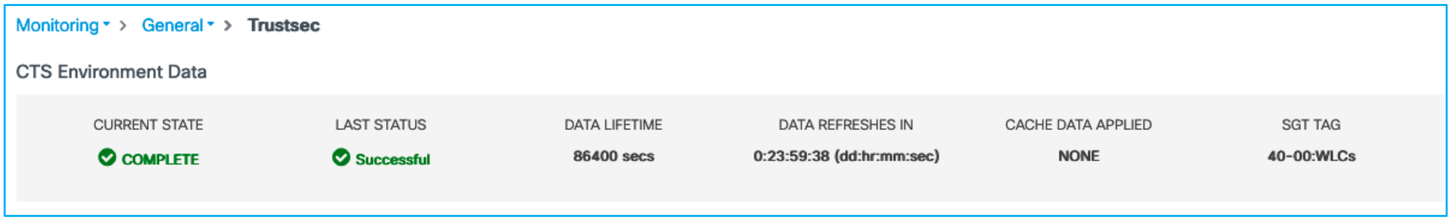
```
RADIUS Protocol
    Code: Access-Request (1)
    Packet identifier: 0x10 (16)
    Length: 368
    Authenticator: d9e462725bbe8ff2030ef9b7cf8201b3
    [The response to this request is in frame 244]
    Attribute Value Pairs
        AVP: t=Vendor-Specific(26) l=203 vnd=ciscoSystems(9)
            Type: 26
            Length: 203
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=197 val=cts-pac-opaque=\000\002\000�\000\003\000\0
        AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
        AVP: t=Vendor-Specific(26) l=36 vnd=ciscoSystems(9)
            Type: 26
            Length: 36
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=30 val=cts-environment-data=9800-CL
        AVP: t=Vendor-Specific(26) l=47 vnd=ciscoSystems(9)
            Type: 26
            Length: 47
            Vendor ID: ciscoSystems (9)
            VSA: t=Cisco-AVPair(1) l=41 val=cts-device-capability=env-data-fragment
        AVP: t=User-Password(2) l=18 val=Encrypted
        AVP: t=Service-Type(6) l=6 val=Dialout-Framed-User(5)
        AVP: t=NAS-IP-Address(4) l=6 val=10.1.200.10
        AVP: t=Message-Authenticator(80) l=18 val=7d8cb092bb3aaaa697d0ed10db4848c0
```

Finally, ISE sends the updated table with the new Device SGT cts:security-group-tag=0028 (which is hex, decimal = 4):



```
RADIUS Protocol
    Code: Access-Accept (2)
    Packet identifier: 0x10 (16)
    Length: 346
    Authenticator: de3377d3eef97b8bd990feffeb949176
    [This is a response to a request in frame 236]
    [Time from request: 0.032332000 seconds]
    Attribute Value Pairs
      AVP: t=User-Name(1) l=14 val=#CTSREQUEST#
      AVP: t=Class(25) l=92 val=434143533a30613031363531653765a4938524f6c57566a51656f576a6438634f7a49784f…
      AVP: t=Message-Authenticator(80) l=18 val=385a59876706a0cdd98b651b288e911a
      AVP: t=Vendor-Specific(26) l=43 vnd=ciscoSystems(9)
          Type: 26
          Length: 43
          Vendor ID: ciscoSystems (9)
        VSA: t=Cisco-AVPair(1) l=37 val=cts:server-list=CTSServerList1-0001
      AVP: t=Vendor-Specific(26) l=38 vnd=ciscoSystems(9)
          Type: 26
          Length: 38
          Vendor ID: ciscoSystems (9)
        VSA: t=Cisco-AVPair(1) l=32 val=cts:security-group-tag=0028-00
      AVP: t=Vendor-Specific(26) l=41 vnd=ciscoSystems(9)
          Type: 26
          Length: 41
          Vendor ID: ciscoSystems (9)
        VSA: t=Cisco-AVPair(1) l=35 val=cts:environment-data-expiry=86400
      AVP: t=Vendor-Specific(26) l=40 vnd=ciscoSystems(9)
          Type: 26
          Length: 40
          Vendor ID: ciscoSystems (9)
        VSA: t=Cisco-AVPair(1) l=34 val=cts:security-group-table=0001-41
      AVP: t=Vendor-Specific(26) l=40 vnd=ciscoSystems(9)
          Type: 26
          Length: 40
          Vendor ID: ciscoSystems (9)
        VSA: t=Cisco-AVPair(1) l=34 val=cts:security-group-table=0002-32
```

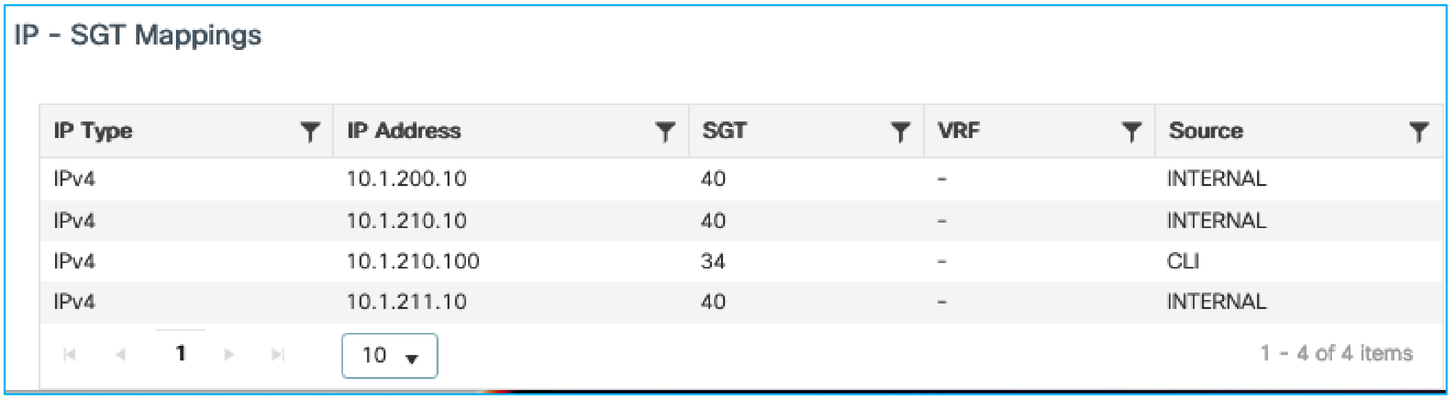
In the C9800 UI, navigate to Monitoring > General > TrustSec, and check the Device SGT near the top-right (it is labelled SGT TAG in the UI); it should have been updated (a screen refresh may be needed):



CTS Environment Data

CURRENT STATE	LAST STATUS	DATA LIFETIME	DATA REFRESHES IN	CACHE DATA APPLIED	SGT TAG
✓ COMPLETE	✓ Successful	86400 secs	0:23:59:38 (dd:hr:mm:sec)	NONE	40-00:WLCs

If you scroll to the bottom of that screen, you'll see the internal IP addresses of the C9800 have now been mapped to the new SGT:



IP - SGT Mappings

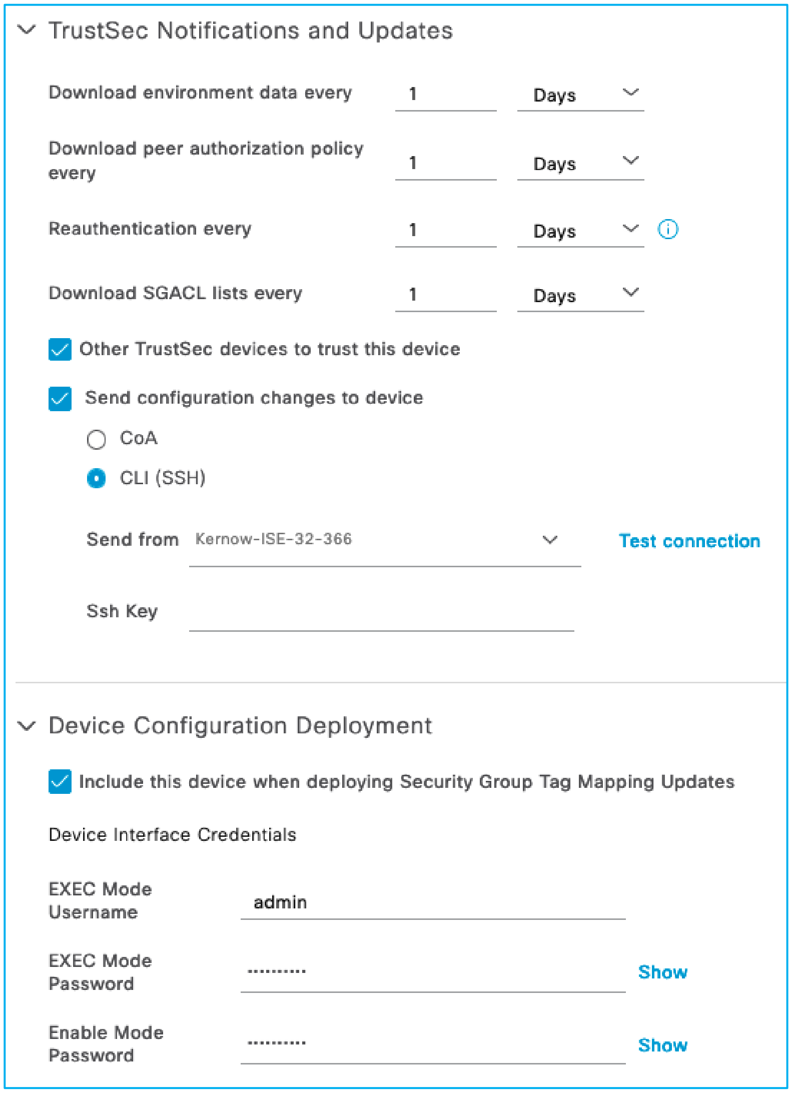
IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.200.10	40	-	INTERNAL
IPv4	10.1.210.10	40	-	INTERNAL
IPv4	10.1.210.100	34	-	CLI
IPv4	10.1.211.10	40	-	INTERNAL

The conclusion is that CoA can successfully be used to update the Device SGT within the C9800.

To continue testing, the Device SGT was set back to TrustSec_Devices SGT 2.

Adding SGT and pushing the change via SSH

Now, change the C9800 Network Device entry in ISE to use SSH for updates instead of using RADIUS CoA.



TrustSec Notifications and Updates

Download environment data every	1	Days
Download peer authorization policy every	1	Days
Reauthentication every	1	Days
Download SGACL lists every	1	Days

☑ Other TrustSec devices to trust this device

☑ Send configuration changes to device

○ CoA

● CLI (SSH)

Send from: Kernow-ISE-32-366

Ssh Key:

Device Configuration Deployment

☑ Include this device when deploying Security Group Tag Mapping Updates

Device Interface Credentials

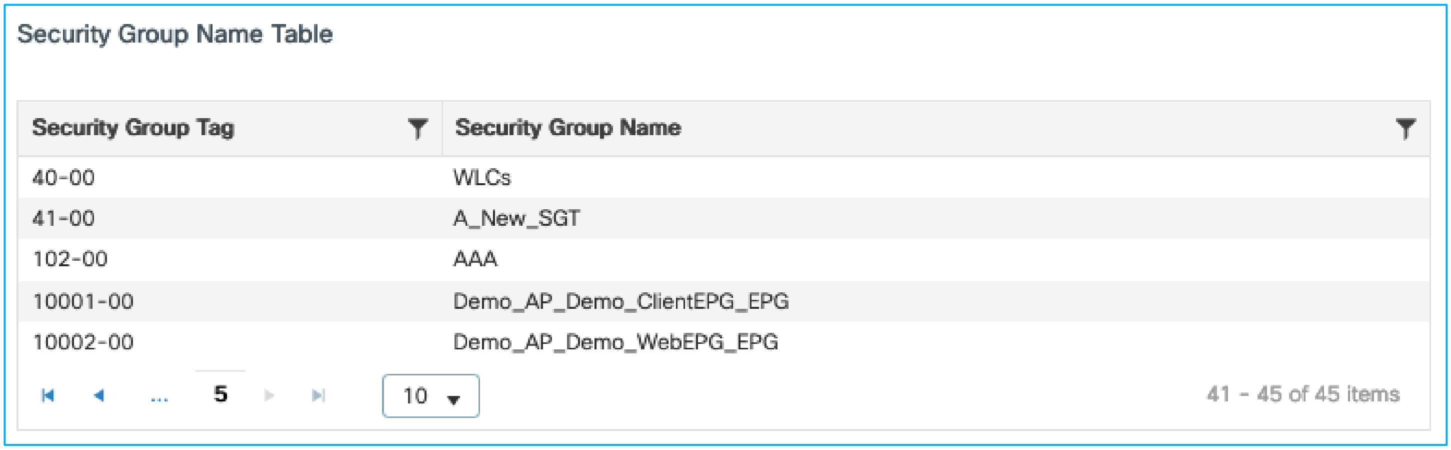
EXEC Mode Username: admin

EXEC Mode Password: ....

Enable Mode Password: ....

In ISE add a new SGT, perhaps called ‘A_New_SGT’ with SGT 41. Push the change so that the C9800 is made aware of the addition.

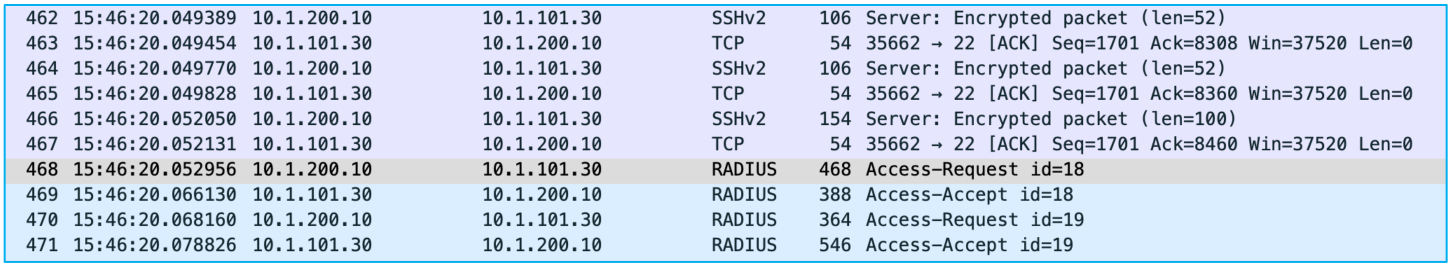
On the C9800, navigate to Monitoring > General > TrustSec, and go through the Security Group Name Table to find the newly added SGT:



Security Group Name Table

Security Group Tag	Security Group Name
40-00	WLCs
41-00	A_New_SGT
102-00	AAA
10001-00	Demo_AP_Demo_ClientEPG_EPG
10002-00	Demo_AP_Demo_WebEPG_EPG

A wireshark capture shows SSH being used to inform the C9800 of a change, then the C9800 uses RADIUS to check of any change made:



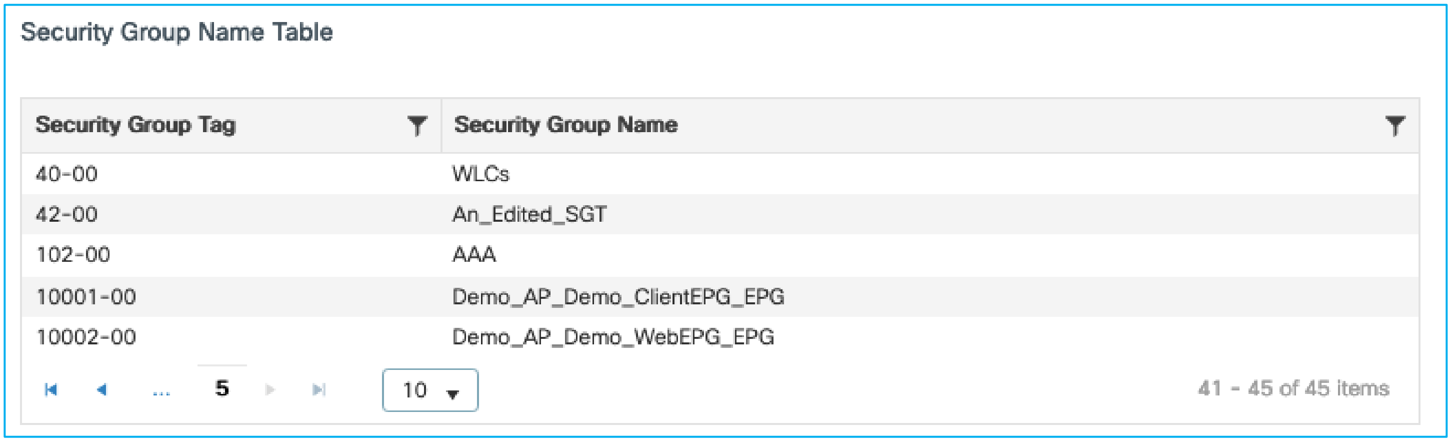
```
462  15:46:20.049389  10.1.200.10        10.1.101.30        SSHv2     106  Server: Encrypted packet (len=52)
463  15:46:20.049454  10.1.101.30        10.1.200.10        TCP        54  35662 → 22 [ACK] Seq=1701 Ack=8308 Win=37520 Len=0
464  15:46:20.049770  10.1.200.10        10.1.101.30        SSHv2     106  Server: Encrypted packet (len=52)
465  15:46:20.049828  10.1.101.30        10.1.200.10        TCP        54  35662 → 22 [ACK] Seq=1701 Ack=8360 Win=37520 Len=0
466  15:46:20.052050  10.1.200.10        10.1.101.30        SSHv2     154  Server: Encrypted packet (len=100)
467  15:46:20.052131  10.1.101.30        10.1.200.10        TCP        54  35662 → 22 [ACK] Seq=1701 Ack=8460 Win=37520 Len=0
468  15:46:20.052956  10.1.200.10        10.1.101.30        RADIUS    468  Access-Request id=18
469  15:46:20.066130  10.1.101.30        10.1.200.10        RADIUS    388  Access-Accept id=18
470  15:46:20.068160  10.1.200.10        10.1.101.30        RADIUS    364  Access-Request id=19
471  15:46:20.078826  10.1.101.30        10.1.200.10        RADIUS    546  Access-Accept id=19
```

SSH can be used successfully from ISE to add a new SGT in the C9800.

Editing SGT and pushing the change via SSH

Using ISE with SSH option selected, edit the SGT just added (A_New-SGT, SGT 41), to be ‘An_Edited_SGT’ with SGT 42. Push the change to instigate an SSH request from ISE to the C9800 to inform of an environment-data change.

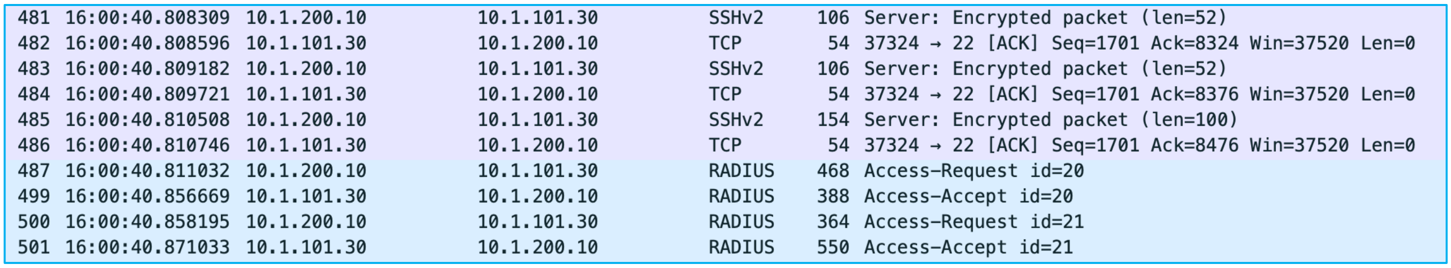
The C9800 shows the change under Monitoring > General > TrustSec:



Security Group Name Table

Security Group Tag	Security Group Name
40-00	WLCs
42-00	An_Edited_SGT
102-00	AAA
10001-00	Demo_AP_Demo_ClientEPG_EPG
10002-00	Demo_AP_Demo_WebEPG_EPG

Wireshark capture shows SSH being used to inform the C9800 of the change and then the C9800 requesting that change using RADIUS:



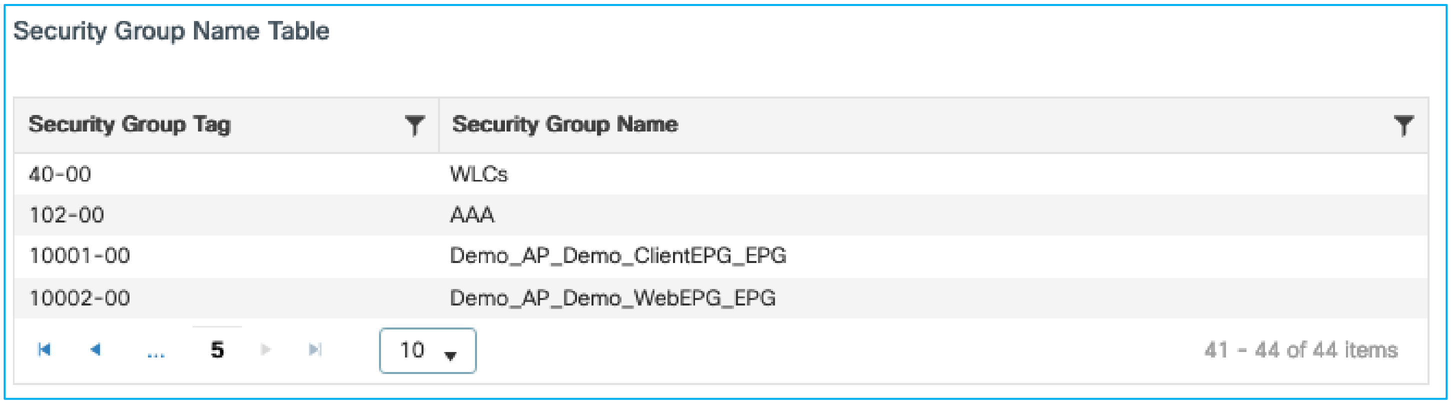
```
481  16:00:40.808309  10.1.200.10          10.1.101.30          SSHv2     106  Server: Encrypted packet (len=52)
482  16:00:40.808596  10.1.101.30          10.1.200.10          TCP        54  37324 → 22 [ACK] Seq=1701 Ack=8324 Win=37520 Len=0
483  16:00:40.809182  10.1.200.10          10.1.101.30          SSHv2     106  Server: Encrypted packet (len=52)
484  16:00:40.809721  10.1.101.30          10.1.200.10          TCP        54  37324 → 22 [ACK] Seq=1701 Ack=8376 Win=37520 Len=0
485  16:00:40.810508  10.1.200.10          10.1.101.30          SSHv2     154  Server: Encrypted packet (len=100)
486  16:00:40.810746  10.1.101.30          10.1.200.10          TCP        54  37324 → 22 [ACK] Seq=1701 Ack=8476 Win=37520 Len=0
487  16:00:40.811032  10.1.200.10          10.1.101.30          RADIUS    468  Access-Request id=20
499  16:00:40.856669  10.1.101.30          10.1.200.10          RADIUS    388  Access-Accept id=20
500  16:00:40.858195  10.1.200.10          10.1.101.30          RADIUS    364  Access-Request id=21
501  16:00:40.871033  10.1.101.30          10.1.200.10          RADIUS    550  Access-Accept id=21
```

To conclude, SGTs can be edited on the C9800 using ISE and SSH to inform of the change.

Deleting SGT and pushing the change via SSH

Use ISE with SSH option selected to delete the SGT called An_Edited_SGT, SGT 41. Push the change.

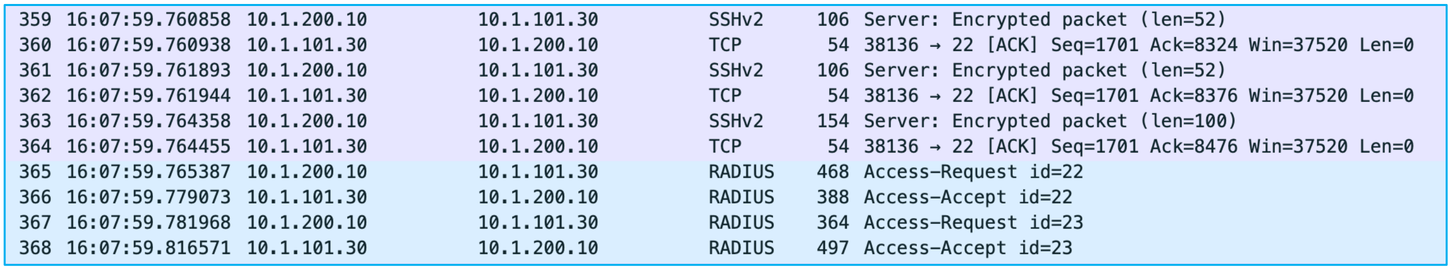
The C9800 shows the change under Monitoring > General > TrustSec:



Security Group Name Table

Security Group Tag	Security Group Name
40-00	WLCs
102-00	AAA
10001-00	Demo_AP_Demo_ClientEPG_EPG
10002-00	Demo_AP_Demo_WebEPG_EPG

Wireshark shows SSH being used to inform the C9800 of the change. The C9800 then requests the change.

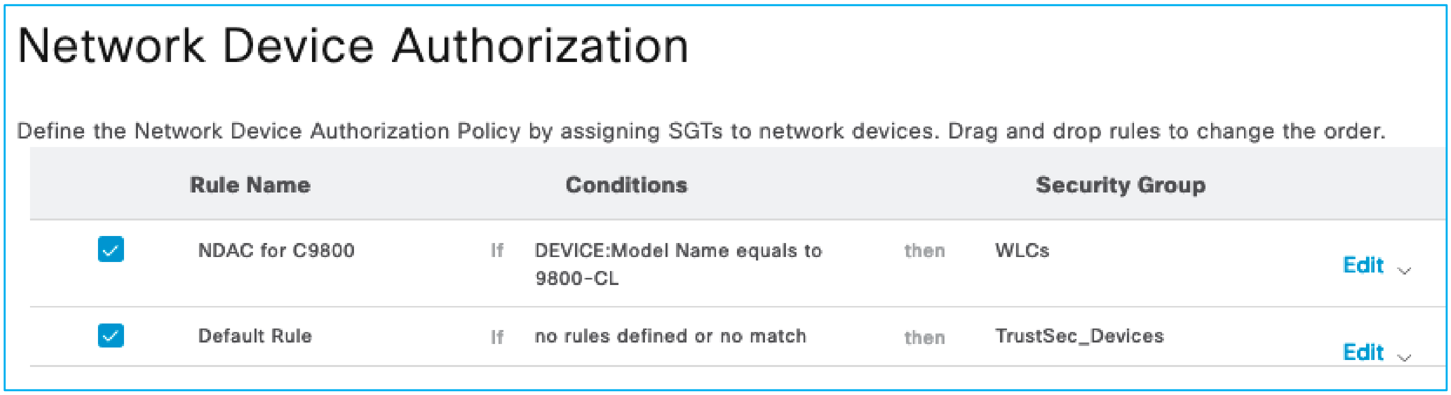


```
359  16:07:59.760858  10.1.200.10          10.1.101.30          SSHv2     106  Server: Encrypted packet (len=52)
360  16:07:59.760938  10.1.101.30          10.1.200.10          TCP        54  38136 → 22 [ACK] Seq=1701 Ack=8324 Win=37520 Len=0
361  16:07:59.761893  10.1.200.10          10.1.101.30          SSHv2     106  Server: Encrypted packet (len=52)
362  16:07:59.761944  10.1.101.30          10.1.200.10          TCP        54  38136 → 22 [ACK] Seq=1701 Ack=8376 Win=37520 Len=0
363  16:07:59.764358  10.1.200.10          10.1.101.30          SSHv2     154  Server: Encrypted packet (len=100)
364  16:07:59.764455  10.1.101.30          10.1.200.10          TCP        54  38136 → 22 [ACK] Seq=1701 Ack=8476 Win=37520 Len=0
365  16:07:59.765387  10.1.200.10          10.1.101.30          RADIUS    468  Access-Request id=22
366  16:07:59.779073  10.1.101.30          10.1.200.10          RADIUS    388  Access-Accept id=22
367  16:07:59.781968  10.1.200.10          10.1.101.30          RADIUS    364  Access-Request id=23
368  16:07:59.816571  10.1.101.30          10.1.200.10          RADIUS    497  Access-Accept id=23
```

SGTs can be deleted from the C9800 using ISE and the SSH protocol to inform of the deletion.

Editing Device's SGT and pushing the change via SSH

As when showing this option using RADIUS CoA, add an additional rule in ISE under Work Centers > TrustSec > TrustSec Policy > Network Device Authorization to be used by the c9800 when downloading the Device SGT:



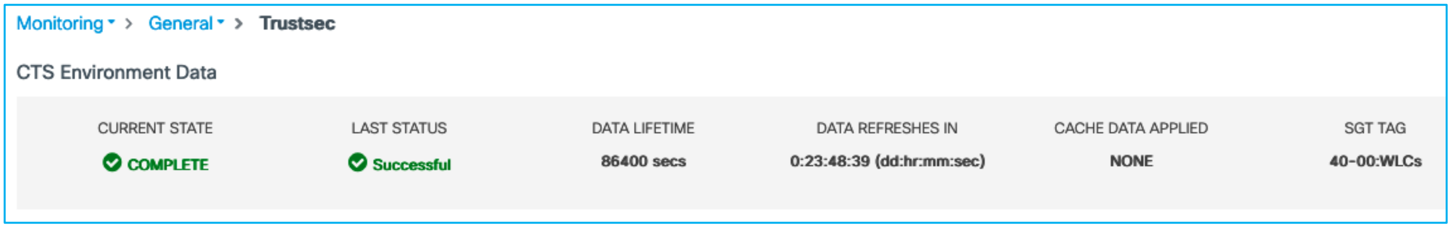
Network Device Authorization

Define the Network Device Authorization Policy by assigning SGTs to network devices. Drag and drop rules to change the order.

	Rule Name		Conditions		Security Group	
☑	NDAC for C9800	If	DEVICE:Model Name equals to 9800-CL	then	WLCs	Edit ⌄
☑	Default Rule	If	no rules defined or no match	then	TrustSec_Devices	Edit ⌄

Use the ‘Push’ function to instigate an SSH message to inform the C9800 that a change to the Device SGT has occurred.

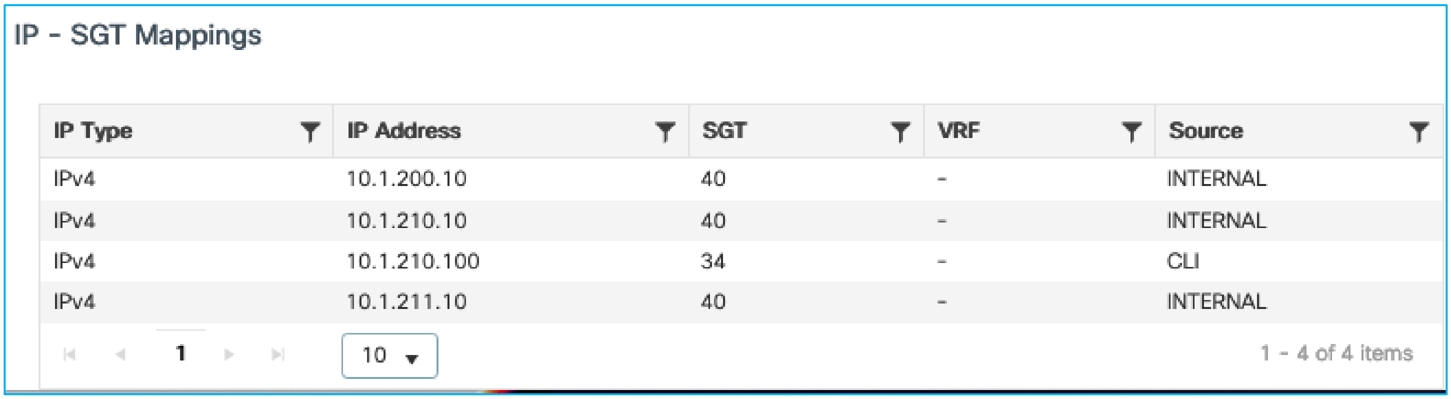
In the C9800 UI, navigate to Monitoring > General > TrustSec, and check the Device SGT near the top-right (it is labelled SGT TAG in the UI); it should have been updated (a screen refresh may be needed):



CTS Environment Data

CURRENT STATE	LAST STATUS	DATA LIFETIME	DATA REFRESHES IN	CACHE DATA APPLIED	SGT TAG
✓ COMPLETE	✓ Successful	86400 secs	0:23:48:39 (dd:hr:mm:sec)	NONE	40-00:WLCs

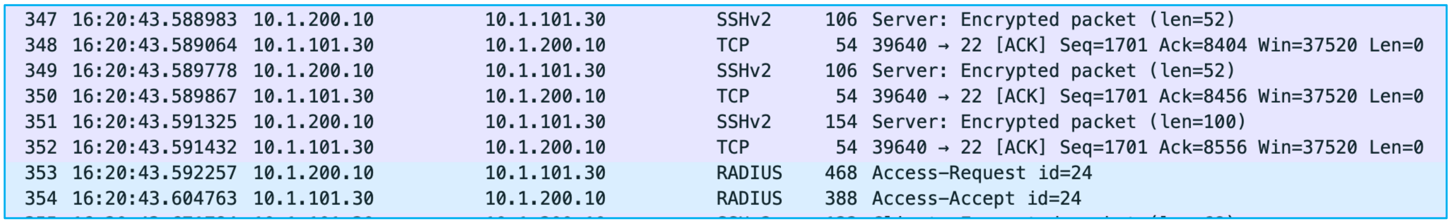
If you scroll to the bottom of that screen, you’ll see the internal IP addresses of the C9800 have now been mapped to the new SGT.



IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.200.10	40	-	INTERNAL
IPv4	10.1.210.10	40	-	INTERNAL
IPv4	10.1.210.100	34	-	CLI
IPv4	10.1.211.10	40	-	INTERNAL

A wireshark capture shows that SSH is used to inform the C9800 of the change before the C9800 uses RADIUS to download the change:



```
347 16:20:43.588983 10.1.200.10         10.1.101.30         SSHv2     106 Server: Encrypted packet (len=52)
348 16:20:43.589064 10.1.101.30         10.1.200.10         TCP        54 39640 → 22 [ACK] Seq=1701 Ack=8404 Win=37520 Len=0
349 16:20:43.589778 10.1.200.10         10.1.101.30         SSHv2     106 Server: Encrypted packet (len=52)
350 16:20:43.589867 10.1.101.30         10.1.200.10         TCP        54 39640 → 22 [ACK] Seq=1701 Ack=8456 Win=37520 Len=0
351 16:20:43.591325 10.1.200.10         10.1.101.30         SSHv2     154 Server: Encrypted packet (len=100)
352 16:20:43.591432 10.1.101.30         10.1.200.10         TCP        54 39640 → 22 [ACK] Seq=1701 Ack=8556 Win=37520 Len=0
353 16:20:43.592257 10.1.200.10         10.1.101.30         RADIUS    468 Access-Request id=24
354 16:20:43.604763 10.1.101.30         10.1.200.10         RADIUS    388 Access-Accept id=24
```

SSH can be used by ISE to update the C9800 Device SGT.

To continue testing, the Device SGT was set back to TrustSec_Devices SGT 2.

East-West Enforcement

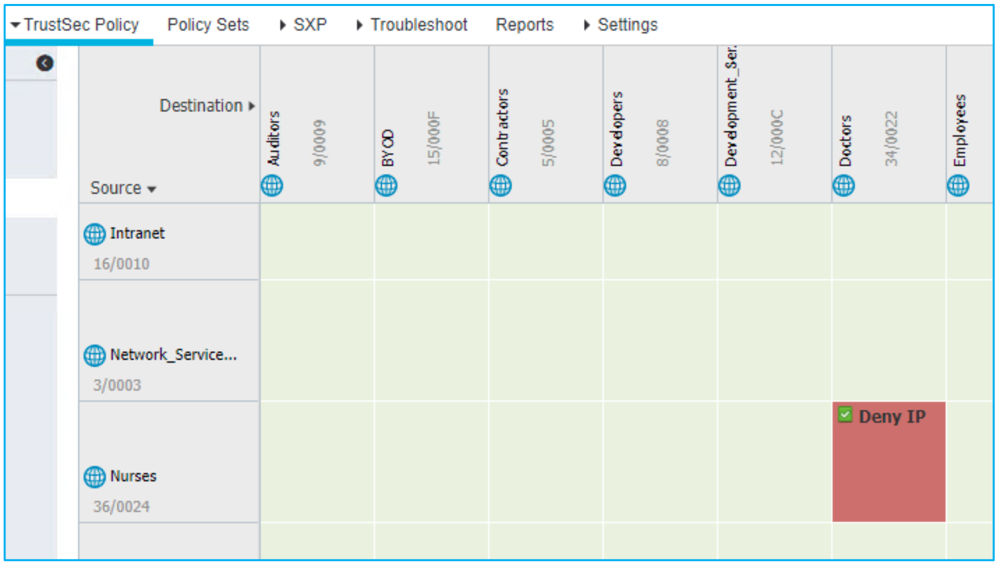
East-West enforcement refers to policy enforcement on traffic from wireless client to another wireless client. There are multiple use cases for this scenario:

Clients connected to the same SSID and same policy profile, upon successful authentication, they are assigned to two SGTs. For example, doctors and nurses would use the same Employee SSID but they receive different SGTs so that a specific policy can be assigned. This is the use case below referred to as “E-W using single policy profile”.

Another use case is where clients connected to two separated SSIDs and policy profiles, for example Doctors and Guest, would receive different SGTs and a specific policy is applied. This is the use case below referred to as “E-W using different policy profile”.

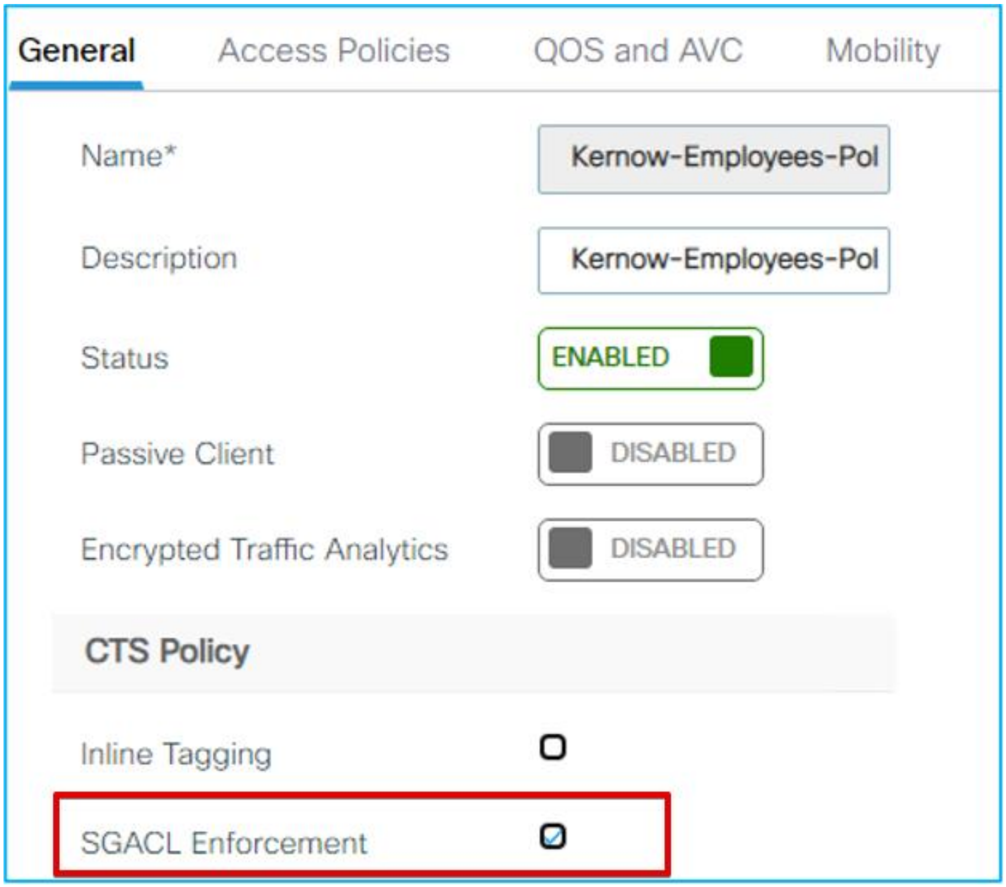
E-W using single Policy Profile

In this case, there is one SSID/WLAN (Employee) and one associated Policy Profile; two groups of users are defined on ISE: Doctors and Nurses. As you can see from ISE policy matrix below, Doctors are assigned SGT = 34 and Nurses = 36 and the SGACL has been configured to deny traffic from Nurses to Doctors.



Source / Destination	Auditors 9/0009	BYOD 15/000F	Contractors 5/0005	Developers 8/0008	Development_Ser. 12/000C	Doctors 34/0022	Employees
Intranet 16/0010							
Network_Service... 3/0003							
Nurses 36/0024						☑ Deny IP	

When a nurse and a doctor wireless clients connect to the Employee SSID, they are assigned to the respective SGT, the policy is downloaded on C9800 automatically. For the policy to be enforced on wireless clients, you need to enable SGACL enforcement on the policy Profile:



Name* Kernow-Employees-Pol

Description Kernow-Employees-Pol

Status ENABLED

Passive Client DISABLED

Encrypted Traffic Analytics DISABLED

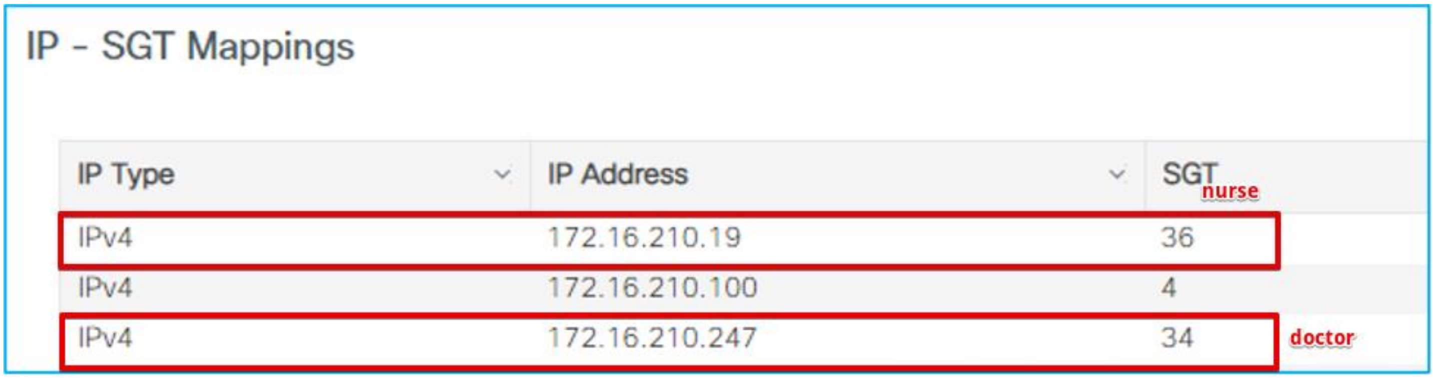
CTS Policy

Inline Tagging ☐

SGACL Enforcement ☑

You can verify under Monitoring > General > TrustSec page on the C9800. Here is the IP to SGT mapping:

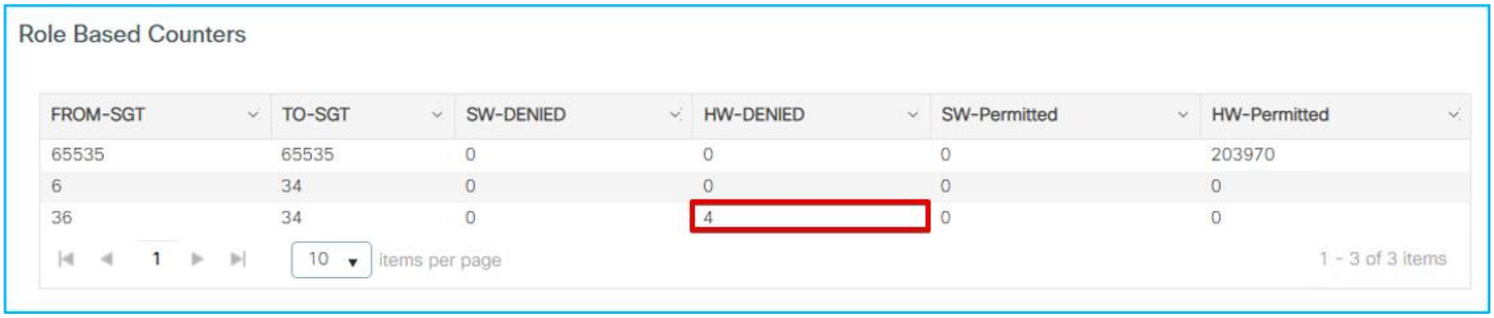
Doctor got an IP of 172.16.210.247 and SGT = 34; the nurse 172.16.210.19 and SGT = 36. Both are on the same subnet and same policy profile. The GBP policy is downloaded to deny traffic from SGT 36 to SGT 34:



IP - SGT Mappings

IP Type	IP Address	SGT	
IPv4	172.16.210.19	36	nurse
IPv4	172.16.210.100	4	
IPv4	172.16.210.247	34	doctor

If a ping is started between the two clients, you can see the HW-DENIED counter increasing:



Role Based Counters

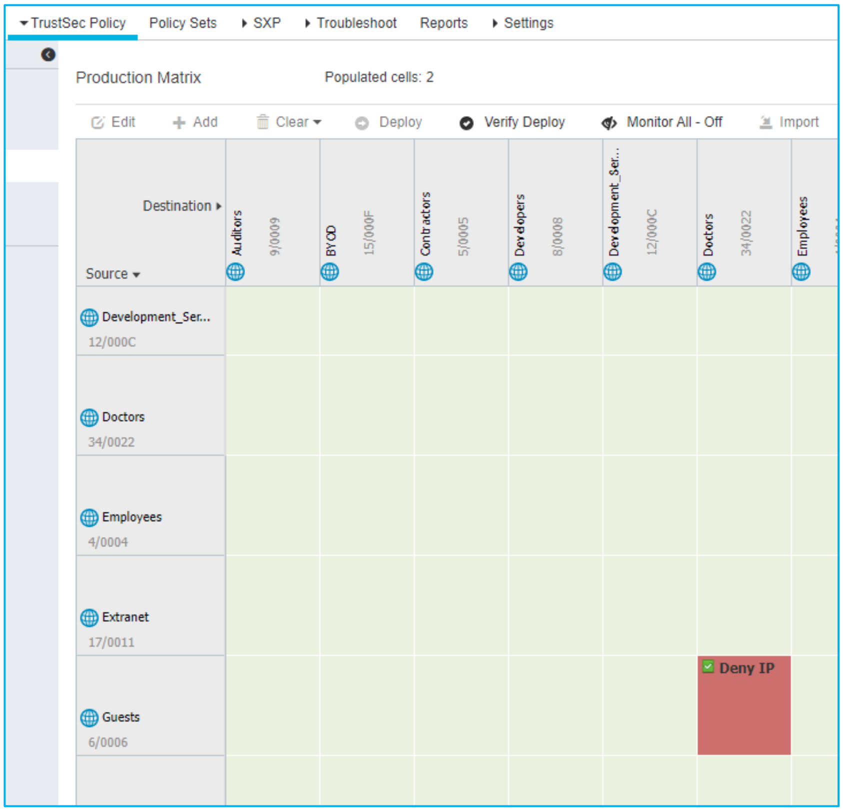
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
65535	65535	0	0	0	203970
6	34	0	0	0	0
36	34	0	4	0	0

This verifies that the policy is enforced at the controller for two clients connected to same SSID/policy profile but different SGTs.

In the past, CTS policies have been seen to remain even after removing enforcement. This is fixed and supported from 17.9.1: CSCwb52864 HCA: 9800L-HA policies were intact even after removing the enforcement from the wireless profile.

E-W Using different Policy Profiles

In this use case, you have two SSIDs (Employee and Guest) and two different policy profiles to associate the clients to two different VLANs, 210 and 211 respectively. A group-based policy is configured on ISE to assign Guest to SGT = 6 and to deny traffic from Guests (source) to Doctors (destination), as you can see from the policy matrix below:

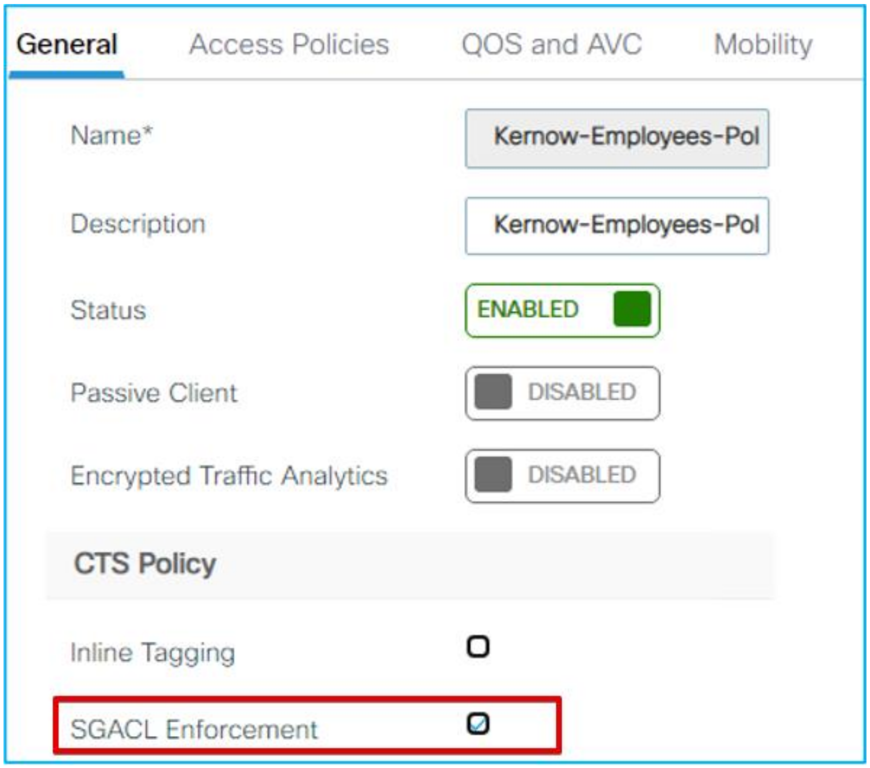


Production Matrix

Populated cells: 2

Source ▾ / Destination ▸	Auditors 9/0009	BYOD 15/000F	Contractors 5/0005	Developers 8/0008	Development_Ser... 12/000C	Doctors 34/0022	Employees
Development_Ser... 12/000C							
Doctors 34/0022							
Employees 4/0004							
Extranet 17/0011							
Guests 6/0006						☑ Deny IP	

When a guest and a doctor wireless clients connect to the respective SSID, they are assigned the SGT and the policy is downloaded on C9800 automatically. For the downloaded policy to be enforced on the wireless clients you need to have SGACL enforcement enabled on the policy profile. Since you have two policy profiles, the rule is no different than on other IOS-XE network devices: enforcement happens closest to the destination; in this case this means that the SGACL enforcement needs to be enabled only on the destination policy profile, which is the Employees one that the Doctor belongs to for enforcement from Guest to Doctor:



Name* Kernow-Employees-Pol

Description Kernow-Employees-Pol

Status ENABLED

Passive Client DISABLED

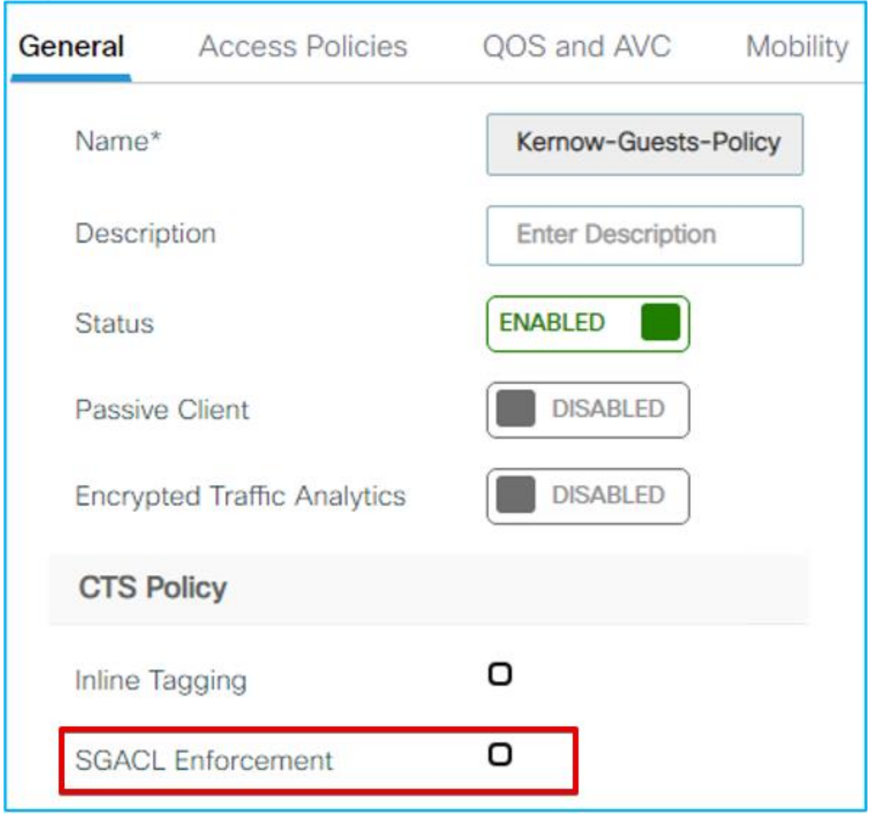
Encrypted Traffic Analytics DISABLED

CTS Policy

Inline Tagging □

SGACL Enforcement ☑

As you can see below, there is no enforcement set on the Guest policy profile:



Name* Kernow-Guests-Policy

Description Enter Description

Status ENABLED

Passive Client DISABLED

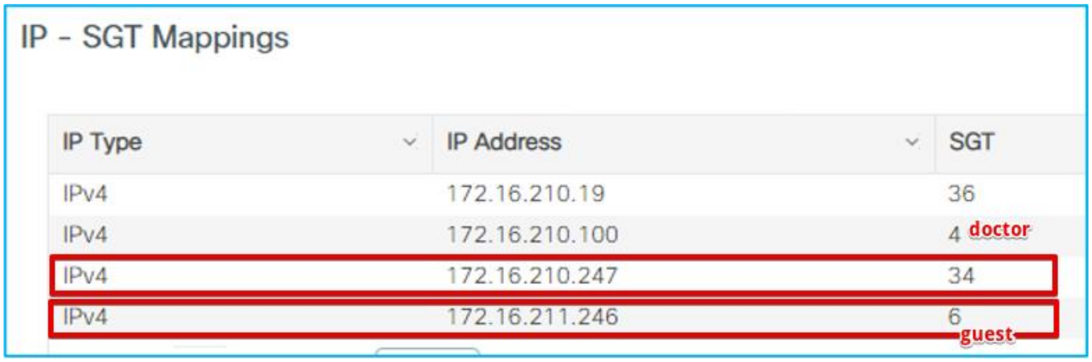
Encrypted Traffic Analytics DISABLED

CTS Policy

Inline Tagging □

SGACL Enforcement □

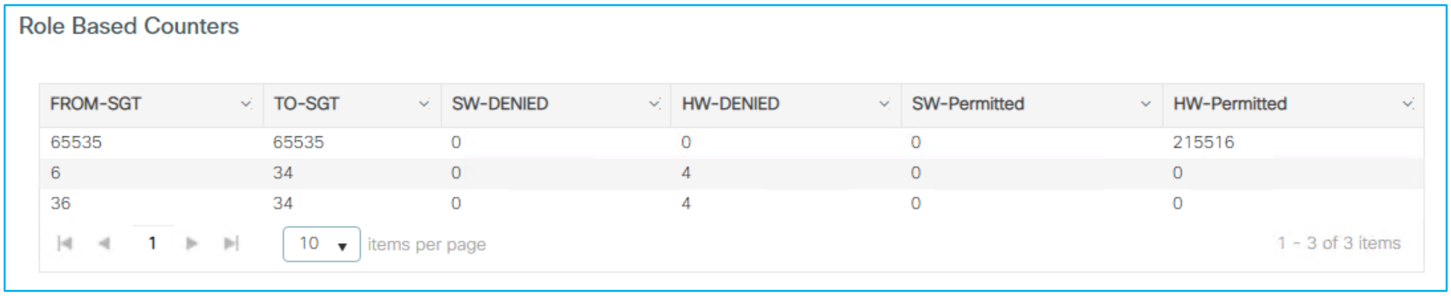
You can verify this under Monitoring > General > TrustSec page on the C9800. Here is the IP to SGT mapping:



IP - SGT Mappings

IP Type	IP Address	SGT
IPv4	172.16.210.19	36
IPv4	172.16.210.100	4 doctor
IPv4	172.16.210.247	34
IPv4	172.16.211.246	6 guest

Doctor got an IP of 172.16.210.247 and SGT = 34; the guest belongs to a different subnet (vlan 211) and is assigned IP 172.16.211.246 and SGT = 6. The GBP policy is downloaded to deny traffic from SGT 6 to SGT 34. If a ping is started between the two clients, you can see the HW-Denied counter is increasing:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
65535	65535	0	0	0	215516
6	34	0	4	0	0
36	34	0	4	0	0

This confirms that the enforcement happened and was enforced on the destination policy profile.

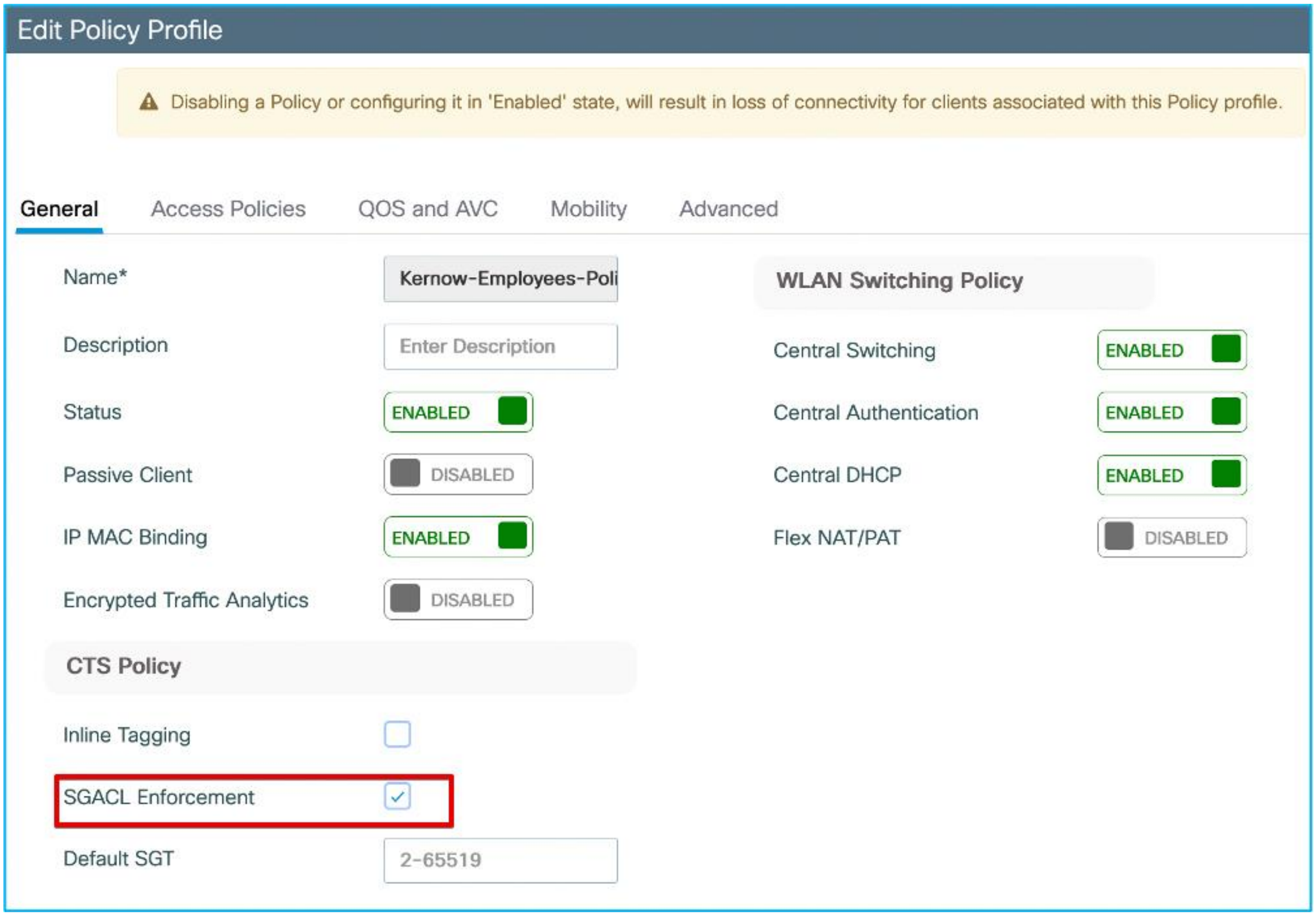
North to South (N-S) Enforcement on C9800

Here the use-case is to enforce a policy on traffic coming from the wired network to the wireless network (commonly known as north to south traffic).

N-S Enforcement Using SXP for Source

This use-case is to enforce wired to wireless on the C9800 but use a source SGT learned from SXP. The destination SGT will be the SGT assigned to a wireless client.

Ensure the Policy Profile in use has SGACL Enforcement enabled:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*: Kernow-Employees-Poli

Description: Enter Description

Status: ENABLED

Passive Client: DISABLED

IP MAC Binding: ENABLED

Encrypted Traffic Analytics: DISABLED

CTS Policy

Inline Tagging: □

SGACL Enforcement: ☑

Default SGT: 2-65519

WLAN Switching Policy

Central Switching: ENABLED

Central Authentication: ENABLED

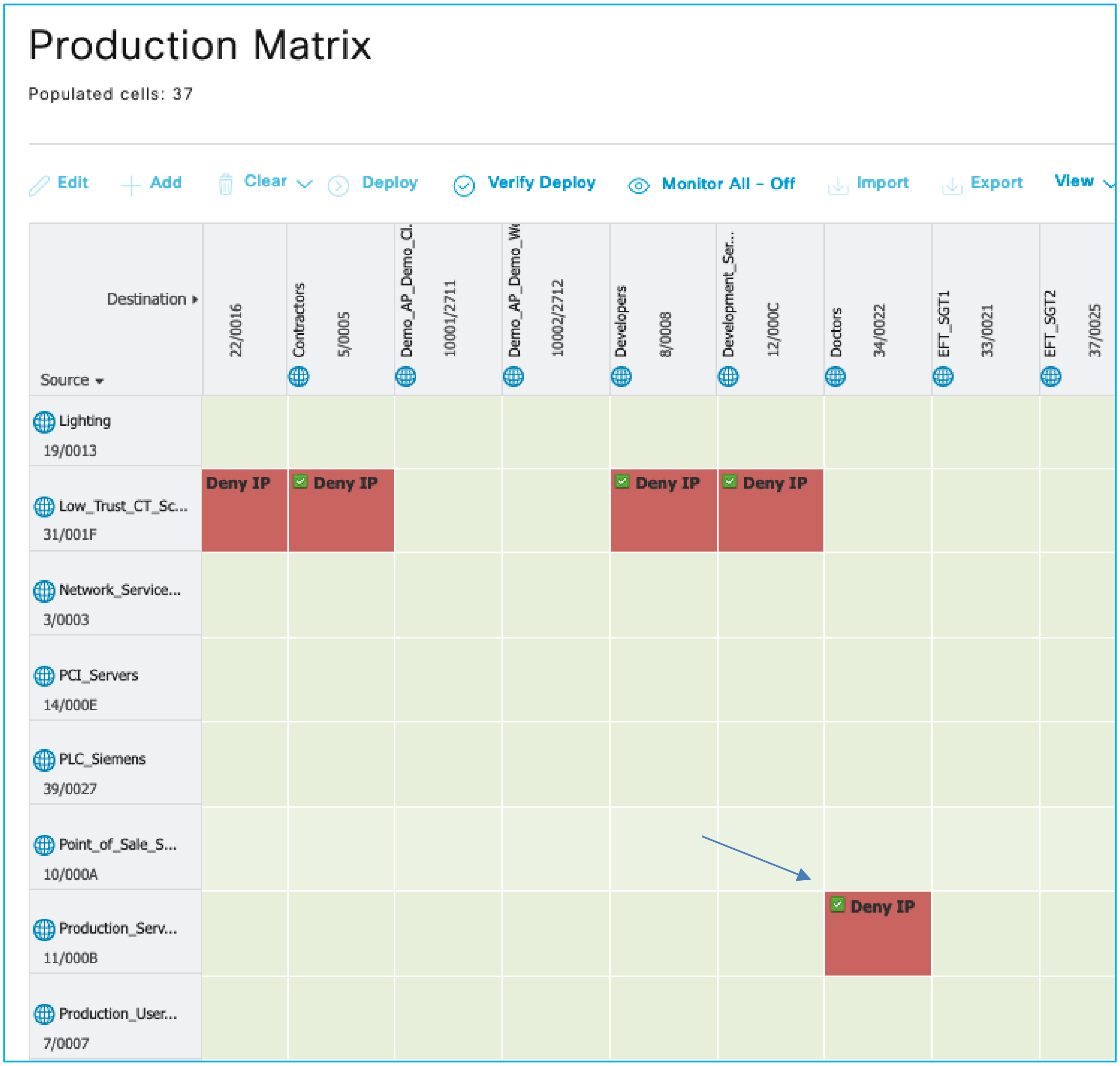
Central DHCP: ENABLED

Flex NAT/PAT: DISABLED

Also ensure that the upstream switch is not set for inline tagging (so inline CMD is not received):

```
interface GigabitEthernet1/0/15
 switchport trunk allowed vlan 200,210,211
 switchport mode trunk
 switchport nonegotiate
 ip dhcp snooping trust
end
```

Wired Production_Server SGT 11, 10.1.140.2 (source) sending data towards wireless client Doctors SGT 34, 10.1.210.100 (destination). Policy exists in ISE to deny traffic from Production_Servers to Doctors:

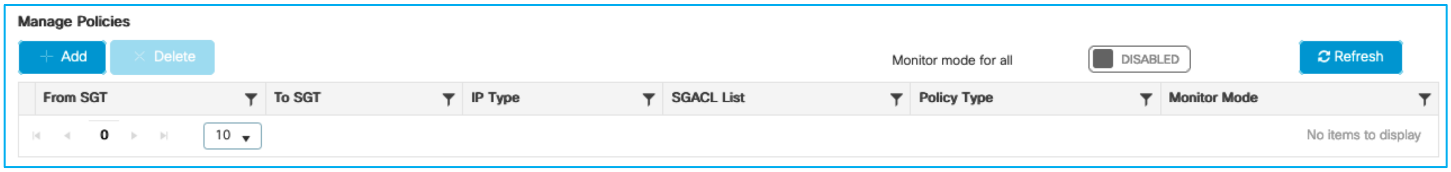


Production Matrix

Populated cells: 37

Destination ▸ / Source ▾	22/0016	Contractors 5/0005	Demo_AP_Demo_Cl 10001/2711	Demo_AP_Demo_W 10002/2712	Developers 8/0008	Development_Ser... 12/000C	Doctors 34/0022	EFT_SGT1 33/0021	EFT_SGT2 37/0025
Lighting 19/0013									
Low_Trust_CT_Sc... 31/001F	Deny IP	✓ Deny IP			✓ Deny IP	✓ Deny IP			
Network_Service... 3/0003									
PCI_Servers 14/000E									
PLC_Siemens 39/0027									
Point_of_Sale_S... 10/000A									
Production_Serv... 11/000B							✓ Deny IP		
Production_User... 7/0007									

Without wireless client connected, no policies downloaded to C9800 yet, check at Configuration > Security > TrustSec > CTS Policies:

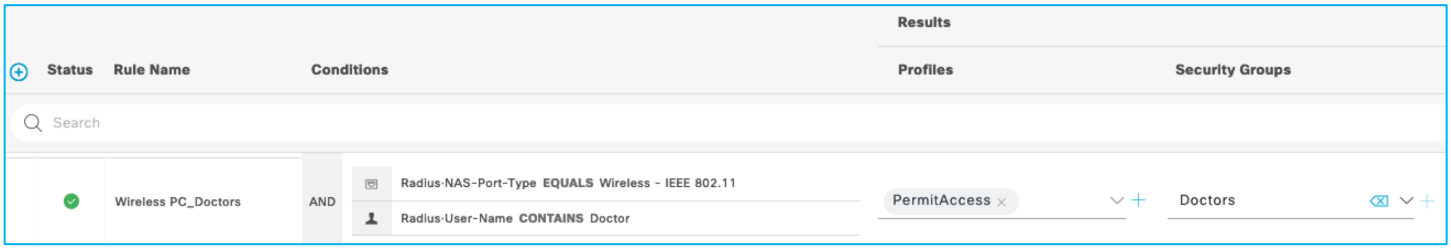


Manage Policies

From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode

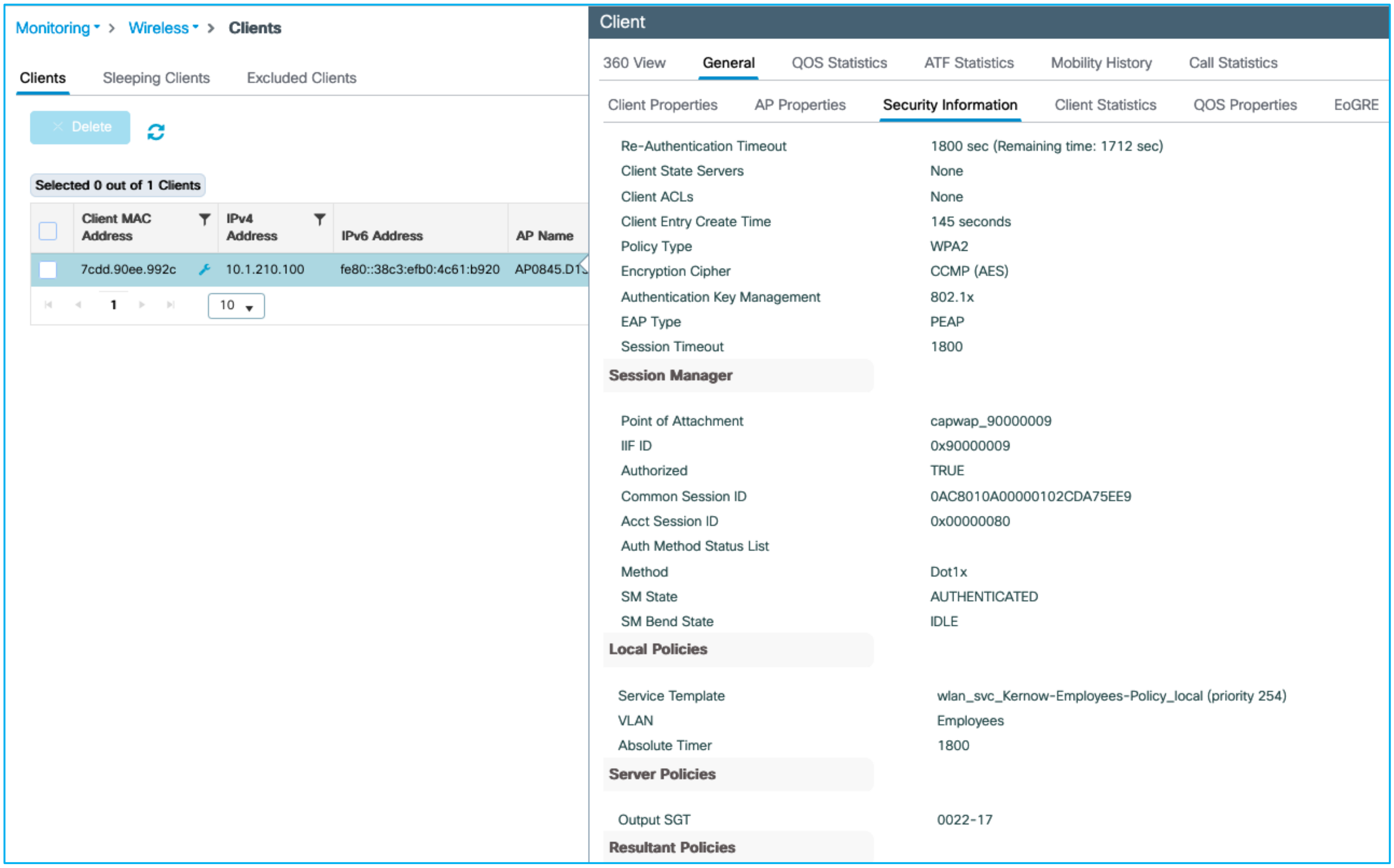
0 | 10 | No items to display

When wireless client connects, ISE assigns Doctors SGT via authorization table:



			Results	
Status	Rule Name	Conditions	Profiles	Security Groups
✓	Wireless PC_Doctors	AND Radius·NAS-Port-Type EQUALS Wireless - IEEE 802.11 Radius·User-Name CONTAINS Doctor	PermitAccess	Doctors

C9800 shows the assigned SGT at bottom of Monitoring > Wireless > Clients > Click Client > General > Security Information (remember this number is in hexadecimal):



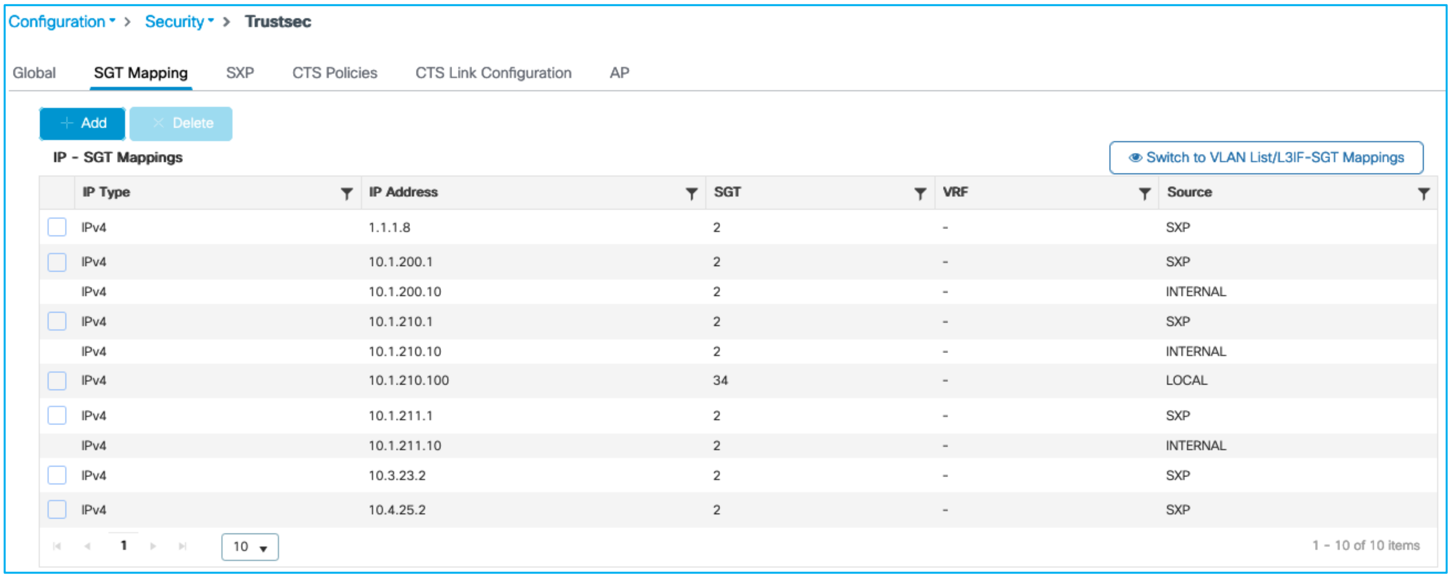
Monitoring > Wireless > Clients
Clients Sleeping Clients Excluded Clients
Delete
Selected 0 out of 1 Clients

Client MAC Address	IPv4 Address	IPv6 Address	AP Name
7cdd.90ee.992c	10.1.210.100	fe80::38c3:efb0:4c61:b920	AP0845.D1

Client
360 View General QOS Statistics ATF Statistics Mobility History Call Statistics
Client Properties AP Properties Security Information Client Statistics QOS Properties EoGRE

Re-Authentication Timeout	1800 sec (Remaining time: 1712 sec)
Client State Servers	None
Client ACLs	None
Client Entry Create Time	145 seconds
Policy Type	WPA2
Encryption Cipher	CCMP (AES)
Authentication Key Management	802.1x
EAP Type	PEAP
Session Timeout	1800
Session Manager	
Point of Attachment	capwap_90000009
IIF ID	0x90000009
Authorized	TRUE
Common Session ID	0AC8010A00000102CDA75EE9
Acct Session ID	0x00000080
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE
Local Policies	
Service Template	wlan_svc_Kernow-Employees-Policy_local (priority 254)
VLAN	Employees
Absolute Timer	1800
Server Policies	
Output SGT	0022-17
Resultant Policies	

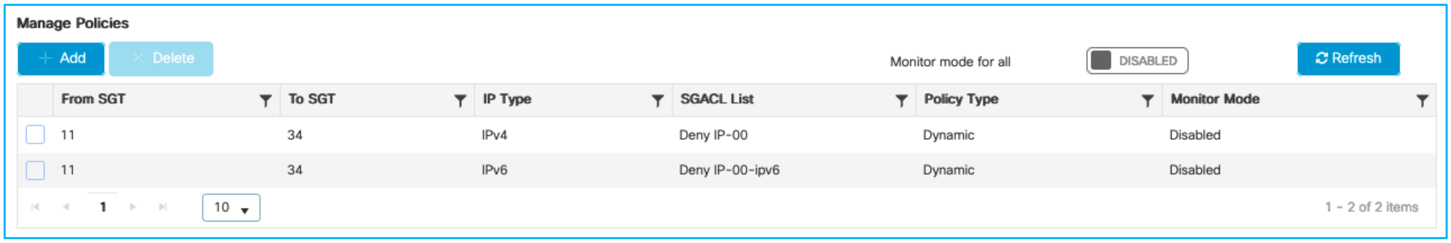
Mapping (10.1.210.100:SGT 34) shown at Configuration > Security > TrustSec > SGT Mapping:



IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	1.1.1.8	2	-	SXP
□	IPv4	10.1.200.1	2	-	SXP
	IPv4	10.1.200.10	2	-	INTERNAL
□	IPv4	10.1.210.1	2	-	SXP
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
□	IPv4	10.1.211.1	2	-	SXP
	IPv4	10.1.211.10	2	-	INTERNAL
□	IPv4	10.3.23.2	2	-	SXP
□	IPv4	10.4.25.2	2	-	SXP

Due to that dynamic IP:SGT mapping being learned, the C9800 downloads any policy from ISE destined for that SGT. Use Configuration > Security > TrustSec > CTS Policies:



Manage Policies

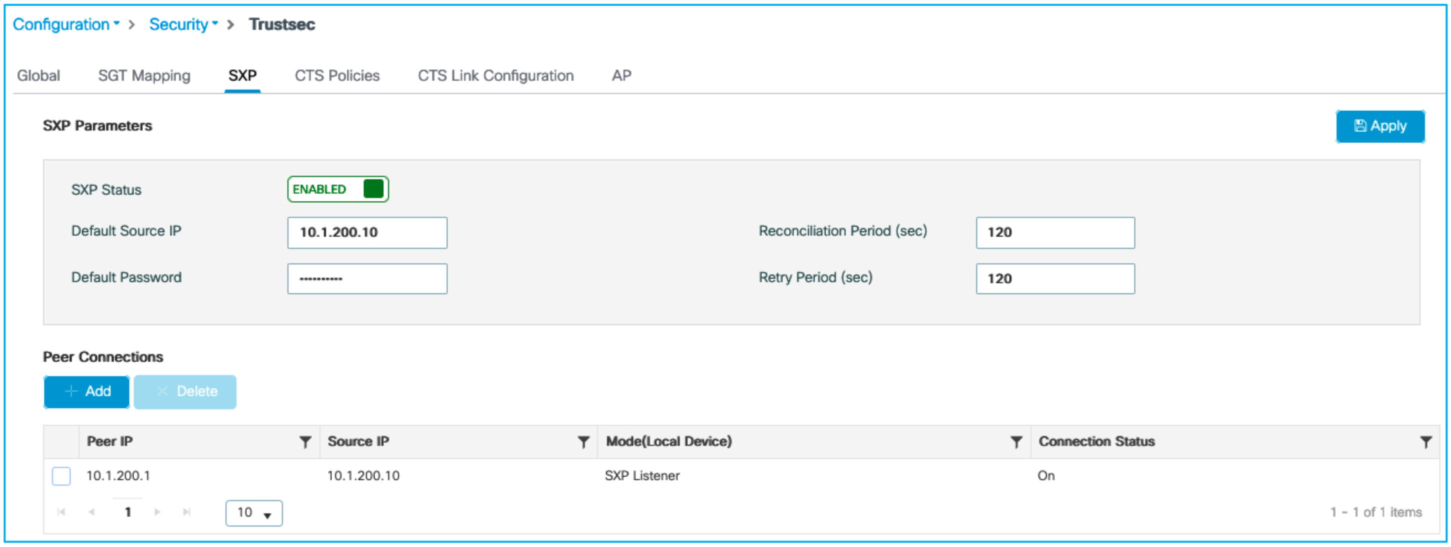
Monitor mode for all: DISABLED

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

The C9800 understands the destination SGT (Doctors SGT 34) and has a policy downloaded to prevent traffic from Production_Servers SGT 11 from communicating with that group. However, the C9800 also needs to understand what IP addresses are in the source group i.e. in the Production_Servers SGT 11 group.

The C9800 will learn this using SXP in this use-case. Ensure SXP is up and operational and the C9800 is listening to mappings from the peer (Cat9k in this example):

Configuration > Security > TrustSec > SXP:



SXP Parameters

SXP Status: ENABLED

Default Source IP: 10.1.200.10

Default Password: ....

Reconciliation Period (sec): 120

Retry Period (sec): 120

Peer Connections

	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	10.1.200.1	10.1.200.10	SXP Listener	On

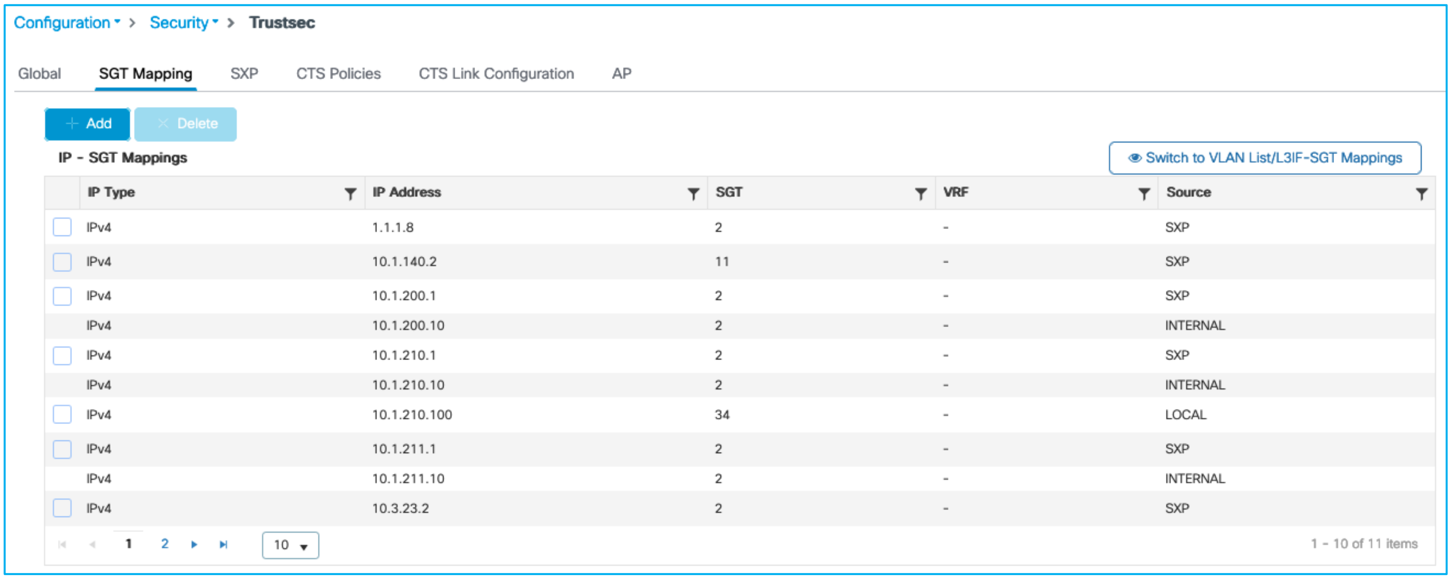
Note: There is no support of IPv6 based peer SXP connections (but the IPv4 based connections do support the propagation of IPv6 SGT bindings).

```
Kernow-Cat9300-b#show cts sxp connections brief
 SXP              : Enabled
 Highest Version Supported: 5
 Default Password : Set
 Default Key-Chain: Not Set
 Default Key-Chain Name: Not Applicable
 Default Source IP: 10.1.200.1
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
----------------------------------------------------------------------------------------
Peer_IP          Source_IP        Conn Status                    Duration
----------------------------------------------------------------------------------------
10.1.200.10      10.1.200.1       On                             0:15:51:13 (dd:hr:mm:sec)
Total num of SXP Connections = 1
```

Now, add a static mapping in the Cat9k for the Production_Server SGT 11 so it can send the mapping via SXP to the C9800:

```
Kernow-Cat9300-b(config)#cts role-based sgt-map 10.1.140.2 sgt 11
```

C9800 shows the mapping learned via SXP (Configuration > Security > TrustSec > SGT Mapping):



Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings

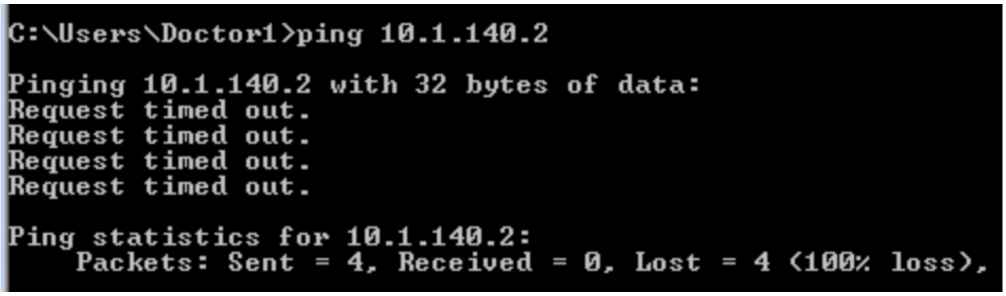
IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	1.1.1.8	2	-	SXP
□	IPv4	10.1.140.2	11	-	SXP
□	IPv4	10.1.200.1	2	-	SXP
	IPv4	10.1.200.10	2	-	INTERNAL
□	IPv4	10.1.210.1	2	-	SXP
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
□	IPv4	10.1.211.1	2	-	SXP
	IPv4	10.1.211.10	2	-	INTERNAL
□	IPv4	10.3.23.2	2	-	SXP

1 2 | 10 | 1 - 10 of 11 items

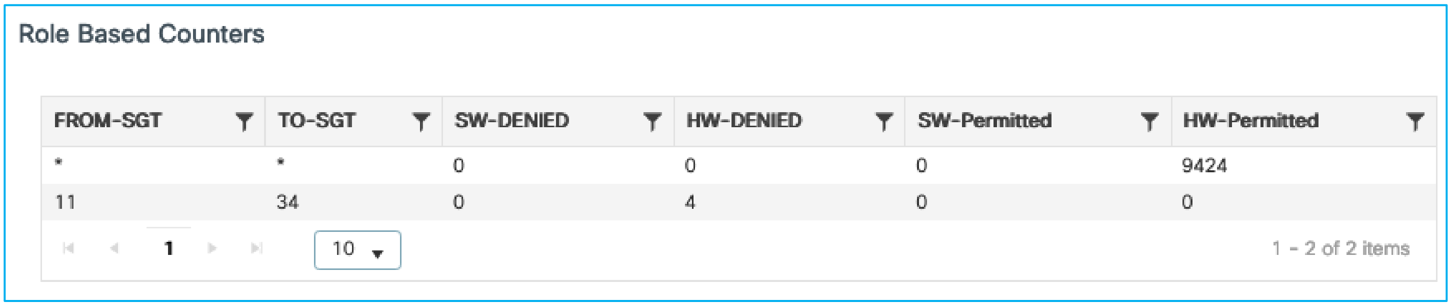
Note: The C9800 controller does support IPv6 SXP mappings/bindings as well as IPv4.

The wireless client is blocked from accessing the Production_Server due to the policy in place:



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Enforcement counts shown at Monitoring > General > TrustSec, proving the C9800 enforces wired to wireless using SXP to learn of source SGT:



Role Based Counters

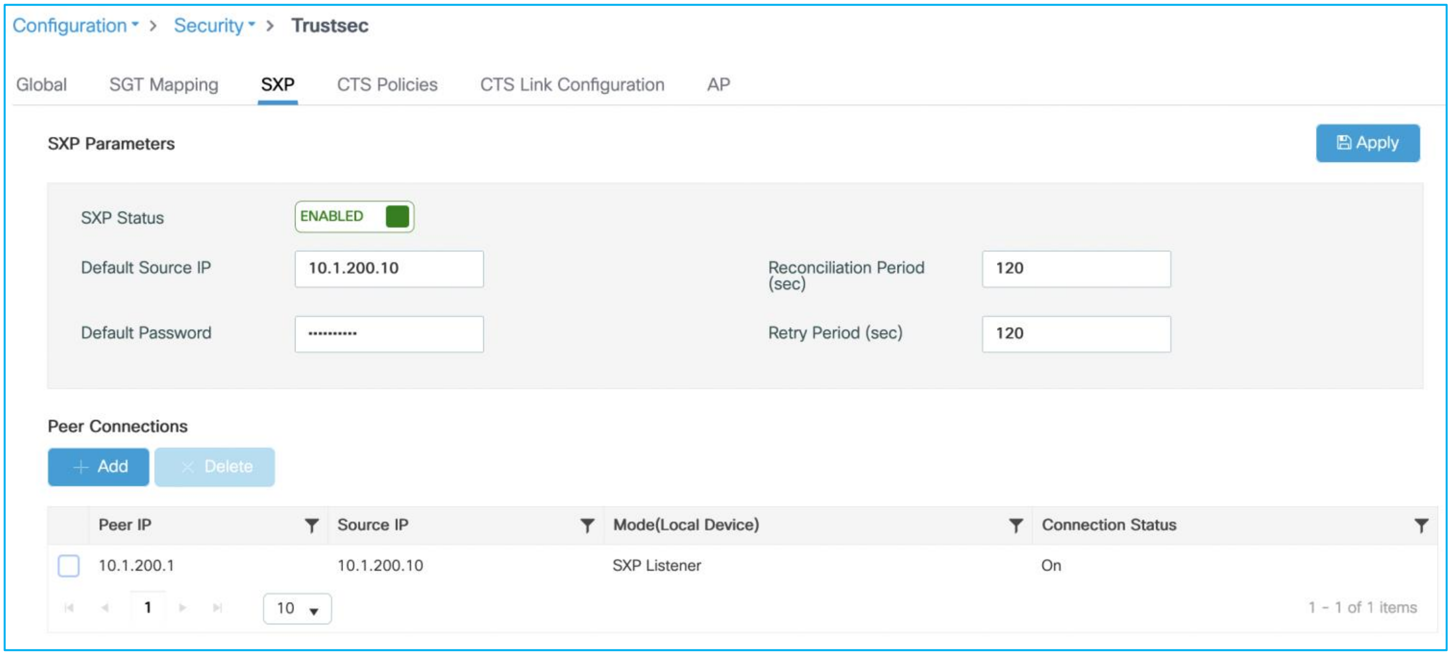
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	9424
11	34	0	4	0	0

Note: the C9800 controller supports SGACL enforcement for both IPv4 and IPv6 client traffic.

SXP Filters for N-S Enforcement

You can apply a filter for SXP connections on the C9800 that receive mappings from elsewhere. An example is the C9800 being a listener for mappings from a Cat9k. The SXP filters are supported only using the CLI, not the GUI/webui today.

C9800 SXP connection set as an SXP listener for the Cat9k peer (10.1.200.1):



SXP Parameters

SXP Status	ENABLED
Default Source IP	10.1.200.10
Default Password	••••••••••
Reconciliation Period (sec)	120
Retry Period (sec)	120

Peer Connections

	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	10.1.200.1	10.1.200.10	SXP Listener	On

Cat9k SXP connection set as a Speaker:

```
Kernow-Cat9300-b(config)#cts sxp connection peer 10.1.200.10 source 10.1.200.1 password
default mode local speaker
```

Mappings currently being shown on the C9800 (including the mappings learned via SXP from the Cat9k):

```
9800-17.9.1#show cts role-based sgt-map all

Active IPv4-SGT Bindings Information

IP Address              SGT     Source

============================================

1.1.1.8                 2       SXP

10.1.140.2              11      CLI

10.1.200.1              2       SXP

10.1.210.1              2       SXP

10.1.210.10             2       INTERNAL

10.1.210.100            34      LOCAL

10.1.211.1              2       SXP

10.1.211.10             2       INTERNAL

10.1.249.10             2       INTERNAL

10.3.23.2               2       SXP

10.4.25.2               2       SXP

10.6.50.100             28      SXP

10.6.50.254             2       SXP
```

A filter will be added on the C9800 to block receiving SGT 2 from the Cat9k:

```
cts sxp filter-enable

!

cts sxp filter-list block-sgt2

 deny sgt 2

 permit sgt all                <- default rule, otherwise will default deny

!

cts sxp filter-group listener listner-from-Cat9k

 filter block-sgt2

 peer ipv4 10.1.200.1
```

On Cat9k configure ‘no cts sxp enable’ and then ‘cts sxp enable’ to refresh the mappings being sent.

Display the results of the filter:

```
9800-17.9.1#show cts sxp filter-group detailed

Global Listener Filter: Not configured

Global Speaker Filter: Not configured

Listener Groups:

Filter-group: listner-from-Cat9k

    Filter-name: block-sgt2

    Filter-rules:

        10 deny sgt 2 (7)

        20 permit sgt all (1)
```

```
   Total Matches: 8
    Default Deny Count: 0
    peer 10.1.200.1
```

New mapping table on the C9800 after filtering has taken place (only 1 entry is now received via SXP from the Cat9k after blocking the entries with SGT 2):

```
9800-17.9.1#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address               SGT     Source
============================================
10.1.140.2               11      CLI
10.1.210.10              2       INTERNAL
10.1.210.100             34      LOCAL
10.1.211.10              2       INTERNAL
10.1.249.10              2       INTERNAL
10.6.50.100              28      SXP
```

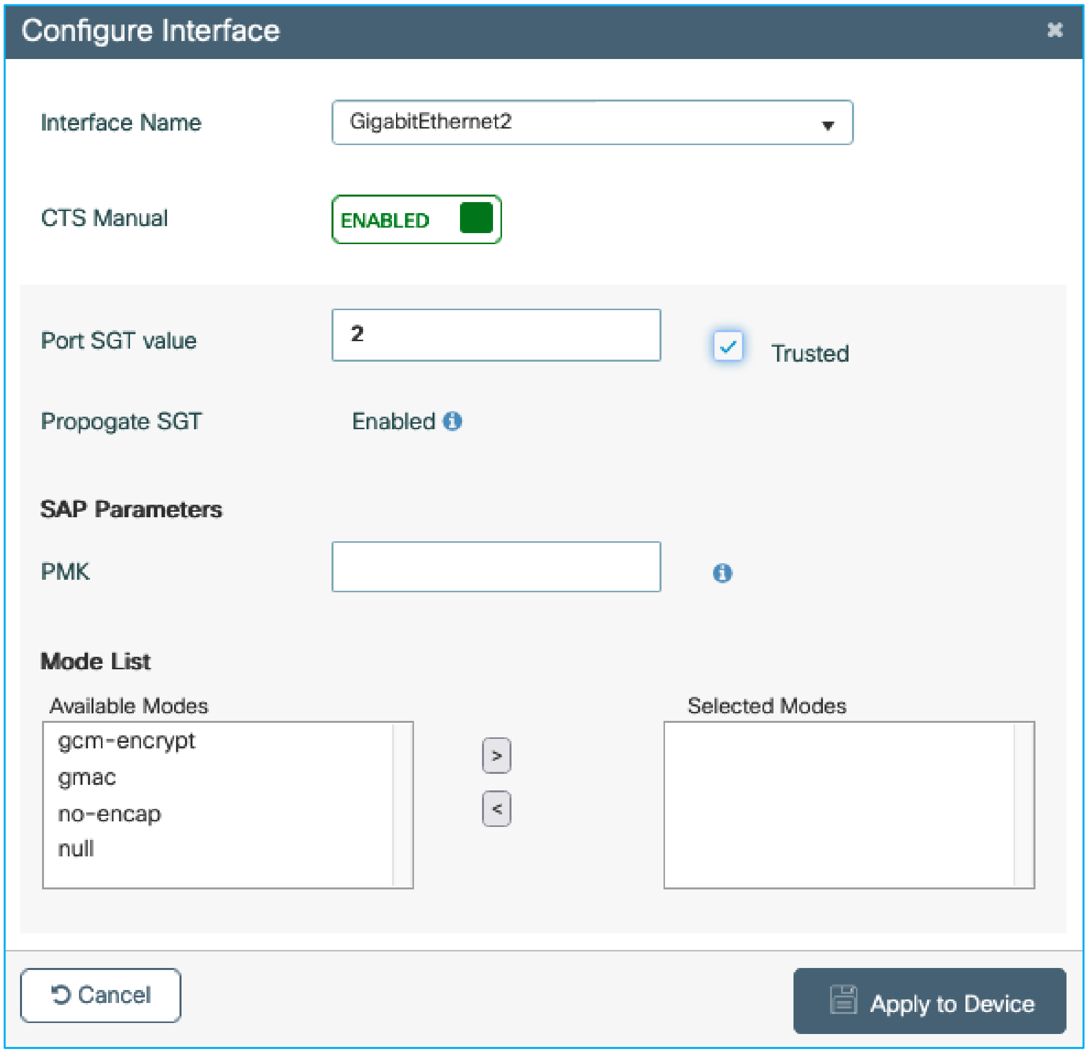
So, SXP filtering works successfully for mappings received from other devices.

N-S Enforcement Using Inline (CMD) for Source

This use-case is to enforce wired to wireless on the C9800 but use a source SGT learned from the CMD field i.e., learned from inline tagging. The destination SGT will be the SGT assigned to a wireless client.

Ensure there are no SXP or static mappings in the C9800 for Production_Servers SGT 11 – we want the source to be learned from inline tagging (CMD).

C9800 uplink interface towards Cat9k is enabled for inline tagging:



Interface Name: GigabitEthernet2

CTS Manual: ENABLED

Port SGT value: 2 ☑ Trusted

Propogate SGT: Enabled

SAP Parameters

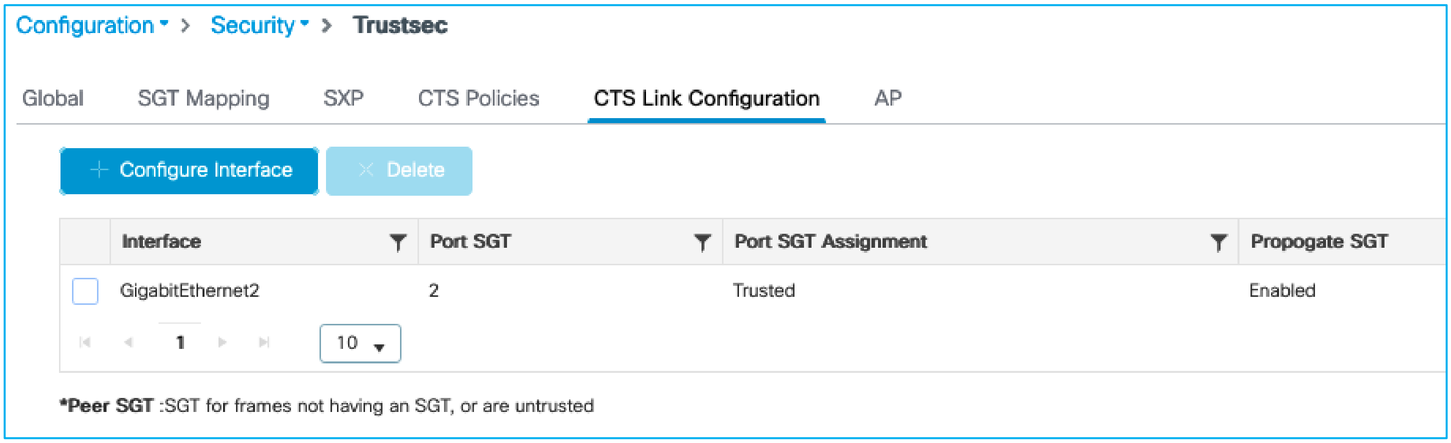
PMK:

Mode List

Available Modes:

gcm-encrypt
gmac
no-encap
null

Selected Modes:



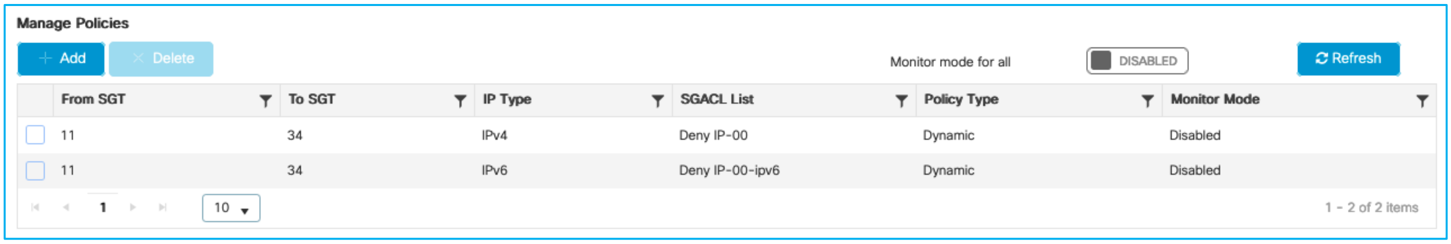
	Interface	Port SGT	Port SGT Assignment	Propogate SGT
□	GigabitEthernet2	2	Trusted	Enabled

***Peer SGT** :SGT for frames not having an SGT, or are untrusted

Cat9k peer is set for inline tagging:

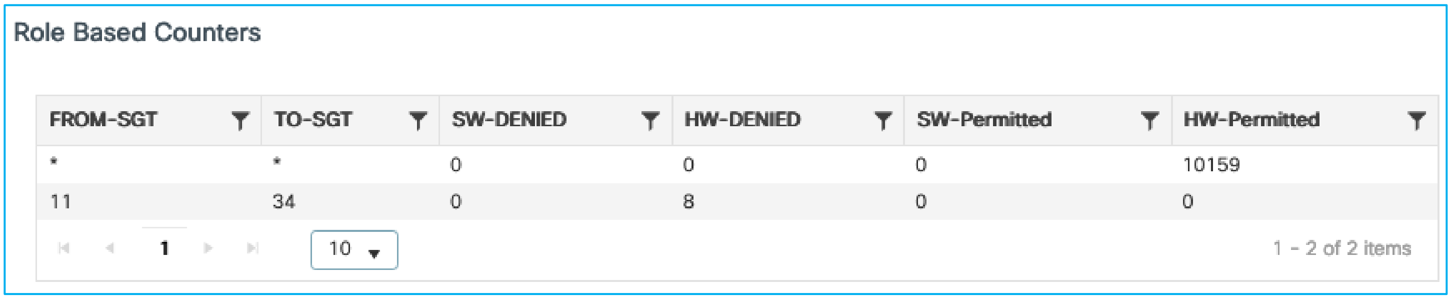
```
interface GigabitEthernet1/0/15
 switchport trunk allowed vlan 200,210,211
 switchport mode trunk
 switchport nonegotiate
 cts manual
  policy static sgt 2 trusted
 ip dhcp snooping trust
end
```

Authenticate a wireless client as was done in the SXP use-case above, assign SGT 34 from ISE which indicates to the C9800 to download any policy destined for that SGT. Use Configuration > Security > TrustSec > CTS Policies to check the policies downloaded:



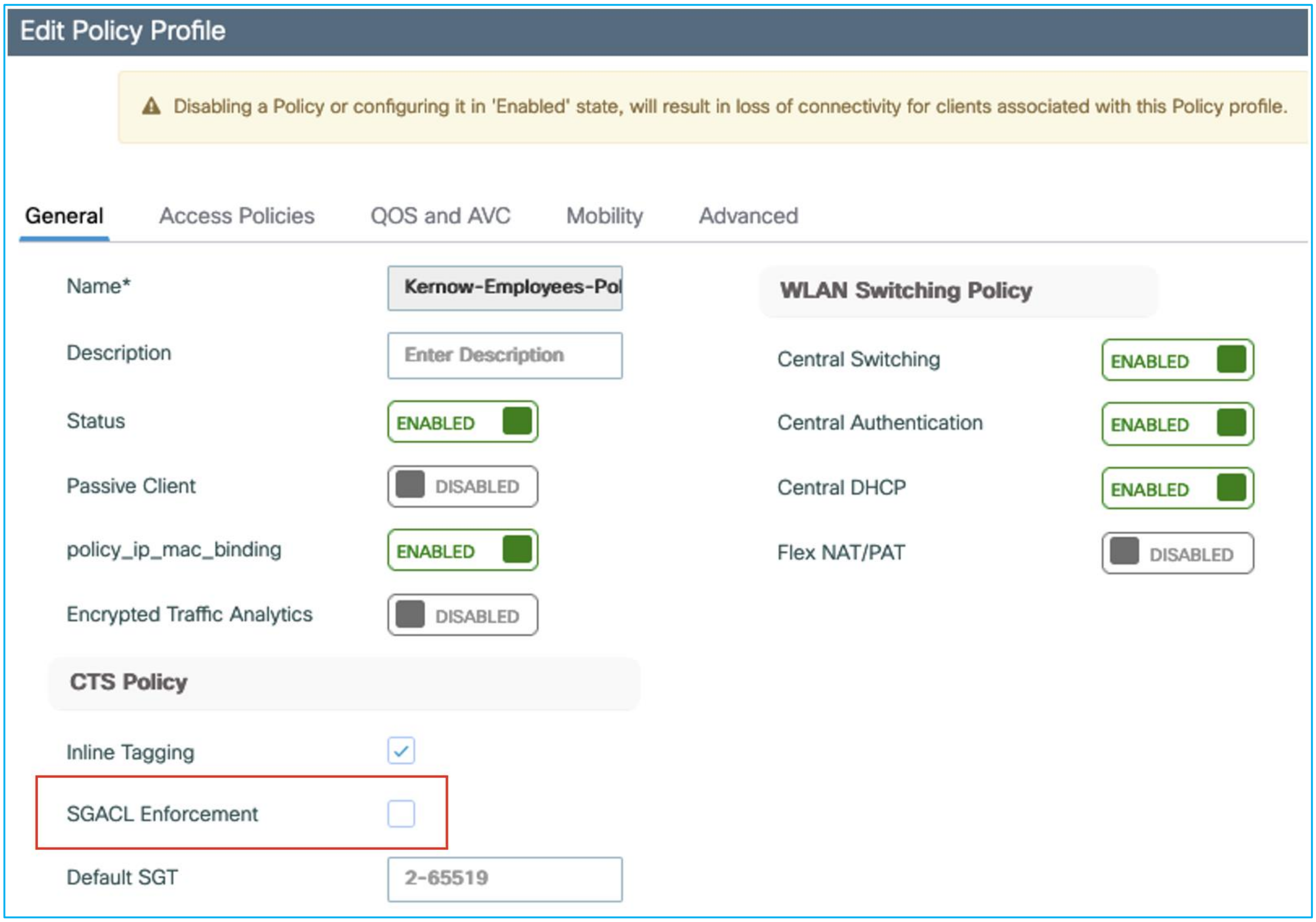
	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

Now, when the Production Server traffic is classified into group Production_Server SGT 11, the C9800 receives this information in every packet from the server within the receiving frame and acts upon it as the source for policy enforcement (Monitoring > General > TrustSec):



FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	10159
11	34	0	8	0	0

Now, this is with the destination Policy Profile set with SGACL Enforcement. We will now disable SGACL Enforcement on this Policy Profile to see what happens:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*	Kernow-Employees-Pol
Description	Enter Description
Status	ENABLED
Passive Client	DISABLED
policy_ip_mac_binding	ENABLED
Encrypted Traffic Analytics	DISABLED

CTS Policy

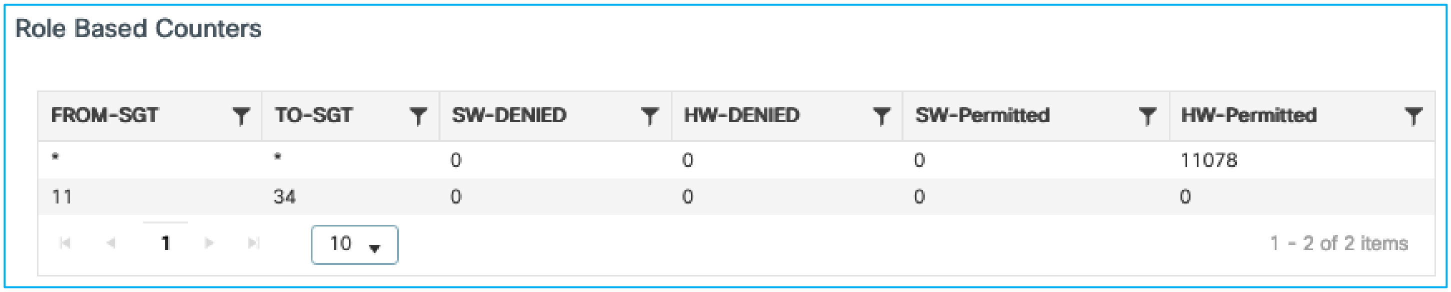
Inline Tagging	☑
SGACL Enforcement	□
Default SGT	2-65519

WLAN Switching Policy

Central Switching	ENABLED
Central Authentication	ENABLED
Central DHCP	ENABLED
Flex NAT/PAT	DISABLED

Data is now permitted, so the destination Policy Profile has to have SGACL Enforcement enabled for traffic to be enforced.

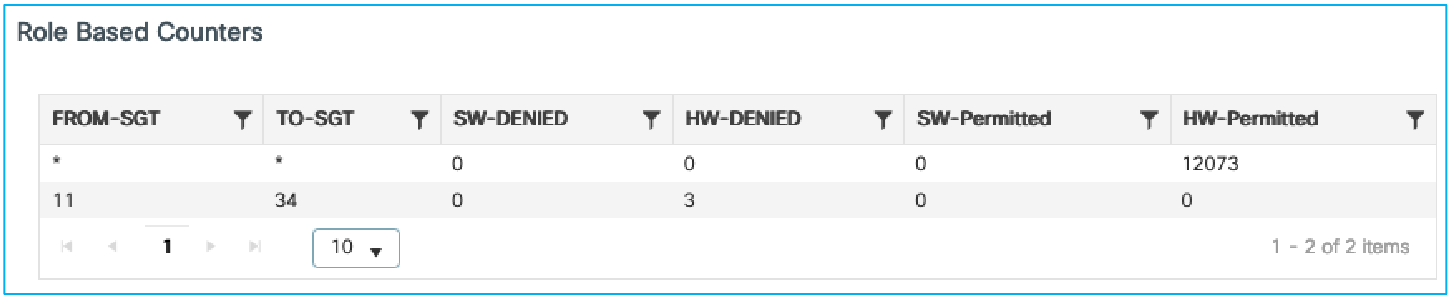
No hits are registered for the specific policy under Monitoring > General > TrustSec with SGACL Enforcement disabled on the Policy Profile:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	11078
11	34	0	0	0	0

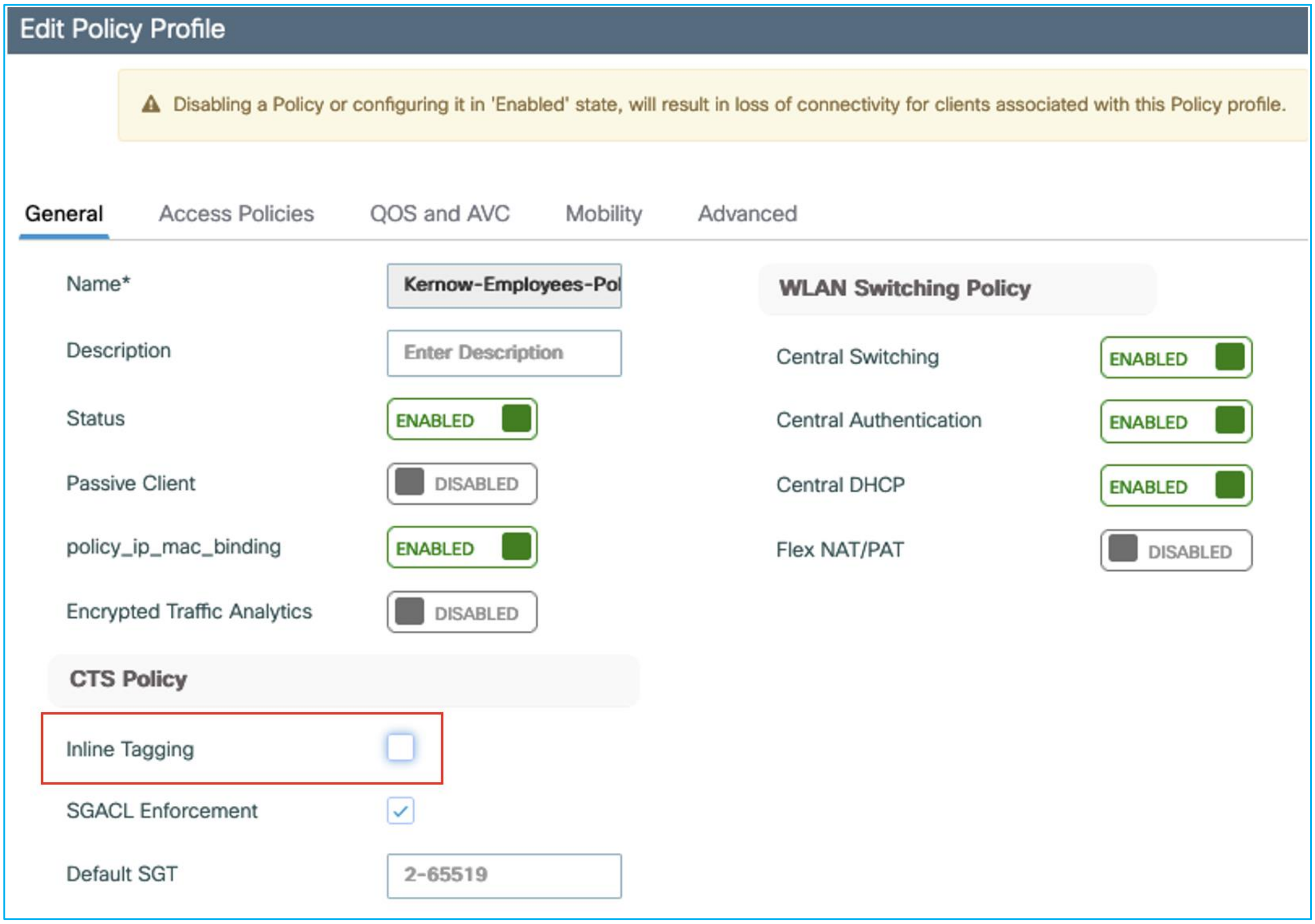
Re-enable on the Policy Profile and data is enforced with hits again being shown:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	12073
11	34	0	3	0	0

For another test, we'll see what happens when inline tagging is disabled on the Policy Profile:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*	Kernow-Employees-Pol
Description	Enter Description
Status	ENABLED
Passive Client	DISABLED
policy_ip_mac_binding	ENABLED
Encrypted Traffic Analytics	DISABLED

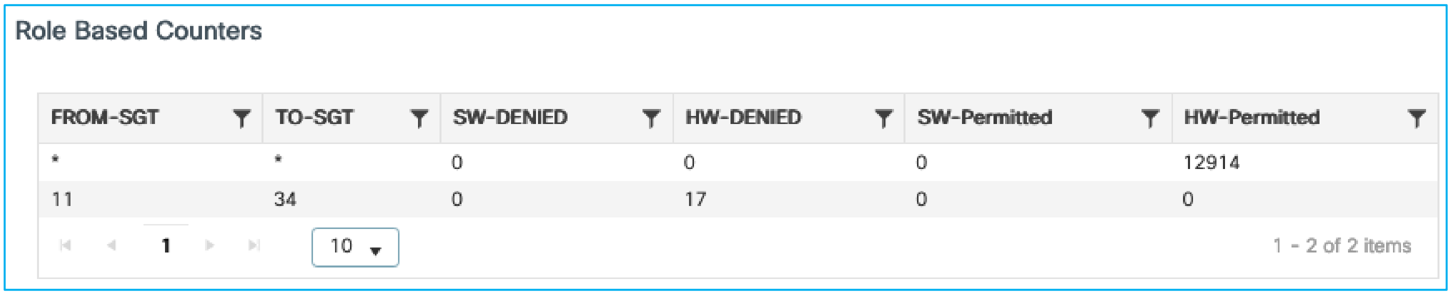
CTS Policy

Inline Tagging	□
SGACL Enforcement	☑
Default SGT	2-65519

WLAN Switching Policy

Central Switching	ENABLED
Central Authentication	ENABLED
Central DHCP	ENABLED
Flex NAT/PAT	DISABLED

It makes no difference, the source lookup for the CMD in the Layer2 frame still occurs and the traffic is still enforced:


Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	12914
11	34	0	17	0	0

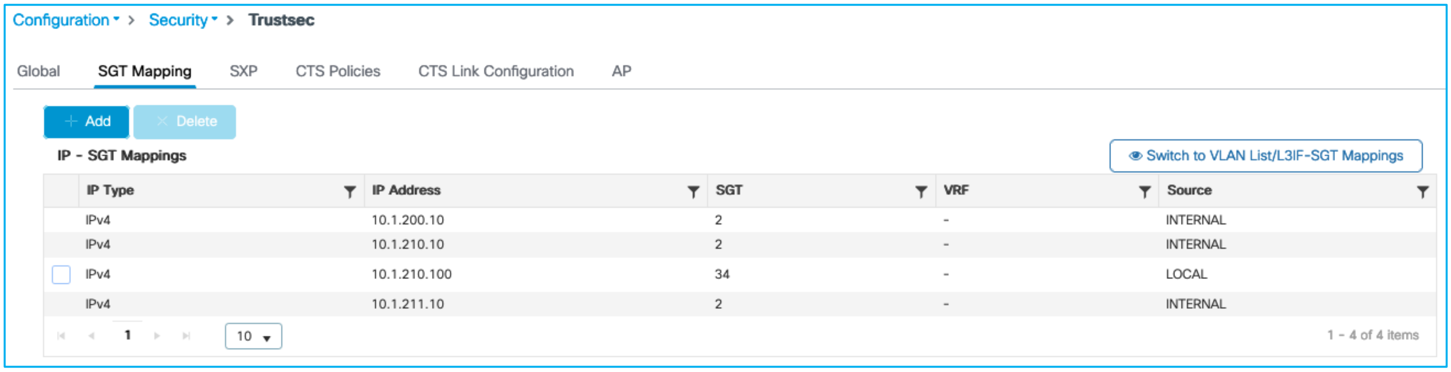
If inline tagging is enabled on the uplink interface under Configuration > Security > TrustSec > CTS Link Configuration, then it doesn't matter what is set for Inline Tagging on the Policy Profile. The use of the inline tagging setting on the policy profile will be introduced in a future release.

N-S Enforcement Using IP:SGT Static Mapping for Source

Test is to ensure a static mapping can be added in the C9800 and used as an SGT source lookup for traffic flowing in the wired to wireless direction.

Ensure there are no mappings learned via SXP and inline tagging is disabled on the uplink interface.

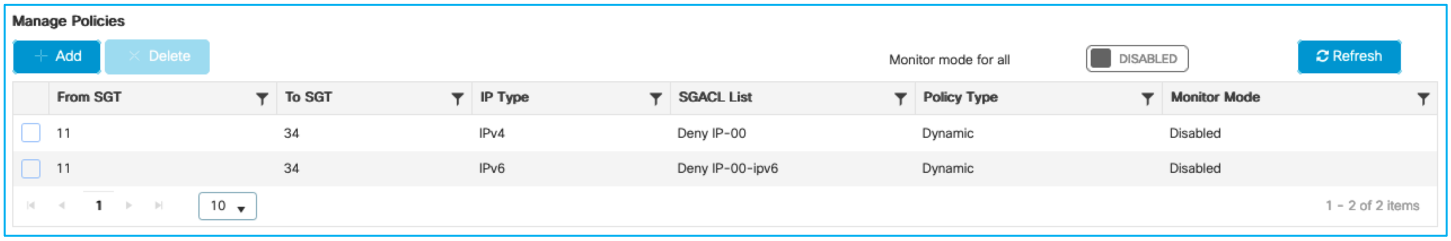
Wireless client is connected with dynamic SGT assigned from ISE (SGT 34):


Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings

IP - SGT Mappings

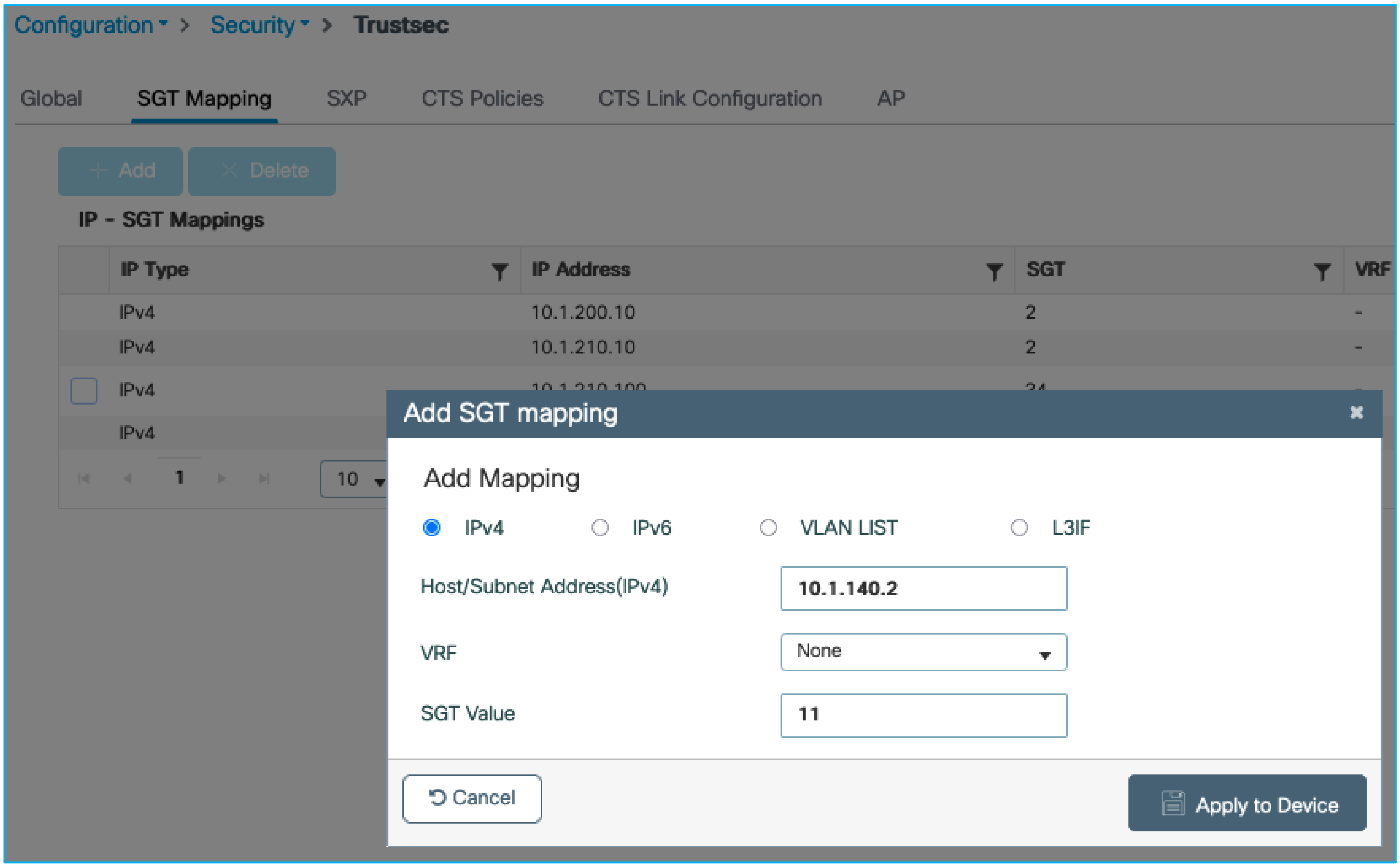
	IP Type	IP Address	SGT	VRF	Source
	IPv4	10.1.200.10	2	-	INTERNAL
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

Policy protecting SGT 34 is downloaded (Configuration > Security > TrustSec > CTS Policies):


Manage Policies

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

Now, add an IP:SGT static mapping in the C9800 for the Production Server:



	IP Type	IP Address	SGT	VRF
	IPv4	10.1.200.10	2	-
	IPv4	10.1.210.10	2	-
□	IPv4	10.1.210.100	34	-
	IPv4			

Add SGT mapping

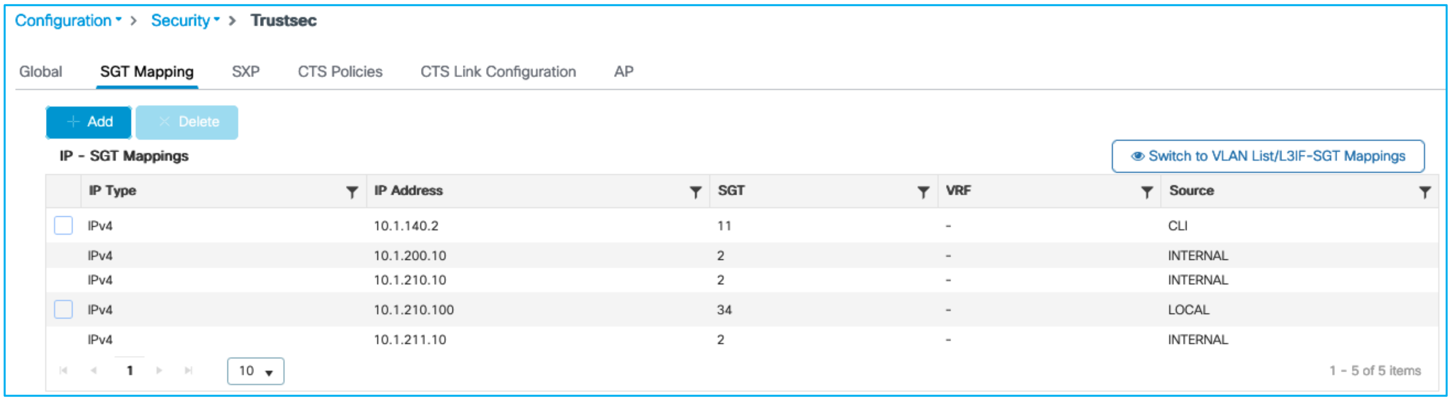
Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

Host/Subnet Address(IPv4): 10.1.140.2

VRF: None

SGT Value: 11



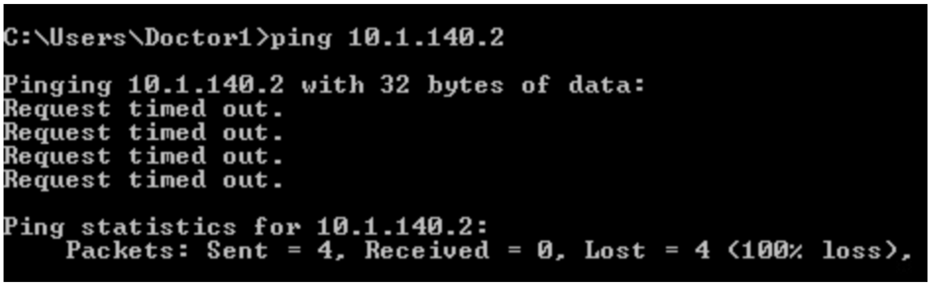
Configuration ▾ > Security ▾ > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
✕ Delete
Switch to VLAN List/L3IF-SGT Mappings

IP - SGT Mappings

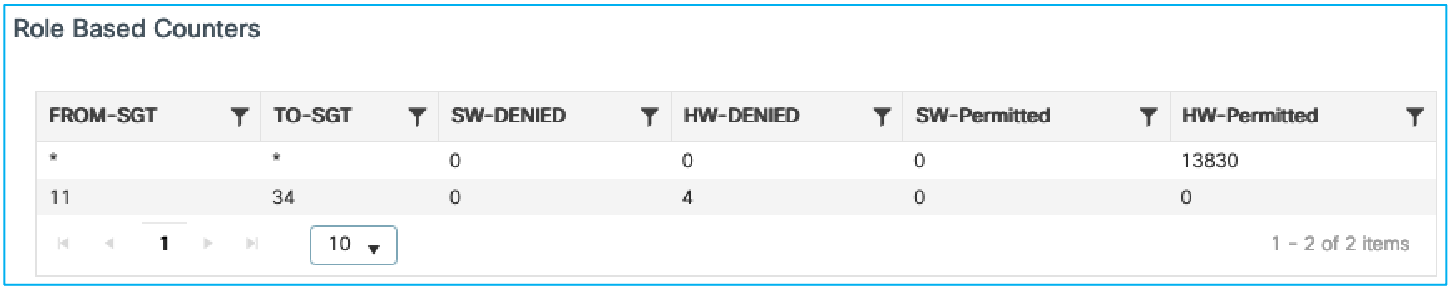
	IP Type	IP Address	SGT	VRF	Source
□	IPv4	10.1.140.2	11	-	CLI
	IPv4	10.1.200.10	2	-	INTERNAL
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

1 - 5 of 5 items

Traffic is denied from Production Server to wireless client:



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	13830
11	34	0	4	0	0

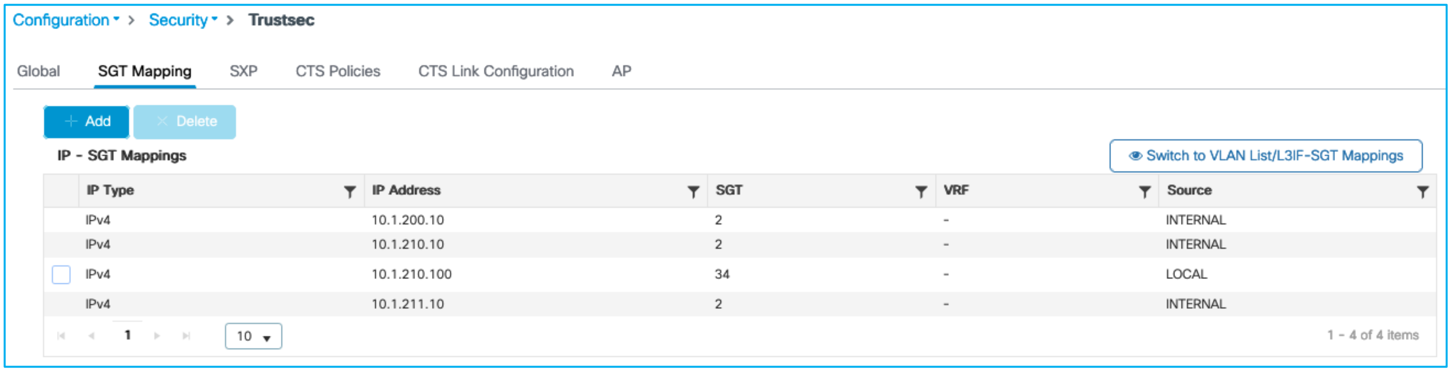
The conclusion is that the C9800 will use static IP:SGT mappings when carrying out a source lookup for enforcing southbound towards wireless clients.

N-S Enforcement Using Subnet:SGT Static Mapping for Source

This use-case is adding a static Subnet:SGT mapping on the C9800 and ensuring it can be used in an SGT source lookup in the wired to wireless direction.

Ensure there are no mappings learned via SXP and inline tagging is disabled on the uplink.

Wireless client is connected with dynamic SGT 34 assigned from ISE:

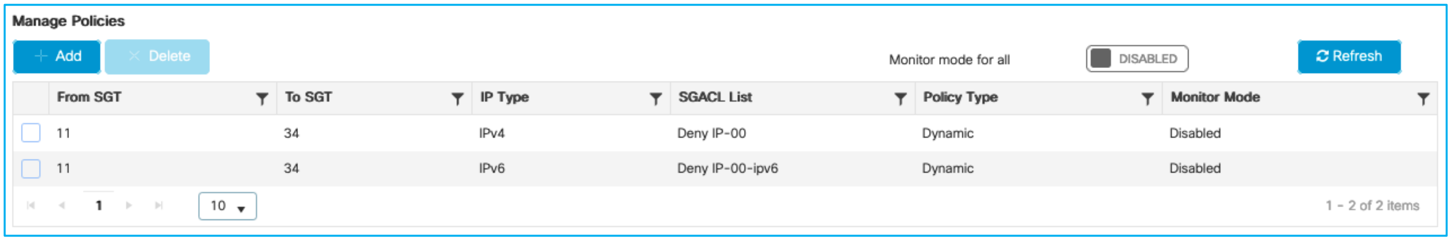


Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
Delete
Switch to VLAN List/L3IF-SGT Mappings

IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.200.10	2	-	INTERNAL
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	34	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL

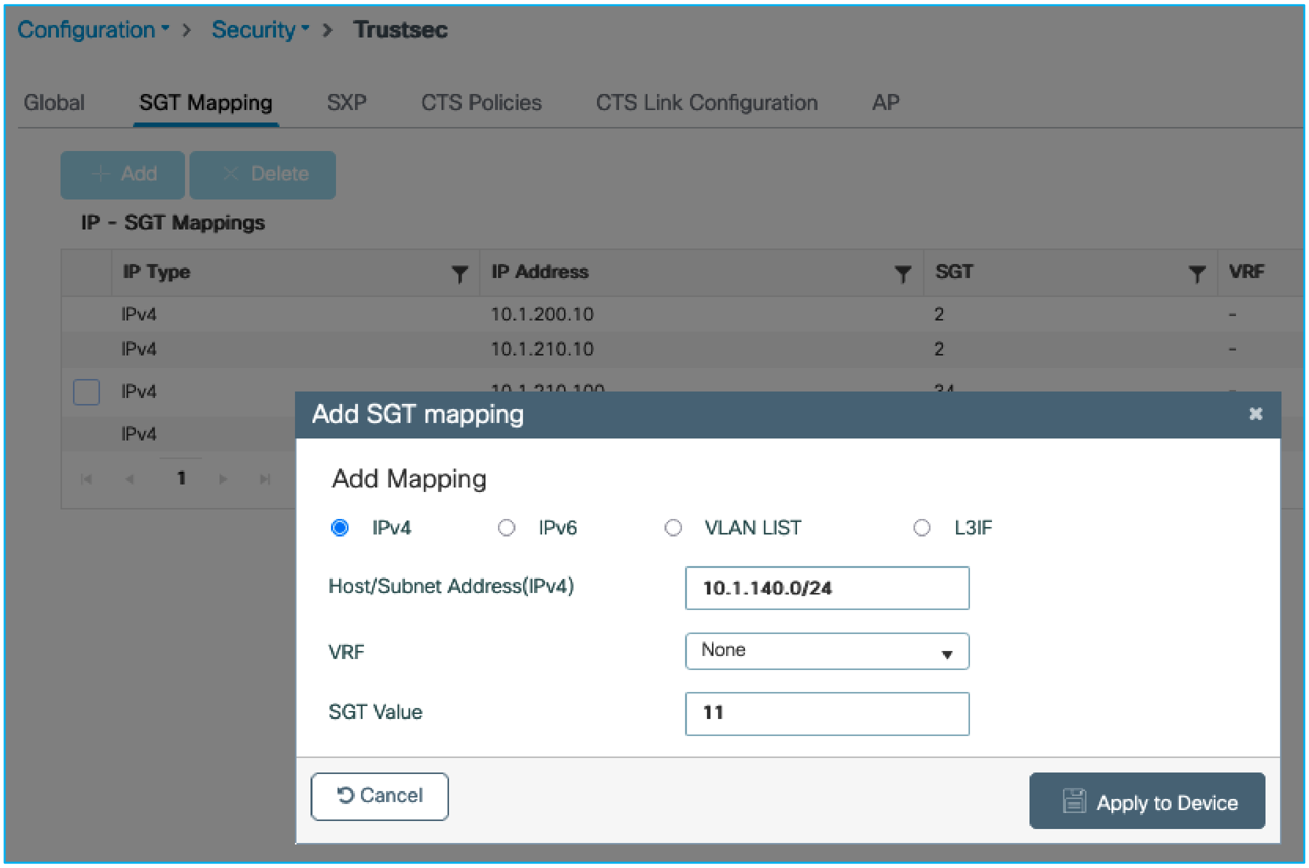
Policy protecting SGT 34 is downloaded (Configuration > Security > TrustSec > CTS Policies):



Manage Policies

From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
11	34	IPv4	Deny IP-00	Dynamic	Disabled
11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

Now, add a Subnet:SGT static mapping in the C9800 for the Production Server:



	IP Type	IP Address	SGT	VRF
	IPv4	10.1.200.10	2	-
	IPv4	10.1.210.10	2	-
□	IPv4	10.1.210.100	34	-
	IPv4			

Add SGT mapping

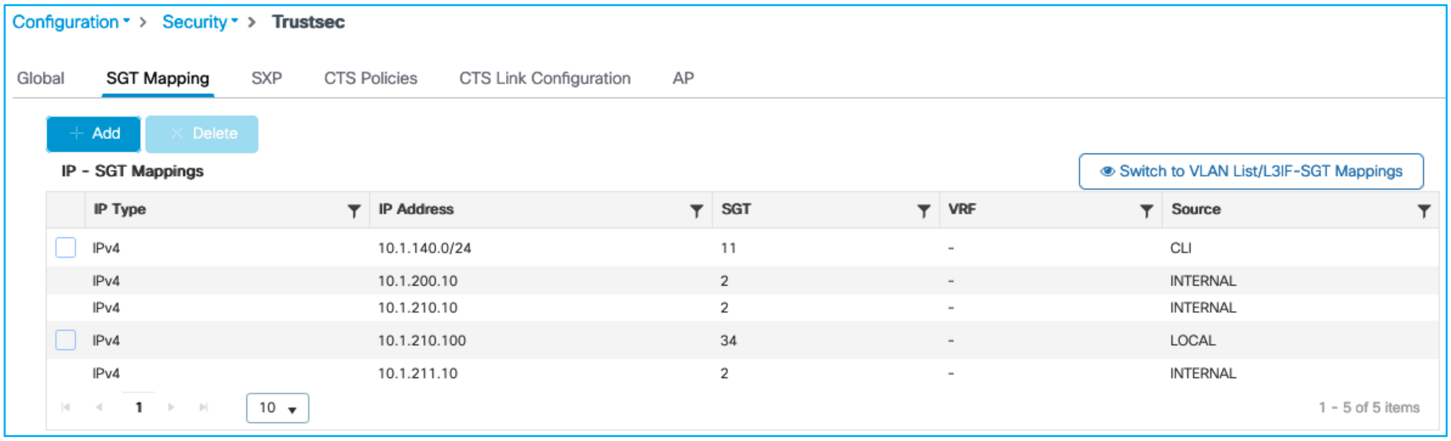
Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

Host/Subnet Address(IPv4): 10.1.140.0/24

VRF: None

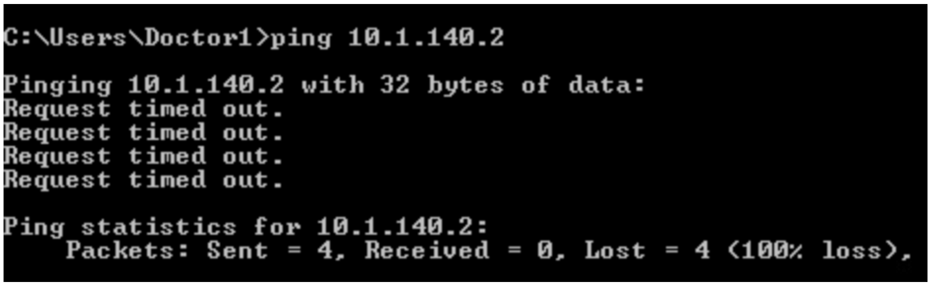
SGT Value: 11


Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
✕ Delete
Switch to VLAN List/L3IF-SGT Mappings

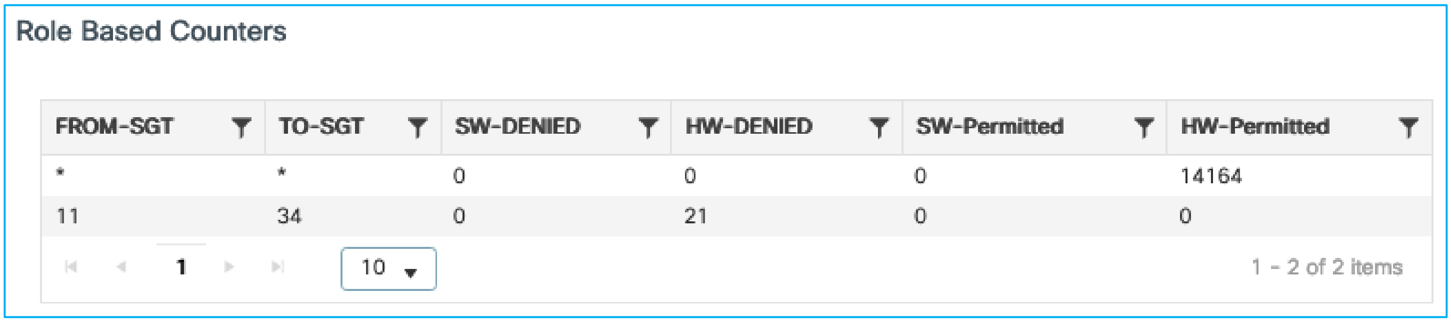
IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	10.1.140.0/24	11	-	CLI
	IPv4	10.1.200.10	2	-	INTERNAL
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

Production Server with SGT 11 is denied communication with wireless client SGT 34 (ICMP reply is blocked):



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```



Role Based Counters

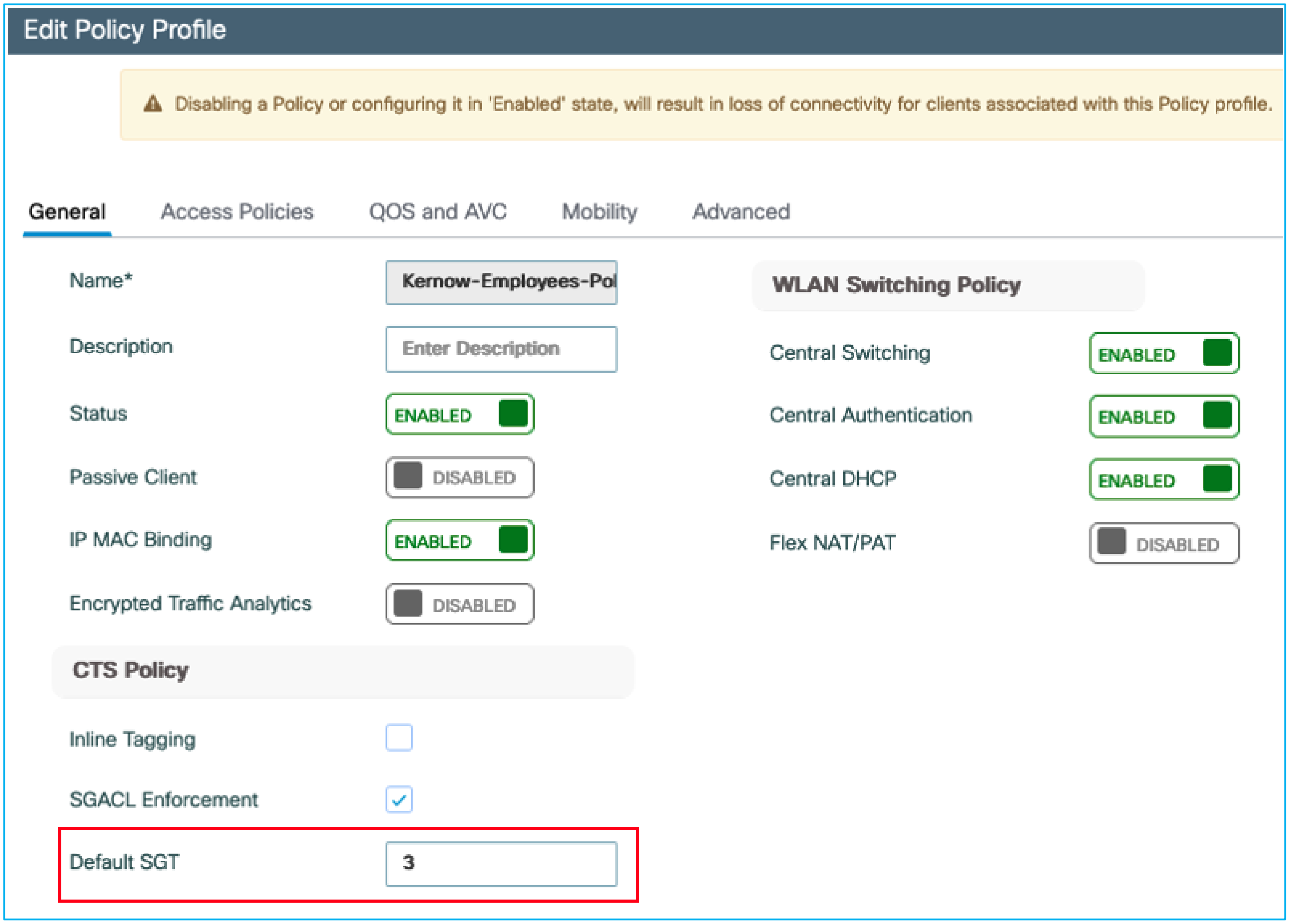
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	14164
11	34	0	21	0	0

To conclude, static Subnet:SGT mappings can be used on the C9800 for source lookup when enforcing southbound from wired towards a wireless client.

N-S Enforcement with Wireless Client Using Default SGT Assigned via Policy Profile

It has previously been seen that the Default SGT setting within the Policy Profile can be used as a default classification for wireless clients if there is no dynamic assignment from ISE. This use-case is to ensure that default SGT can be used to enforce traffic from wired to wireless using that default SGT assigned as a destination.

As previously, set Default SGT in the Policy Profile to be 3 as an example:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*: Kernow-Employees-Pol

Description: Enter Description

Status: ENABLED

Passive Client: DISABLED

IP MAC Binding: ENABLED

Encrypted Traffic Analytics: DISABLED

CTS Policy

Inline Tagging: □

SGACL Enforcement: ☑

Default SGT: 3

WLAN Switching Policy

Central Switching: ENABLED

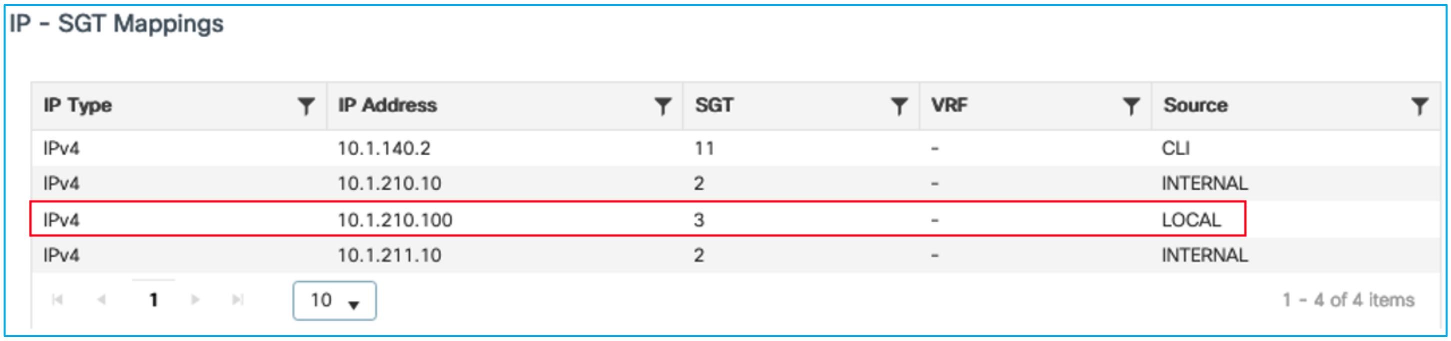
Central Authentication: ENABLED

Central DHCP: ENABLED

Flex NAT/PAT: DISABLED

The wireless client (10.1.210.100) is assigned default SGT 3 if no dynamic SGT assignment is provided from ISE;

seen under Monitoring > General > TrustSec:



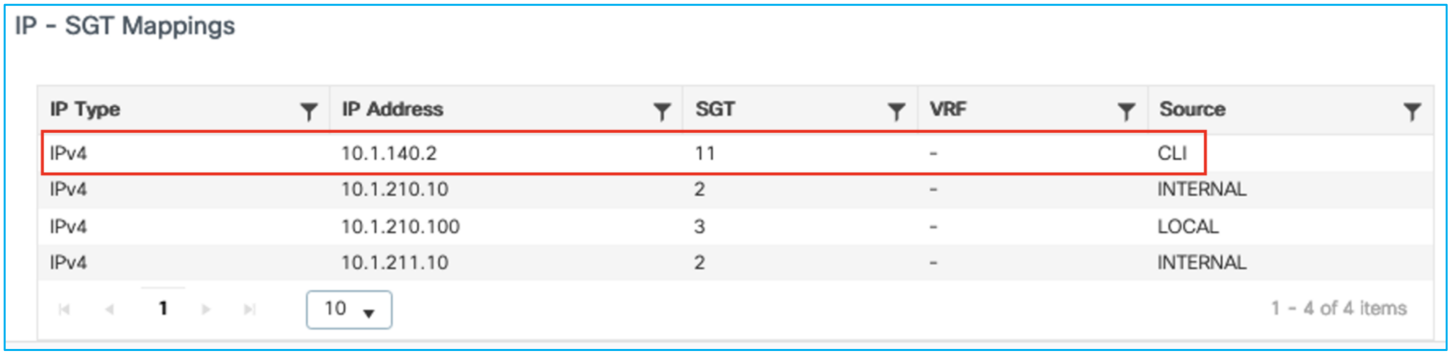
IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.140.2	11	-	CLI
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	3	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL

If there are policies available in ISE destined for SGT 3, then they are dynamically downloaded by the C9800. In this example, ISE has 2 policies that are downloaded, as shown here in the C9800 permissions:

```
9800-17.9.1#show cts role-based permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group 11:Production_Servers to group 3:Network_Services:
        Deny IP-00
IPv4 Role-based permissions from group 255:Quarantined_Systems to group 3:Network_Services:
        Deny IP-00
IPv4 Role-based permissions from group 29:Access_Points to group 11:Production_Servers:
        AllowWeb-00
IPv4 Role-based permissions from group 34:Doctors to group 11:Production_Servers:
        Permit IP-00
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

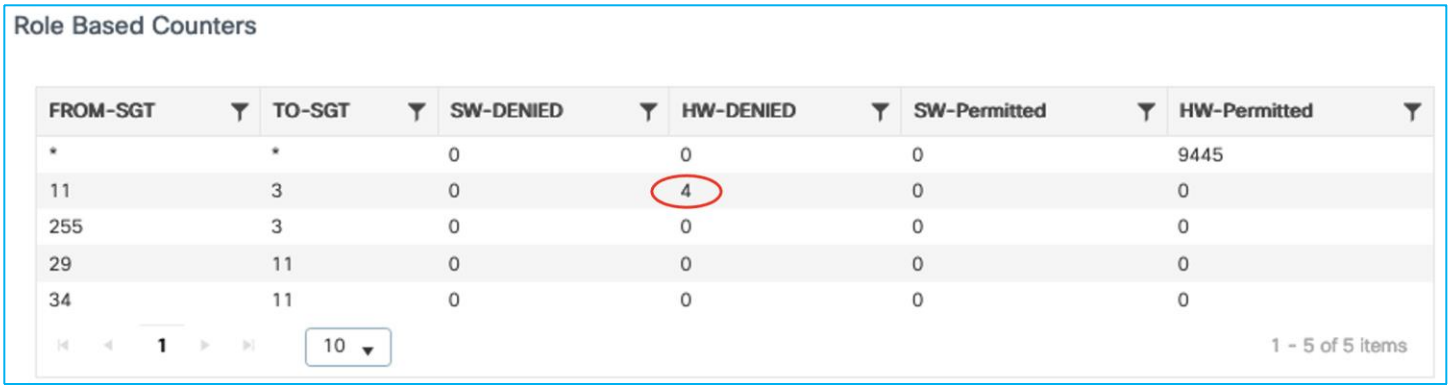
As can be seen from the Monitoring > General > TrustSec table, a static CLI mapping also exists for a server north-bound of the controller:



IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.140.2	11	-	CLI
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	3	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL

If traffic is sent from that north-bound server (10.1.140.2 / SGT 11) to the wireless client (10.1.210.100/ SGT 3) then the traffic is enforced successfully as seen at Monitoring > General > TrustSec:



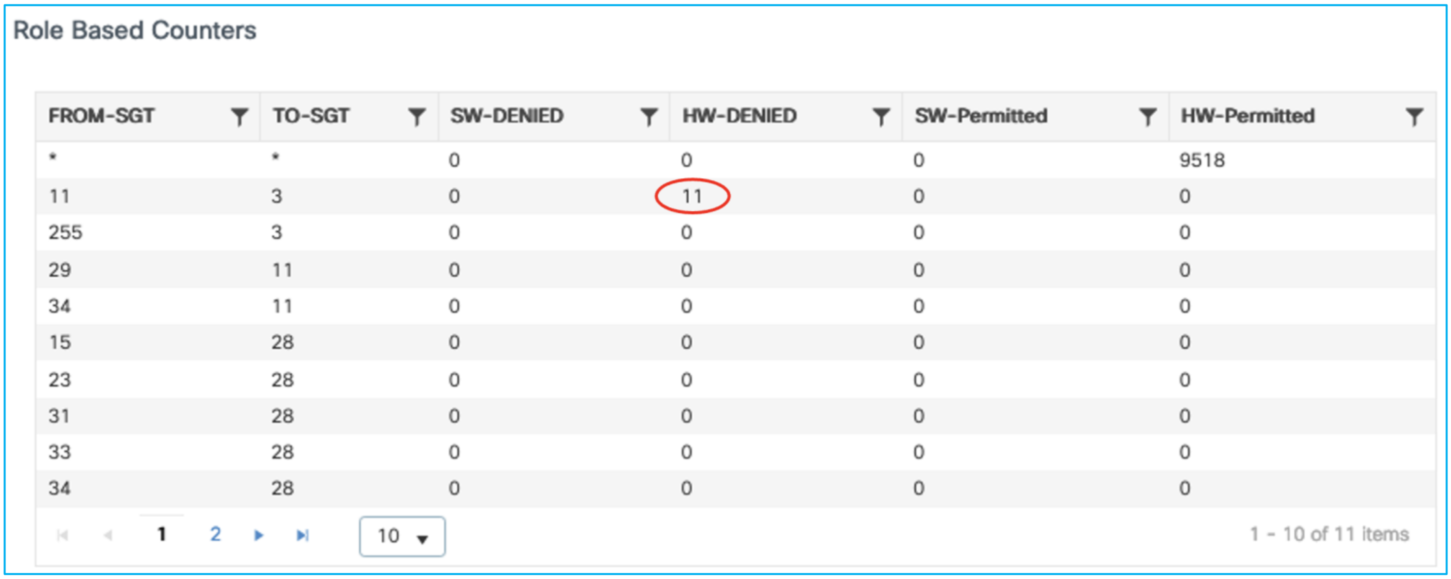
Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	9445
11	3	0	4	0	0
255	3	0	0	0	0
29	11	0	0	0	0
34	11	0	0	0	0

If the source mapping is learned via SXP rather than a static mapping, then enforcement is also successful. In this example, the server 10.1.140.2 has a mapping to SGT 11 learned through SXP:

```
9800-17.9.1#show cts role-based sgt-map 10.1.140.2
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
10.1.140.2              11      SXP
```

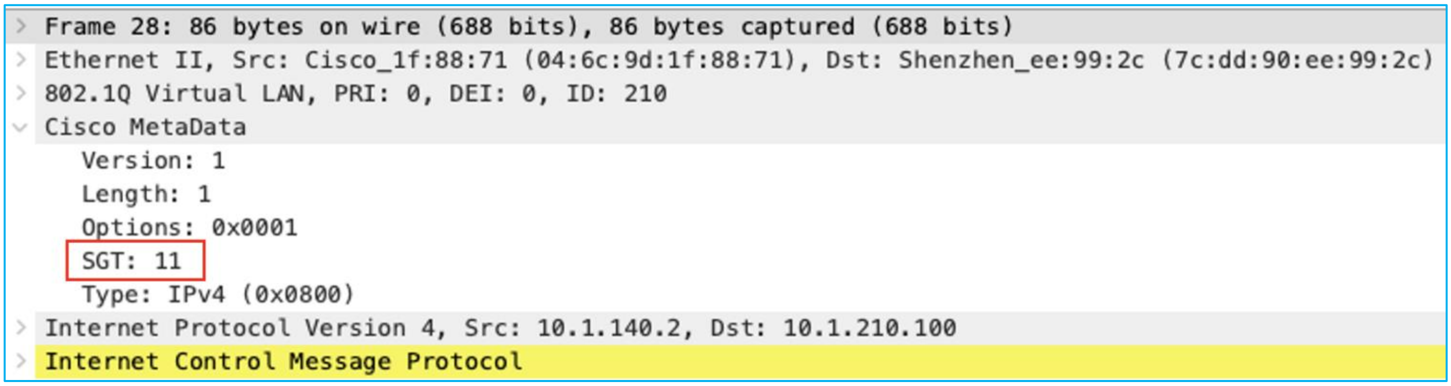
Enforcement is successful when traffic is attempted to be sent from that server (10.1.140.2 / SGT 11) to the wireless client (10.1.210.100 / SGT 3):



Role Based Counters

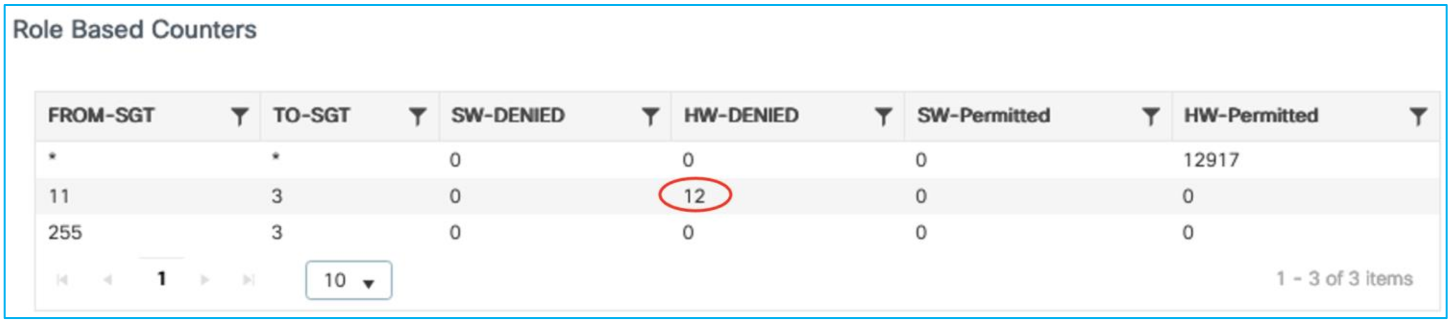
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	9518
11	3	0	11	0	0
255	3	0	0	0	0
29	11	0	0	0	0
34	11	0	0	0	0
15	28	0	0	0	0
23	28	0	0	0	0
31	28	0	0	0	0
33	28	0	0	0	0
34	28	0	0	0	0

Lastly, If the source mapping is learned via inline tagging/CMD, then enforcement is also successful. In this example, the server 10.1.140.2 has a mapping to SGT 11 added in a network device north-bound of the C9800 and inline tagging carries it to the C9800 via the CMD field in the L2 frame. Using the C9800 GUI Troubleshooting > Packet Capture function, see the source SGT captured coming from the wired endpoint:



```
> Frame 28: 86 bytes on wire (688 bits), 86 bytes captured (688 bits)
> Ethernet II, Src: Cisco_1f:88:71 (04:6c:9d:1f:88:71), Dst: Shenzhen_ee:99:2c (7c:dd:90:ee:99:2c)
> 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 210
v Cisco MetaData
     Version: 1
     Length: 1
     Options: 0x0001
     SGT: 11
     Type: IPv4 (0x0800)
> Internet Protocol Version 4, Src: 10.1.140.2, Dst: 10.1.210.100
> Internet Control Message Protocol
```

Enforcement hits are shown up under Monitoring > General > TrustSec:



Role Based Counters

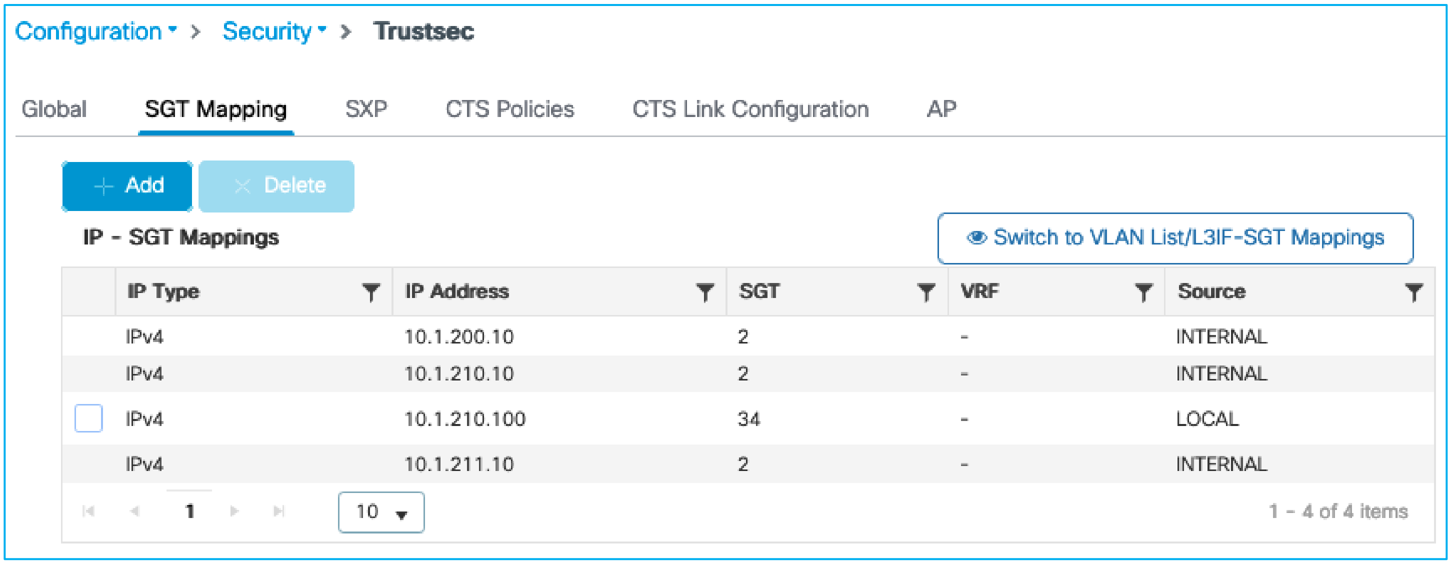
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	12917
11	3	0	12	0	0
255	3	0	0	0	0

The conclusion is that the Default SGT set on the C9800 Policy Profile can be used as a destination for enforcement (wired to wireless). It doesn't matter where the source SGT is learned from, the above tests show the source SGT learned from CLI, SXP and inline tagging/CMD.

N-S Enforcement Using Static VLAN:SGT for Source (Not Supported)

Ensure there are no other static mappings present, no SXP and inline tagging is disabled on the uplink.

Under Configuration > Security > TrustSec > SGT Mapping, click the option to 'Switch to VLAN List/L3IF-SGT Mappings':

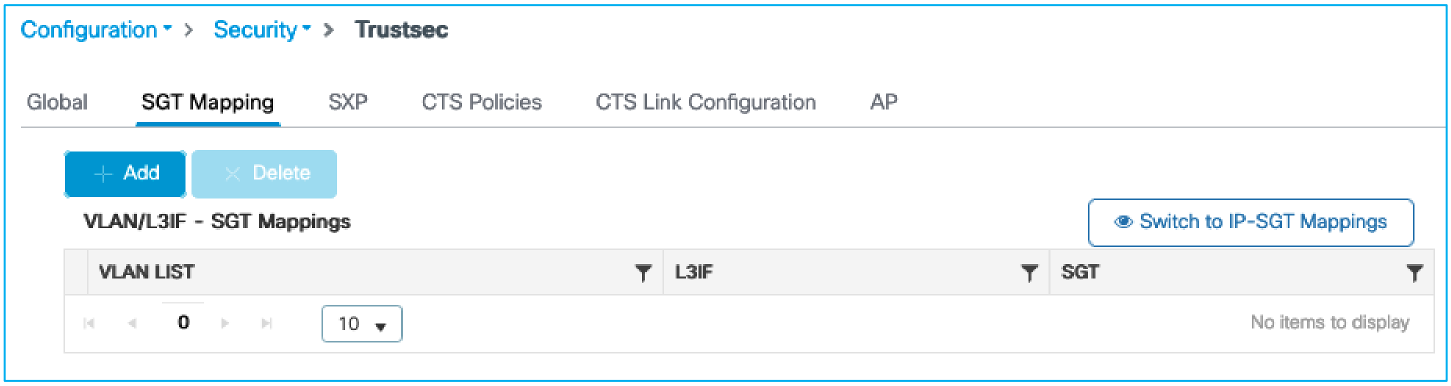


Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings

IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
	IPv4	10.1.200.10	2	-	INTERNAL
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

Then click 'Add':

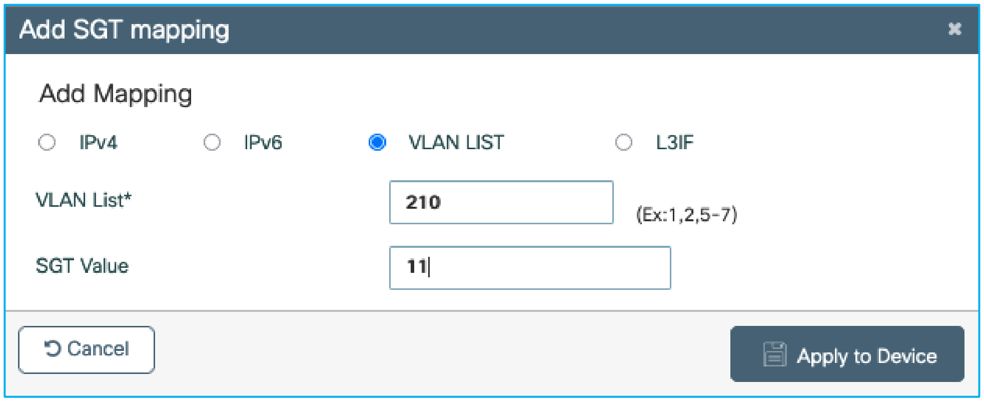


VLAN/L3IF - SGT Mappings

VLAN LIST	L3IF	SGT

No items to display

Select the option for adding a VLAN LIST and then enter the VLAN to learn IP addresses from and the SGT to assign:



Add SGT mapping

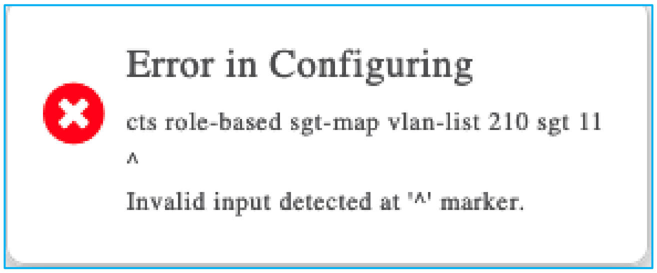
Add Mapping

○ IPv4 ○ IPv6 ● VLAN LIST ○ L3IF

VLAN List* 210 (Ex:1,2,5-7)

SGT Value 11

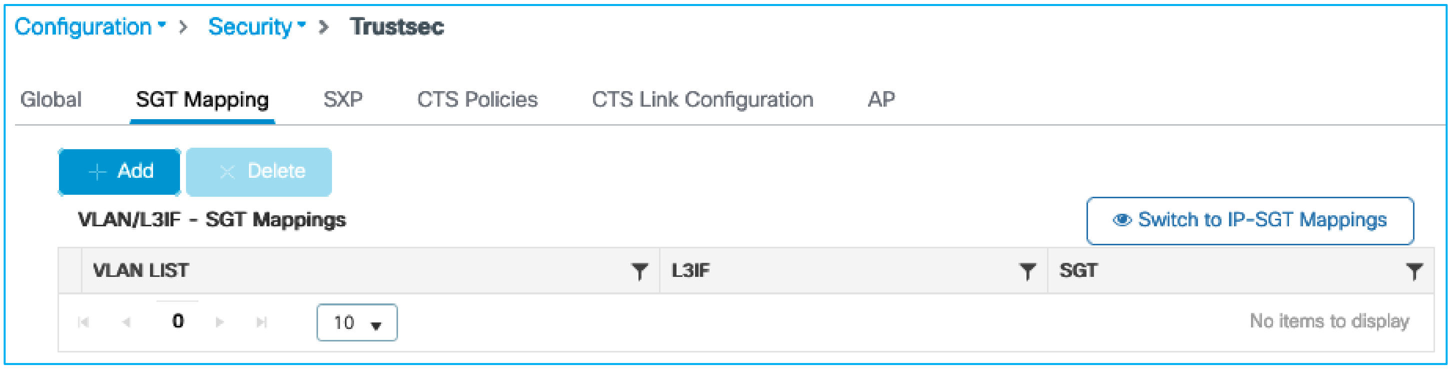
Apply:



Error in Configuring

cts role-based sgt-map vlan-list 210 sgt 11
^
Invalid input detected at '^' marker.

Table remains empty:



VLAN/L3IF - SGT Mappings

VLAN LIST	L3IF	SGT

No items to display

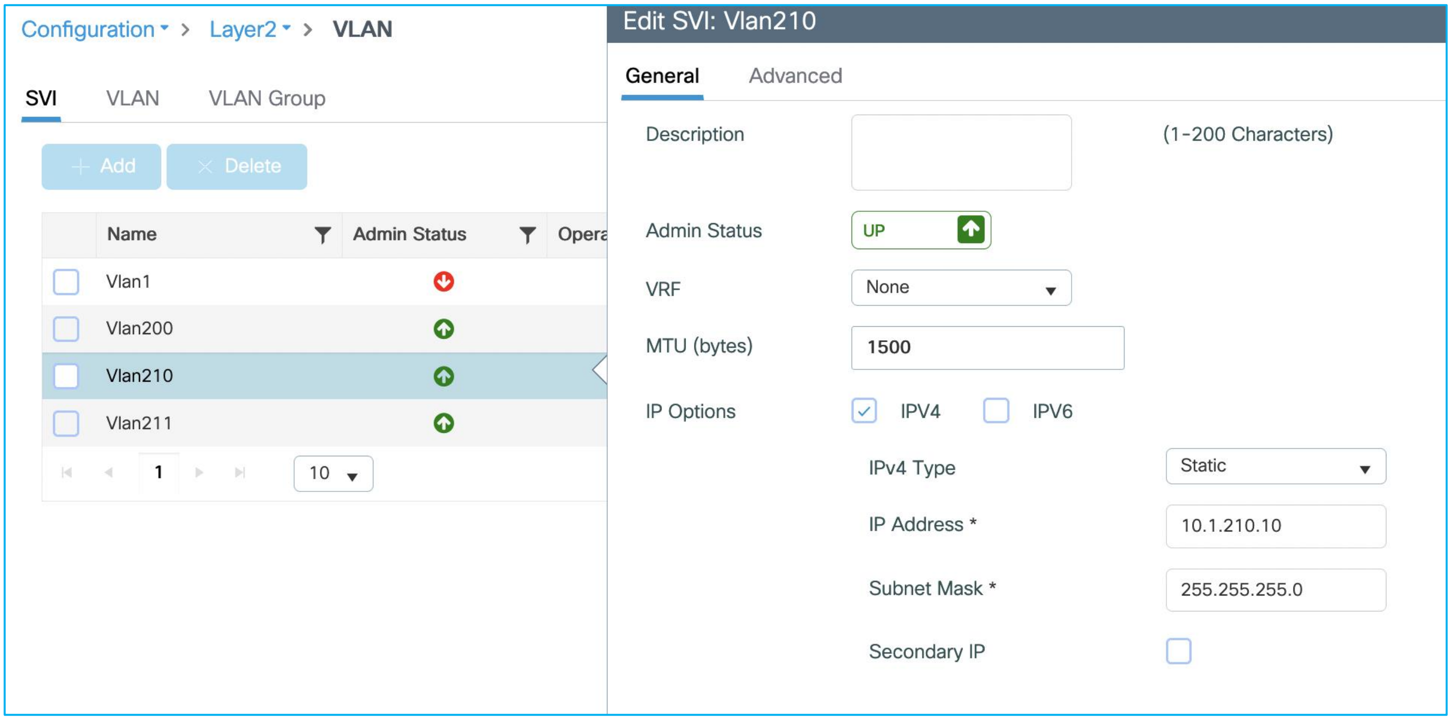
Static VLAN:SGT mapping is not supported on the C9800 and the following DDTS was opened for the generated error: CSCwd06900 C9800 wireless static VLAN to SGT mapping GUI provisioning generates error.

It has been decided to temporarily hide the option to 'Switch to VLAN List/L3IF-SGT Mappings' under Configuration > Security > TrustSec > SGT Mapping in ongoing releases. If either of the two features are required in the future, then the functionality can be investigated and re-introduced. The following DDTS was opened to hide the option: CSCwd14077 C9800: Hide the option to switch to VLAN List and L3IF to SGT Mappings in SGT Mapping screen.

N-S Enforcement Using Static L3IF:SGT for Source

Generally, the L3IF:SGT classification function is for a network device to learn of routing prefixes and to assign an SGT to them. It is typically used for a company to connect to a partner organisation, learning of routing prefixes and assigning an SGT to delineate them from their own prefixes.

Add a L3 interface to the C9800:



Configuration > Layer2 > VLAN

SVI | VLAN | VLAN Group

+ Add | × Delete

	Name	Admin Status	Opera
□	Vlan1	⬇	
□	Vlan200	⬆	
□	Vlan210	⬆	
□	Vlan211	⬆	

1 | 10

Edit SVI: Vlan210

General | Advanced

Description: (1-200 Characters)

Admin Status: UP

VRF: None

MTU (bytes): 1500

IP Options: ☑ IPV4 □ IPV6

IPv4 Type: Static

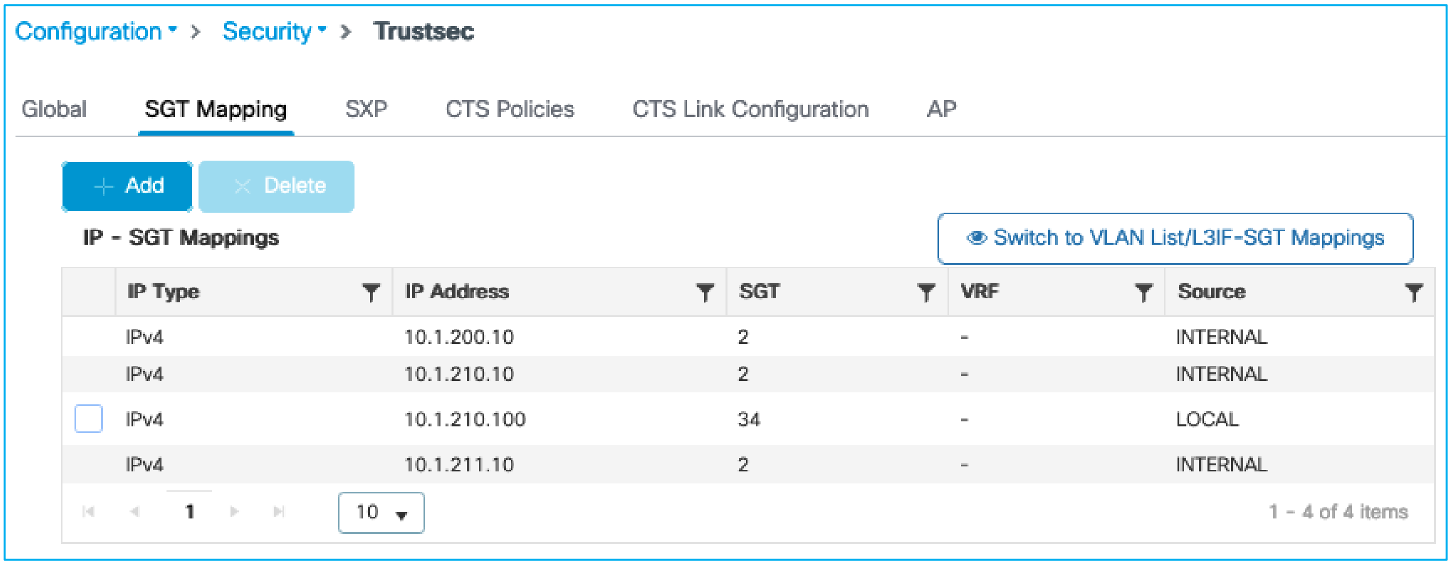
IP Address *: 10.1.210.10

Subnet Mask *: 255.255.255.0

Secondary IP: □

Ensure there are no other static mappings present, no SXP and inline tagging is disabled on the uplink.

Under Configuration > Security > TrustSec > SGT Mapping, click the option to 'Switch to VLAN List/L3IF-SGT Mappings':

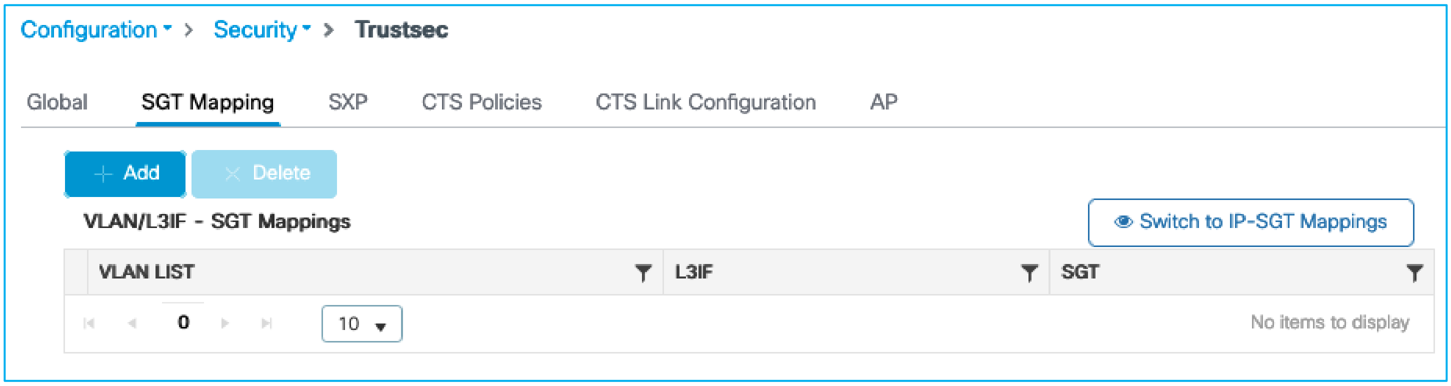

Configuration ▾ > Security ▾ > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings
10 ▾

IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
	IPv4	10.1.200.10	2	-	INTERNAL
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

1 – 4 of 4 items

Then click 'Add':

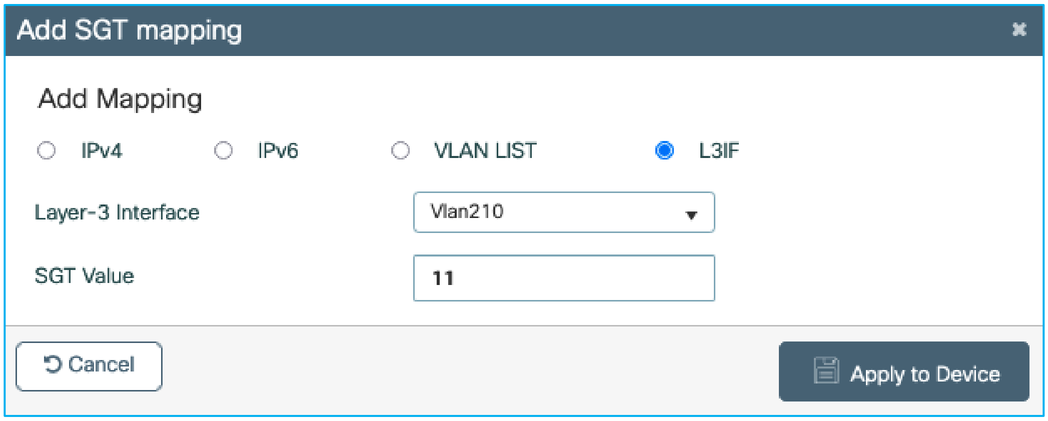


VLAN/L3IF - SGT Mappings

VLAN LIST	L3IF	SGT

No items to display

Select the option to add a L3IF mapping, then add a L3 interface and an SGT value to assign:

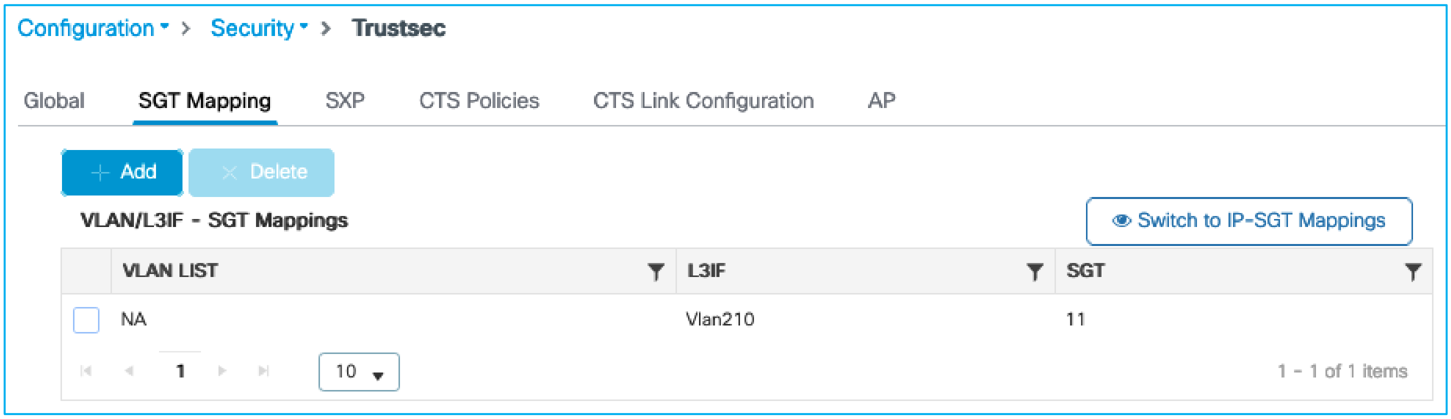


Add Mapping

○ IPv4 ○ IPv6 ○ VLAN LIST ● L3IF

Layer-3 Interface	Vlan210
SGT Value	11

An entry is added to the table:



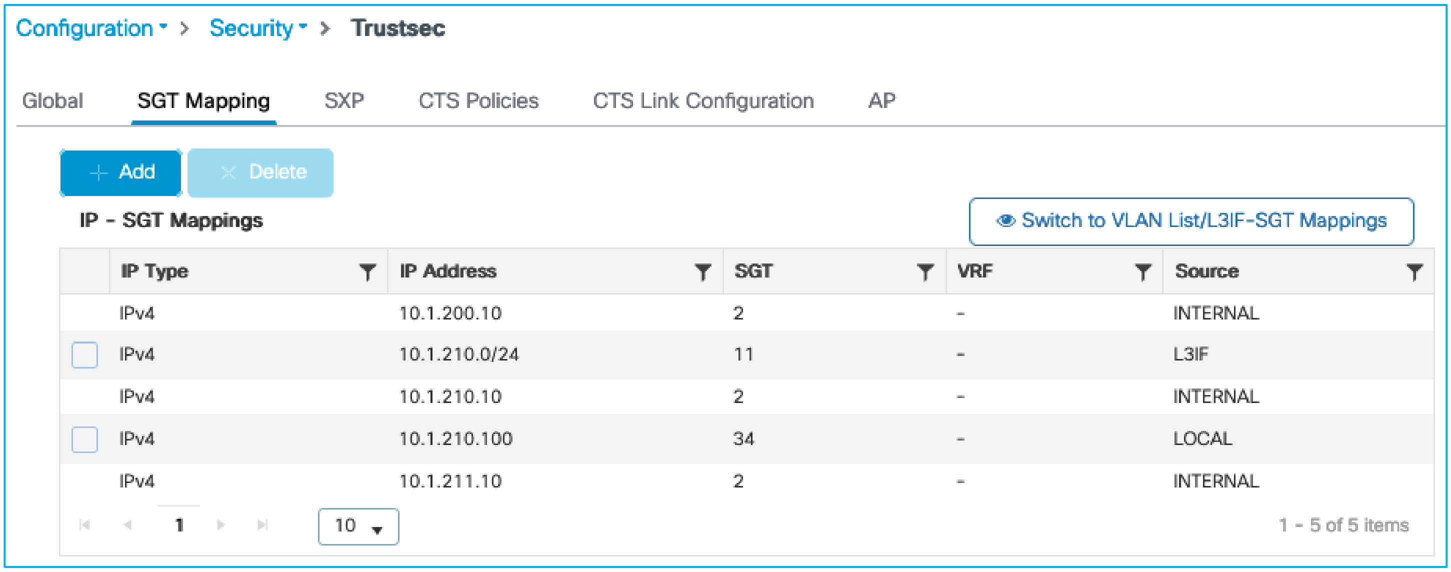
VLAN/L3IF - SGT Mappings

	VLAN LIST	L3IF	SGT
□	NA	Vlan210	11

The CLI added via the GUI action:

```
interface Vlan210
 cts role-based sgt-map sgt 11
```

The mapping table shows:

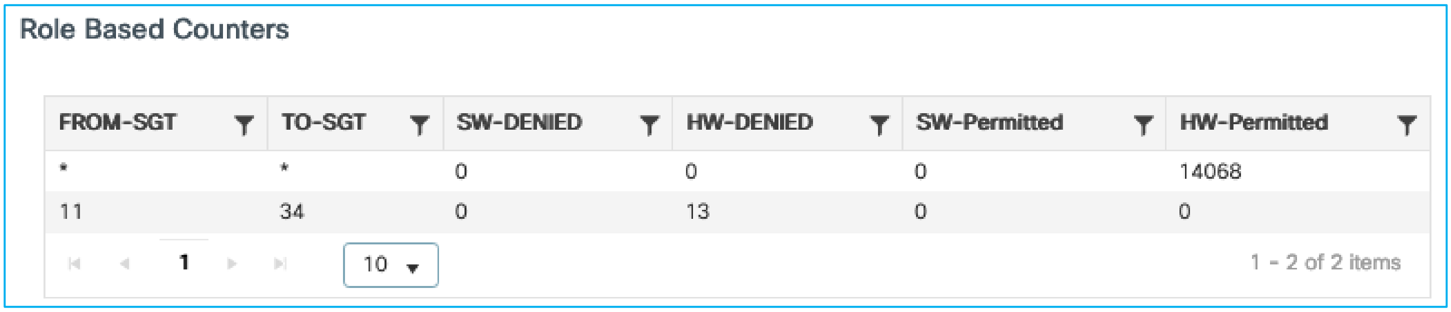


IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
	IPv4	10.1.200.10	2	-	INTERNAL
□	IPv4	10.1.210.0/24	11	-	L3IF
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL

Traffic is enforced from the 10.1.210.0/24 subnet to the wireless client:

```
Kernow-Cat9300-b#ping 10.1.210.100 source 10.1.210.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.210.100, timeout is 2 seconds:
Packet sent with a source address of 10.1.210.1
.....
Success rate is 0 percent (0/5)
```



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	14068
11	34	0	13	0	0

So, the L3IF mapping does add a relevant Subnet mapping but that isn't really the intention of the L3IF function. If a Subnet:SGT mapping is required then why not just use the static Subnet:SGT function?
As the C9800 is largely a L2 platform the full function cannot currently be realised.

It has been decided to temporarily hide the option to 'Switch to VLAN List/L3IF-SGT Mappings' under Configuration > Security > TrustSec > SGT Mapping in ongoing releases. If either of the two features are required in the future, then the functionality can be investigated and re-introduced. The following DDTS was opened to hide the option: CSCwd14077 C9800: Hide the option to switch to VLAN List and L3IF to SGT Mappings in SGT Mapping screen.

N-S Precedence Order for Classification and Enforcement

There is a strict order of precedence for source SGT lookup and enforcement, as defined by the Group-Based Policy specification. SGT received by inline tagging is the highest priority, then SXP with CLI last in the supported classification methods. Additionally, it works on longest match (an example being prioritising IP /32 mappings over /24.

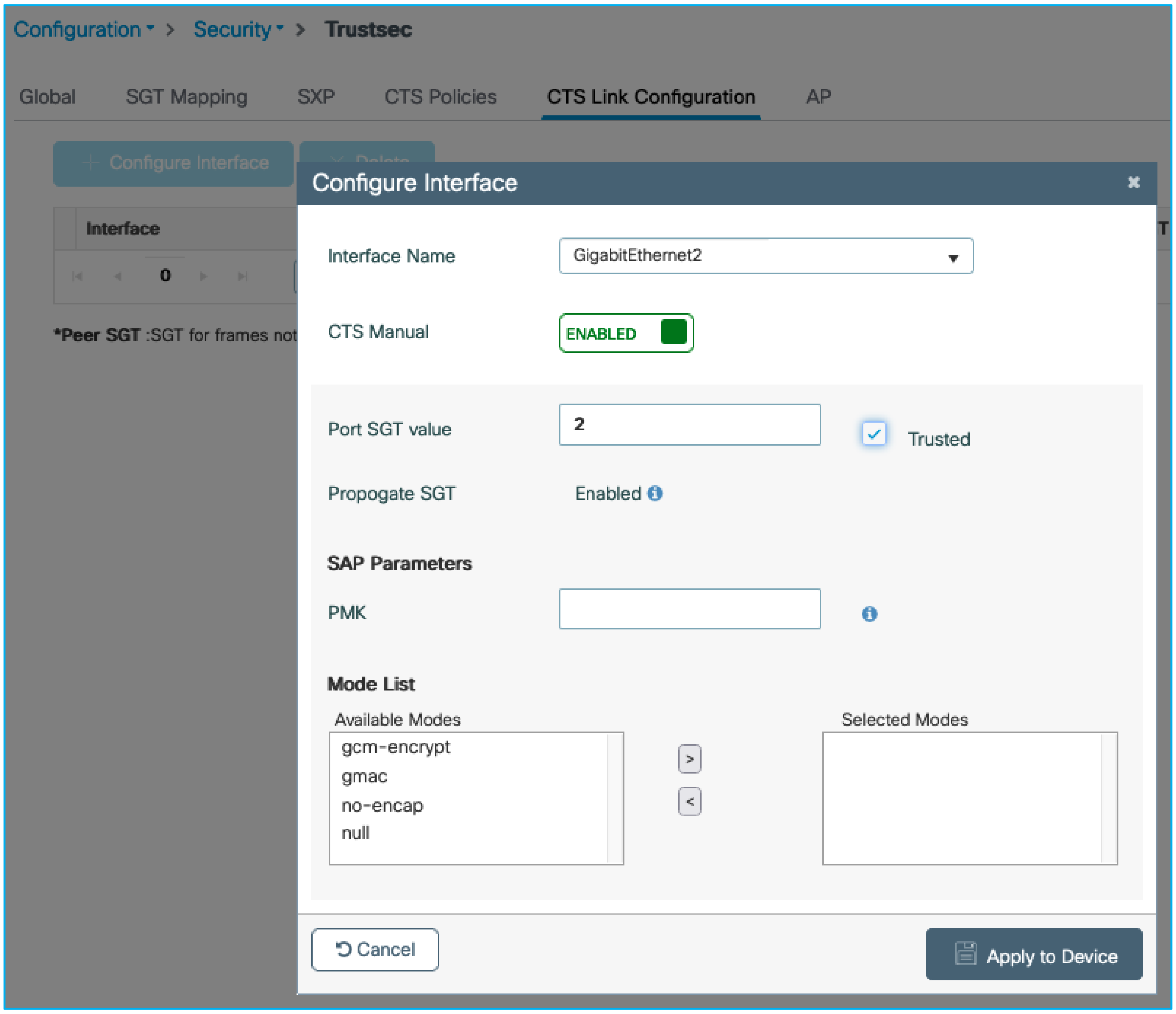
This use-case configures mappings as per the following:

IP Address	Assigned SGT	Learned From
10.1.140.2	11 (Production_Servers)	Inline Tagging (CMD)
10.1.140.2	12 (Development_Servers)	SXP
10.1.140.2	13 (Test_Servers)	CLI (IP:SGT)
10.1.140.0/24	14 (PCI_Servers)	CLI (Subnet:SGT)

Testing will occur with all four classifications present; SGT 11 should take precedence (learned from inline tagging (CMD).

Without inline tagging, SXP should take precedence with SGT 12. Without inline and SXP, CLI IP:SGT should take precedence with SGT 13 and lastly CLI Subnet:SGT with SGT 14.

Firstly, enable inline tagging on the C9800 uplink and Cat9k peer:



Interface Name: GigabitEthernet2

CTS Manual: ENABLED

Port SGT value: 2 ☑ Trusted

Propogate SGT: Enabled

SAP Parameters

PMK:

Mode List

Available Modes: gcm-encrypt, gmac, no-encap, null

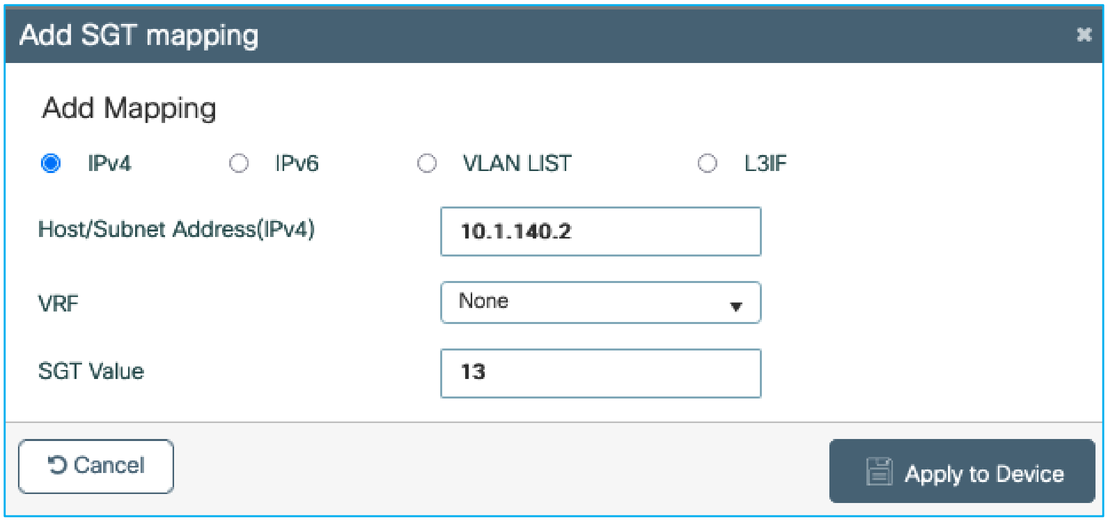
Selected Modes:

```
interface GigabitEthernet1/0/15
 switchport trunk allowed vlan 200,210,211
 switchport mode trunk
 switchport nonegotiate
 cts manual
  policy static sgt 2 trusted
 ip dhcp snooping trust
end
```

On the Cat9k, add a classification for the Production Server so the C9800 receives this SGT inline:

```
Kernow-Cat9300-b(config)#cts role-based sgt-map 10.1.140.2 sgt 11
```

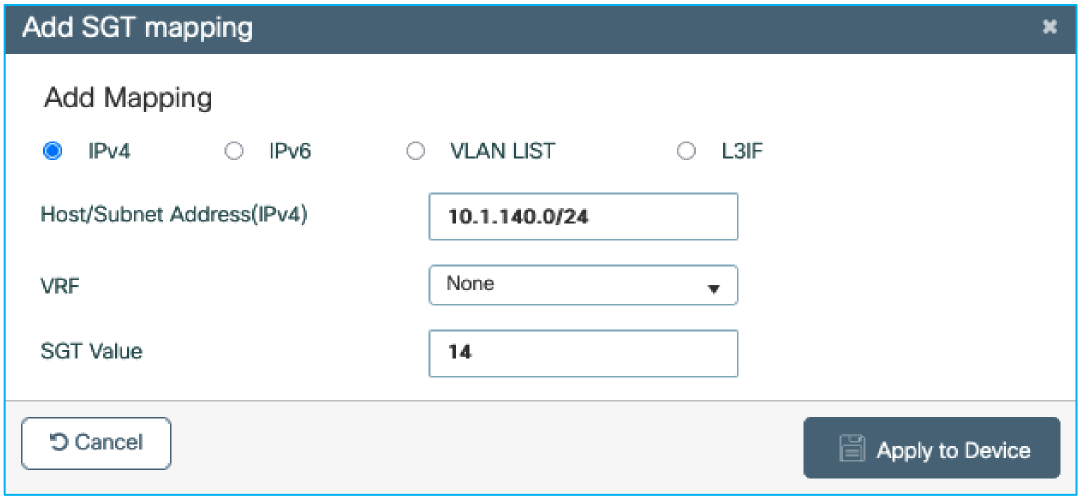
Now, add two static mappings in the C9800, one IP:SGT and one Subnet:SGT:



Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

Host/Subnet Address(IPv4)	10.1.140.2
VRF	None
SGT Value	13

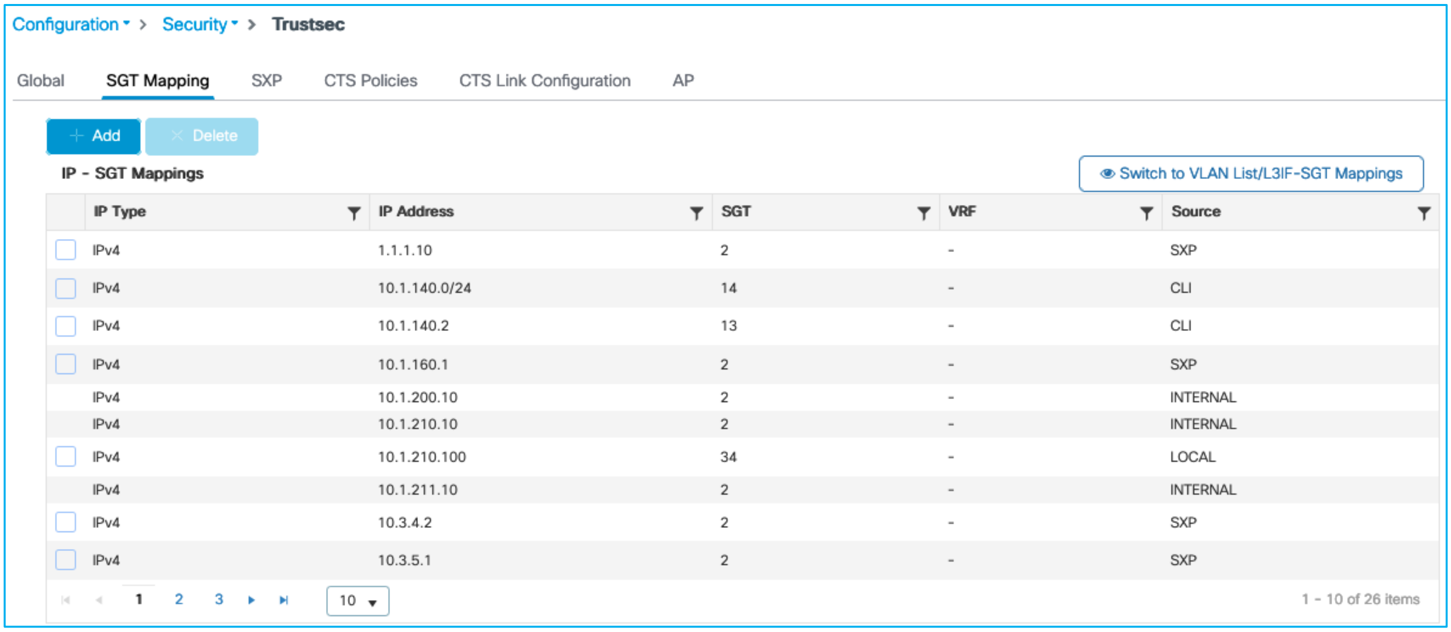


Add Mapping

● IPv4 ○ IPv6 ○ VLAN LIST ○ L3IF

Host/Subnet Address(IPv4)	10.1.140.0/24
VRF	None
SGT Value	14

Both the /32 and /24 entries are shown in the SGT Mapping table:



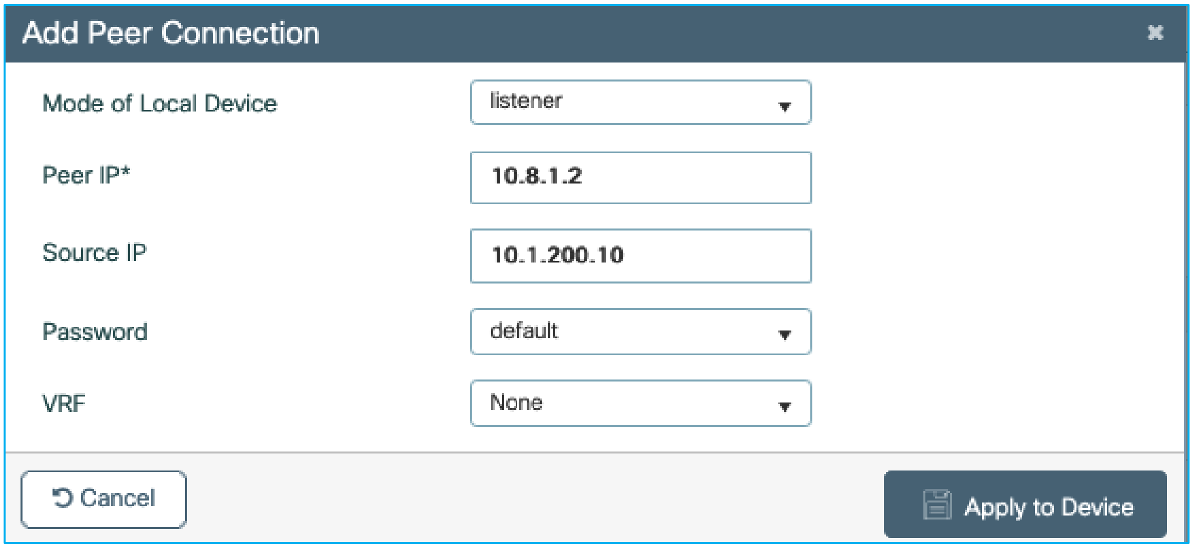
IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	1.1.1.10	2	-	SXP
IPv4	10.1.140.0/24	14	-	CLI
IPv4	10.1.140.2	13	-	CLI
IPv4	10.1.160.1	2	-	SXP
IPv4	10.1.200.10	2	-	INTERNAL
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	34	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL
IPv4	10.3.4.2	2	-	SXP
IPv4	10.3.5.1	2	-	SXP

1 - 10 of 26 items

Now, add an SXP connection from another platform (Cat6k in this example) to the C9800 in order to add an SXP mapping. Cat6k will be an SXP Speaker whilst the C9800 will be the SXP Listener.

On C9800, use Configuration > Security > TrustSec > SXP to add a new SXP connection:

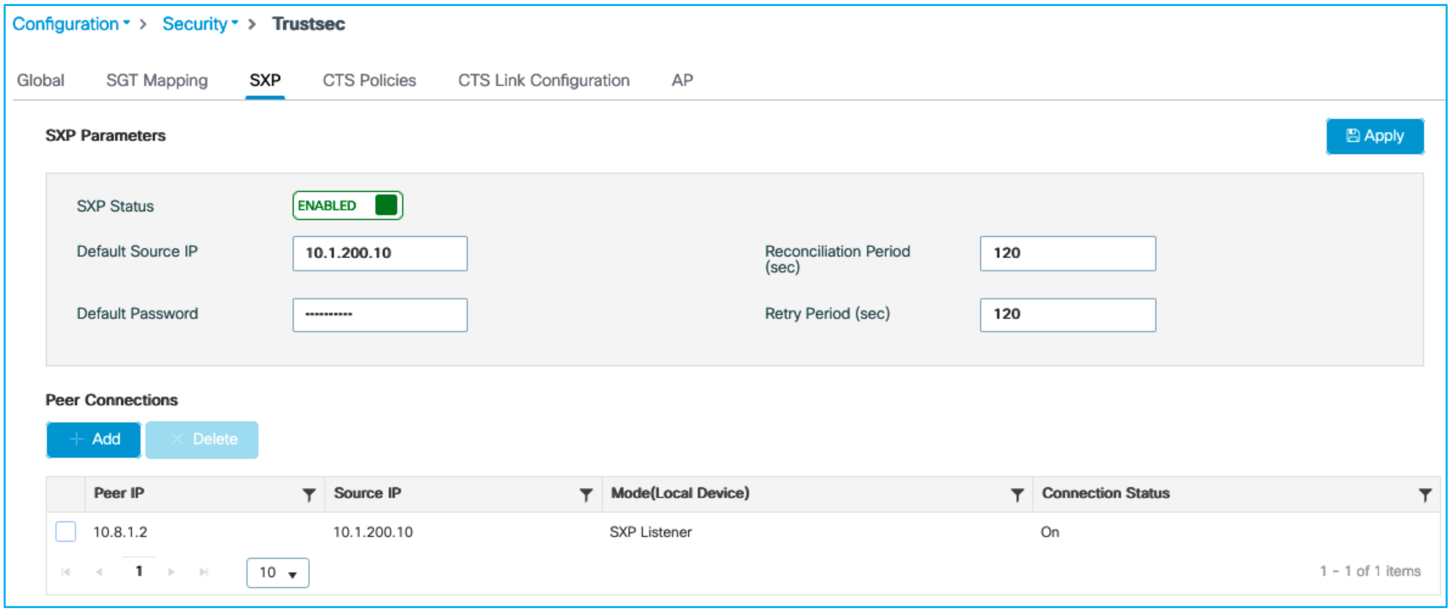


Add Peer Connection

Mode of Local Device	listener
Peer IP*	10.8.1.2
Source IP	10.1.200.10
Password	default
VRF	None

(where 10.8.1.2 is the peer IP address on the Cat6k).

Once the connection is added on the Cat6k end, the C9800 shows the connection as 'On':



SXP Parameters

SXP Status	ENABLED		
Default Source IP	10.1.200.10	Reconciliation Period (sec)	120
Default Password	----------	Retry Period (sec)	120

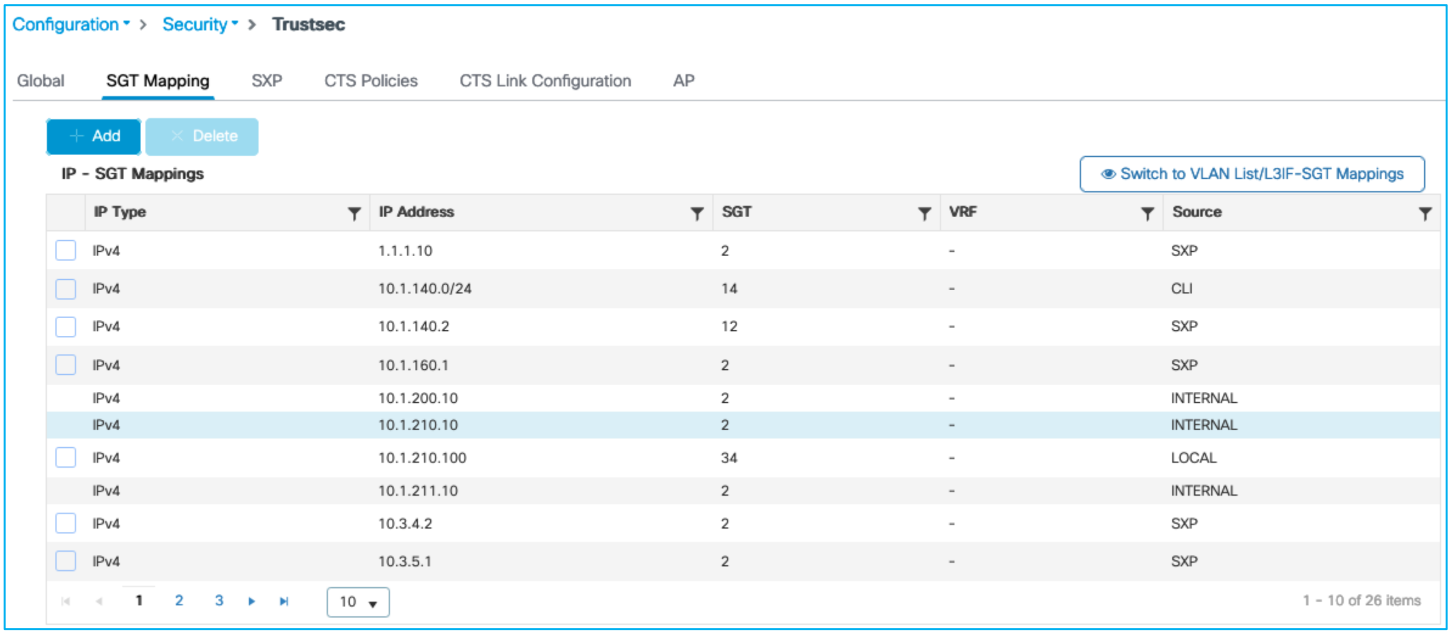
Peer Connections

	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	10.8.1.2	10.1.200.10	SXP Listener	On

Now, add the Production Server mapping in the Cat6k so that the C9800 can learn it via SXP:

Kernow-6500(config)#cts role-based sgt-map 10.1.140.2 sgt 12

C9800 learns it via SXP but you'll see that the C9800 has prioritised the mapping from SXP over the same IP:SGT mapping added via CLI (the CLI entry has been removed from the table):


Configuration > Security > Trustsec
Global
SGT Mapping
SXP
CTS Policies
CTS Link Configuration
AP
+ Add
× Delete
Switch to VLAN List/L3IF-SGT Mappings

IP - SGT Mappings

	IP Type	IP Address	SGT	VRF	Source
□	IPv4	1.1.1.10	2	-	SXP
□	IPv4	10.1.140.0/24	14	-	CLI
□	IPv4	10.1.140.2	12	-	SXP
□	IPv4	10.1.160.1	2	-	SXP
	IPv4	10.1.200.10	2	-	INTERNAL
	IPv4	10.1.210.10	2	-	INTERNAL
□	IPv4	10.1.210.100	34	-	LOCAL
	IPv4	10.1.211.10	2	-	INTERNAL
□	IPv4	10.3.4.2	2	-	SXP
□	IPv4	10.3.5.1	2	-	SXP

So, the C9800 prioritises SXP mappings over statically added IP:SGT /32 entries.

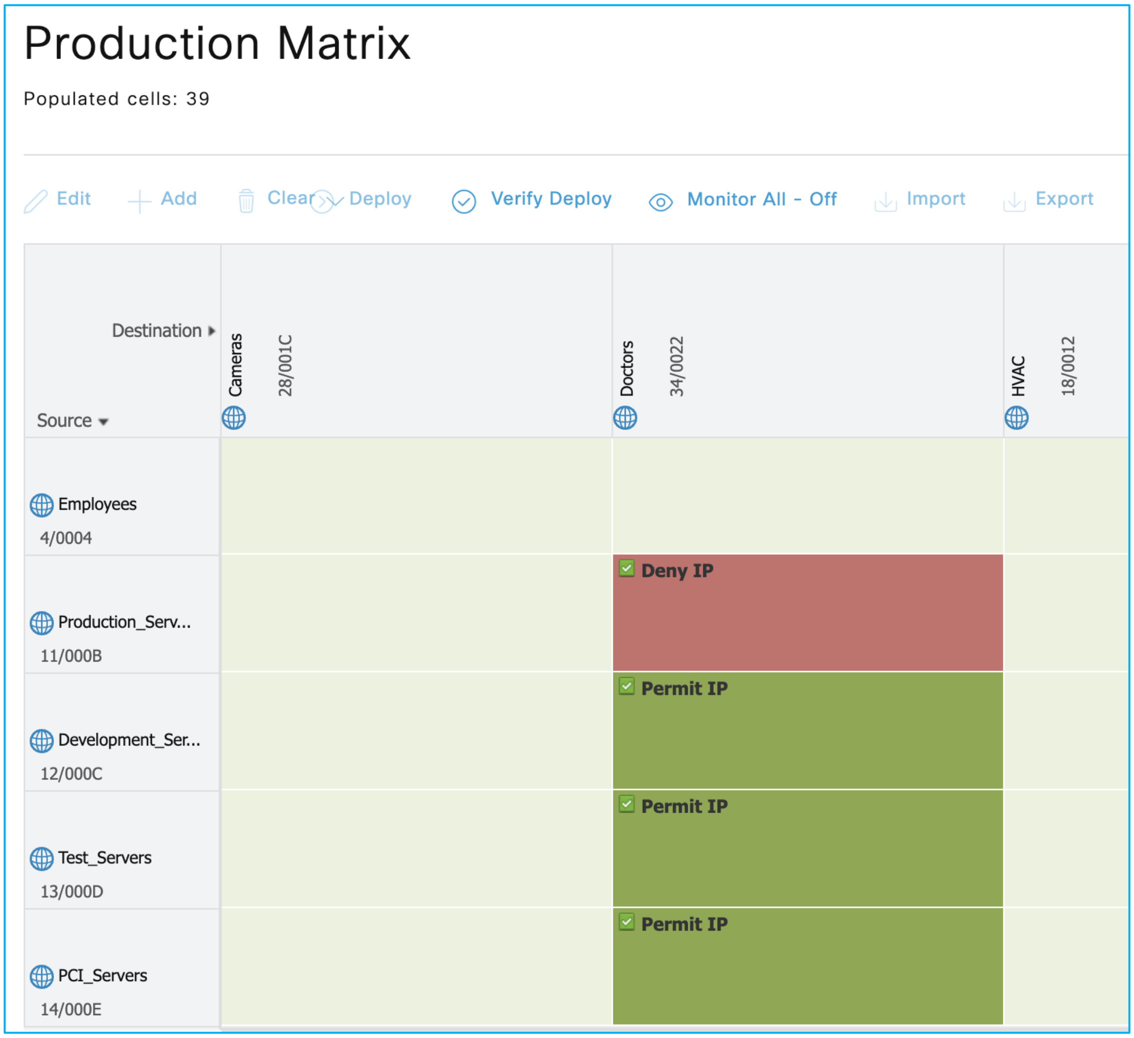
With the C9800 already showing classification prioritisation behaviour of SXP over CLI, we are left with:

Inline tagging, assigning SGT 11 to 10.1.140.2

SXP assigning SGT 12 to 10.1.140.2

Subnet:SGT assigning SGT 14 to 10.1.140.2

Add policies in ISE to prove the prioritisation:



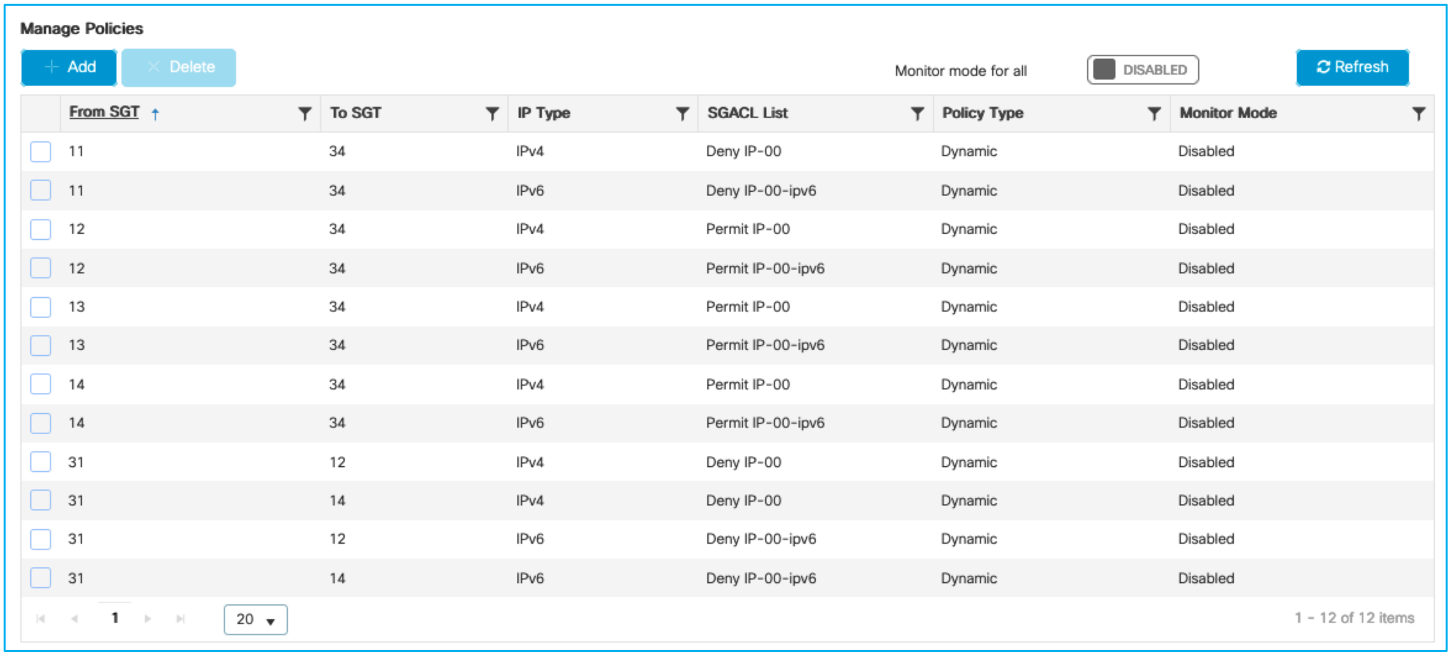
Production Matrix

Populated cells: 39

Edit | Add | Clear | Deploy | Verify Deploy | Monitor All - Off | Import | Export

Destination ▸ / Source ▾	Cameras 28/001C	Doctors 34/0022	HVAC 18/0012
Employees 4/0004			
Production_Serv... 11/000B		☑ Deny IP	
Development_Ser... 12/000C		☑ Permit IP	
Test_Servers 13/000D		☑ Permit IP	
PCI_Servers 14/000E		☑ Permit IP	

The C9800 downloads the policies:



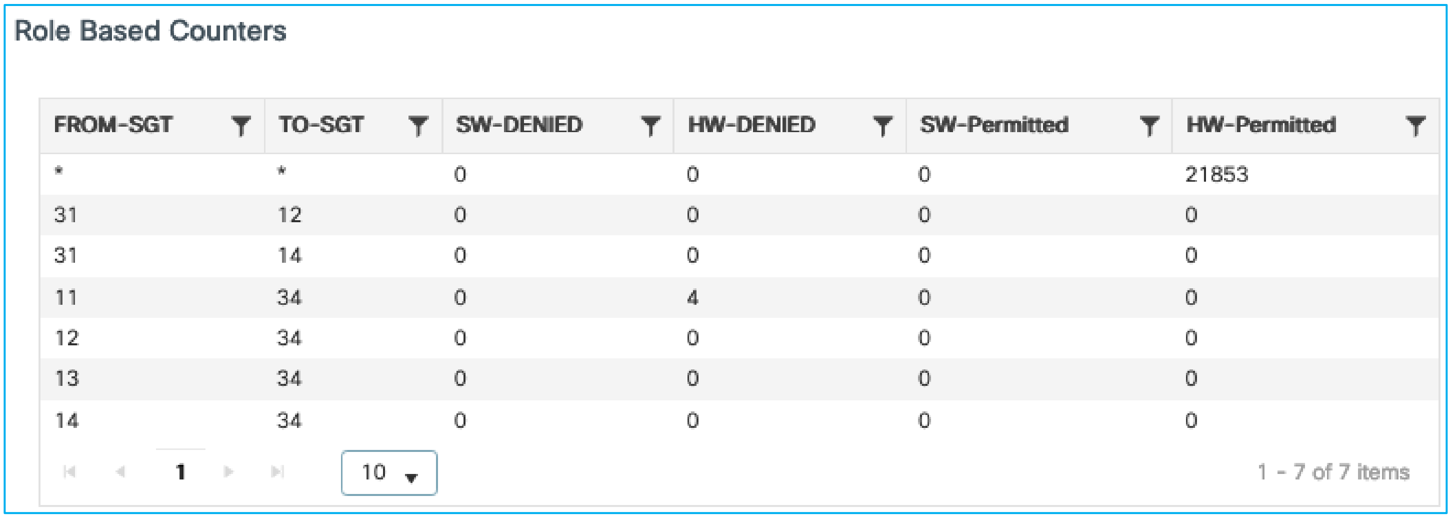
Manage Policies

+ Add | × Delete | Monitor mode for all DISABLED | Refresh

	From SGT ↑	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled
□	12	34	IPv4	Permit IP-00	Dynamic	Disabled
□	12	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled
□	13	34	IPv4	Permit IP-00	Dynamic	Disabled
□	13	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled
□	14	34	IPv4	Permit IP-00	Dynamic	Disabled
□	14	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled
□	31	12	IPv4	Deny IP-00	Dynamic	Disabled
□	31	14	IPv4	Deny IP-00	Dynamic	Disabled
□	31	12	IPv6	Deny IP-00-ipv6	Dynamic	Disabled
□	31	14	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

1 | 20 ▾ | 1 - 12 of 12 items

Traffic is denied between the wireless client (SGT 34) and the Production Server IP 10.1.140.2, and the Counters table shows it's the policy from 11 to 34 that is being hit:



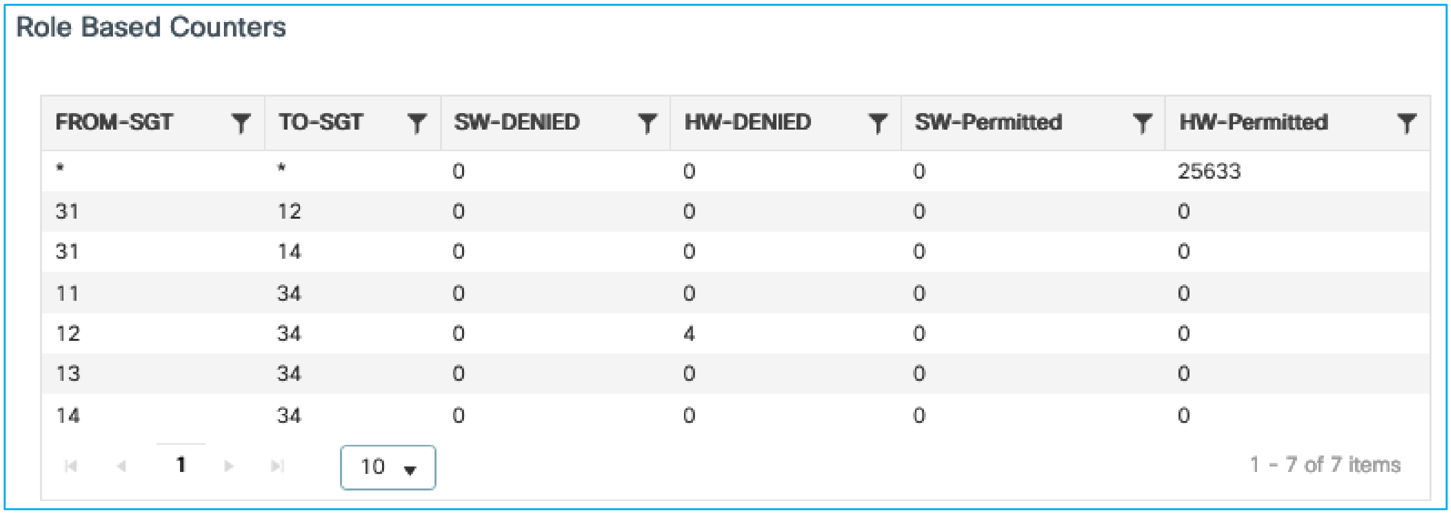
Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	21853
31	12	0	0	0	0
31	14	0	0	0	0
11	34	0	4	0	0
12	34	0	0	0	0
13	34	0	0	0	0
14	34	0	0	0	0

So, inline tagging does take precedence.

Note: Inline tagging will always take precedence, even if the received SGT is 0/Unknown.

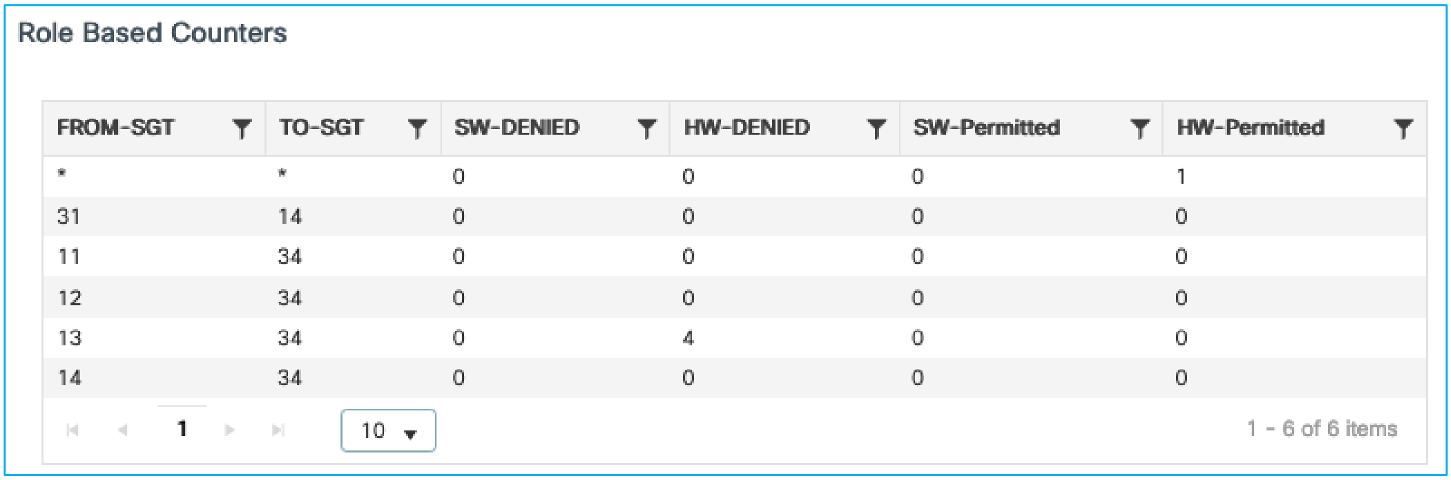
Now, remove inline tagging and set a deny policy on the SXP mapping with SGT 12. Traffic is enforced so SXP does come next in precedence order:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	25633
31	12	0	0	0	0
31	14	0	0	0	0
11	34	0	0	0	0
12	34	0	4	0	0
13	34	0	0	0	0
14	34	0	0	0	0

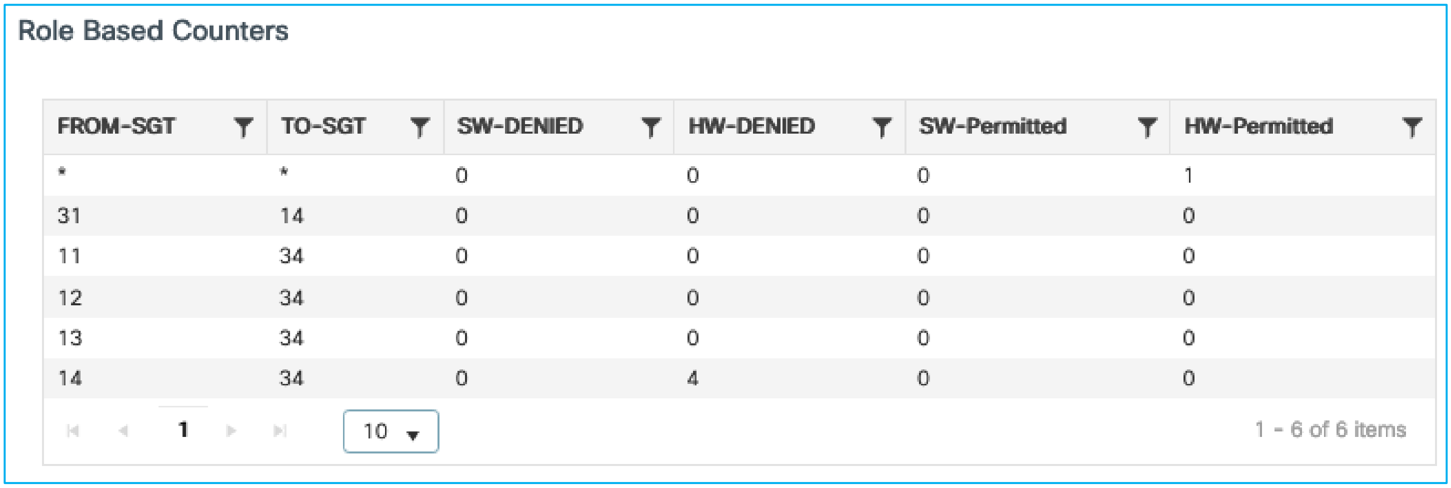
Remove the SXP mapping and SGT 13 is acted upon which is the static IP:SGT mapping using /32:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	1
31	14	0	0	0	0
11	34	0	0	0	0
12	34	0	0	0	0
13	34	0	4	0	0
14	34	0	0	0	0

Remove the /32 IP:SGT mapping and SGT 14 is acted upon which is the /24 IP:SGT mapping:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	1
31	14	0	0	0	0
11	34	0	0	0	0
12	34	0	0	0	0
13	34	0	0	0	0
14	34	0	4	0	0

Note: In order to clear the role-based counters, navigate to Administration > Command Line Interface, and under the Exec option, run the command "clear cts role-based counters".

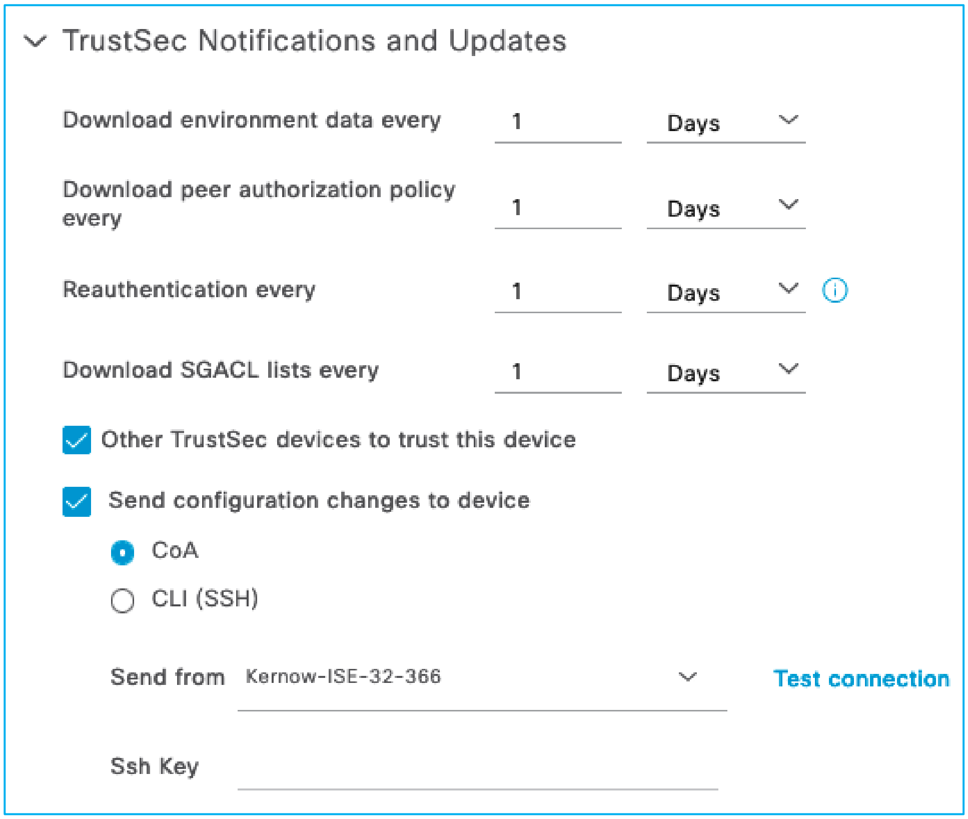
The conclusion is that the order of precedence for classification and enforcement is comparable with the operation of other Cisco network devices.

CoA and SSH for Policy Updates

This use-case is testing CoA and SSH pushed from ISE for policy updates.

CoA for Policy Update

In ISE, navigate to Administration > Network Resources > Network Devices and edit the C9800 entry. Scroll down and ensure 'Send configuration changes to device' is set and CoA is selected:



TrustSec Notifications and Updates

Download environment data every 1 Days

Download peer authorization policy every 1 Days

Reauthentication every 1 Days

Download SGACL lists every 1 Days

☑ Other TrustSec devices to trust this device

☑ Send configuration changes to device

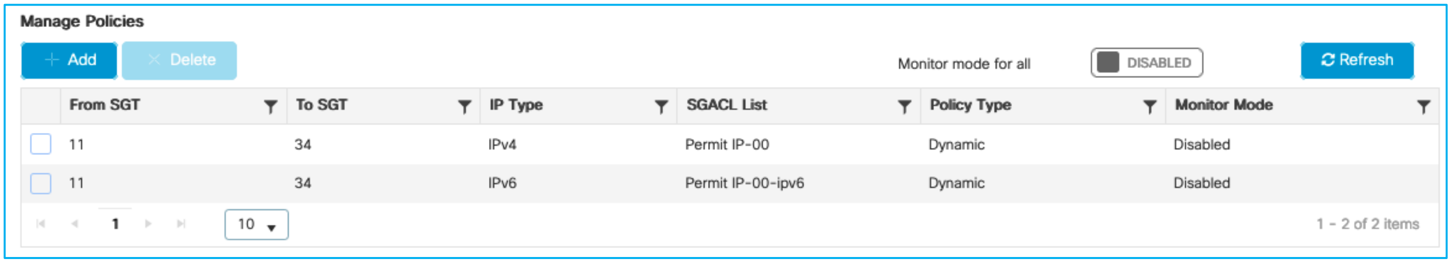
● CoA

○ CLI (SSH)

Send from Kernow-ISE-32-366

Ssh Key

A wireless client is connected and assigned SGT 34 from ISE. Due to this, policies protecting SGT 34 are downloaded:



Manage Policies

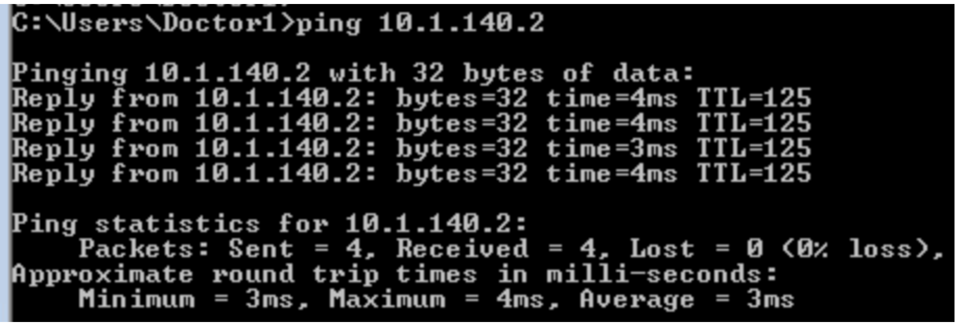
Monitor mode for all DISABLED

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Permit IP-00	Dynamic	Disabled
□	11	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled

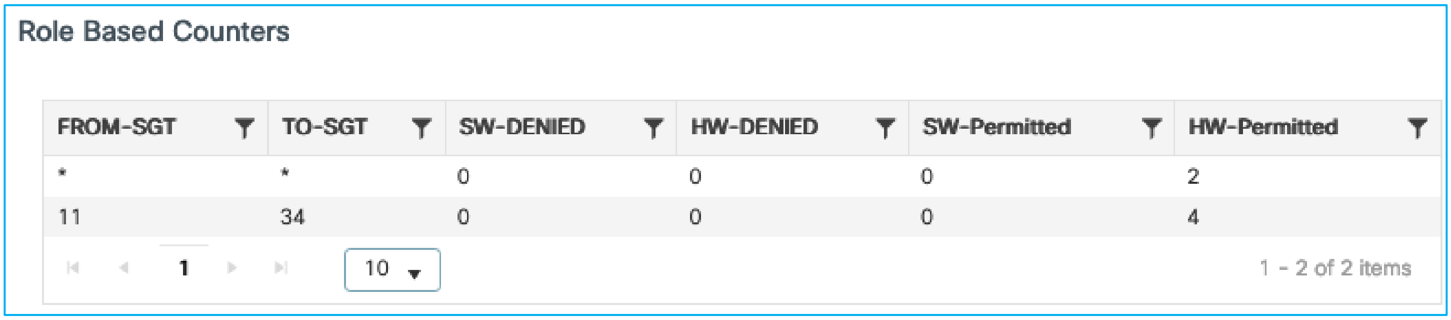
1 - 2 of 2 items

So, policy from SGT 11 to SGT 34 has been downloaded and the action is to permit traffic.

The permit can be seen to be honoured from the client and from the C9800 role-based counters (Monitoring > General > TrustSec):



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=3ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 4ms, Average = 3ms
```

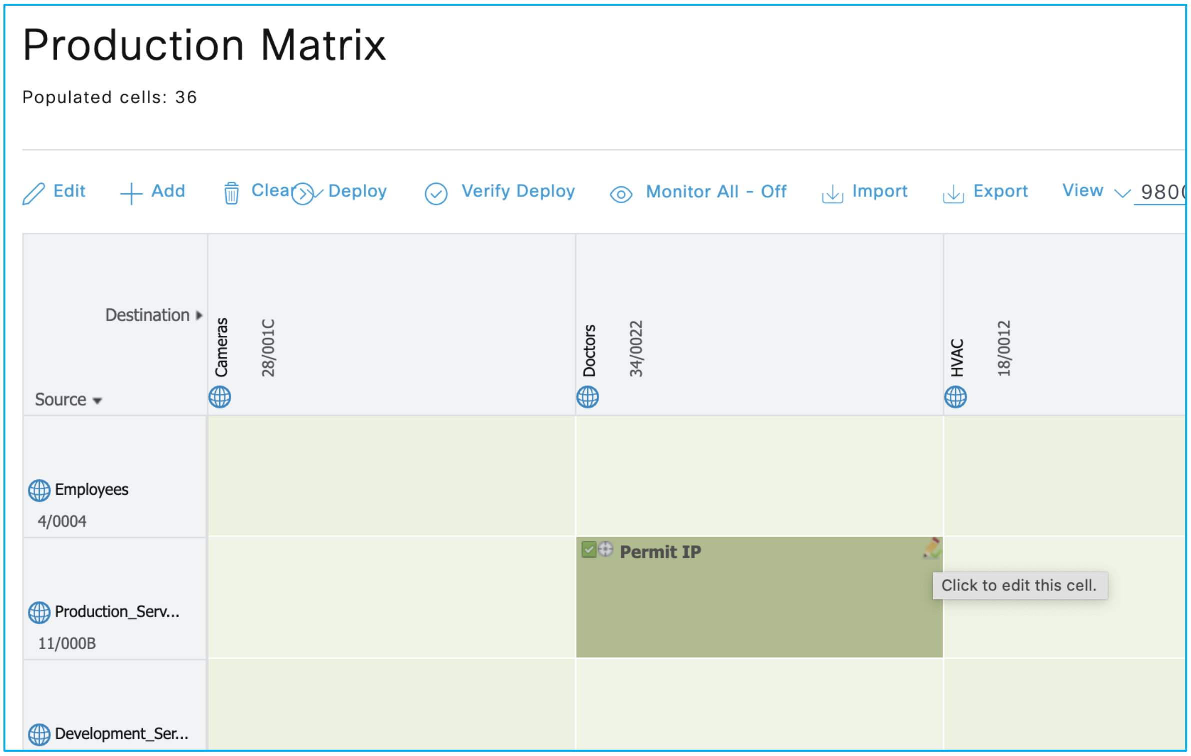


Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	2
11	34	0	0	0	4

Now, use ISE to change the SGACL in use to be a deny instead of a permit and push the change to the C9800 (using CoA as per the ISE network device setting).

One way to edit the assigned SGACL in ISE is to find the cell in the policy matrix and select 'Edit' from the icon within the cell:

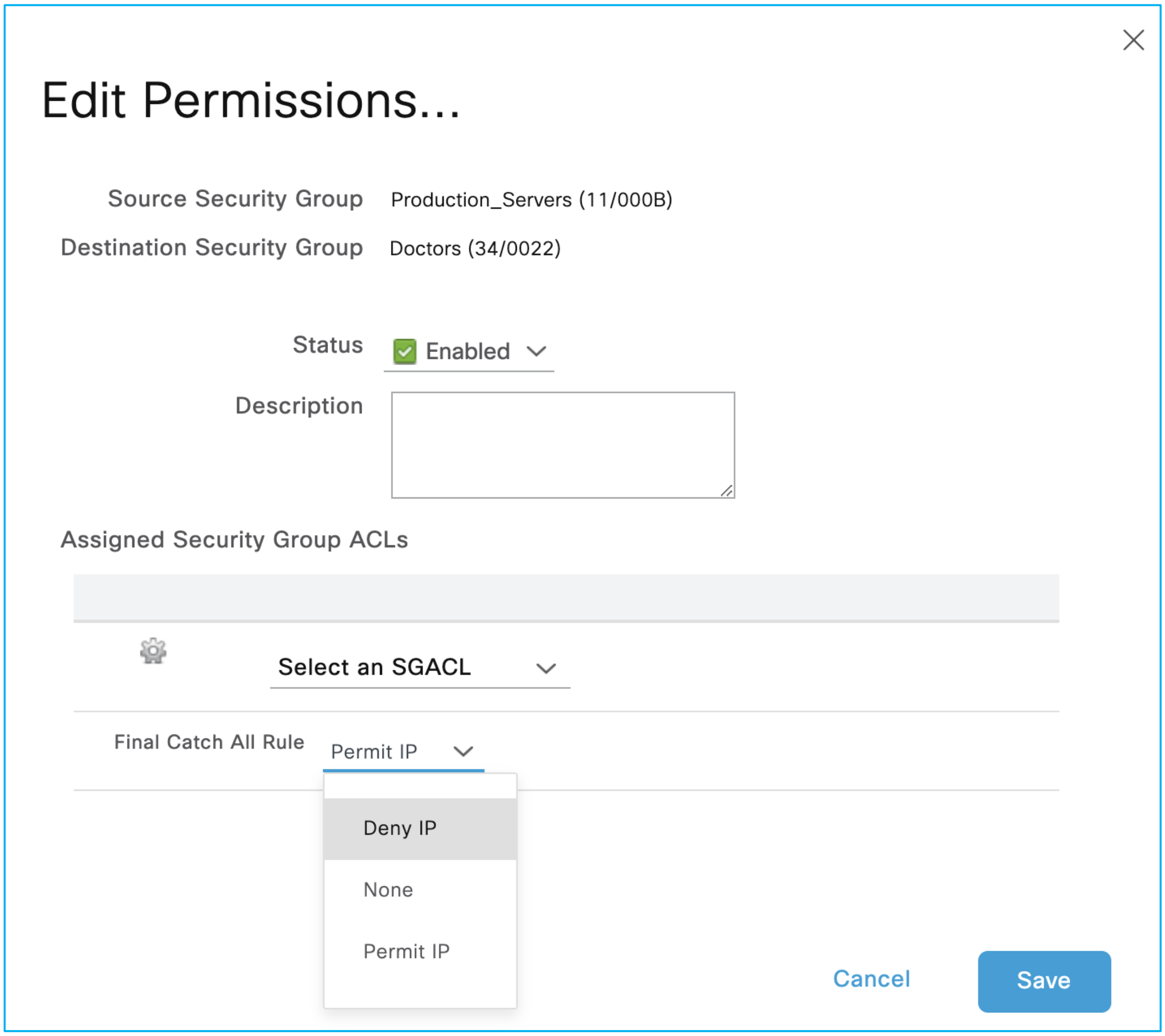


Production Matrix

Populated cells: 36

Destination ▸ Source ▾	Cameras 28/001C	Doctors 34/0022	HVAC 18/0012
Employees 4/0004			
Production_Serv... 11/000B		Permit IP	
Development_Ser...			

Then change the catch all rule Permit IP to a Deny IP:



Edit Permissions...

Source Security Group Production_Servers (11/000B)

Destination Security Group Doctors (34/0022)

Status ☑ Enabled

Description

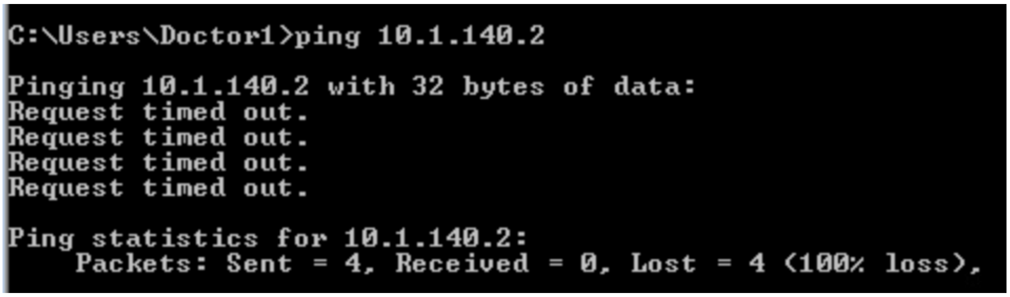
Assigned Security Group ACLs

Select an SGACL

Final Catch All Rule Permit IP

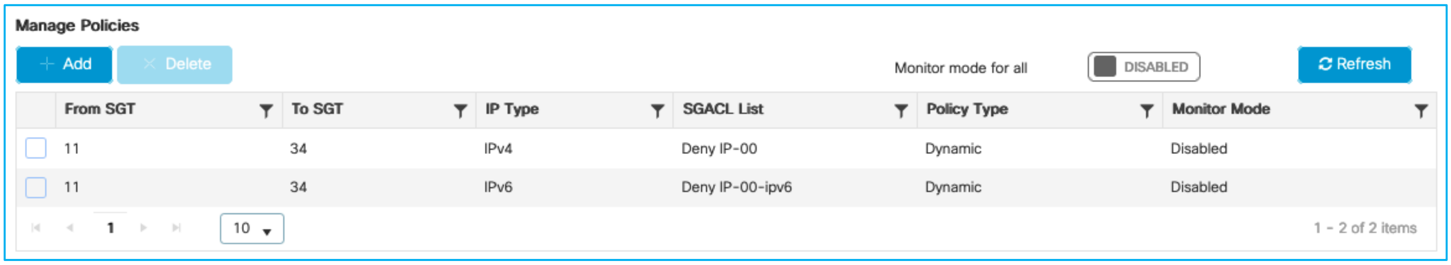
Save the change and use the ‘Deploy’ function at the top of the matrix to send the update to the network devices.

The client is blocked from communicating with the Production Server proving the policy update worked successfully:



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

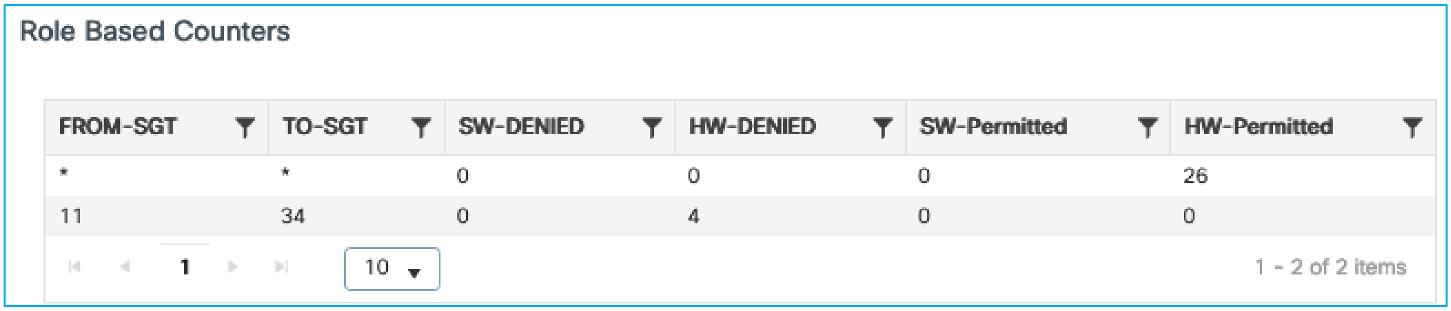
Policy updated in C9800:



Manage Policies

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

Hit counts on C9800 now showing denies:



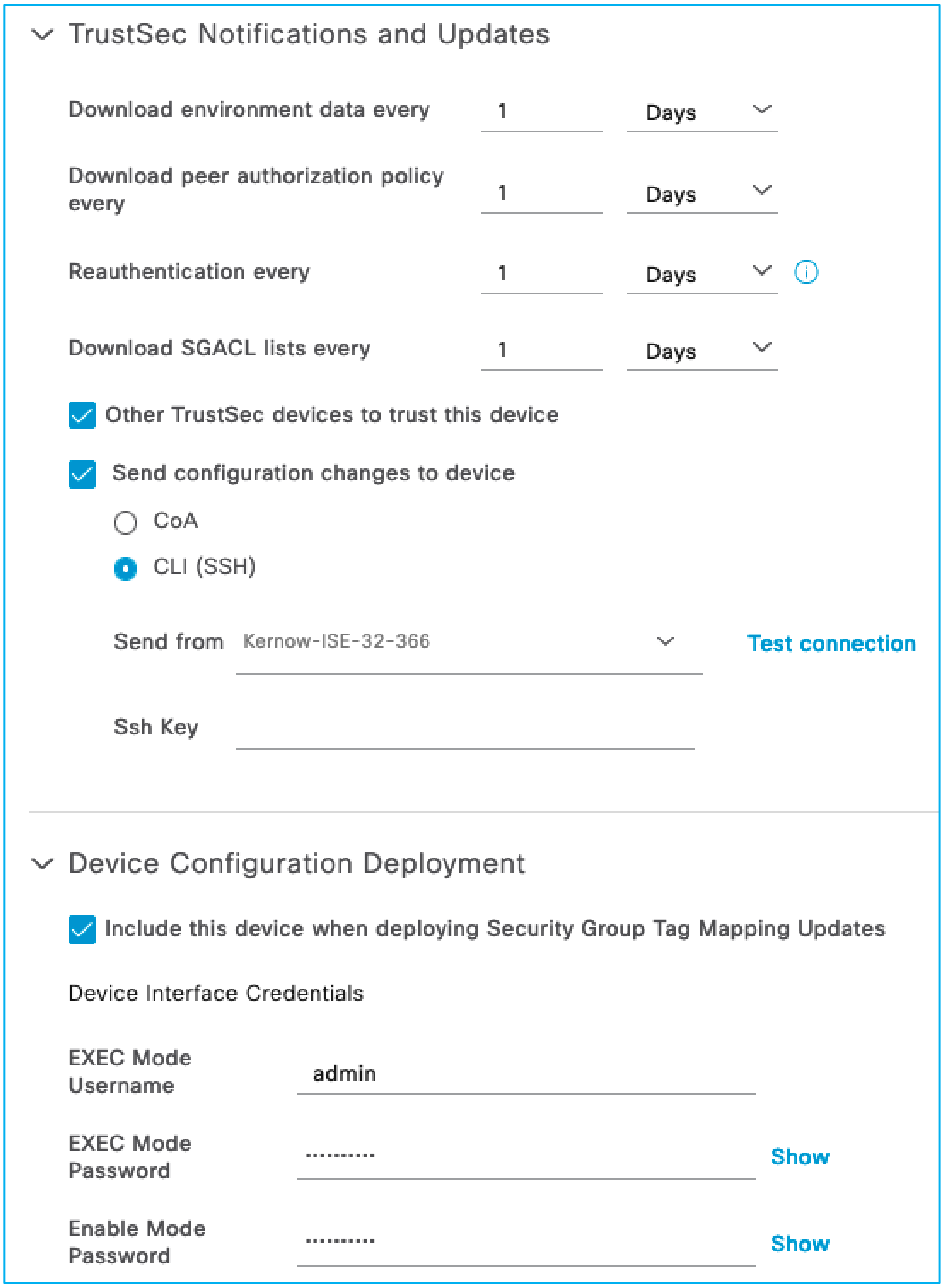
Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	26
11	34	0	4	0	0

The policy can be updated successfully using CoA from ISE.

SSH for Policy Update

In ISE, navigate to Administration > Network Resources > Network Devices and edit the C9800 entry. Scroll down and ensure ‘Send configuration changes to device’ is set and CLI (SSH) is selected. Also ensure the C9800 access credentials are set correctly under ‘Device Configuration Deployment’:



TrustSec Notifications and Updates

Download environment data every	1	Days
Download peer authorization policy every	1	Days
Reauthentication every	1	Days
Download SGACL lists every	1	Days

☑ Other TrustSec devices to trust this device

☑ Send configuration changes to device

○ CoA

● CLI (SSH)

Send from: Kernow-ISE-32-366

Ssh Key:

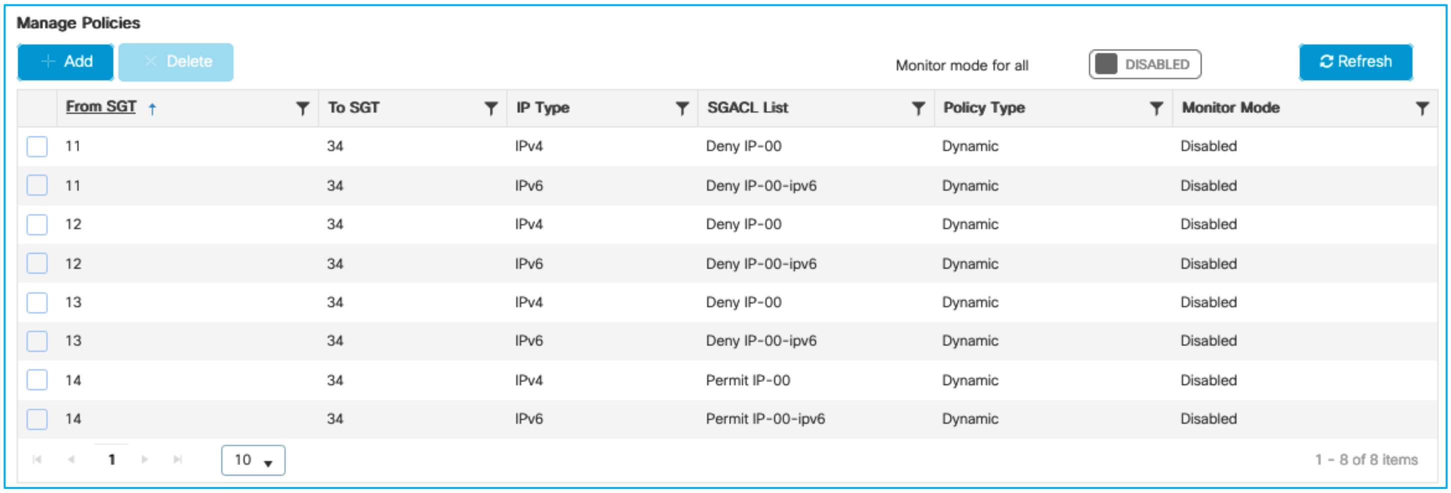
Device Configuration Deployment

☑ Include this device when deploying Security Group Tag Mapping Updates

Device Interface Credentials

EXEC Mode Username	admin
EXEC Mode Password	··········
Enable Mode Password	··········

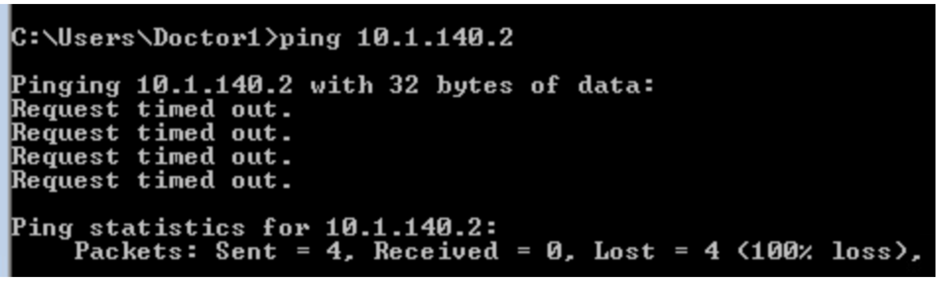
A wireless client is connected and assigned SGT 34 from ISE. Due to this, policies protecting SGT 34 are downloaded:



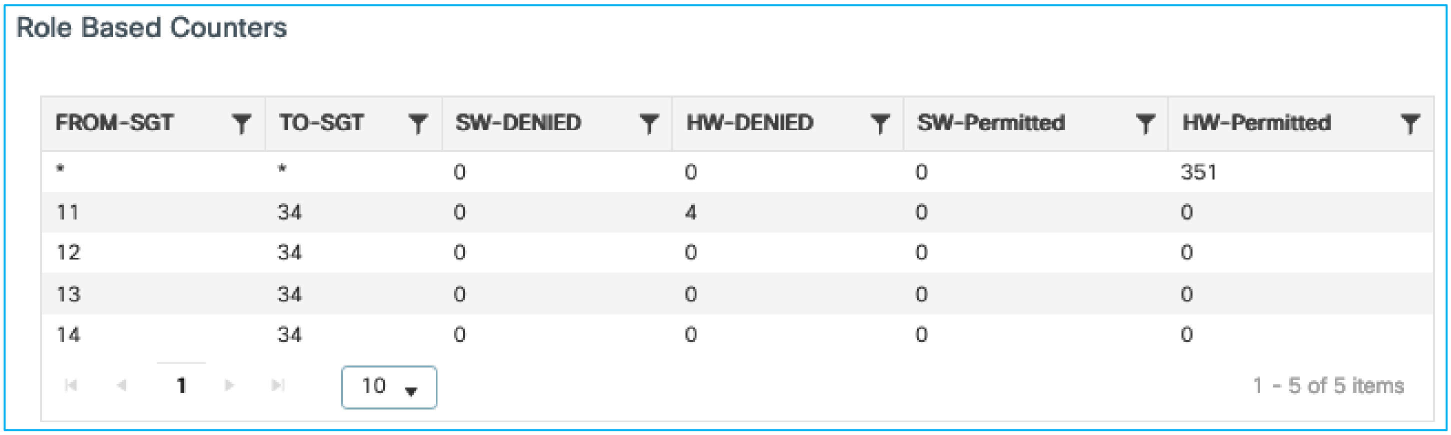
	From SGT ↑	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled
□	12	34	IPv4	Deny IP-00	Dynamic	Disabled
□	12	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled
□	13	34	IPv4	Deny IP-00	Dynamic	Disabled
□	13	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled
□	14	34	IPv4	Permit IP-00	Dynamic	Disabled
□	14	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled

So, policy from SGT 11 to SGT 34 has been downloaded and the action is to deny traffic.

The deny can be seen to be honoured from the client and from the C9800 role-based counters (Monitoring > General > TrustSec):



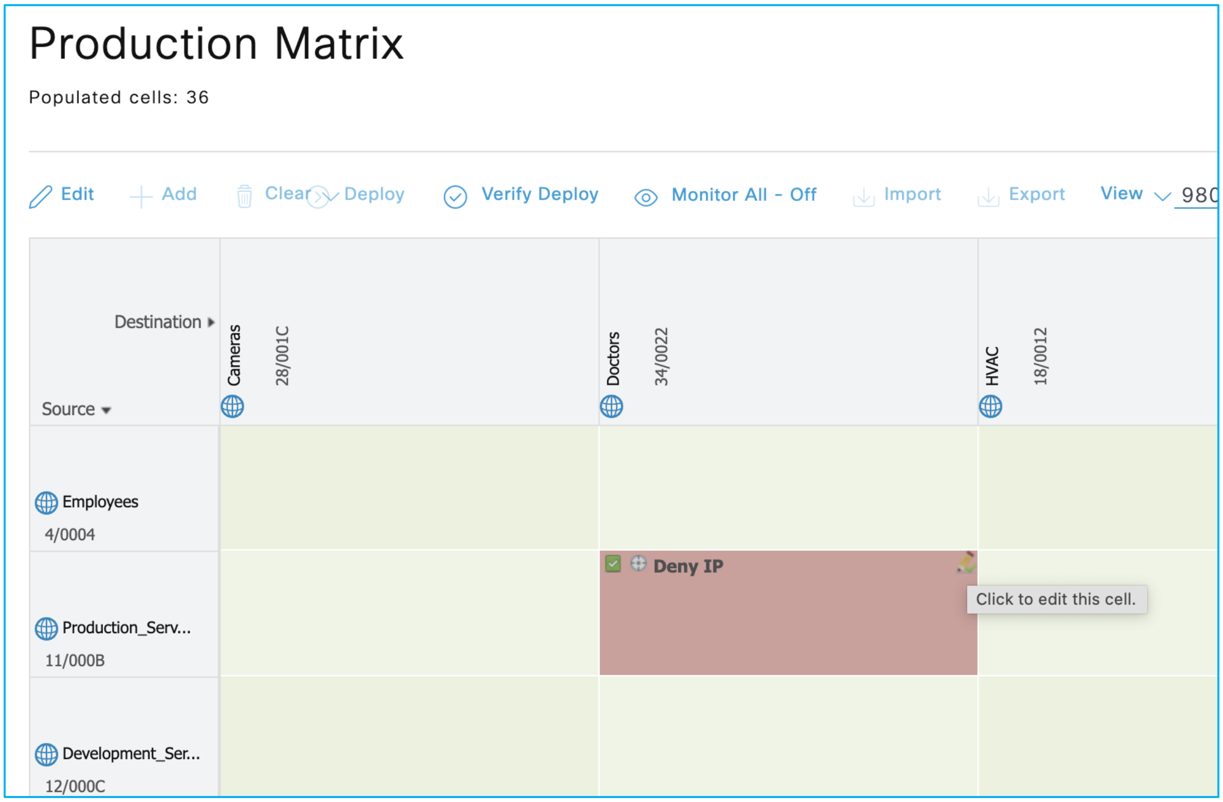
```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```



FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	351
11	34	0	4	0	0
12	34	0	0	0	0
13	34	0	0	0	0
14	34	0	0	0	0

Now, use ISE to change the SGACL in use to be a permit instead of a deny and push the change to the C9800 (using SSH as per the ISE network device setting).

One way to edit the assigned SGACL in ISE is to find the cell in the policy matrix and select ‘Edit’ from the icon within the cell:



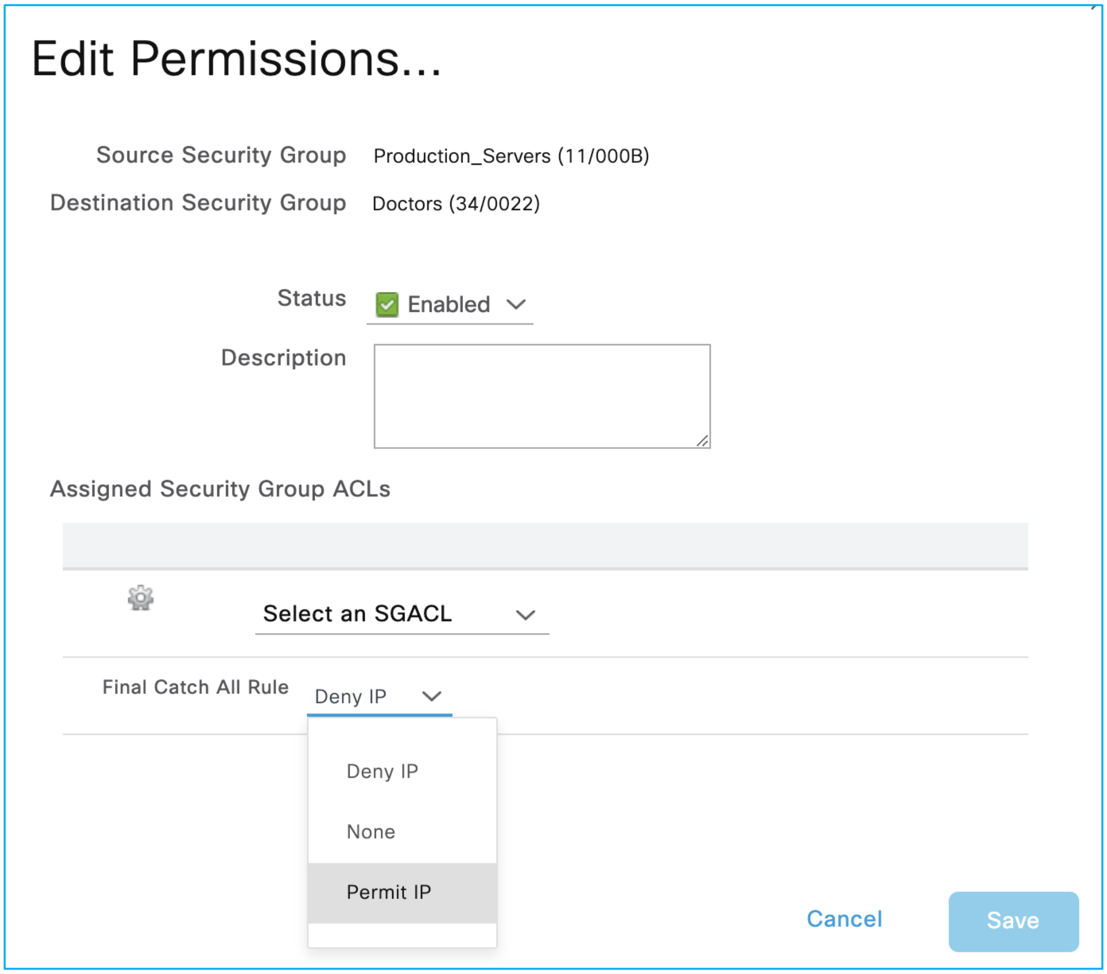
Production Matrix

Populated cells: 36

Source ▾ / Destination ▸	Cameras 28/001C	Doctors 34/0022	HVAC 18/0012
Employees 4/0004			
Production_Serv... 11/000B		☑ Deny IP	
Development_Ser... 12/000C			

Click to edit this cell.

Then change the catch all rule Deny IP to a Permit IP:



Edit Permissions...

Source Security Group: Production_Servers (11/000B)

Destination Security Group: Doctors (34/0022)

Status: Enabled

Description:

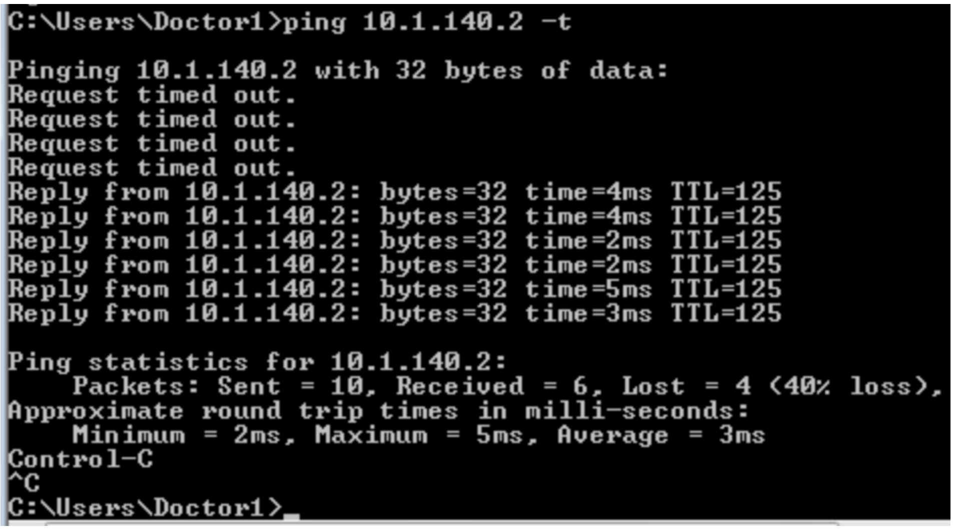
Assigned Security Group ACLs

Select an SGACL

Final Catch All Rule: Deny IP

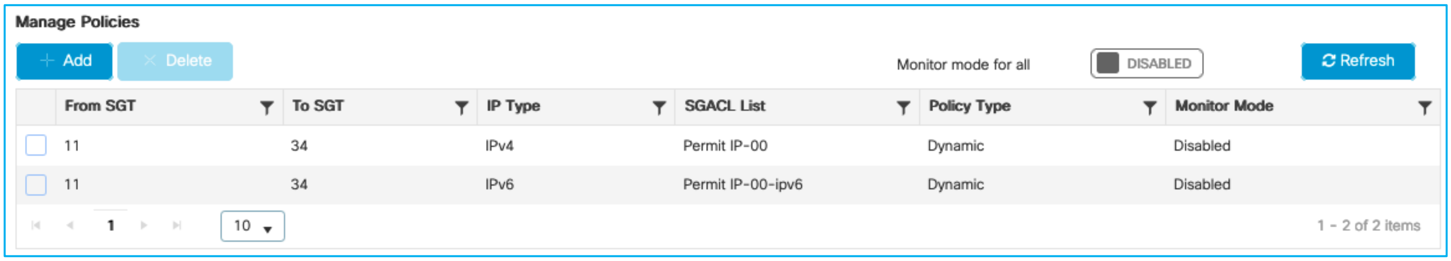
Save the change and use the ‘Deploy’ function at the top of the matrix to send the update to the network devices.

The client starts to communicate proving the policy update worked successfully:



```
C:\Users\Doctor1>ping 10.1.140.2 -t

Pinging 10.1.140.2 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=2ms TTL=125
Reply from 10.1.140.2: bytes=32 time=2ms TTL=125
Reply from 10.1.140.2: bytes=32 time=5ms TTL=125
Reply from 10.1.140.2: bytes=32 time=3ms TTL=125

Ping statistics for 10.1.140.2:
    Packets: Sent = 10, Received = 6, Lost = 4 (40% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 5ms, Average = 3ms
Control-C
^C
C:\Users\Doctor1>_
```

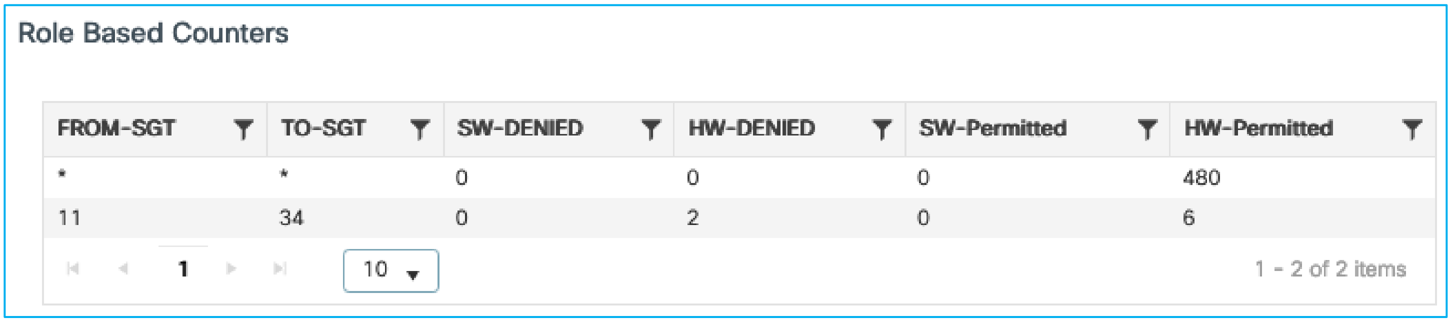
Policy updated in C9800:



Manage Policies

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Permit IP-00	Dynamic	Disabled
□	11	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled

Hit counts now showing permits:



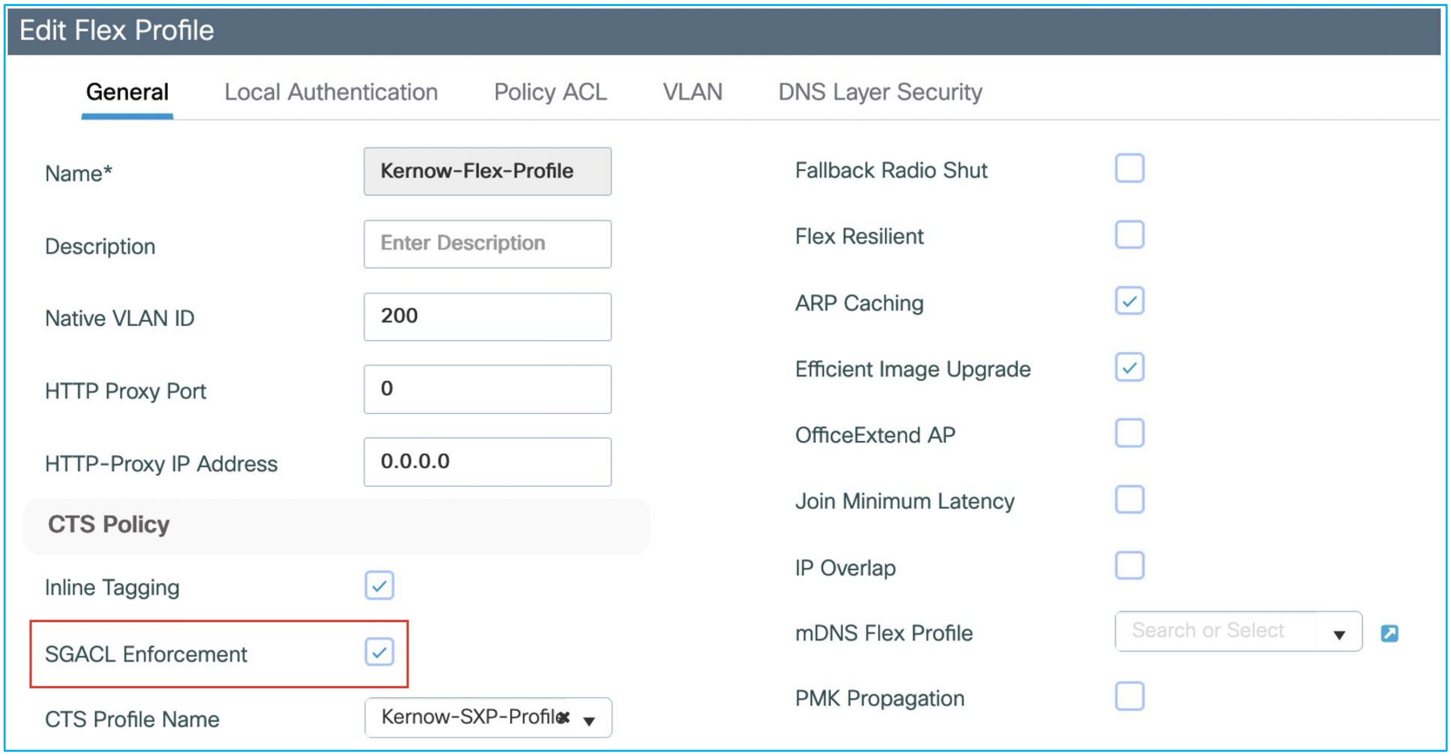
Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	480
11	34	0	2	0	6

The policy can be updated successfully using SSH from ISE.

CoA and SSH for Policy Update on Flex AP

Flex Profile has SGACL enforcement enabled:



Edit Flex Profile

Name*	Kernow-Flex-Profile
Description	Enter Description
Native VLAN ID	200
HTTP Proxy Port	0
HTTP-Proxy IP Address	0.0.0.0

CTS Policy

Inline Tagging	☑
SGACL Enforcement	☑
CTS Profile Name	Kernow-SXP-Profile

Fallback Radio Shut	□
Flex Resilient	□
ARP Caching	☑
Efficient Image Upgrade	☑
OfficeExtend AP	□
Join Minimum Latency	□
IP Overlap	□
mDNS Flex Profile	Search or Select
PMK Propagation	□

A wireless client is authenticated and authorized with Doctors SGT 34, as seen on the Flex AP:

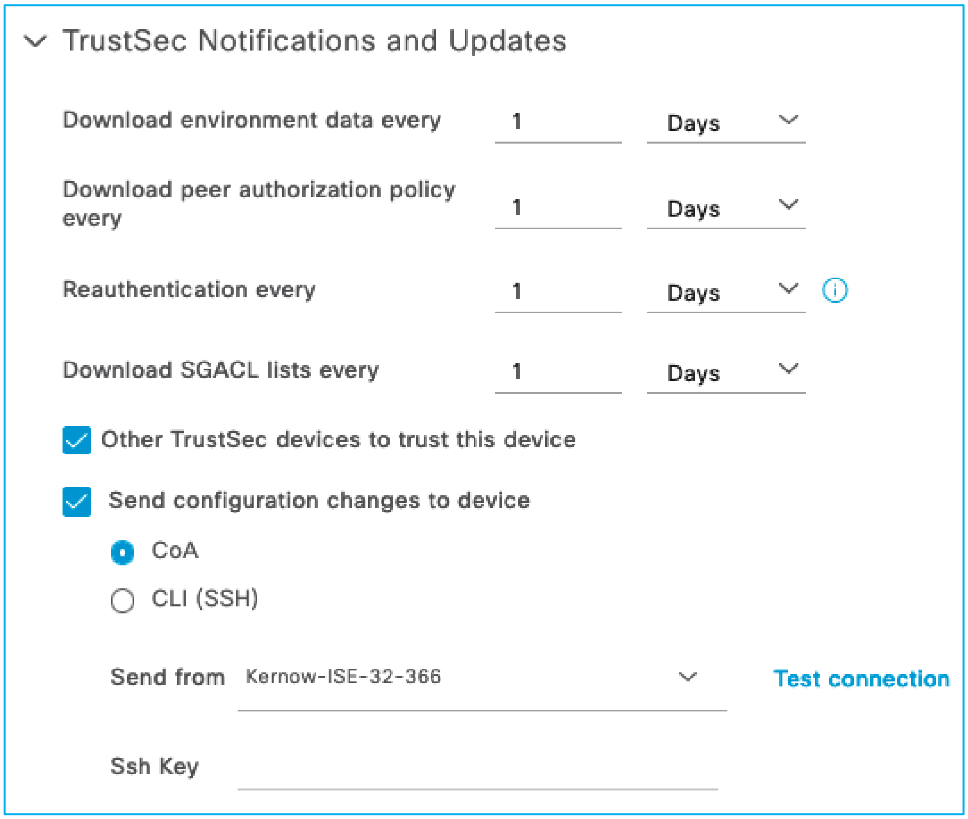
```
AP0845.D132.75F8#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
         IP SGT SOURCE
```

```
10.1.202.10   34   LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
Active IPv6-SGT Bindings Information
                       IP SGT SOURCE
fe80::38c3:efb0:4c61:b920  34  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
```

A wired client is classified with SGT 33 and traffic is enforced on the Flex AP from 33 to 34 using SGACL DenyIPlog:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT DGT          ACL
 11  34      Deny_IP
 23  34 AllowDHCPDNS
 33  34    DenyIPlog
AP0845.D132.75F8#show cts role-based counters from 33 to 34
IPv4 ACL: DenyIPlog
Packets Allowed : 0
Packets Denied  : 930
IPv6 ACL: DenyIPlog
Packets Allowed : 0
Packets Denied  : 0
```

Network Device entry in ISE for the C9800-CL is currently set to use CoA for policy updates (Administration > Network Resources > Network Devices). Scroll down and see ‘Send configuration changes to device’ is set and CoA is selected:



TrustSec Notifications and Updates

Download environment data every 1 Days

Download peer authorization policy every 1 Days

Reauthentication every 1 Days

Download SGACL lists every 1 Days

☑ Other TrustSec devices to trust this device

☑ Send configuration changes to device

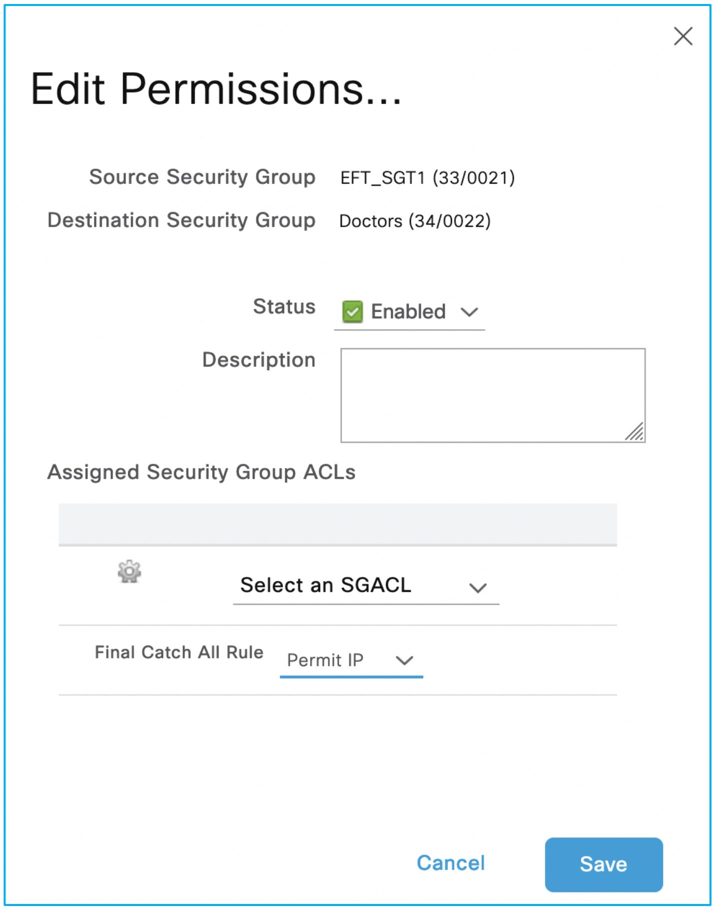
● CoA

○ CLI (SSH)

Send from Kernow-ISE-32-366

Ssh Key

Now, change the policy in ISE to use the catch all rule of 'Permit IP' SGACL:



Edit Permissions...

Source Security Group EFT_SGT1 (33/0021)

Destination Security Group Doctors (34/0022)

Status ☑ Enabled

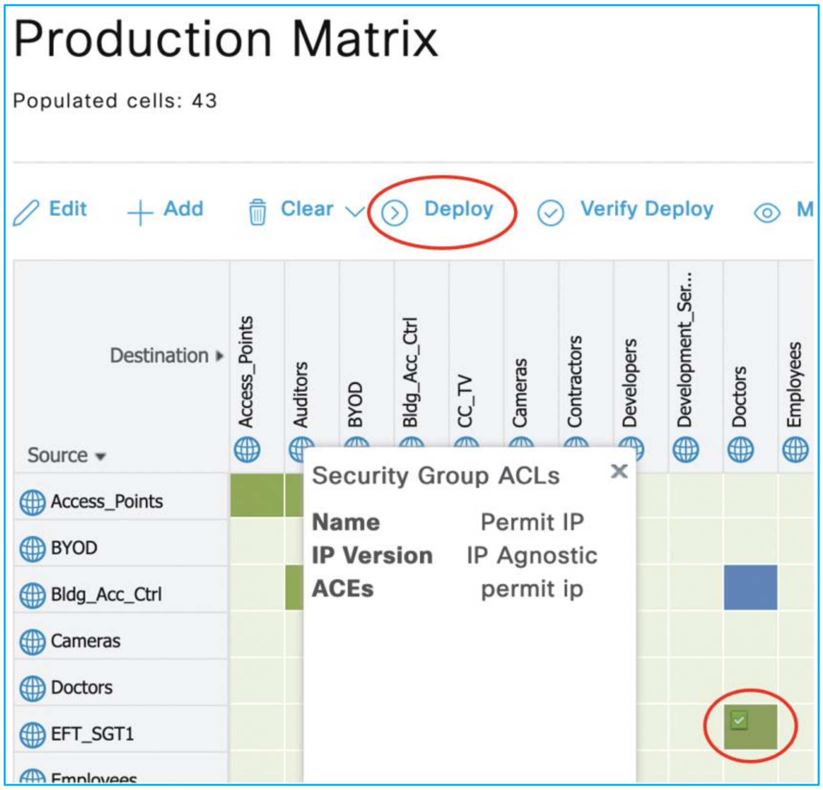
Description

Assigned Security Group ACLs

Select an SGACL

Final Catch All Rule Permit IP

Deploy the change from ISE:



Security Group ACLs

Name Permit IP

IP Version IP Agnostic

ACEs permit ip

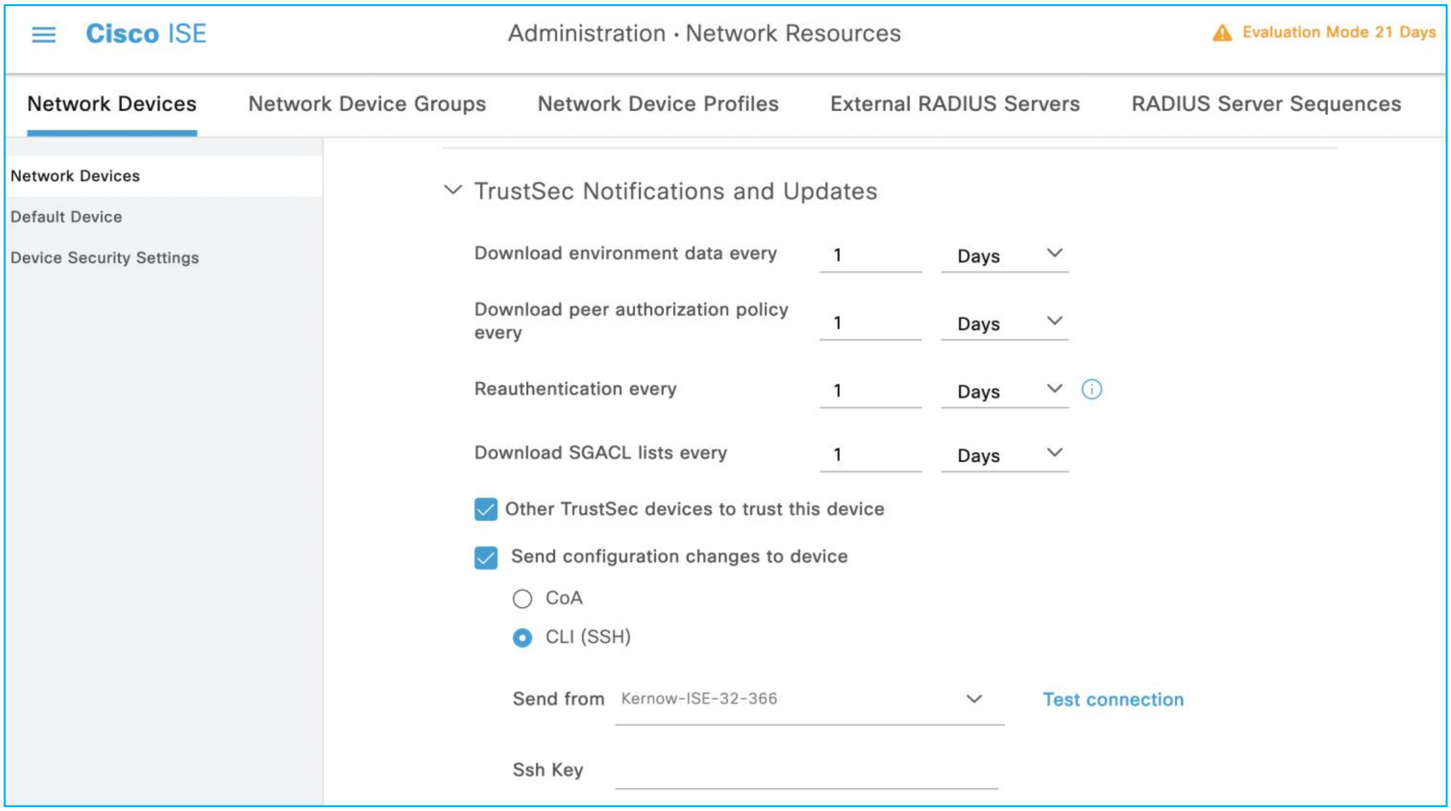
Policy from 33 (EFT_SGT1) to 34 (Doctors) is shown to have been updated on the Flex AP:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT  DGT           ACL
 11   34       Deny_IP
 23   34 AllowDHCPDNS
 33   34     Permit_IP
```

```
Policy on Flex AP is now permitting traffic:
AP0845.D132.75F8#show cts role-based counters from 33 to 34
IPv4 ACL: Permit_IP
Packets Allowed : 5
Packets Denied  : 0
IPv6 ACL: Permit_IP
Packets Allowed : 0
Packets Denied  : 0
```

This proves that using CoA for policy change works successfully for policy on a Flex AP.

Update the ISE Network Device entry for the 9800-CL to use SSH to push policy changes rather than using CoA:



TrustSec Notifications and Updates

Download environment data every 1 Days

Download peer authorization policy every 1 Days

Reauthentication every 1 Days

Download SGACL lists every 1 Days

☑ Other TrustSec devices to trust this device

☑ Send configuration changes to device

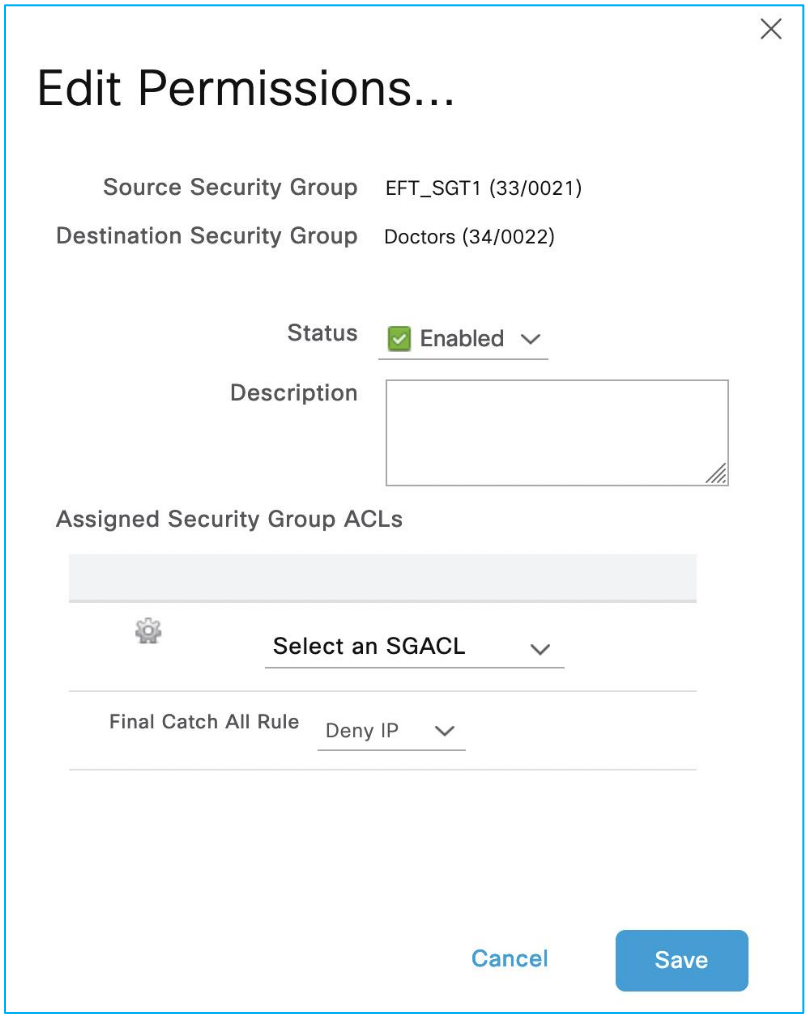
○ CoA

● CLI (SSH)

Send from Kernow-ISE-32-366

Ssh Key

Again, change the policy in ISE from 33 (EFT_SGT1) to 34 (Doctors) but use ‘Deny IP’ as a final catch all SGACL rule:



Edit Permissions...

Source Security Group EFT_SGT1 (33/0021)

Destination Security Group Doctors (34/0022)

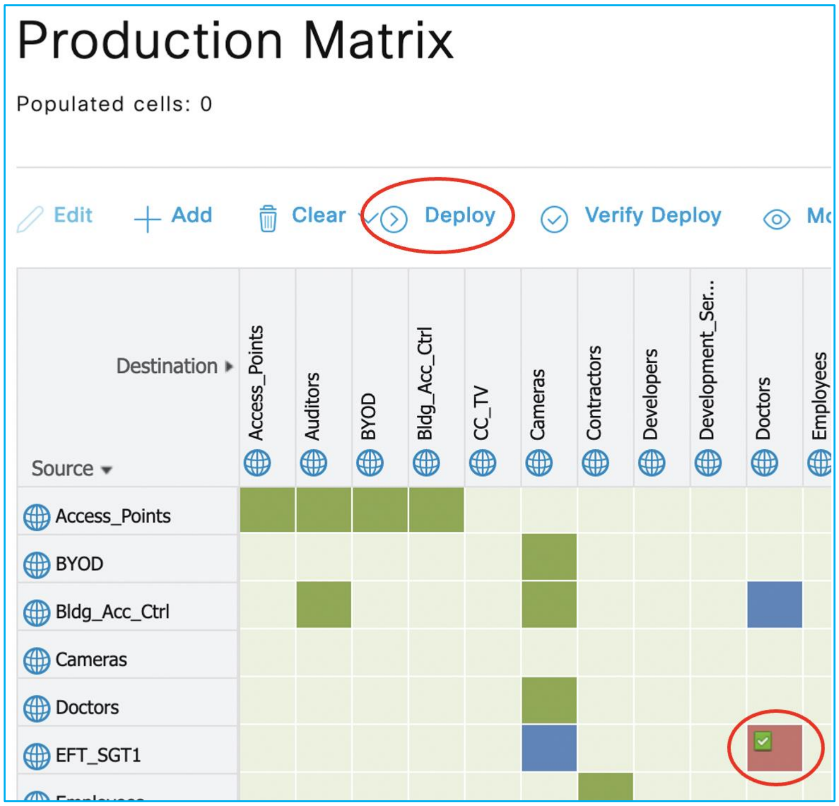
Status ☑ Enabled

Description

Assigned Security Group ACLs

Final Catch All Rule Deny IP

Deploy the policy change:



Production Matrix

Populated cells: 0

Source ▾ / Destination ▸	Access_Points	Auditors	BYOD	Bldg_Acc_Ctrl	CC_TV	Cameras	Contractors	Developers	Development_Ser...	Doctors	Employees
Access_Points	🟩	🟩	🟩	🟩							
BYOD						🟩					
Bldg_Acc_Ctrl		🟩				🟩				🟦	
Cameras											
Doctors						🟩					
EFT_SGT1						🟦				🟥 ✓	
Employees							🟩				

Flex AP shows policy has been changed from Permit IP to Deny IP:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT  DGT             ACL
 11   34        Deny_IP
 23   34 AllowDHCPDNS
 33   34        Deny_IP
IPv6 role-based permissions:
SGT  DGT             ACL
 11   34        Deny_IP
 23   34 AllowDHCPDNS
 33   34        Deny_IP
```

Traffic is enforced from SGT 33 to 34:

```
AP0845.D132.75F8#show cts role-based counters from 33 to 34
IPv4 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 5

IPv6 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 0
```

So, CoA and SSH can be used from ISE to update any policy changes on the Flex AP's. However, sometimes when there are multiple policy changes and therefore multiple CoA pushes, it has been seen that the C9800 controller running 17.9.1 does not always send policy updates to the APs. This is documented in the following DDTS: CSCwc15911 CoA changes are not reflecting in Flex mode APs for TrustSec

This is fixed in release 17.9.2.

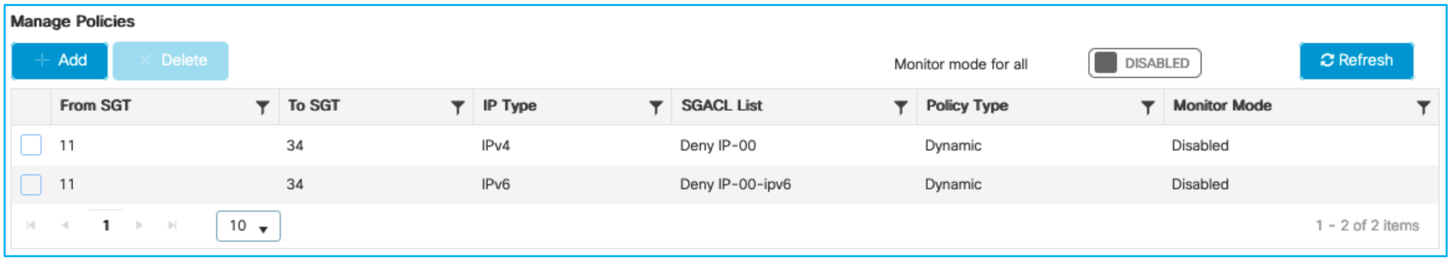
Monitor Mode for Policy Entries

Monitor Mode is a function to allow policies to be pushed and downloaded to network devices, but traffic is always permitted. It is useful for visibility before full enforcement is enabled.

Monitor Mode on C9800 controller

There is an existing policy downloaded from ISE on this C9800 (as a wireless client is authorized with Doctors SGT 34):

Navigate to Configuration > Security > TrustSec > CTS Policies:



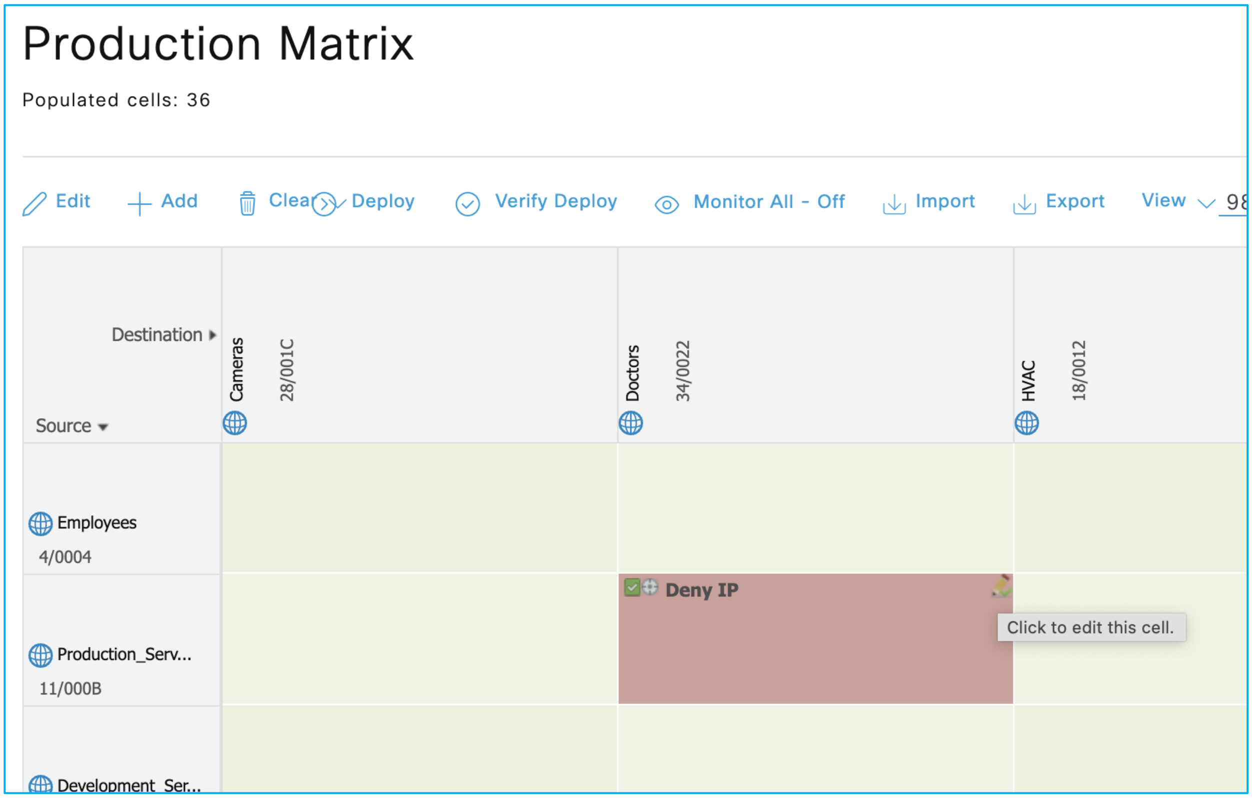
Manage Policies

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

Initially tested that this policy was denying traffic from and endpoint with SGT 11 to the wireless client with SGT 34.

Now, in ISE, edit the policy cell and change it to monitor mode.

Click the edit icon in the corner of the matrix cell in ISE:

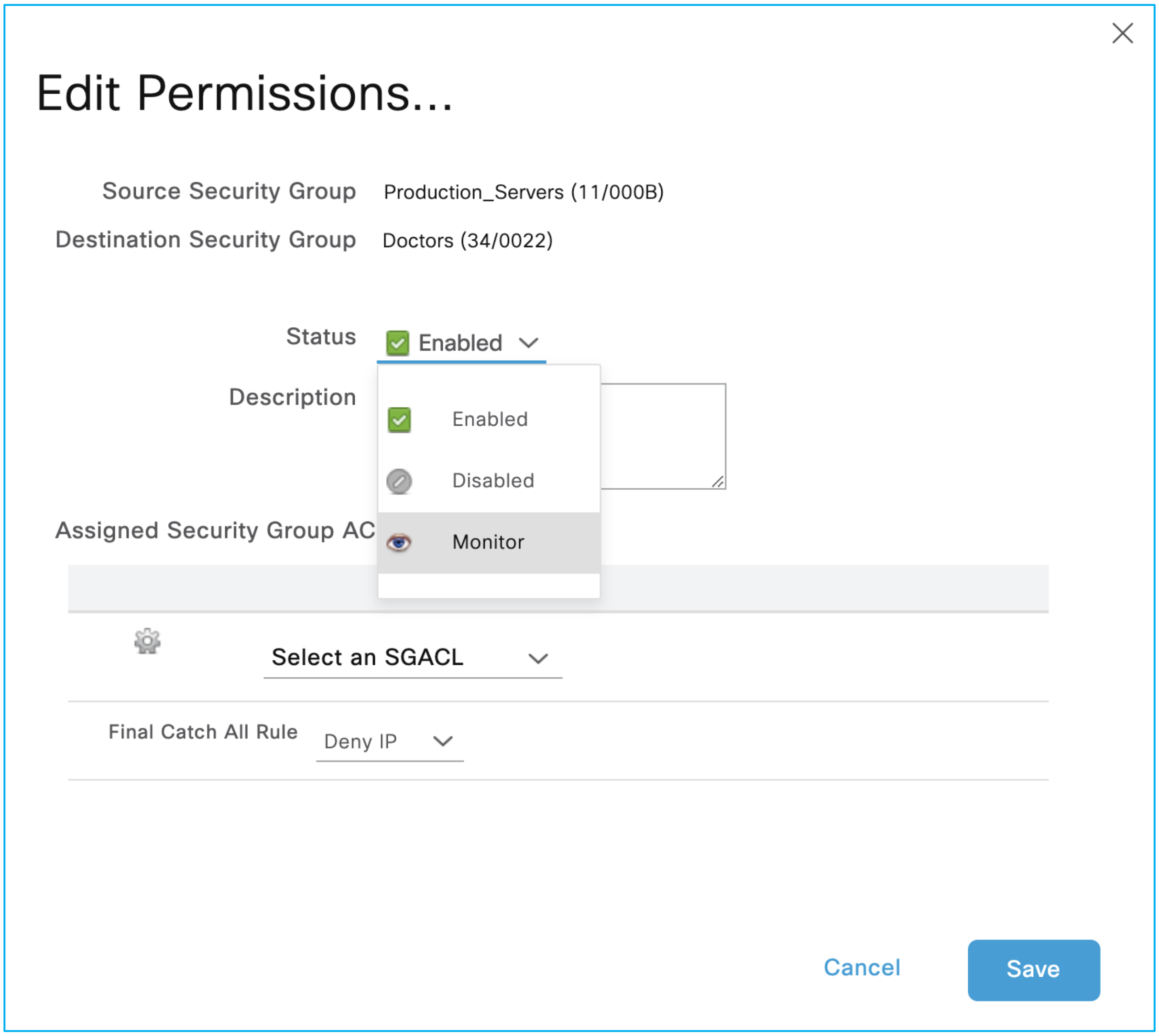


Production Matrix

Populated cells: 36

Destination ▸ Source ▾	Cameras 28/001C	Doctors 34/0022	HVAC 18/0012
Employees 4/0004			
Production_Serv... 11/000B		☑ Deny IP	
Development_Ser...			

Then edit the policy by dropping the ‘Status’ function down and selecting ‘Monitor’:



Edit Permissions...

Source Security Group: Production_Servers (11/000B)

Destination Security Group: Doctors (34/0022)

Status: ☑ Enabled

Description

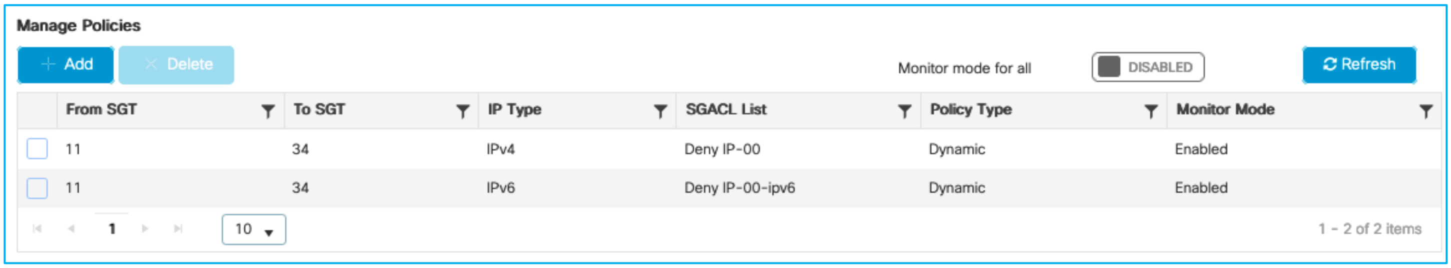
Assigned Security Group AC

Select an SGACL

Final Catch All Rule: Deny IP

Save and Deploy the change using the Deploy function at the top of the matrix.

The C9800 shows the policy entries with Monitor Mode Enabled:



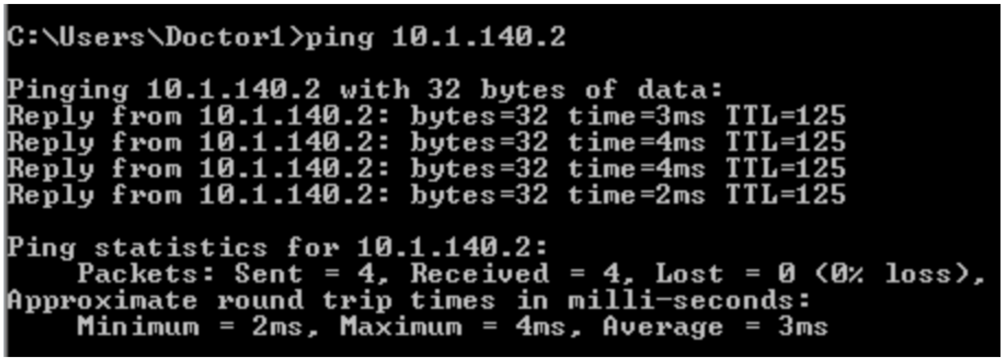
Manage Policies

Monitor mode for all: DISABLED

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Enabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Enabled

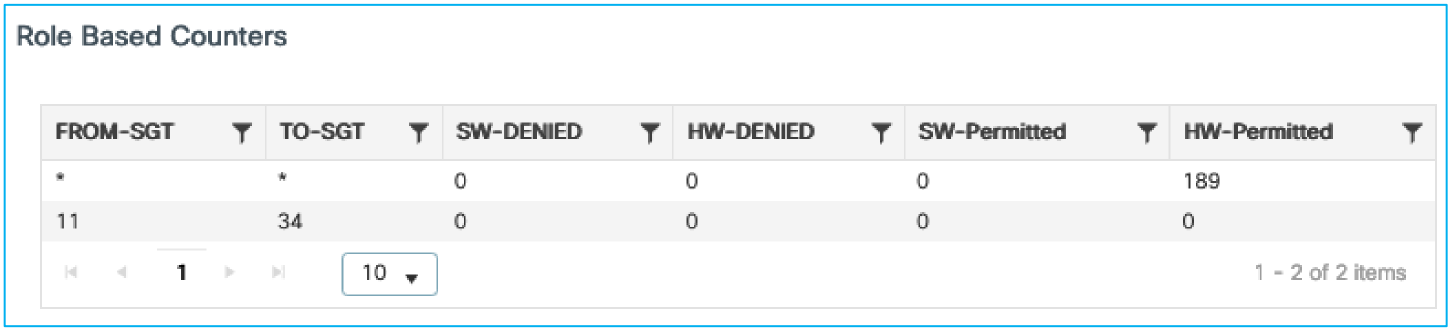
1 - 2 of 2 items

And a ping from wireless client to Production Server goes through:



```
C:\Users\Doctor1>ping 10.1.140.2

Pinging 10.1.140.2 with 32 bytes of data:
Reply from 10.1.140.2: bytes=32 time=3ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=2ms TTL=125

Ping statistics for 10.1.140.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 4ms, Average = 3ms
```

There are no role-based counters in the webui for Monitor Mode:



Role Based Counters

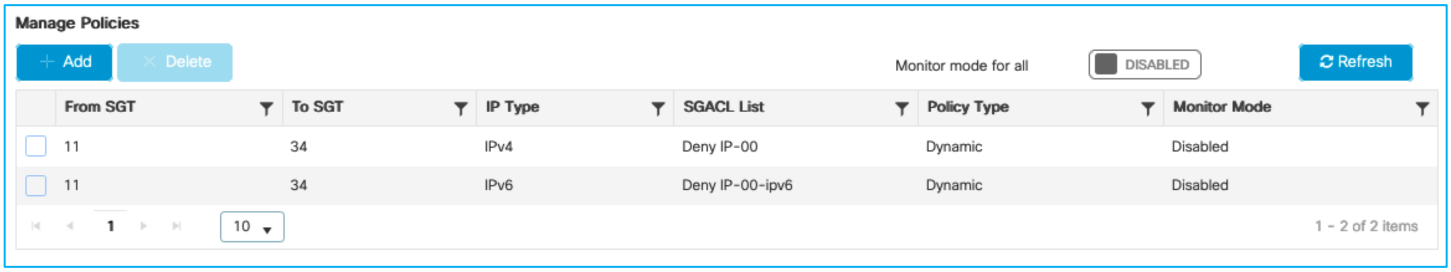
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	189
11	34	0	0	0	0

But you can see the Monitor counters via CLI in the C9800:

```
9800-17.9.1#show cts role-based counters
Role-based IPv4 counters
From    To      SW-Denied  HW-Denied  SW-Permitt HW-Permitt SW-Monitor HW-Monitor
*       *       0          0          0          105        0          0
29      11      0          0          0          0          0          0
34      11      0          0          0          0          0          0
15      28      0          0          0          0          0          0
23      28      0          0          0          0          0          0
31      28      0          0          0          0          0          0
33      28      0          0          0          0          0          0
34      28      0          0          0          0          0          0
11      34      0          0          0          0          0          93
```

So, the function works but the CLI would currently need to be used for visibility. Counters are being introduced in the webui for Monitor Mode in release 17.11: CSCwc96257 WebUI: SGACL counters is not getting shown for Monitor mode in webui.

A second test is to use the C9800 function in the GUI to set ‘Monitor Mode for all’ under Configuration > Security > TrustSec > CTS Policies:

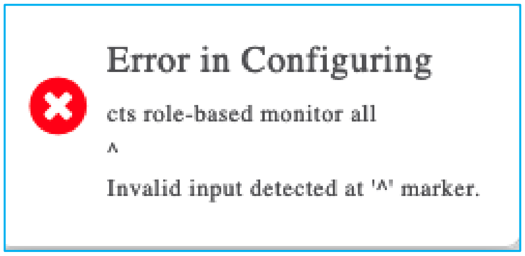


Monitor mode for all: DISABLED

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

1 - 2 of 2 items

Click ‘Disabled’ after ‘Monitor Mode for all’ to set Enabled:



```
Error in Configuring
cts role-based monitor all
^
Invalid input detected at '^' marker.
```

The conclusion is that Monitor Mode works ok on the C9800 controller but the CLI needs to be used currently to investigate any counters – the GUI does not show them.

Additionally, the ‘Monitor Mode for all’ feature is not supported.

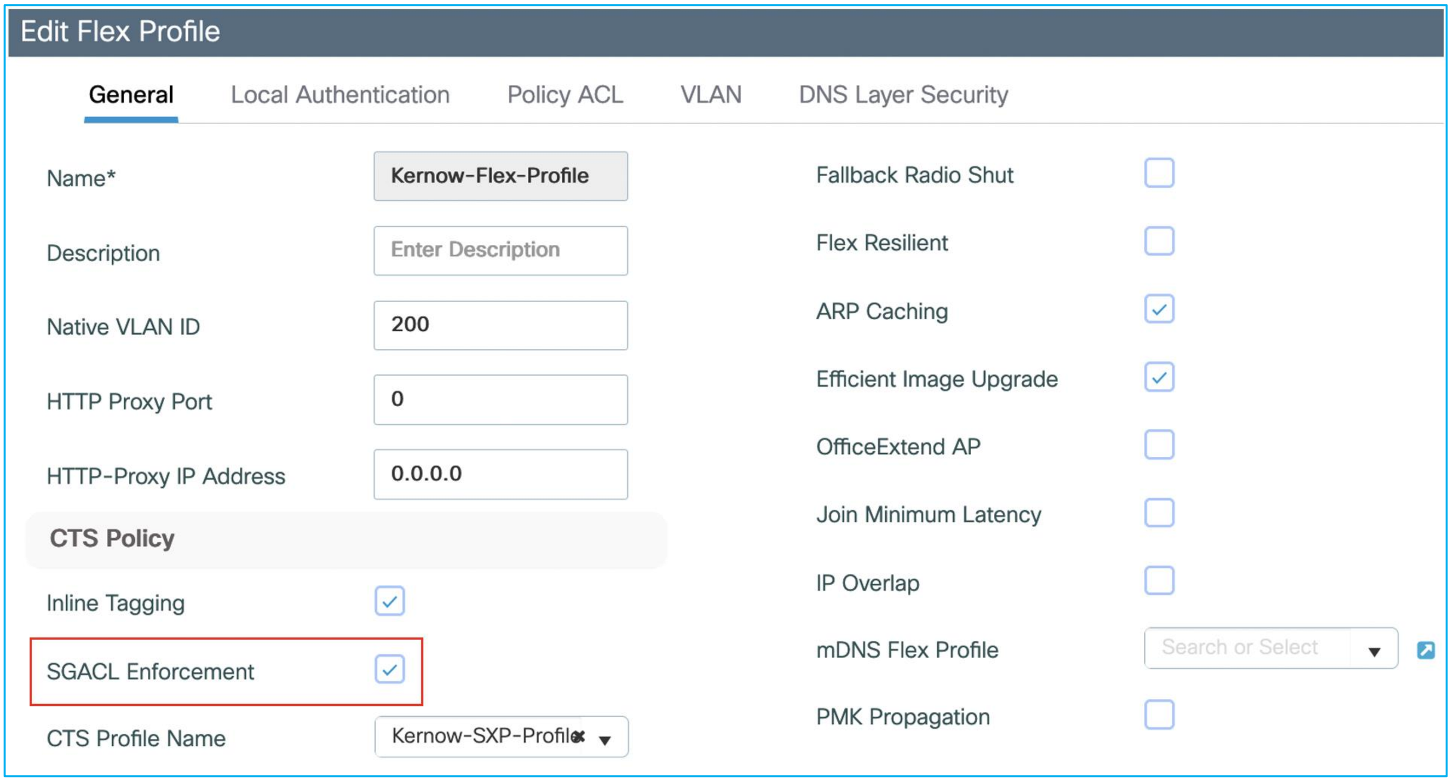
The following two DDTS entries were opened to track both these issues:

CSCwc96257 WebUI: SGACL counters is not getting shown for Monitor mode in webui.

CSCwd14088 C9800: The option to set CTS Policy Monitor mode for all generates an error.

Monitor Mode on Flex AP (Not Supported)

Flex AP is configured for SGACL enforcement (via Flex Profile):



Name* Kernow-Flex-Profile

Description Enter Description

Native VLAN ID 200

HTTP Proxy Port 0

HTTP-Proxy IP Address 0.0.0.0

CTS Policy

Inline Tagging ☑

SGACL Enforcement ☑

CTS Profile Name Kernow-SXP-Profile

Fallback Radio Shut ☐

Flex Resilient ☐

ARP Caching ☑

Efficient Image Upgrade ☑

OfficeExtend AP ☐

Join Minimum Latency ☐

IP Overlap ☐

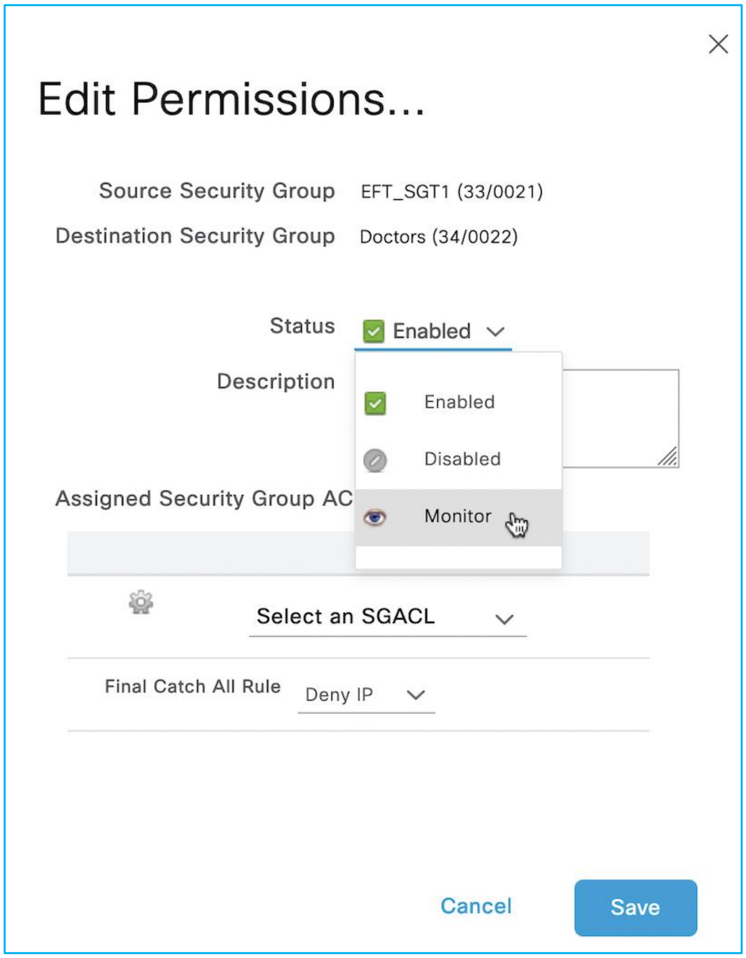
mDNS Flex Profile Search or Select

PMK Propagation ☐

Enforcement is active from wired SGT 33 to wireless SGT 34:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT  DGT          ACL
 11   34       Deny_IP
 23   34 AllowDHCPDNS
 33   34       Deny_IP
IPv6 role-based permissions:
SGT  DGT          ACL
 11   34       Deny_IP
 23   34 AllowDHCPDNS
 33   34       Deny_IP
AP0845.D132.75F8#show cts role-based counters from 33 to 34
IPv4 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 10
IPv6 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 0
```

Now, edit the policy in ISE and change it to Monitor Mode:



Edit Permissions...

Source Security Group EFT_SGT1 (33/0021)

Destination Security Group Doctors (34/0022)

Status ☑ Enabled

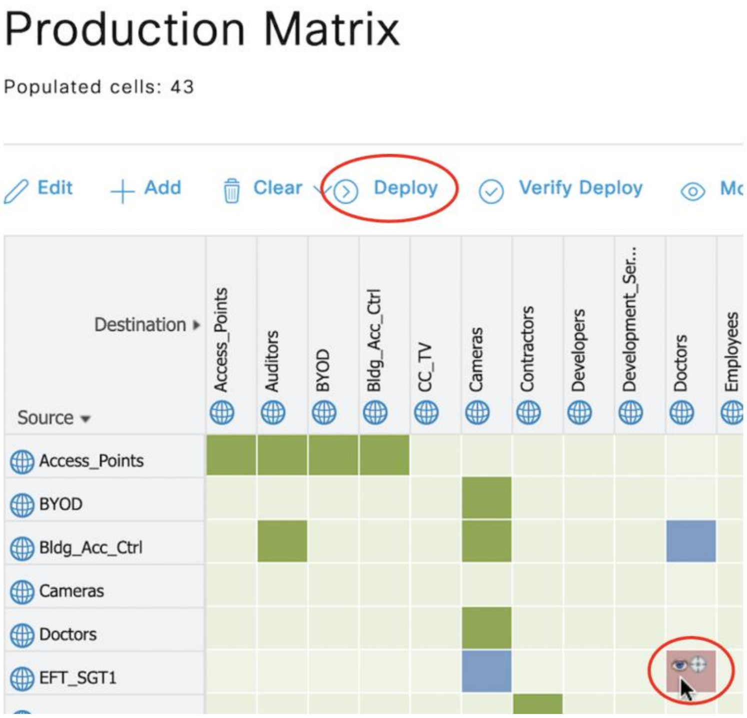
Description

Assigned Security Group AC

Select an SGACL

Final Catch All Rule Deny IP

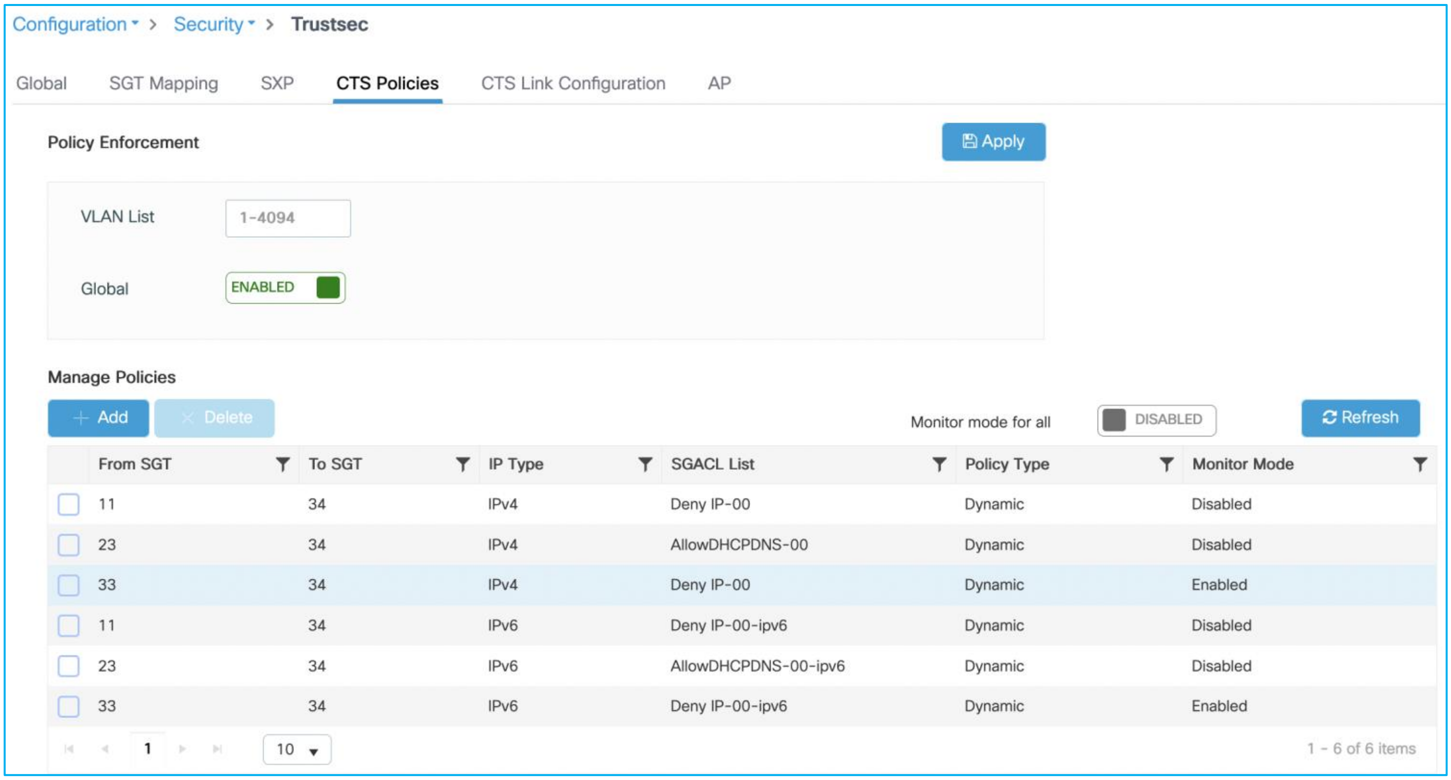
Deploy the change:



Production Matrix

Populated cells: 43

The policy is updated on the C9800 controller (Monitor Mode shown to be Enabled) for policy from SGT 33 to 34:



Policy Enforcement

VLAN List: 1-4094

Global: ENABLED

Manage Policies

Monitor mode for all: DISABLED

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	23	34	IPv4	AllowDHCPDNS-00	Dynamic	Disabled
□	33	34	IPv4	Deny IP-00	Dynamic	Enabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled
□	23	34	IPv6	AllowDHCPDNS-00-ipv6	Dynamic	Disabled
□	33	34	IPv6	Deny IP-00-ipv6	Dynamic	Enabled

1   10 ▾   1 - 6 of 6 items

But the policy does not change on the AP:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT  DGT           ACL
 11   34       Deny_IP
 23   34  AllowDHCPDNS
 33   34       Deny_IP
IPv6 role-based permissions:
SGT  DGT           ACL
 11   34       Deny_IP
 23   34  AllowDHCPDNS
 33   34       Deny_IP
```

The only impact is that the hit counters are reset on the Flex AP:

```
AP0845.D132.75F8#show cts role-based counters from 33 to 34
IPv4 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 3

IPv6 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 0
```

The conclusion is that Monitor Mode is not supported on the Flex AP's.

Flex Access Point Propagation and Enforcement Scenarios

These flex use-cases use the following:

AP: 0845.d132.75f8, IPv4: 10.1.201.101

Client: 7cdd.90ee.992c, IPv4: 10.1.202.10

Policy Profile: Kernow-Flex_Policy

Flex Profile: Kernow-Flex-Profile

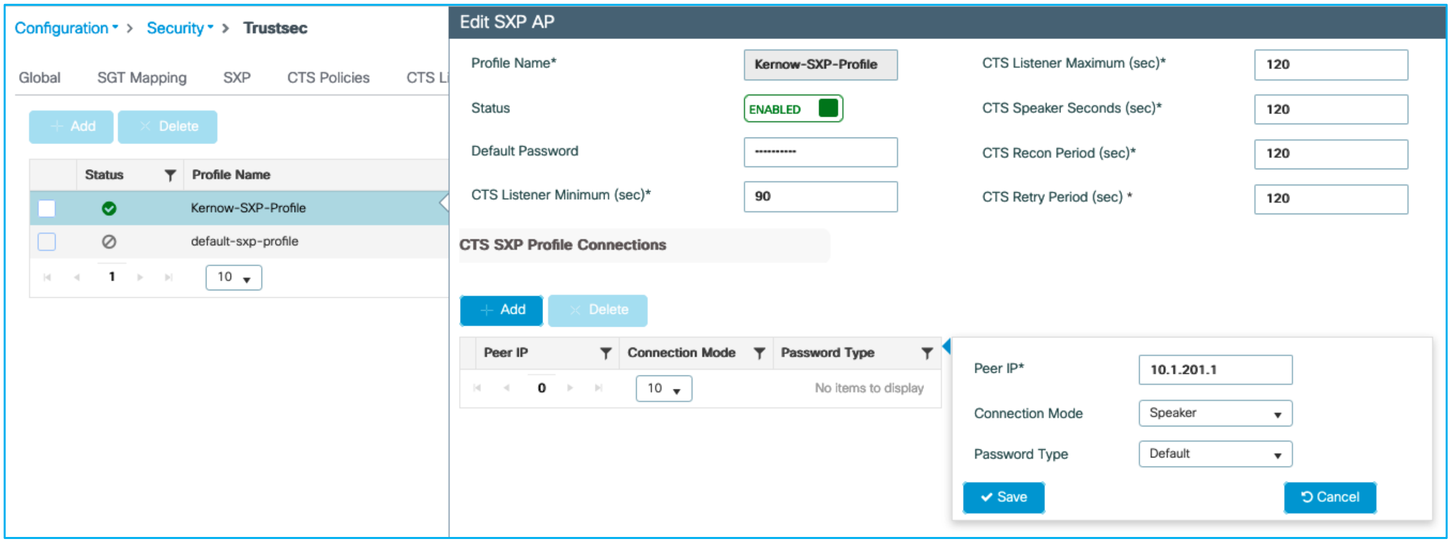
VLAN: Employee-Flex

WLAN and SSID: Kernow-Employees-Flex

Flex AP Sending SXP

On C9800 controller, navigate to Configuration > Security > TrustSec > AP.

Choose the associated Flex Profile and add an SXP connection peering with a separate enforcing network device. Make the AP end a Speaker and set a Default password:



Status	Profile Name
✓	Kernow-SXP-Profile
⊘	default-sxp-profile

Profile Name*: Kernow-SXP-Profile

Status: ENABLED

Default Password: ----------

CTS Listener Minimum (sec)*: 90

CTS Listener Maximum (sec)*: 120

CTS Speaker Seconds (sec)*: 120

CTS Recon Period (sec)*: 120

CTS Retry Period (sec) *: 120

Peer IP	Connection Mode	Password Type

No items to display

Peer IP*: 10.1.201.1

Connection Mode: Speaker

Password Type: Default

Update and apply the change to the device.

Add the other half of the SXP connection on the enforcing device:

```
Kernow-C9k-top(config)#cts sxp enable
Kernow-C9k-top(config)#cts sxp default password xxxx
Kernow-C9k-top(config)#cts sxp conn peer 10.1.201.101 source 10.1.201.1 password default
mode local listener
```

The SXP connection is 'On' or successfully connected as shown on the switch end:

```
Kernow-C9k-top#show cts sxp connections brief
 SXP              : Enabled
 Highest Version Supported: 5
 Default Password : Set
 Default Key-Chain: Not Set
 Default Key-Chain Name: Not Applicable
 Default Source IP: Not Set
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
----------------------------------------------------------------------------------------
Peer_IP          Source_IP        Conn Status                   Duration
----------------------------------------------------------------------------------------
10.1.201.101     10.1.201.1       On                            0:00:01:36 (dd:hr:mm:sec)
Total num of SXP Connections = 1
```

A similar command can be run on the AP itself:

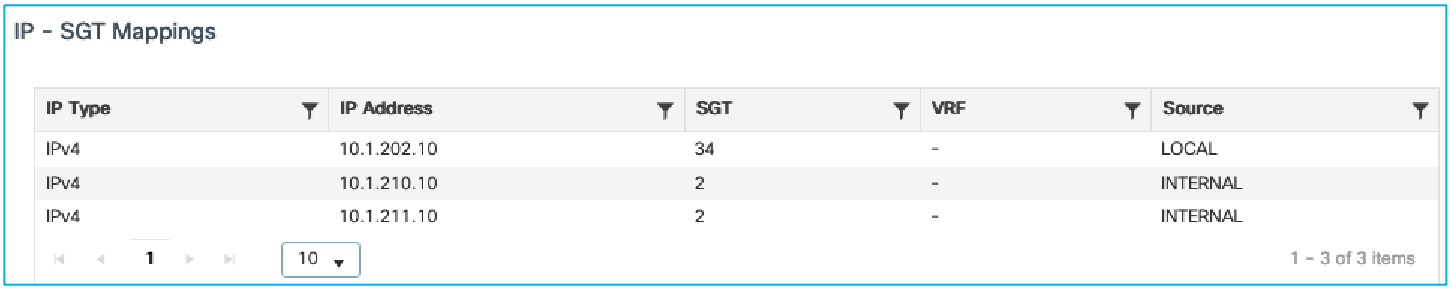
```
AP0845.D132.75F8#show cts sxp connections
SXP              : Enabled
Highest Version Supported: 4
Default Password : Set
SXP Timers:
Connection retry open period:120
Reconcile period:120
Keepalive period:65535
Speaker minimum hold-time:120
Listener minimum hold-time:90
Listener maximum hold-time:120
SXP Connection Info:
peer #0: 10.1.201.1:64999
        1 connection(s) active
        connection status: successful
        keepalive timer is armed
        peer has listener role
1 configured peer(s)
```

Connect client to SSID Kernow-Employees-Flex, ISE assigns SGT Doctors 34.

The controller sends the IP:SGT mapping for the current client (10.1.202.10) to the AP:

```
AP0845.D132.75F8#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
          IP SGT SOURCE
 10.1.202.10  34  LOCAL
10.1.210.100   0  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 2
Total number of active   bindings = 2
Active IPv6-SGT Bindings Information
                       IP SGT SOURCE
fe80::e586:d6cd:12be:f42c  34  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
```

This corresponds with the entry in the controller at Monitoring > General > TrustSec > IP – SGT Mappings:



IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.202.10	34	-	LOCAL
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.211.10	2	-	INTERNAL

Due to the SXP connection being up from the AP to the Cat9k switch, we can see that client mapping has been sent to that switch (and learned via SXP):

```
Kernow-C9k-top#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
10.1.202.10             34      SXP
10.6.5.111              34      LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of SXP      bindings = 1
Total number of LOCAL    bindings = 1
Total number of active   bindings = 2
Active IPv6-SGT Bindings Information
IP Address                                  SGT     Source
================================================================
FE80::E586:D6CD:12BE:F42C                   34      SXP
IP-SGT Active Bindings Summary
============================================
Total number of SXP      bindings = 1
Total number of active   bindings = 1
```

The client mapping can be used in enforcing traffic from/to the client in the Cat9k (the following example shows enforcing from SGT 11 to SGT 34):

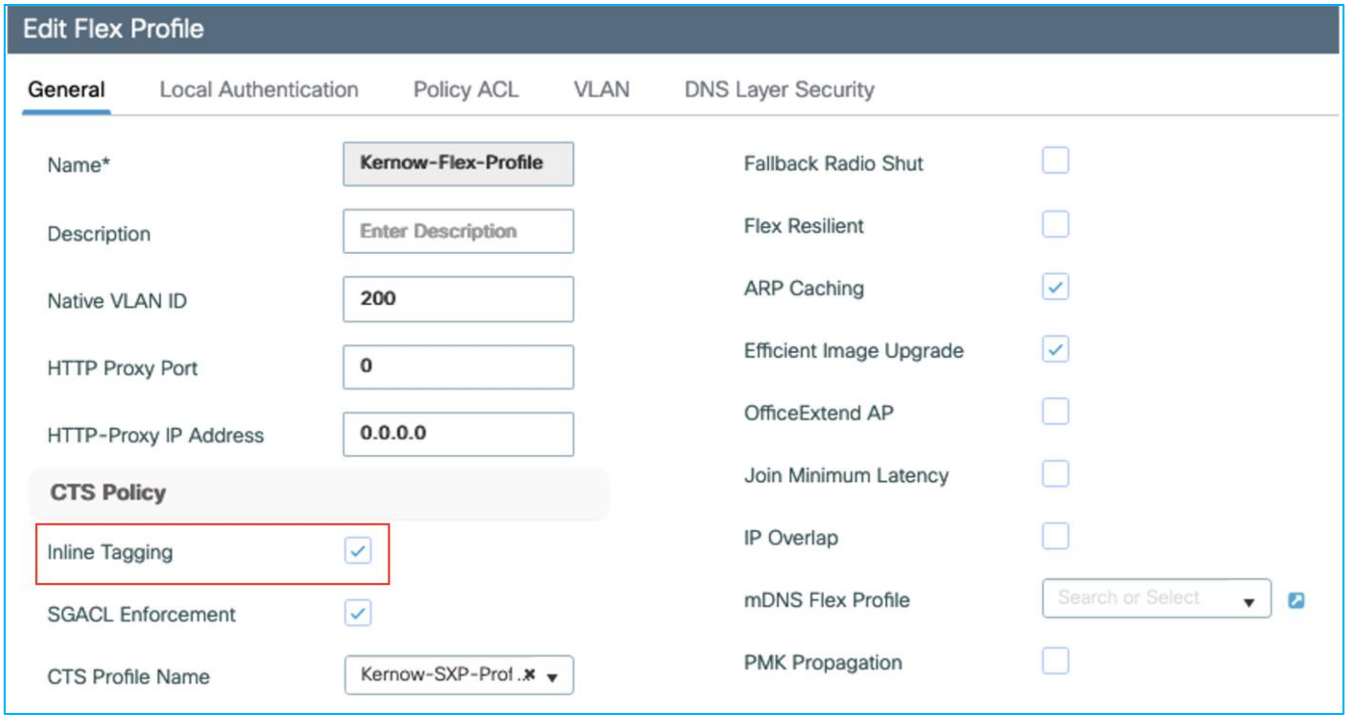
```
Kernow-C9k-top#sh cts role counters
```

```
Role-based IPv4 counters
From     To       SW-Denied   HW-Denied   SW-Permitt  HW-Permitt  SW-Monitor  HW-Monitor
*        *        0           0           89          1578        0           0
29       11       0           0           0           0           0           0
11       34       0           3           0           0           0           0
33       34       0           0           0           0           0           0
```

So, the flex AP successfully propagates IP:SGT mappings via SXP

Flex AP Sending Inline (CMD)

Enable inline tagging on Flex Profile (disable the SXP Profile to ensure SXP mappings do not interfere with the results):



Edit Flex Profile

Name*	Kernow-Flex-Profile	Fallback Radio Shut	□
Description	Enter Description	Flex Resilient	□
Native VLAN ID	200	ARP Caching	☑
HTTP Proxy Port	0	Efficient Image Upgrade	☑
HTTP-Proxy IP Address	0.0.0.0	OfficeExtend AP	□
CTS Policy		Join Minimum Latency	□
Inline Tagging	☑	IP Overlap	□
SGACL Enforcement	☑	mDNS Flex Profile	Search or Select
CTS Profile Name	Kernow-SXP-Prof	PMK Propagation	□

On interconnected switch (Cat9k), configure inline tagging to match:

```
interface GigabitEthernet1/0/18
 switchport trunk native vlan 201
 switchport trunk allowed vlan 201,202
 switchport mode trunk
 cts manual
  policy static sgt 2 trusted
end
```

Authenticate a wireless client and assign an SGT from ISE:

```
AP0845.D132.75F8#sh cts role-based sgt-map all
Active IPv4-SGT Bindings Information
            IP SGT SOURCE
   10.1.202.10  34  LOCAL
```

Use monitor capture on the interconnected Cat9k to see if CMD is sent by the Flex AP. Send pings from wireless client to wired 10.4.21.1:

Cat9k receives SGT 34 in the CMD field so Flex AP is sending the SGT via inline tagging:

```
Kernow-C9k-top#show mon cap joff buff det | beg Frame 52
Frame 52: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface
/tmp/epc_ws/wif_to_ts_pipe, id 0
    Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)
        Interface name: /tmp/epc_ws/wif_to_ts_pipe
    Encapsulation type: Ethernet (1)
    Arrival Time: Aug 18, 2022 10:52:24.690760000 UTC
    [Time shift for this packet: 0.000000000 seconds]
    Epoch Time: 1660819944.690760000 seconds
    [Time delta from previous captured frame: 0.268312000 seconds]
    [Time delta from previous displayed frame: 0.268312000 seconds]
    [Time since reference or first frame: 11.974915000 seconds]
    Frame Number: 52
    Frame Length: 86 bytes (688 bits)
    Capture Length: 86 bytes (688 bits)
    [Frame is marked: False]
    [Frame is ignored: False]
    [Protocols in frame: eth:ethertype:vlan:ethertype:cmd:ethertype:ip:icmp:data]
Ethernet II, Src: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c), Dst: 04:6c:9d:1f:88:42
(04:6c:9d:1f:88:42)
    Destination: 04:6c:9d:1f:88:42 (04:6c:9d:1f:88:42)
        Address: 04:6c:9d:1f:88:42 (04:6c:9d:1f:88:42)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Source: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        Address: 7c:dd:90:ee:99:2c (7c:dd:90:ee:99:2c)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: 802.1Q Virtual LAN (0x8100)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 202
    000. .... .... .... = Priority: Best Effort (default) (0)
    ...0 .... .... .... = DEI: Ineligible
    .... 0000 1100 1010 = ID: 202
    Type: CiscoMetaData (0x8909)
Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 34
    Type: IPv4 (0x0800)
Internet Protocol Version 4, Src: 10.1.202.10, Dst: 10.4.21.1
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
        0000 00.. = Differentiated Services Codepoint: Default (0)
        .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
    Total Length: 60
    Identification: 0x3711 (14097)
    Flags: 0x0000
        0... .... .... .... = Reserved bit: Not set
        .0.. .... .... .... = Don't fragment: Not set
        ..0. .... .... .... = More fragments: Not set
    Fragment offset: 0
    Time to live: 128
    Protocol: ICMP (1)
    Header checksum: 0x10a0 [validation disabled]
    [Header checksum status: Unverified]
    Source: 10.1.202.10
    Destination: 10.4.21.1
Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0x4cd8 [correct]
    [Checksum Status: Good]
    Identifier (BE): 1 (0x0001)
    Identifier (LE): 256 (0x0100)
    Sequence number (BE): 131 (0x0083)
    Sequence number (LE): 33536 (0x8300)
    Data (32 bytes)
```

If policy exists in the Cat9k to enforce from wireless to wired (Doctors 34 to Production_Servers 11)

```
Kernow-C9k-top#show cts role-based permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group 34:Doctors to group 11:Production_Servers:
        Deny IP-00
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

Then the Cat9k switch enforces using the source SGT lookup of CMD from the Flex AP:

```
Kernow-C9k-top#sh cts role-based counters
Role-based IPv4 counters
```

```
From     To       SW-Denied  HW-Denied  SW-Permitt HW-Permitt SW-Monitor HW-Monitor
*        *        0          0          29         349        0          0
34       11       0          4          0          0          0          0
```

Note: the inline tagging setting on the Policy Profile is irrelevant, it’s the setting on the Flex Profile which is used to determine if inline tagging is enabled or not on the Flex AP.

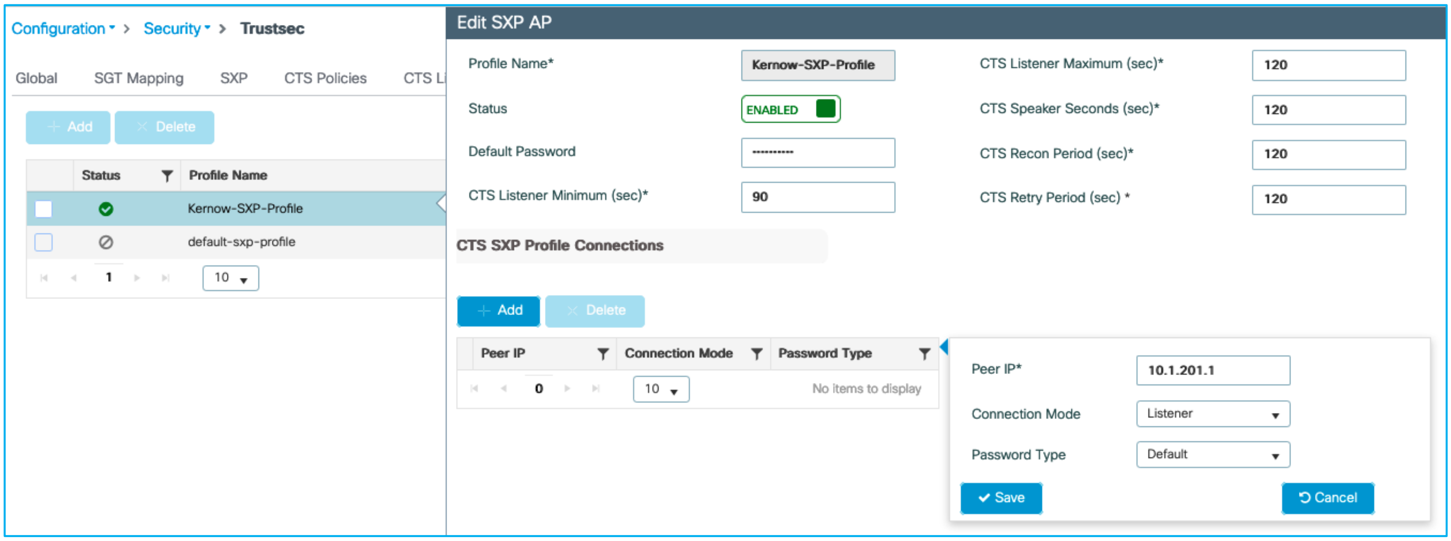
Flex AP Enforcing from SXP

This use-case is to ensure the flex AP can enforce traffic using a source SGT learned from SXP and a destination SGT learned from an authenticated client.

Setup an SXP connection from a Cat9k switch to an AP in Flex Mode.

In the C9800 webui, navigate to Configuration > Security > TrustSec > AP and either add a new SXP Profile or change the existing one. In this example we will set the Cat9k to be the Speaker and the AP the Listener.

Under the SXP Profile, ensure a default password is set and delete any existing SXP Connections. Add a new SXP Connection on the AP peering with the Cat9k (10.1.201.1) but make the AP a Listener so the AP can receive mappings and use them for enforcement:



Status	Profile Name
✓	Kernow-SXP-Profile
⊘	default-sxp-profile

Profile Name*: Kernow-SXP-Profile

Status: ENABLED

Default Password: ----------

CTS Listener Minimum (sec)*: 90

CTS Listener Maximum (sec)*: 120

CTS Speaker Seconds (sec)*: 120

CTS Recon Period (sec)*: 120

CTS Retry Period (sec) *: 120

Peer IP	Connection Mode	Password Type

No items to display

Peer IP*: 10.1.201.1

Connection Mode: Listener

Password Type: Default

Save the change and then Update and apply the changes to the device.

Now, change the Cat9k end of the SXP connection to ensure it is sending mappings (set as Speaker) to the AP.

Remove any existing SXP connections on the Cat9k, then add a new connection:

```
Kernow-C9k-top(config)#cts sxp enable
Kernow-C9k-top(config)#cts sxp default password xxxx
Kernow-C9k-top(config)#cts sxp connection peer 10.1.201.101 source 10.1.201.1 password
default mode local speaker
```

Cat9k end shows the connection is up or ‘on’:

```
Kernow-C9k-top#show cts sxp connections brief
 SXP              : Enabled
 Highest Version Supported: 5
 Default Password : Set
 Default Key-Chain: Not Set
 Default Key-Chain Name: Not Applicable
 Default Source IP: Not Set
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
----------------------------------------------------------------------------------------
Peer_IP          Source_IP        Conn Status                  Duration
----------------------------------------------------------------------------------------
10.1.201.101     10.1.201.1       On                           0:00:00:58 (dd:hr:mm:sec)
Total num of SXP Connections = 1
```

AP shows the connection successful:

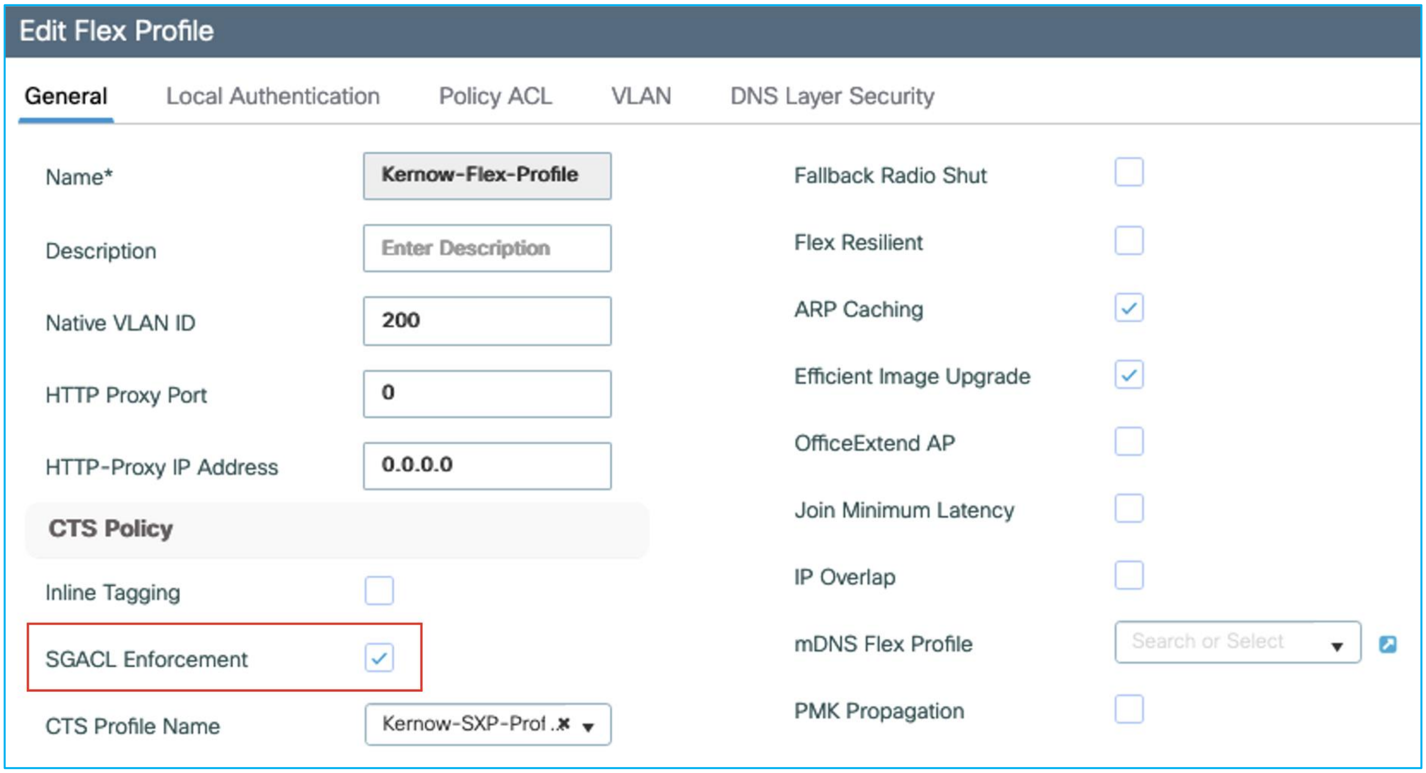
```
AP0845.D132.75F8#sh cts sxp connections
SXP              : Enabled
Highest Version Supported: 4
Default Password : Set
SXP Timers:
Connection retry open period:120
Reconcile period:120
Keepalive period:65535
Speaker minimum hold-time:120
Listener minimum hold-time:90
Listener maximum hold-time:120
SXP Connection Info:
peer #0: 10.1.201.1:64999
        1 connection(s) active
        connection status: successful
        hold timer is armed
        peer has speaker role
1 configured peer(s)
```

Firstly, a policy will be added to deny traffic from Production_Servers SGT 11 to Doctors SGT 34.

Now, a wireless client will be connected and assigned an SGT of Doctors 34 on the AP. The AP should download policies from the controller/ISE that are destined for the Doctors SGT.

We will classify traffic from a Production_Server (IP 10.4.21.1) with SGT 11 and send that classification through SXP to the AP and test if the AP enforces the communication.

Flex Profile > General (SGACL Enforcement is enabled):

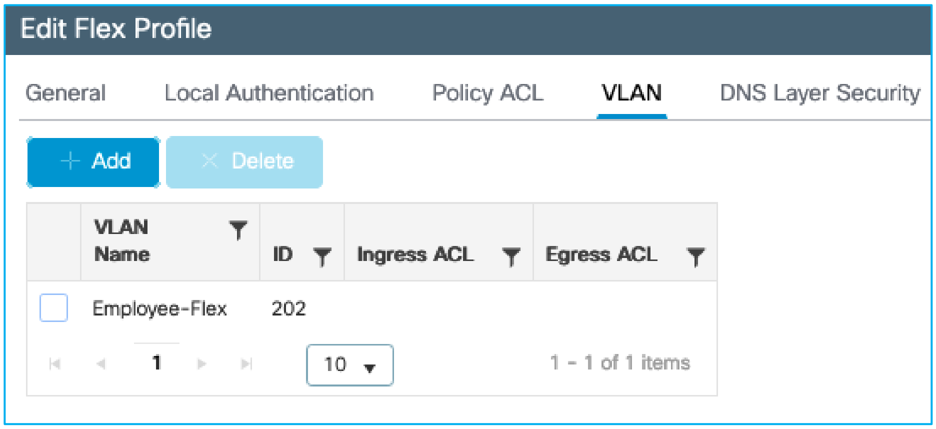


Edit Flex Profile

General | Local Authentication | Policy ACL | VLAN | DNS Layer Security

Name*	Kernow-Flex-Profile	Fallback Radio Shut	□
Description	Enter Description	Flex Resilient	□
Native VLAN ID	200	ARP Caching	☑
HTTP Proxy Port	0	Efficient Image Upgrade	☑
HTTP-Proxy IP Address	0.0.0.0	OfficeExtend AP	□
CTS Policy		Join Minimum Latency	□
Inline Tagging	□	IP Overlap	□
SGACL Enforcement	☑	mDNS Flex Profile	Search or Select
CTS Profile Name	Kernow-SXP-Prof	PMK Propagation	□

Flex Profile > VLAN (local VLAN 202):

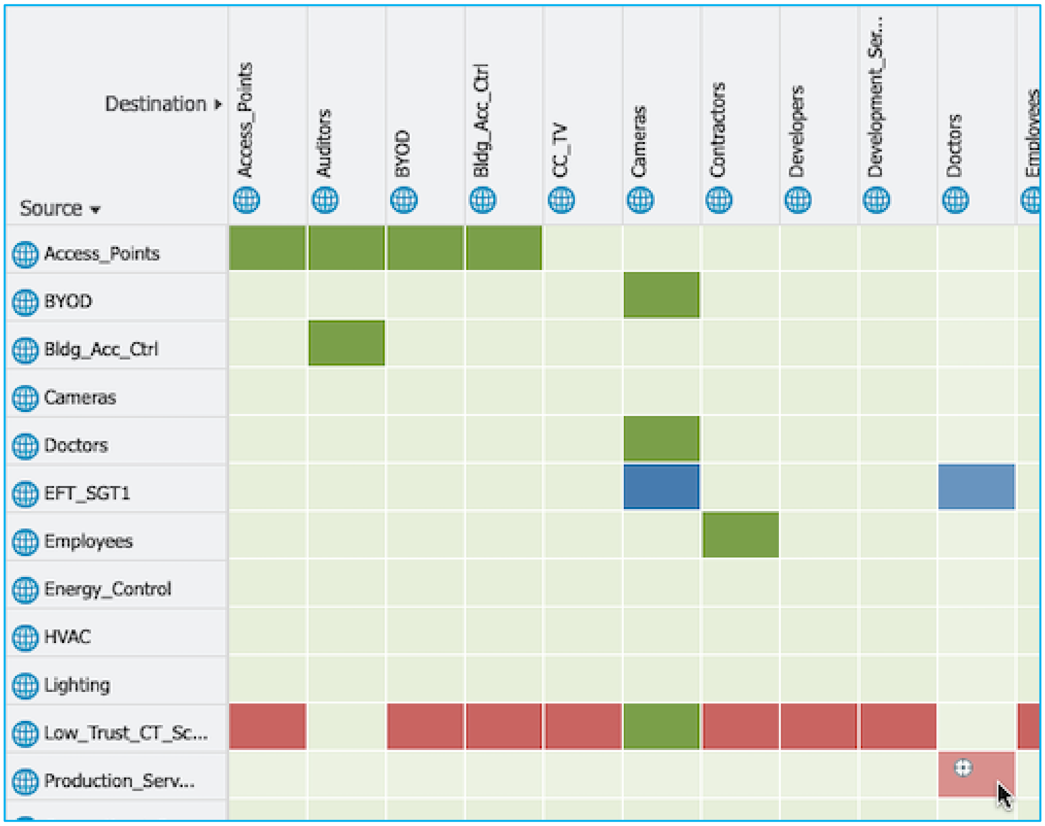


Edit Flex Profile

General | Local Authentication | Policy ACL | VLAN | DNS Layer Security

	VLAN Name	ID	Ingress ACL	Egress ACL
□	Employee-Flex	202		

In ISE, add a policy to deny traffic from Production_Servers SGT 11 to Doctors SGT 34:



Source ▾ / Destination ▸	Access_Points	Auditors	BYOD	Bldg_Acc_Ctrl	CC_TV	Cameras	Contractors	Developers	Development_Ser...	Doctors	Employees
Access_Points	🟩	🟩	🟩	🟩							
BYOD						🟩					
Bldg_Acc_Ctrl		🟩									
Cameras											
Doctors						🟩					
EFT_SGT1						🟦				🟦	
Employees							🟩				
Energy_Control											
HVAC											
Lighting											
Low_Trust_CT_Sc...	🟥		🟥	🟥	🟥	🟩	🟥	🟥	🟥		🟥
Production_Serv...										🟥	

Now, connect wireless client.

The AP shows ISE has assigned SGT 34 for the wireless client (10.1.202.10):

```
AP0845.D132.75F8#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
         IP  SGT  SOURCE
    1.1.1.6    2     SXP
 10.1.201.1    2     SXP
 10.1.202.1    2     SXP
10.1.202.10   34   LOCAL
  10.3.25.2    2     SXP
  10.4.21.2    2     SXP
 10.6.5.111   34     SXP
 10.6.5.254    2     SXP
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of SXP      bindings = 7
Total number of active   bindings = 8
Active IPv6-SGT Bindings Information
                       IP SGT SOURCE
fe80::e586:d6cd:12be:f42c  34  LOCAL
IP-SGT Active Bindings Summary
```

```
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
```

The controller then downloads the policies protecting that SGT, and passes them to the AP:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT DGT       ACL
 11  34   Deny_IP
 33  34 DenyIPlog
 65535 65535    Permit_IP
IPv6 role-based permissions:
SGT DGT       ACL
 11  34   Deny_IP
 33  34 DenyIPlog
 65535 65535    Permit_IP
```

To test whether the Flex AP enforces from an SXP mapping towards a wireless client, add a mapping for a wired endpoint 10.4.21.1 into the Cat9k and send it to the AP via the SXP connection.

Add mapping on Cat9k:

```
Kernow-C9k-top(config)#cts role-based sgt-map 10.4.21.1 sgt 11
```

Can see it's received by the AP via SXP:

```
AP0845.D132.75F8#sh cts role sgt-map all
Active IPv4-SGT Bindings Information
            IP SGT SOURCE
       1.1.1.6   2    SXP
    10.1.201.1   2    SXP
    10.1.202.1   2    SXP
   10.1.202.10  34  LOCAL
     10.3.25.2   2    SXP
     10.4.21.1  11    SXP
     10.4.21.2   2    SXP
    10.6.5.111  34    SXP
    10.6.5.254   2    SXP
169.254.244.44   0  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 2
Total number of SXP      bindings = 8
Total number of active   bindings = 10
Active IPv6-SGT Bindings Information
                       IP SGT SOURCE
fe80::e586:d6cd:12be:f42c  34  LOCAL
```

```
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
```

And traffic is enforced from wired endpoint to wireless:

```
AP0845.D132.75F8#show cts role-based counters from 11 to 34
IPv4 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 5
IPv6 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 0
```

——————————

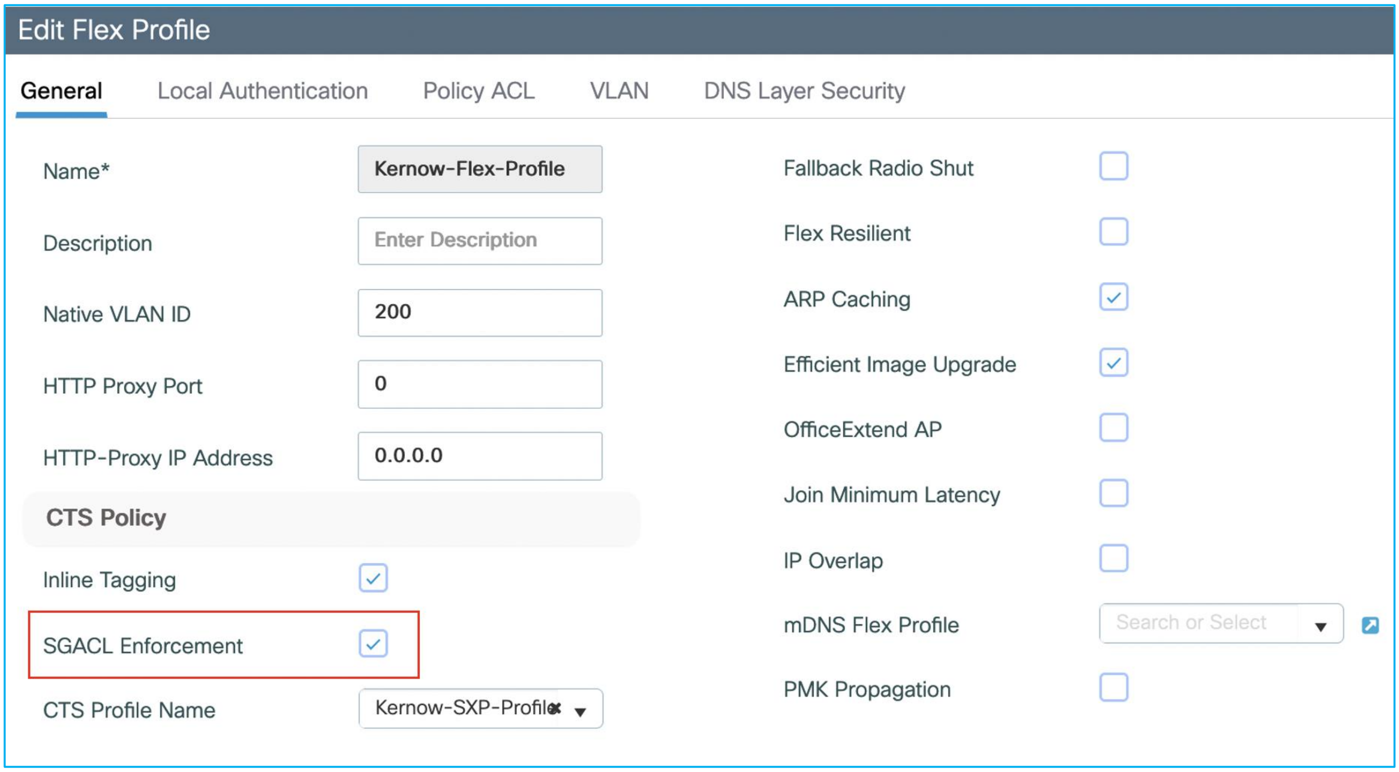
Why is there enforcement settings on both Flex Profile and Policy Profile, and which one takes precedence?

The test above has enforcement set on both.

Now, test by disabling enforcement on the Flex Profile and leaving enabled on the Policy Profile. Client authenticates, a mapping is seen on the AP, but no policy is downloaded:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT DGT ACL
IPv6 role-based permissions:
SGT DGT ACL
```

Now, test enforcement enabled on Flex Profile and disabled on Policy Profile:



Name* Kernow-Flex-Profile

Description Enter Description

Native VLAN ID 200

HTTP Proxy Port 0

HTTP-Proxy IP Address 0.0.0.0

CTS Policy

Inline Tagging ☑

SGACL Enforcement ☑

CTS Profile Name Kernow-SXP-Profile

Fallback Radio Shut □

Flex Resilient □

ARP Caching ☑

Efficient Image Upgrade ☑

OfficeExtend AP □

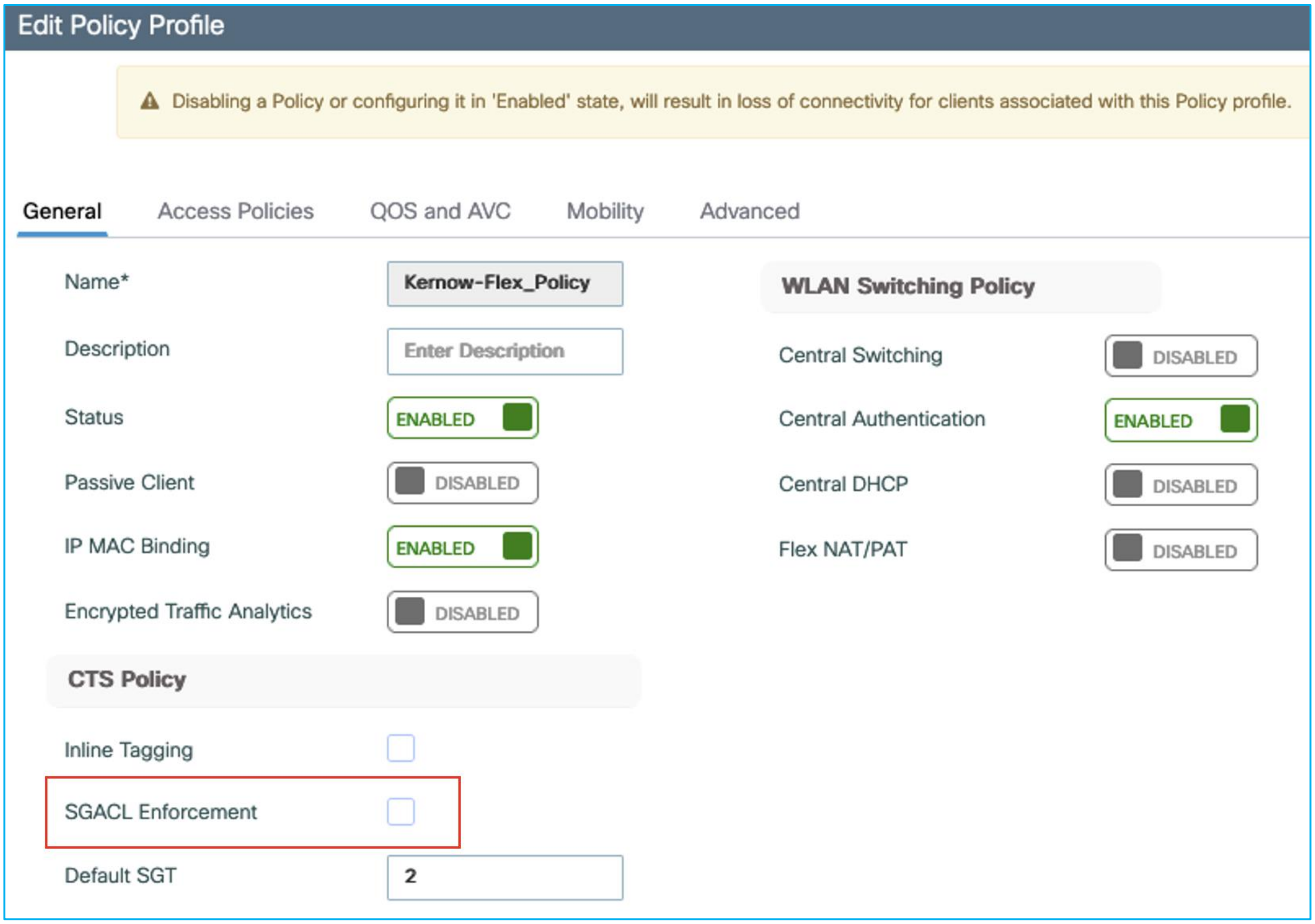
Join Minimum Latency □

IP Overlap □

mDNS Flex Profile Search or Select

PMK Propagation □

Disabled on Policy Profile:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy profile.

Name*	Kernow-Flex_Policy
Description	Enter Description
Status	ENABLED
Passive Client	DISABLED
IP MAC Binding	ENABLED
Encrypted Traffic Analytics	DISABLED

CTS Policy

Inline Tagging	☐
SGACL Enforcement	☐
Default SGT	2

WLAN Switching Policy

Central Switching	DISABLED
Central Authentication	ENABLED
Central DHCP	DISABLED
Flex NAT/PAT	DISABLED

Note: Central switching is disabled, and central authentication enabled. DHCP is also using an IP-helper on the local switch SVI, not central.

Re-auth the client, a mapping is seen on the AP, and this time policy is downloaded:

```
AP0845.D132.75F8#sh cts role-based permissions
IPv4 role-based permissions:
SGT  DGT       ACL
 11   34   Deny_IP
 33   34  DenyIPlog

IPv6 role-based permissions:
SGT  DGT       ACL
 11   34   Deny_IP
 33   34  DenyIPlog
```

Conclusion: the enforcement setting in the Flex Profile is the setting to control enforcement on the Flex AP.

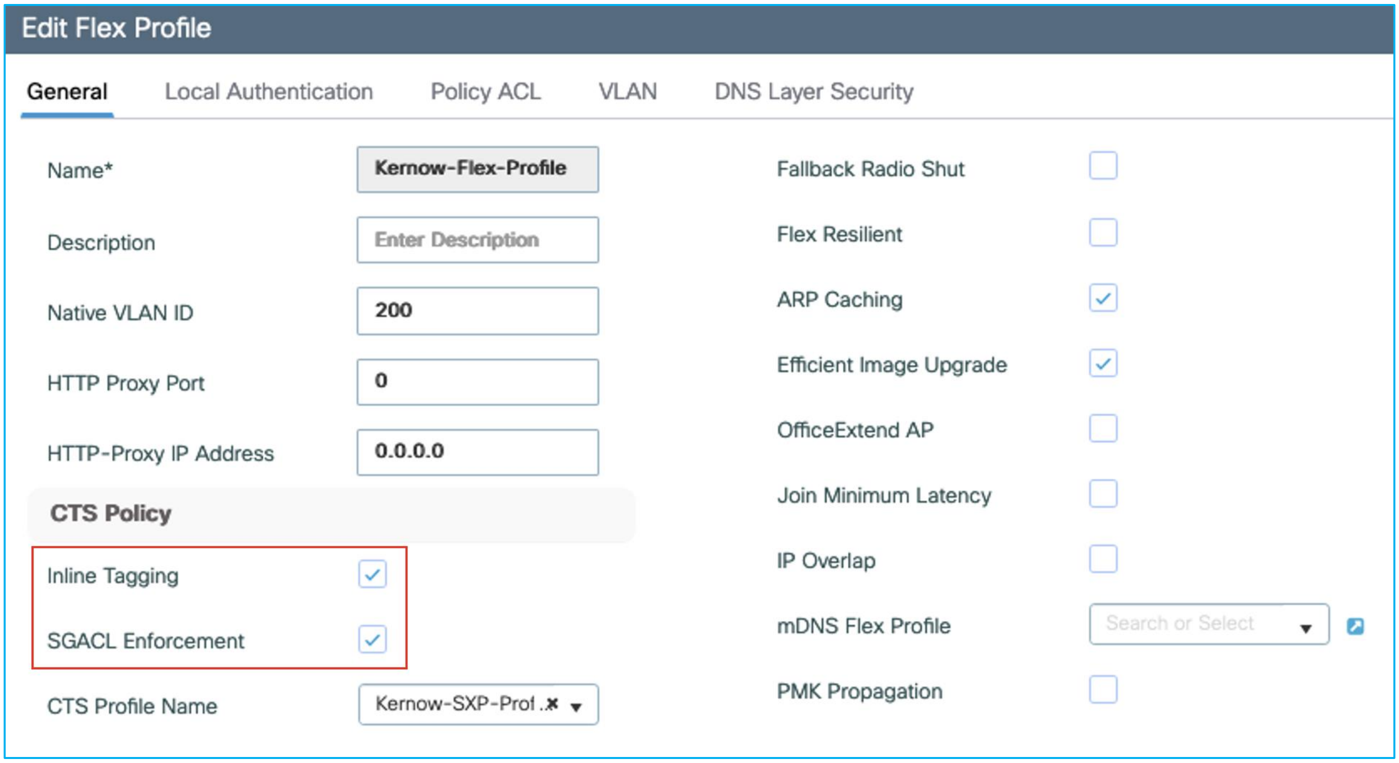
Note: the use-case above is enforcing North to South, for example, wired to wireless. When the wireless client authenticates, this is through the C9800 controller and therefore the C9800 controller knows to download policy and send that policy to the AP.

Note: In the South to North direction, for example trying to enforce wireless to wired on the Flex AP, a policy would be required protecting the mapping received from SXP. In this scenario, the C9800 controller is not aware of the mappings received by the Flex AP and hence, no policy is downloaded by the C9800 controller and therefore no policy is sent to the AP.

Note: To summarize, the Flex AP can only enforce from North to South (wired to wireless), not South to North (wireless to wired). If South to North enforcement is required, then propagate the wireless source SGT northbound using SXP or inline tagging/CMD to enforce on another platform.

Flex AP Enforcing from Inline (CMD)

Set inline tagging on the Flex Profile; also enable enforcement as we want to enforce North to South (wired to wireless) in this use-case:



Name* Kernow-Flex-Profile

Description Enter Description

Native VLAN ID 200

HTTP Proxy Port 0

HTTP-Proxy IP Address 0.0.0.0

CTS Policy

Inline Tagging ☑

SGACL Enforcement ☑

CTS Profile Name Kernow-SXP-Prof

Fallback Radio Shut ☐

Flex Resilient ☐

ARP Caching ☑

Efficient Image Upgrade ☑

OfficeExtend AP ☐

Join Minimum Latency ☐

IP Overlap ☐

mDNS Flex Profile Search or Select

PMK Propagation ☐

Ensure the SXP Profile is disabled so SXP mappings do not interfere with the results.

Set inline tagging on the interconnected Cat9k switch to ensure the point-to-point link between Cat9k switch and Flex AP is sending CMD:

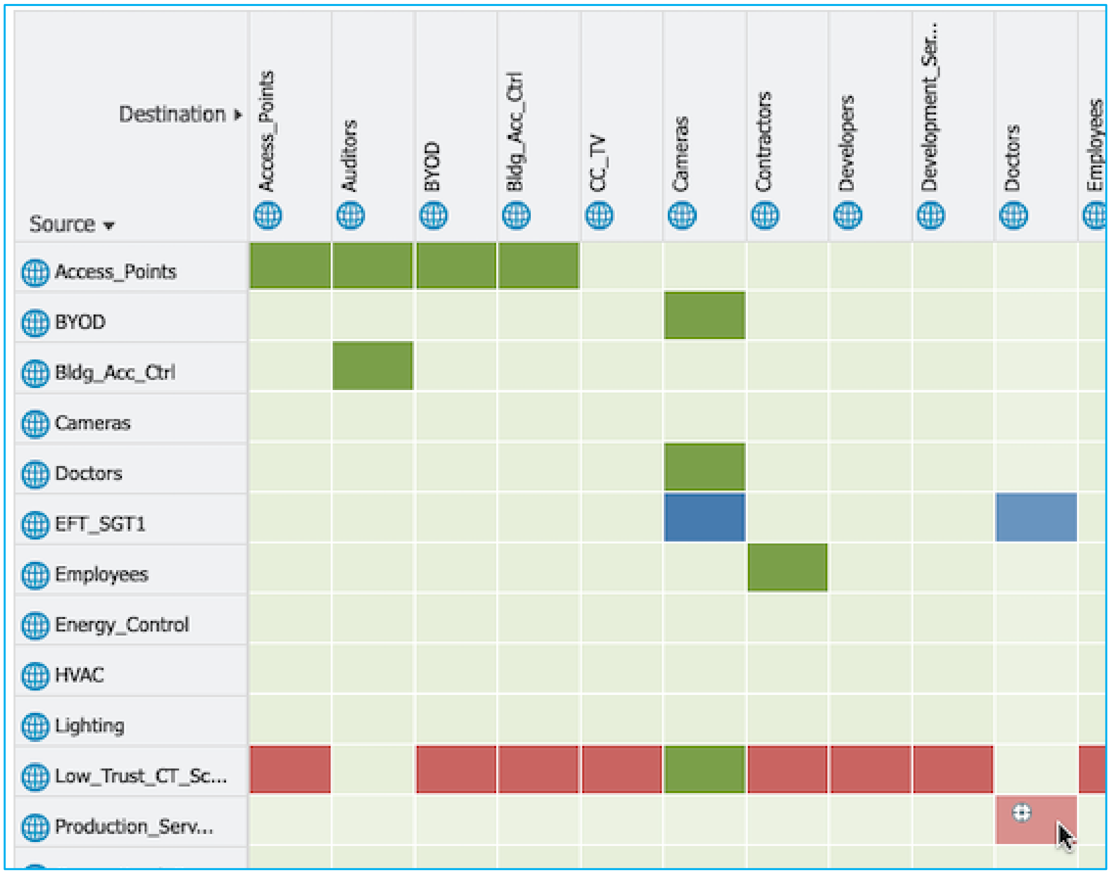
```
interface GigabitEthernet1/0/18
 switchport trunk native vlan 201
 switchport trunk allowed vlan 201,202
 switchport mode trunk
 cts manual
  policy static sgt 2 trusted
end
```

Authenticate a wireless endpoint and assign an SGT from ISE:

```
AP0845.D132.75F8#sh cts role-based sgt-map all
```

```
Active IPv4-SGT Bindings Information
         IP SGT SOURCE
10.1.202.10   34  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
Active IPv6-SGT Bindings Information
                       IP SGT SOURCE
fe80::e586:d6cd:12be:f42c  34  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
```

ISE has a policy to deny traffic from Production_Servers SGT 11 to Doctors SGT 34:



Destination ▸ Source ▾	Access_Points	Auditors	BYOD	Bldg_Acc_Ctrl	CC_TV	Cameras	Contractors	Developers	Development_Ser...	Doctors	Employees
Access_Points	🟩	🟩	🟩	🟩							
BYOD						🟩					
Bldg_Acc_Ctrl		🟩									
Cameras											
Doctors						🟩					
EFT_SGT1						🟦				🟦	
Employees							🟩				
Energy_Control											
HVAC											
Lighting											
Low_Trust_CT_Sc...	🟥		🟥	🟥	🟥	🟩	🟥	🟥	🟥		🟥
Production_Serv...										🟥	

So, C9800 controller downloads the policies to protect destination SGT 34 and sends them to the Flex AP:

```
AP0845.D132.75F8#sh cts role-based permissions
IPv4 role-based permissions:
SGT DGT       ACL
 11  34   Deny_IP
 33   34 DenyIPlog
IPv6 role-based permissions:
SGT  DGT        ACL
 11   34    Deny_IP
 33   34 DenyIPlog
```

Traffic from my wired client 10.4.21.1 is enforced destined towards the wireless client 10.1.202.10:

```
AP0845.D132.75F8#show cts role-based counters from 11 to 34
IPv4 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 5
IPv6 ACL: Deny_IP
Packets Allowed : 0
Packets Denied  : 0
```

This proves that the Flex AP can carry out a source lookup from received CMD and enforce towards a wireless client.

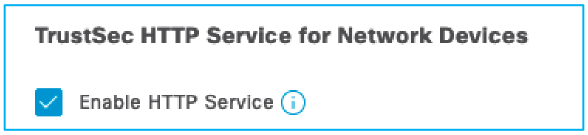
Note: the inline tagging setting on the Policy Profile is irrelevant when enabling inline tagging on the Flex AP. It is the setting on the Flex Profile which enables or disables this feature.

Download Environment-Data and Policy Using HTTPS

The primary intent of this feature is to address transport, reliability and resiliency concerns with RADIUS and move towards a reliable and extensible approach to source SGACL policies and Environment-Data from ISE.

This use case tests the HTTPS download function on the C9800.

In ISE, enable HTTP Service under Work Centers > TrustSec > Settings > General TrustSec Settings:

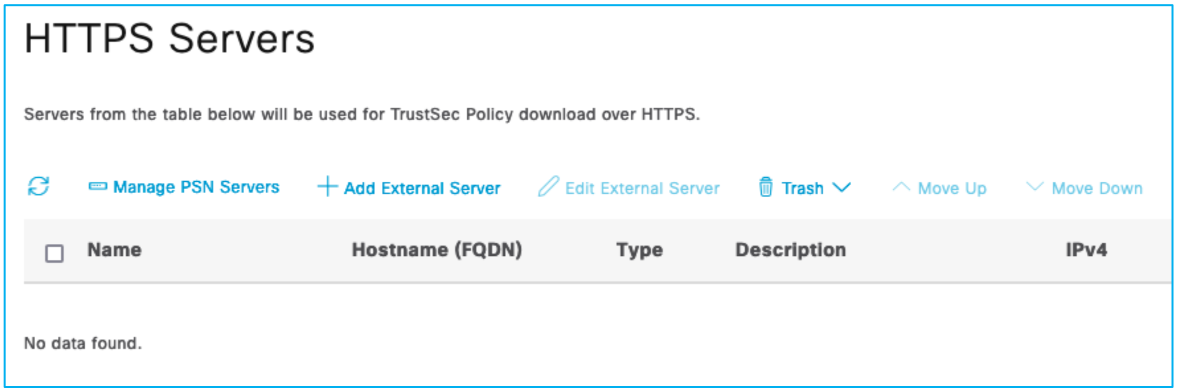


TrustSec HTTP Service for Network Devices

☑ Enable HTTP Service ⓘ

Save the change.

Then, under Work Centers > TrustSec > Components > TrustSec Servers > HTTPS Servers, click ‘Manage PSN Servers’:



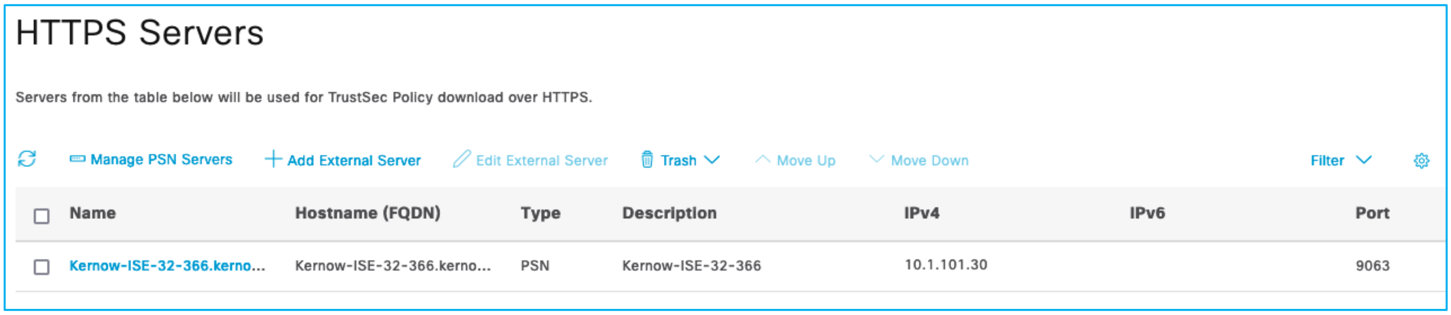
HTTPS Servers

Servers from the table below will be used for TrustSec Policy download over HTTPS.

□	Name	Hostname (FQDN)	Type	Description	IPv4

No data found.

Select the PSN that is used by the C9800 controller and click on Save.



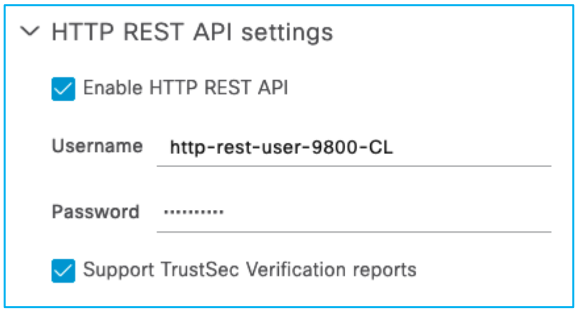
HTTPS Servers

Servers from the table below will be used for TrustSec Policy download over HTTPS.

□	Name	Hostname (FQDN)	Type	Description	IPv4	IPv6	Port
□	Kernow-ISE-32-366.kerno...	Kernow-ISE-32-366.kerno...	PSN	Kernow-ISE-32-366	10.1.101.30		9063

Navigate to the C9800 controller network device in ISE via Administration > Network Resources > Network Devices, click on the C9800 controller network device entry.

Scroll down to Advanced TrustSec Settings, enable HTTP REST API and enter credentials for HTTP REST API settings:



HTTP REST API settings

☑ Enable HTTP REST API

Username: http-rest-user-9800-CL

Password: ••••••••••

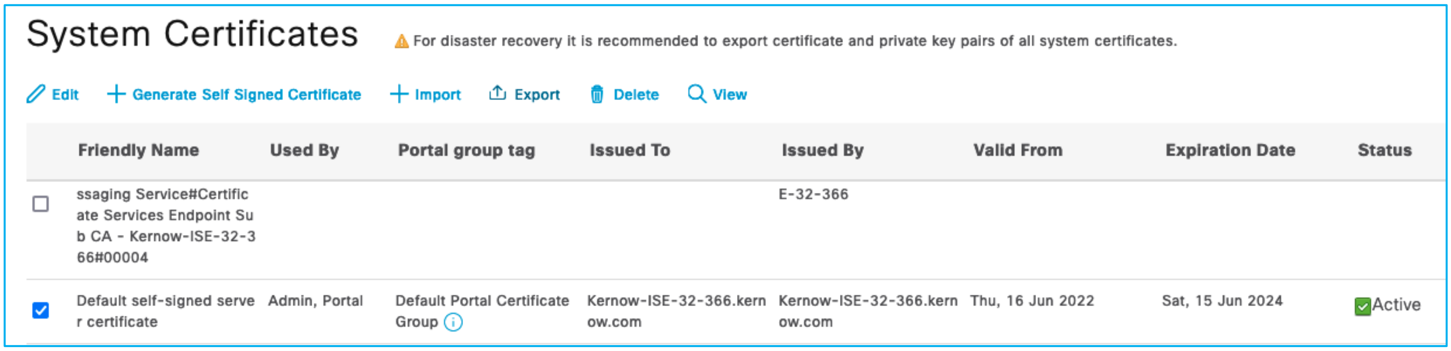
☑ Support TrustSec Verification reports

Note: Currently this username must be different per network device within an ISE deployment.

Save the change.

In ISE, export the ISE Admin certificate public keys for your ISE PSN node(s)

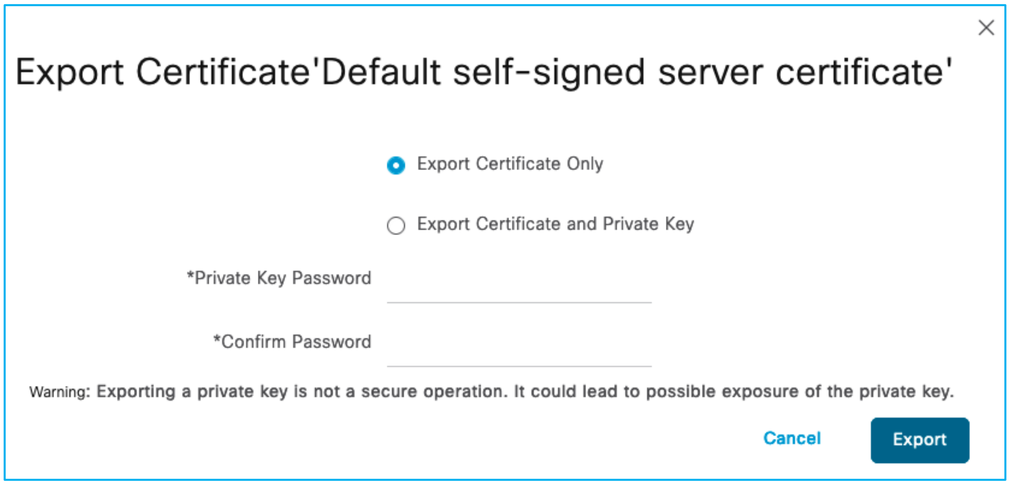
(Administration > System > Certificates)



System Certificates

⚠ For disaster recovery it is recommended to export certificate and private key pairs of all system certificates.

	Friendly Name	Used By	Portal group tag	Issued To	Issued By	Valid From	Expiration Date	Status
□	ssaging Service#Certificate Services Endpoint Sub CA - Kernow-ISE-32-366#00004				E-32-366			
☑	Default self-signed server certificate	Admin, Portal	Default Portal Certificate Group ⓘ	Kernow-ISE-32-366.kernow.com	Kernow-ISE-32-366.kernow.com	Thu, 16 Jun 2022	Sat, 15 Jun 2024	✓Active



Export Certificate'Default self-signed server certificate'

● Export Certificate Only

○ Export Certificate and Private Key

*Private Key Password

*Confirm Password

Warning: Exporting a private key is not a secure operation. It could lead to possible exposure of the private key.

Click Export and save the pem file locally.

On the C9800 controller:

```
9800-17.9.1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
9800-17.9.1(config)#crypto pki trustpoint ISE-REST
9800-17.9.1(ca-trustpoint)#enrollment mode ra
9800-17.9.1(ca-trustpoint)#enrollment terminal
9800-17.9.1(ca-trustpoint)#usage ssl-client
9800-17.9.1(ca-trustpoint)#revocation-check none
9800-17.9.1(ca-trustpoint)#exit
```

Open the pem file saved locally from the ISE export and copy the entirety of the contents.

On the C9800 controller:

```
9800-17.9.1(config)#crypto pki authenticate ISE-REST
```

Enter the base 64 encoded CA certificate.

End with a blank line or the word " quit" on a line by itself

Note: Paste the copied pem file here, as follows:

-----BEGIN CERTIFICATE-----
MIIFWjCCA0KgAwIBAgIMNX0ZYC/oELoCLNCfMA0GCSqGSIb3DQEBDAUAMCcxJTAj
BgNVBAMTHEtlcm5vdy1JU0UtMzItMzY2Lmtlcm5vdy5jb20wHhcNMjIwNjE2MTU0
MTQ4WhcNMjQwNjE1MTU0MTQ4WjAnMSUwIwYDVQQDExxLZXJub3ctSVNFLTMyLTM2
Ni5rZXJub3cuY29tMIICIjANBgkqhkiG9w0BAQEFAAOCAg8AMIICCgKCAgEAvq07
Sd/QLn+WCBozYvV5ymgeWuRBjzYai1ymBcvnUNV5Dh9rtiBcXSF3aLvnbsaaCuqm
nXn9Q1OITBJvcdnU/hf7N/5D44nWHshzasBxfBVxpcrl+8FbQpj9qzoCeRg7Ph9n
48qvDAwTp4inzc9k4n9ShTv88woKhek7ewRU7b+VcEWciJr6MU/731RxC7B1E8y8
aUMFSBwkEZiq0ibmEMbiY/uKFF33X2E5rht/Dmt3V7H3ngENtuVD0+OZx4wCyHmA

```
CiumZpZvyoXh3jF/mK5VI1O9GSihwe6xHZiQQUMbwG/FSRWP8NF/Vi7n52721Ssh
nH+ygtGfIKsNAHdfLXqpEhcIoCxjxMIb+En58mEVJI53d9w0qh7Ge42i58s3dqW0
k5L5HckVW1mKpCOZppSGX/vBPGBIzzGH9bazibRSi4n4FBgJvKdzJd2QV3NgQuos
t0xRJFhWurWupDmeZpQgFSZYukpzivz9+dJ6x1KQYQpGIjIGZLn3LhQ/WGsa1PSV
yLm1mt0hJsQBvDyeoRWqFL0PHoHkaXCGI7WMy2GB3B3uqn1dQ7q8HdvQHO4emWCd
9+QnEXqgPR44jZw7skRZ/9aTZYgZ5M6P5Bx4AXqH7BAyhYQtgwSUco5nzcAjO3aI
Z0Jrw5HMn5i21JwTGomk1McfasF/nHGJuwoS8u8CAwEAAaOBhTCBgjAnBgNVHREE
IDAeghxLZXJub3ctSVNFLTMyLTM2Ni5rZXJub3cuY29tMAwGA1UdEwQFMAMBAf8w
CwYDVR0PBAQDAgLsMB0GA1UdDgQWBBSy2QLr72Ey1GgbX5WnYEJfibrFEjAdBgNV
HSUEFjAUBggrBgEFBQcDAQYIKwYBBQUHAwIwDQYJKoZIhvcNAQEMBQADggIBADAh
1tCxmgLN0yLQg4XKynk9hr/djdbE9SWBr3JQWJjKmTG3+QrxJ+w/v9m6ABikN5EN
vkrI9tQ5GHzNG9fiIS1RNG6ZhcCD3Ht85wBd1sjwu2iTGwAIdQRnOiaTWCBvFn3w
B6r6dDoVq149q4HAno/CJpNsxU1UoL7ifrL9HLWkYqbRqBx/0HY0Z8RZrzUp8izZ
u0jLtC0GHIp386KcsKLWhFApSa+YvuI0fiinGGbRvOGO9/BTSwtqsA4ZjAdeTYWt
o297G2XfUQ6FA5nS/RnGwWEFp1sn9oLrrafeDHNxCh2UG5XDingI3Bp+hY0FByyy
ZK7Pf8UIH/Hmmx+xX7I9I4K6S6MQuIWNG10bjfsu9DxNIZmIQwZouyTP99hfKbw4
oI4pLHuXJIZOv6fuzkuhgRR60sPugSFTIB5thWUXBRafNHhFjKIzugt4FOQDvRQr
zehiCCK9gyy5teSNV9/bNLnIzGY6ss6KdYRxybvVSrINiUhoHRCzk6gHS3BTdzwC
j7Z6gNuwateI0vQnT8XE7FN+u4hbaUk72LExbghIicZDyovzbfXQXYSZx46guRZY
ZiRTU0JYfgbOCu+c5FkzFMbyKcCuoMr5JTQ0+SZVhG2nWa5Edir6EHqfhrrnFHry
/HbuPm6iA5ht2KE2MUJDpu9euKrUQC0yu3N3fI4Y
-----END CERTIFICATE-----
```

```
quit
Certificate has the following attributes:
       Fingerprint MD5: DB2AA78C 375B6ECE F28FFE5F CCDDF3FE
      Fingerprint SHA1: 4EBBD588 778E261A 382C9D00 44691DAF E092506E
% Do you accept this certificate? [yes/no]: yes
Trustpoint CA certificate accepted.
% Certificate successfully imported
```

Remove the cts authorization list in the C9800 controller config to switch over from using RADIUS to using HTTPS REST:

```
9800-17.9.1(config)#no cts authorization list CTS-Authz-List
9800-17.9.1(config)#no aaa authorization network CTS-Authz-List group
RADIUS_SERVER_GROUP_DAY0
```

Add the policy download configuration:

```
9800-17.9.1(config)#cts policy-server name ISE-REST
9800-17.9.1(config-policy-server)#address ipv4 10.1.101.30
9800-17.9.1(config-policy-server)#address domain-name ISE-REST.kernow.com
9800-17.9.1(config-policy-server)#port 9063
9800-17.9.1(config-policy-server)#tls server-trustpoint ISE-REST
9800-17.9.1(config-policy-server)#retransmit 3
9800-17.9.1(config-policy-server)#timeout 15
9800-17.9.1(config-policy-server)#content-type json
9800-17.9.1(config-policy-server)#exit
9800-17.9.1(config)#cts policy-server username http-rest-user-9800-CL password 0 xxxx
9800-17.9.1(config)#cts policy-server device-id 9800-CL
9800-17.9.1(config)#cts environment-data enable
9800-17.9.1#show cts policy-server details all
Server Name   : ISE-REST
Server Status : Inactive
  IPv4 Address     : 10.1.101.30 (Reachable)
  Domain-name      : ISE-REST.kernow.com (Reachable)
  Trustpoint       : ISE-REST
  Port-num         : 9063
  Retransmit count : 3
  Timeout          : 15
  App Content type : JSON
  Trustpoint chain : NOT CONFIGURED
Server Name   : Kernow-ISE-32-366.kernow.com
Server Status : Active
  IPv4 Address     : 10.1.101.30 (Reachable)
  Domain-name      : Kernow-ISE-32-366.kernow.com (Reachable)
  Trustpoint       : cts_tp_Kernow-ISE-32-366.kernow.com_0
  Port-num         : 9063
  Retransmit count : 3
  Timeout          : 15
  App Content type : JSON
  Trustpoint chain : NOT CONFIGURED
```

After clearing previous PACs and environment-data, environment-data is re-downloaded (via HTTPS REST) without requiring a PAC:

```
9800-17.9.1#show cts pacs
No PACs found in the key store.
9800-17.9.1#show cts environment-data
```

```
CTS Environment Data
====================
Current state = COMPLETE
Last status = Successful
Service Info Table:
Local Device SGT:
  SGT tag = 2:TrustSec_Devices
Server List Info:
Security Group Name Table:
    0-01:Unknown
    2-01:TrustSec_Devices
    3-02:Network_Services
…etc
```

When new policy is added in ISE, it is downloaded successfully without RADIUS being displayed in the ISE Live Log. This tests prove HTTPS can be used instead of RADIUS for environment-data and Policy download from ISE.

High Availability Operation With SGTs

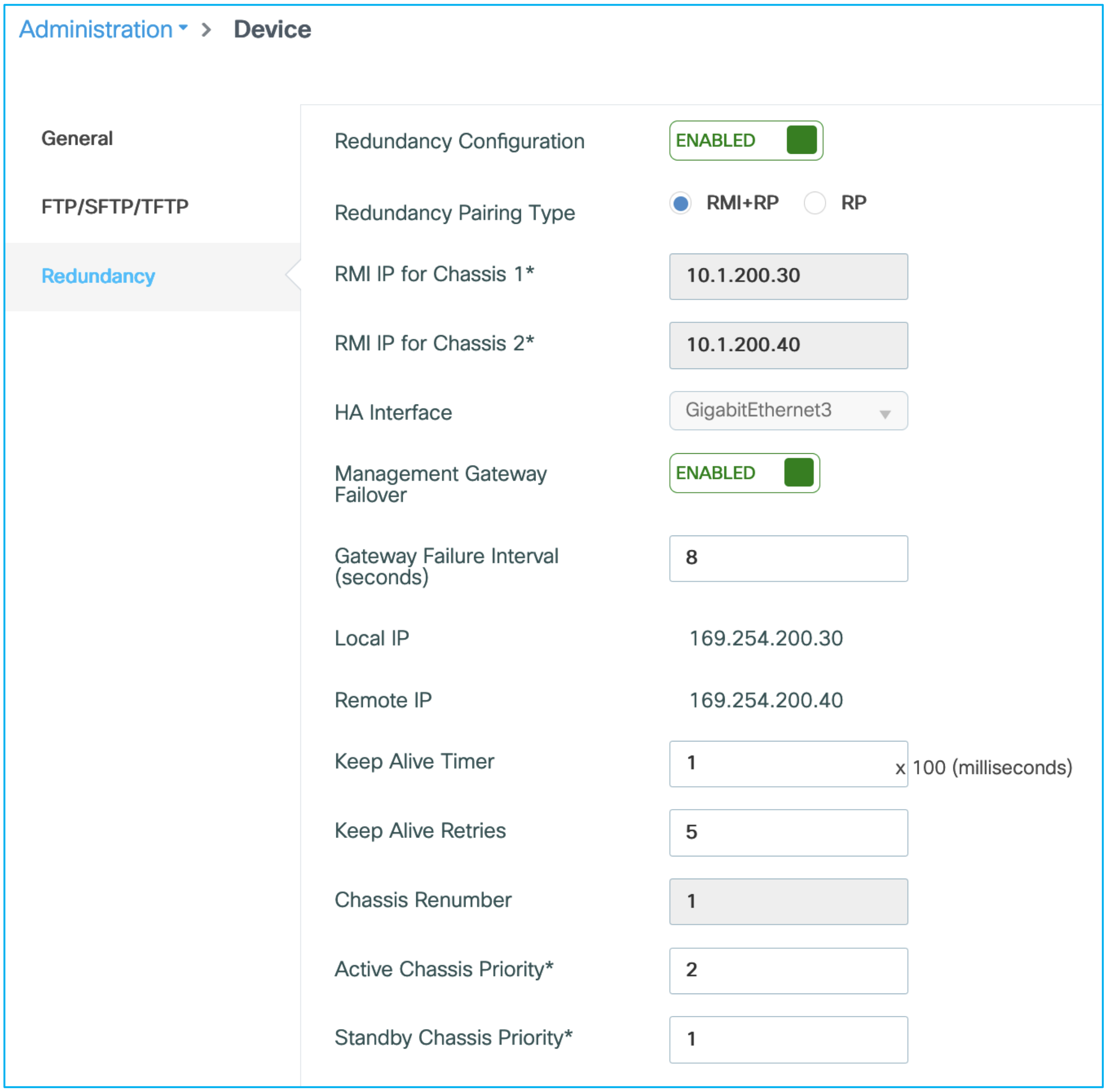
HA Setup

On standby C9800, use the following CLI command to change the chassis number to 2:

```
9800-17.9.1HA#chassis 1 renumber 2
```

Then reload

Then, used the GUI:



Redundancy Configuration: ENABLED

Redundancy Pairing Type: ● RMI+RP ○ RP

RMI IP for Chassis 1*: 10.1.200.30

RMI IP for Chassis 2*: 10.1.200.40

HA Interface: GigabitEthernet3

Management Gateway Failover: ENABLED

Gateway Failure Interval (seconds): 8

Local IP: 169.254.200.30

Remote IP: 169.254.200.40

Keep Alive Timer: 1 x 100 (milliseconds)

Keep Alive Retries: 5

Chassis Renumber: 1

Active Chassis Priority*: 2

Standby Chassis Priority*: 1

Then reloaded again.

To enable console access on the standby, enter the following command on the active:

```
redundancy
  mode sso
   main-cpu
     standby console enable
```

Relevant config shown on the active:

```
!
redundancy
 mode sso
 main-cpu
  standby console enable
!
interface Vlan200
```

```
 ip address 10.1.200.30 255.255.255.0 secondary
 ip address 10.1.200.10 255.255.255.0
!
redun-management interface Vlan200 chassis 1 address 10.1.200.30 chassis 2 address
10.1.200.40
Relevant config on the standby C9800:
!
redundancy
 mode sso
 main-cpu
  standby console enable
!
interface Vlan200
 ip address 10.1.200.40 255.255.255.0
!
redun-management interface Vlan200 chassis 1 address 10.1.200.30 chassis 2 address
10.1.200.40
```

Note: 10.1.200.10 under vlan200 is the management IP. This is the IP that we terminate SXP connections on. Upon failover, this management IP is available on the new active platform and remote access is still possible and SXP connections remain up.

```
9800-17.9.1#show chassis
Chassis/Stack Mac Address : 0050.56b2.f56e - Local Mac Address
Mac persistency wait time: Indefinite
                                             H/W   Current
Chassis#   Role    Mac Address     Priority Version  State                 IP
-------------------------------------------------------------------------------------
*1       Active   0050.56b2.f56e     2      V02     Ready                169.254.200.30
 2       Standby  0050.56b2.6155     1      V02     Ready                169.254.200.40

9800-17.9.1#show redundancy
Redundant System Information :
------------------------------
       Available system uptime = 55 minutes
Switchovers system experienced = 0
              Standby failures = 0
        Last switchover reason = none

                 Hardware Mode = Duplex
    Configured Redundancy Mode = sso
     Operating Redundancy Mode = sso
              Maintenance Mode = Disabled
                Communications = Up
```

```
Current Processor Information :
-------------------------------
               Active Location = slot 1
        Current Software state = ACTIVE
       Uptime in current state = 55 minutes
                 Image Version = Cisco IOS Software [Cupertino], C9800-CL Software (C9800-
CL-K9_IOSXE), Version 17.9.1eft15, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Fri 24-Jun-22 20:01 by mcpre
                          BOOT = bootflash:packages.conf,12;
        Configuration register = 0x2102
               Recovery mode   = Not Applicable
             Fast Switchover   = Enabled
                Initial Garp   = Enabled
Peer Processor Information :
----------------------------
              Standby Location = slot 2
        Current Software state = STANDBY HOT
       Uptime in current state = 53 minutes
                 Image Version = Cisco IOS Software [Cupertino], C9800-CL Software (C9800-
CL-K9_IOSXE), Version 17.9.1eft15, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Fri 24-Jun-22 20:01 by mcpre
                          BOOT = bootflash:packages.conf,12;
                   CONFIG_FILE =
        Configuration register = 0x2102
```

HA Operation

Retrieved from Active C9800	Retrieved from Standby C9800

`9800-17.9.1#sh cts pacs`
`AID: AF8B97E848CC486737DFC8124B7F00AD`
`PAC-Info:`
`    PAC-type = Cisco Trustsec`
`    AID: AF8B97E848CC486737DFC8124B7F00AD`
`    I-ID: 9800-CL`
`    A-ID-Info: Identity Services Engine`
`    Credential Lifetime: 10:44:32 British Oct 4 2022`
`PAC-Opaque: 000200B00…`
`Refresh timer is set for 6w3d`
	`9800-17.9.1-stby#sh cts pacs`
	`This command is disabled on standby units.`
	Note: PACs are not shared and are acquired on the new active C9800 immediately after switchover

9800-17.9.1#sh cts environment-data CTS Environment Data ==================== Current state = COMPLETE Last status = Successful Service Info Table: Local Device SGT: SGT tag = 2-01:TrustSec_Devices Server List Info: Installed list: CTSServerList1-0001, 1 server(s): *Server: 10.1.101.30, port 1812, A-ID AF8B97E848CC486737DFC8124B7F00AD Status = ALIVE auto-test = TRUE, keywrap-enable = FALSE, idle-time = 60 mins, deadtime = 20 secs Security Group Name Table: 0-00:Unknown 2-00:TrustSec_Devices 3-01:Network_Services 4-01:Employees 5-02:Contractors 6-01:Guests 7-01:Production_Users 8-01:Developers 9-02:Auditors 10-01:Point_of_Sale_Systems 11-10:Production_Servers 12-03:Development_Servers 13-00:Test_Servers 14-01:PCI_Servers 15-02:BYOD 16-00:Intranet 17-00:Extranet 18-02:HVAC 19-02:Lighting 20-02:Water_Control 21-00:Entertainment_Systems 22-01:CC_TV 23-02:Bldg_Acc_Ctrl	9800-17.9.1-stby#sh cts environment-data CTS Environment Data ==================== Current state = COMPLETE Last status = Successful Service Info Table: Local Configured Device SGT: 2:TrustSec_Devices Server List Info: Installed list: CTSServerList1-0001, 1 server(s): Server: 10.1.101.30, port 1812, A-ID AF8B97E848CC486737DFC8124B7F00AD Status = ALIVE auto-test = FALSE, keywrap-enable = FALSE, idle-time = 60 mins, deadtime = 20 secs Security Group Name Table: 0-00:Unknown 2-00:TrustSec_Devices 3-01:Network_Services 4-01:Employees 5-02:Contractors 6-01:Guests 7-01:Production_Users 8-01:Developers 9-02:Auditors 10-01:Point_of_Sale_Systems 11-10:Production_Servers 12-03:Development_Servers 13-00:Test_Servers 14-01:PCI_Servers 15-02:BYOD 16-00:Intranet 17-00:Extranet 18-02:HVAC 19-02:Lighting 20-02:Water_Control 21-00:Entertainment_Systems 22-01:CC_TV 23-02:Bldg_Acc_Ctrl 24-00:Intruder_Detection

```
    24-00:Intruder_Detection
    25-02:Energy_Control
    27-02:IP_Phones
    28-09:Cameras
    29-01:Access_Points
    30-00:High_Trust_CT_Scanners
    31-00:Low_Trust_CT_Scanners
    32-01:Wireless_Clients
    33-00:EFT_SGT1
    34-39:Doctors
    35-01:Storage
    36-08:Scanners
    37-00:Nurses
    255-00:Quarantined_Systems
    39-00:PLC_Siemens
    40-00:WLCs
Environment Data Lifetime = 86400 secs
Last update time = 11:55:49 British Thu
Aug 18 2022
Env-data expires in   0:22:26:37
(dd:hr:mm:sec)
Env-data refreshes in 0:22:26:37
(dd:hr:mm:sec)
Cache data applied           = NONE
State Machine is running
Retry_timer (60 secs) is not running
```

```
    25-02:Energy_Control
    27-02:IP_Phones
    28-09:Cameras
    29-01:Access_Points
    30-00:High_Trust_CT_Scanners
    31-00:Low_Trust_CT_Scanners
    32-01:Wireless_Clients
    33-00:EFT_SGT1
    34-39:Doctors
    35-01:Storage
    36-08:Scanners
    37-00:Nurses
    255-00:Quarantined_Systems
    39-00:PLC_Siemens
    40-00:WLCs
Environment Data Lifetime = 86400 secs
Last update time = 11:55:49 British Thu Aug
18 2022
Env-data expires in   0:22:26:10
(dd:hr:mm:sec)
Env-data refreshes in 0:22:26:10
(dd:hr:mm:sec)
Cache data applied           = NONE
State Machine is running
Retry_timer (60 secs) is not running
```

```
9800-17.9.1#sh cts role-based sgt-map
all
Active IPv4-SGT Bindings Information


IP Address                SGT     Source
=================================
1.1.1.8                   2       SXP
10.1.200.1                2       SXP
10.1.210.1                2       SXP
10.1.210.10               2
INTERNAL
10.1.210.100              34      LOCAL
10.1.211.1                2       SXP
10.1.211.10               2
```

```
9800-17.9.1-stby#sh cts role-based sgt-map
all
Active IPv4-SGT Bindings Information

IP Address                SGT     Source
============================================
10.1.210.10               2       INTERNAL
10.1.210.100              34      LOCAL
10.1.211.10               2       INTERNAL

IP-SGT Active Bindings Summary
===============================
Total number of LOCAL    bindings = 1
Total number of INTERNAL bindings = 2
Total number of active   bindings = 3
```

```
INTERNAL
10.3.23.2               2       SXP
10.4.25.2               2       SXP
10.6.50.100             28      SXP
10.6.50.254             2       SXP

IP-SGT Active Bindings Summary
====================================
Total number of SXP      bindings = 8
Total number of LOCAL    bindings = 1
Total number of INTERNAL bindings = 2
Total number of active   bindings = 11

Active IPv6-SGT Bindings Information

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

```
Active IPv6-SGT Bindings Information

IP Address
SGT     Source
```

Note: Doesn't show SXP entries therefore doesn't show any mapping to SGT 28

```
9800-17.9.1#sh cts rbacl
CTS RBACL Policy
================
RBACL IP Version Supported: IPv4 &
IPv6
  name   = Deny_IP_Log-00
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip log

  name   = Deny IP-00
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip

  name   = Permit IP-00
  IP protocol version = IPV4, IPV6
  refcnt = 6
```

```
9800-17.9.1-stby#sh cts rbacl
CTS RBACL Policy
================
RBACL IP Version Supported: IPv4 & IPv6
  name   = Deny_IP_Log-00
  IP protocol version = IPV4, IPV6
  refcnt = 1
  flag   = 0xC0000000
  stale  = FALSE
  RBACL ACEs:
    deny ip log

  name   = Deny IP-00
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip

  name   = Permit IP-00
  IP protocol version = IPV4, IPV6
  refcnt = 5
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    permit ip

  name   = DenyIPlog-01
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip log
```

```
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    permit ip

  name   = DenyIPlog-01
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip log
```

```
9800-17.9.1#show cts role-based
permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group
15:BYOD to group 28:Cameras:
        Permit IP-00
IPv4 Role-based permissions from group
31:Low_Trust_CT_Scanners to group
28:Cameras:
        Permit IP-00
IPv4 Role-based permissions from group
33:EFT_SGT1 to group 28:Cameras:
        Deny_IP_Log-00
IPv4 Role-based permissions from group
34:Doctors to group 28:Cameras:
        Permit IP-00
IPv4 Role-based permissions from group
11:Production_Servers to group 34:Doctors:
        Deny IP-00
IPv4 Role-based permissions from group
33:EFT_SGT1 to group 34:Doctors:
        DenyIPlog-01
RBACL Monitor All for Dynamic Policies :
FALSE
RBACL Monitor All for Configured Policies
: FALSE
```

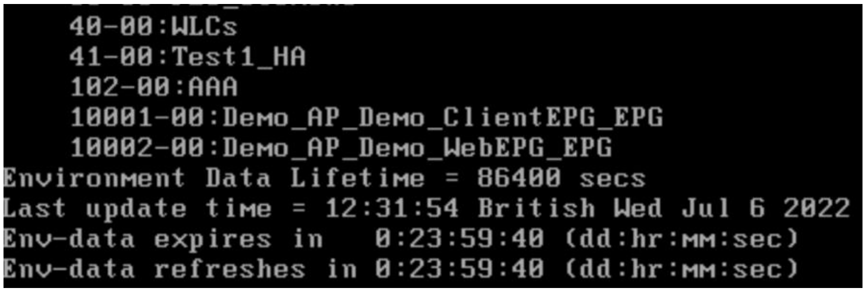
```
9800-17.9.1-stby#show cts role-based
permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group
11:Production_Servers to group 34:Doctors:
        Deny IP-00
IPv4 Role-based permissions from group
33:EFT_SGT1 to group 34:Doctors:
        DenyIPlog-01
RBACL Monitor All for Dynamic Policies :
FALSE
RBACL Monitor All for Configured Policies :
FALSE
```

Note: Due to not showing SXP mappings, the permissions table is reduced as policies for those mappings are not shown (destined for SGT 28 for example).

Using ISE, a new SGT was added: Test1_HA, SGT 41. Pushed the change.

The active C9800 was updated, and the change was sync'd to the Standby.

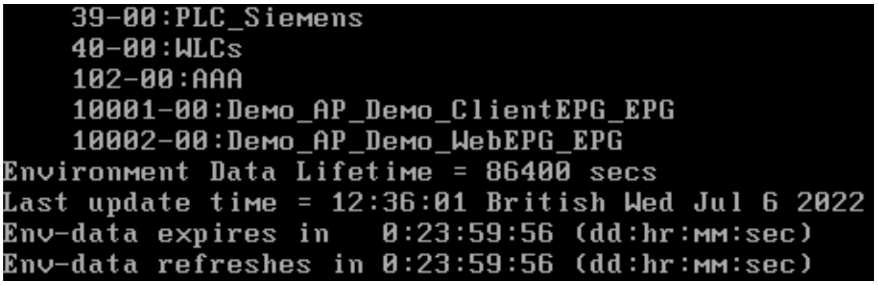
New SGT can be seen in the Standby using the 'show cts environment-data command', the last update time and expires/refresh time also updated:



```
    40-00:WLCs
    41-00:Test1_HA
    102-00:AAA
    10001-00:Demo_AP_Demo_ClientEPG_EPG
    10002-00:Demo_AP_Demo_WebEPG_EPG
Environment Data Lifetime = 86400 secs
Last update time = 12:31:54 British Wed Jul 6 2022
Env-data expires in   0:23:59:40 (dd:hr:mm:sec)
Env-data refreshes in 0:23:59:40 (dd:hr:mm:sec)
```

Delete that same SGT in ISE and push the change.

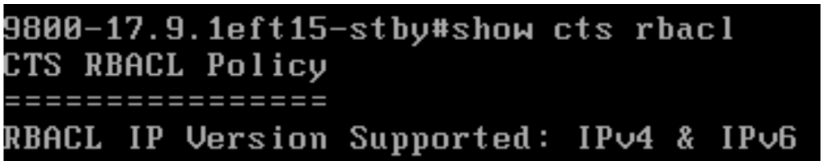
Again, the active C9800 is updated and sync'd to the standby:



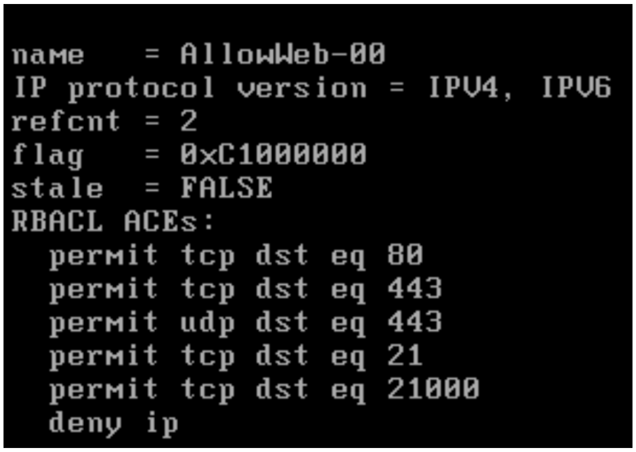
```
    39-00:PLC_Siemens
    40-00:WLCs
    102-00:AAA
    10001-00:Demo_AP_Demo_ClientEPG_EPG
    10002-00:Demo_AP_Demo_WebEPG_EPG
Environment Data Lifetime = 86400 secs
Last update time = 12:36:01 British Wed Jul 6 2022
Env-data expires in   0:23:59:56 (dd:hr:mm:sec)
Env-data refreshes in 0:23:59:56 (dd:hr:mm:sec)
```

Add a new policy in ISE and assign an SGACL not already downloaded by the C9800. Add new policy from 29 to 11 using SGACL called AllowWeb.

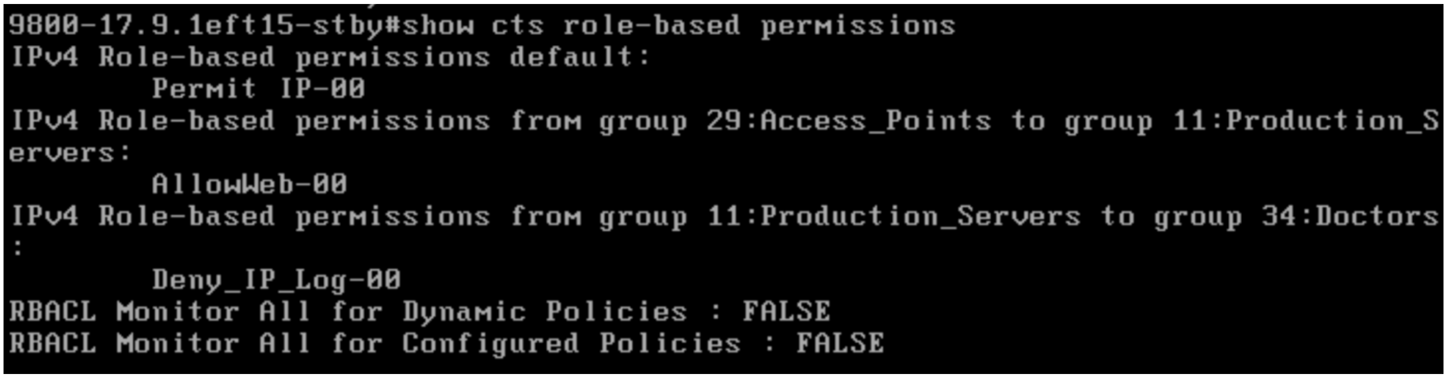
As SGT 11 is being protected by the C9800, the newly added policy and SGACL are downloaded, and sync'd to the Standby:



```
9800-17.9.1eft15-stby#show cts rbacl
CTS RBACL Policy
================
RBACL IP Version Supported: IPv4 & IPv6
```



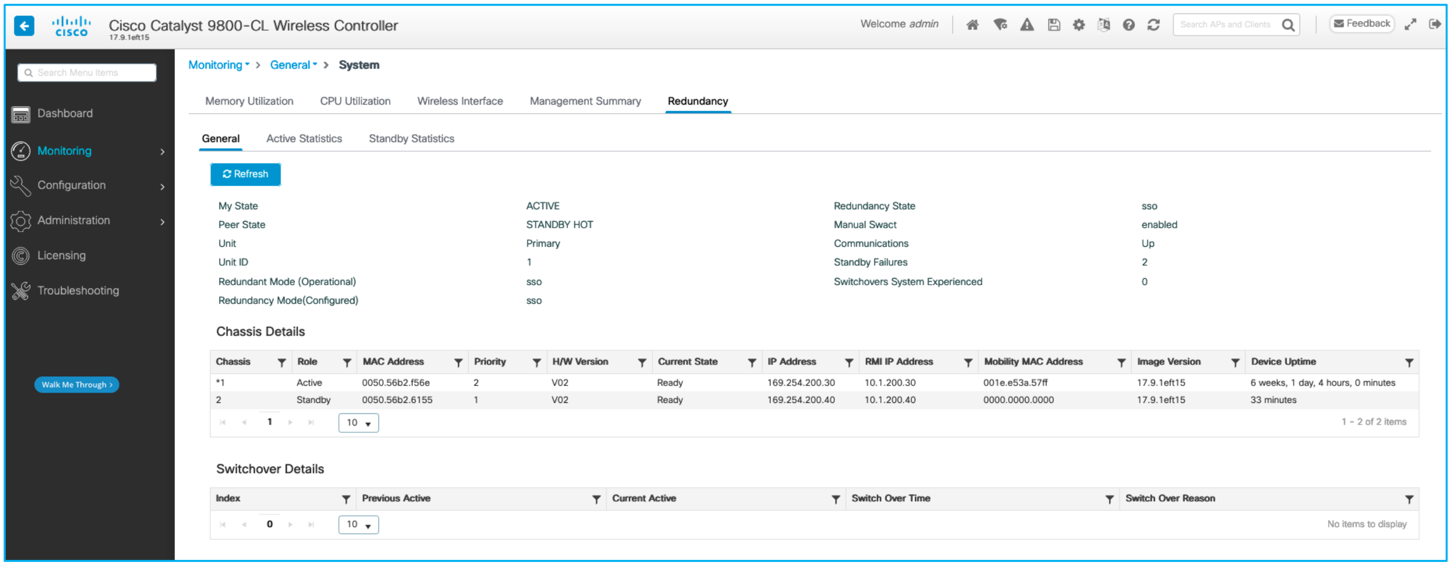
```
name    = AllowWeb-00
IP protocol version = IPV4, IPV6
refcnt  = 2
flag    = 0xC1000000
stale   = FALSE
RBACL ACEs:
  permit tcp dst eq 80
  permit tcp dst eq 443
  permit udp dst eq 443
  permit tcp dst eq 21
  permit tcp dst eq 21000
  deny ip
```



```
9800-17.9.1eft15-stby#show cts role-based permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group 29:Access_Points to group 11:Production_Servers:
        AllowWeb-00
IPv4 Role-based permissions from group 11:Production_Servers to group 34:Doctors:
        Deny_IP_Log-00
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

To test switch-over behaviour: A wireless client is authenticated (10.1.210.100) and assigned Doctors SGT 34. Traffic being sent from wireless client to wired (10.1.140.2) using central switching.

Before switch-over:



My State	ACTIVE	Redundancy State	sso
Peer State	STANDBY HOT	Manual Swact	enabled
Unit	Primary	Communications	Up
Unit ID	1	Standby Failures	2
Redundant Mode (Operational)	sso	Switchovers System Experienced	0
Redundancy Mode(Configured)	sso		

Chassis Details

Chassis	Role	MAC Address	Priority	H/W Version	Current State	IP Address	RMI IP Address	Mobility MAC Address	Image Version	Device Uptime
*1	Active	0050.56b2.f56e	2	V02	Ready	169.254.200.30	10.1.200.30	001e.e53a.57ff	17.9.1eft15	6 weeks, 1 day, 4 hours, 0 minutes
2	Standby	0050.56b2.6155	1	V02	Ready	169.254.200.40	10.1.200.40	0000.0000.0000	17.9.1eft15	33 minutes

1 - 2 of 2 items

Switchover Details

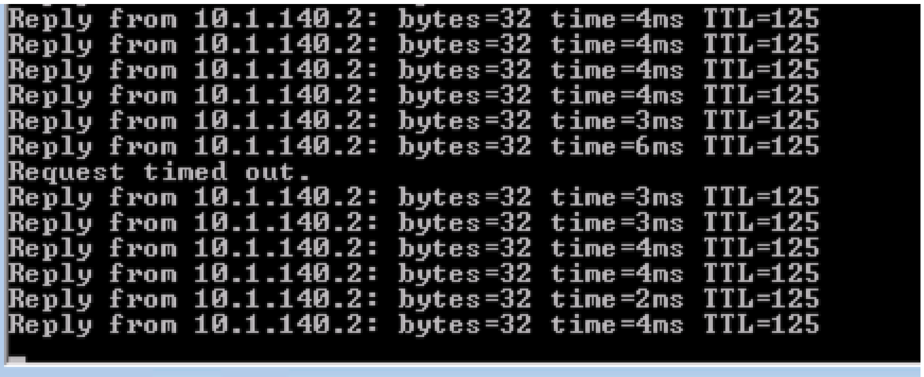
Index	Previous Active	Current Active	Switch Over Time	Switch Over Reason

No items to display

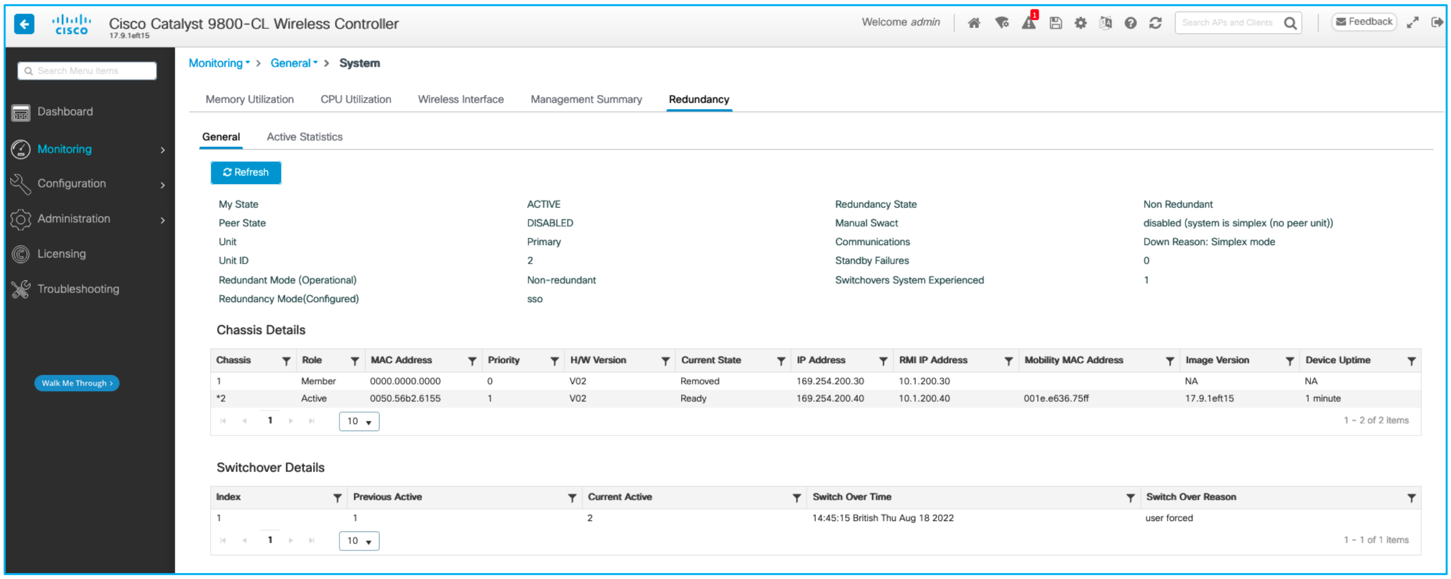
```
9800-17.9.1#redundancy force-switchover

System configuration has been modified. Save? [yes/no]: yes

Building configuration...

[OK]Proceed with switchover to standby RP? [confirm]

    Manual Swact = enabled

[Connection to 10.1.200.30 closed by foreign host]
```

Was dropped from GUI access but could log in again very quickly.

Centrally switched client experienced a very small outage:



```
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=3ms TTL=125
Reply from 10.1.140.2: bytes=32 time=6ms TTL=125
Request timed out.
Reply from 10.1.140.2: bytes=32 time=3ms TTL=125
Reply from 10.1.140.2: bytes=32 time=3ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
Reply from 10.1.140.2: bytes=32 time=2ms TTL=125
Reply from 10.1.140.2: bytes=32 time=4ms TTL=125
```



My State	ACTIVE	Redundancy State	Non Redundant
Peer State	DISABLED	Manual Swact	disabled (system is simplex (no peer unit))
Unit	Primary	Communications	Down Reason: Simplex mode
Unit ID	2	Standby Failures	0
Redundant Mode (Operational)	Non-redundant	Switchovers System Experienced	1
Redundancy Mode(Configured)	sso		

Chassis Details

Chassis	Role	MAC Address	Priority	H/W Version	Current State	IP Address	RMI IP Address	Mobility MAC Address	Image Version	Device Uptime
1	Member	0000.0000.0000	0	V02	Removed	169.254.200.30	10.1.200.30		NA	NA
*2	Active	0050.56b2.6155	1	V02	Ready	169.254.200.40	10.1.200.40	001e.e636.75ff	17.9.1eft15	1 minute

1 - 2 of 2 items

Switchover Details

Index	Previous Active	Current Active	Switch Over Time	Switch Over Reason
1	1	2	14:45:15 British Thu Aug 18 2022	user forced

1 - 1 of 1 items

On the new active C9800 controller, captured the following output.

See that a new PAC has been downloaded, the management IP is available on the new active controller, and SXP is now terminated on the new active platform so IP:SGT mappings from SXP are shown:

```
9800-17.9.1#show redundancy

Redundant System Information :

------------------------------

       Available system uptime = 6 weeks, 1 day, 4 hours, 8 minutes

Switchovers system experienced = 1

              Standby failures = 0

        Last switchover reason = user forced

                 Hardware Mode = Duplex

    Configured Redundancy Mode = sso

     Operating Redundancy Mode = sso

              Maintenance Mode = Disabled

                Communications = Up

Current Processor Information :

-------------------------------

               Active Location = slot 2
        Current Software state = ACTIVE
       Uptime in current state = 6 minutes
                 Image Version = Cisco IOS Software [Cupertino], C9800-CL Software (C9800-
CL-K9_IOSXE), Version 17.9.1eft15, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Fri 24-Jun-22 20:01 by mcpre
                          BOOT = bootflash:packages.conf,12;
                   CONFIG_FILE =
        Configuration register = 0x2102
               Recovery mode   = Not Applicable
             Fast Switchover   = Enabled
                Initial Garp   = Enabled
Peer Processor Information :
----------------------------
              Standby Location = slot 1
        Current Software state = STANDBY HOT
       Uptime in current state = 2 minutes
                 Image Version = Cisco IOS Software [Cupertino], C9800-CL Software (C9800-
CL-K9_IOSXE), Version 17.9.1eft15, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Fri 24-Jun-22 20:01 by mcpre
                          BOOT = bootflash:packages.conf,12;
                   CONFIG_FILE =
        Configuration register = 0x2102
9800-17.9.1#show cts pacs
AID: AF8B97E848CC486737DFC8124B7F00AD
PAC-Info:
    PAC-type = Cisco Trustsec
    AID: AF8B97E848CC486737DFC8124B7F00AD
    I-ID: 9800-CL
    A-ID-Info: Identity Services Engine
    Credential Lifetime: 14:45:28 British Nov 16 2022
PAC-Opaque:
000200B00003000100040010AF8B97E848CC486737DFC8124B7F00AD000600940003010030E530662F9D5B3B8601
E4CE0EF219B40000001362F529BE00093A80CF372B658E9FFDE1540B6AD39FC684DCB55BF26962FEF47528023372
B48DAEE2F58430FE7279B66DE8227C9D4C9BC584CDB33C49661B4FF836F8A0CF28AA68B61B894FCF409A47441F5D
CAC97EECC332BF6D53EDCC71A6D12662E4A79865ED2B1E917FE3E3D46A5D0B1194DC8329425EB595B2EF
Refresh timer is set for 12w4d
9800-17.9.1#show cts environment-data
CTS Environment Data
====================
Current state = COMPLETE
Last status = Successful
Service Info Table:
Local Device SGT:
  SGT tag = 2-01:TrustSec_Devices
Server List Info:
Installed list: CTSServerList1-0001, 1 server(s):
 Server: 10.1.101.30, port 1812, A-ID AF8B97E848CC486737DFC8124B7F00AD
          Status = ALIVE
          auto-test = FALSE, keywrap-enable = FALSE, idle-time = 60 mins, deadtime = 20 secs
Security Group Name Table:
    0-00:Unknown
    2-00:TrustSec_Devices
    3-01:Network_Services
    4-01:Employees
    5-02:Contractors
    6-01:Guests
    7-01:Production_Users
    8-01:Developers
    9-02:Auditors
    10-01:Point_of_Sale_Systems
    11-10:Production_Servers
    12-03:Development_Servers
    13-00:Test_Servers
    14-01:PCI_Servers
    15-02:BYOD
    16-00:Intranet
    17-00:Extranet
    18-02:HVAC
    19-02:Lighting
    20-02:Water_Control
    21-00:Entertainment_Systems
    22-01:CC_TV
    23-02:Bldg_Acc_Ctrl
    24-00:Intruder_Detection
    25-02:Energy_Control
    27-02:IP_Phones
    28-09:Cameras
    29-01:Access_Points
    30-00:High_Trust_CT_Scanners
    31-00:Low_Trust_CT_Scanners
    32-01:Wireless_Clients
    33-00:EFT_SGT1
    34-39:Doctors
    35-01:Storage
    36-08:Scanners
    37-00:Nurses
    255-00:Quarantined_Systems
    39-00:PLC_Siemens
    40-00:WLCs
Environment Data Lifetime = 86400 secs
Last update time = 14:45:41 British Thu Aug 18 2022
Env-data expires in   0:23:57:46 (dd:hr:mm:sec)
Env-data refreshes in 0:23:57:46 (dd:hr:mm:sec)
Cache data applied           = NONE
State Machine is running
Retry_timer (60 secs) is not running
9800-17.9.1#
9800-17.9.1#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
IP Address              SGT     Source
============================================
1.1.1.8                 2       SXP
10.1.200.1              2       SXP
10.1.210.1              2       SXP
10.1.210.10             2       INTERNAL
10.1.210.100            34      LOCAL
10.1.211.1              2       SXP
10.1.211.10             2       INTERNAL
10.3.23.2               2       SXP
10.4.25.2               2       SXP
10.6.50.100             28      SXP
10.6.50.254             2       SXP
IP-SGT Active Bindings Summary
============================================
Total number of SXP      bindings = 8
Total number of LOCAL    bindings = 1
Total number of INTERNAL bindings = 2
Total number of active   bindings = 11

Active IPv6-SGT Bindings Information
IP Address                                  SGT     Source
================================================================
9800-17.9.1#
```

```
9800-17.9.1#show cts rbacl
CTS RBACL Policy
================
RBACL IP Version Supported: IPv4 & IPv6
  name   = Deny_IP_Log-00
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip log
  name   = Deny IP-00
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip
  name   = Permit IP-00
  IP protocol version = IPV4, IPV6
  refcnt = 6
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    permit ip
  name   = DenyIPlog-01
  IP protocol version = IPV4, IPV6
  refcnt = 2
  flag   = 0xC1000000
  stale  = FALSE
  RBACL ACEs:
    deny ip log
9800-17.9.1#show cts role-based permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group 15:BYOD to group 28:Cameras:
        Permit IP-00
IPv4 Role-based permissions from group 31:Low_Trust_CT_Scanners to group 28:Cameras:
        Permit IP-00
IPv4 Role-based permissions from group 33:EFT_SGT1 to group 28:Cameras:
        Deny_IP_Log-00
IPv4 Role-based permissions from group 34:Doctors to group 28:Cameras:
        Permit IP-00
IPv4 Role-based permissions from group 11:Production_Servers to group 34:Doctors:
        Deny IP-00
IPv4 Role-based permissions from group 33:EFT_SGT1 to group 34:Doctors:
        DenyIPlog-01
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

The conclusion is that HA operation works successfully in a GBP environment. Take note of the following DDTS entry for HA operation: CSCwc78021 9800: Standby controller crash @ fman_acl_remove_default_ace

This is fixed in release 17.10.1

Foreign – Anchor Operation with SGTs

Setup and SGT Assignment in Anchor Scenario

Foreign - Anchor is a commonly used design when customers want to segment the wireless traffic in a secure and easy way from multiple distributed locations (where the Foreign WLCs would reside) to a centralized one (where the Anchor would be placed), typically the DMZ of the Internet edge network. A typical use case would be for guest traffic to be tunneled directly to the DMZ to have a direct access to Internet, in one location that you can easily control, for example filtering or rate limiting. Same is true for IoT traffic that needs to be segmented and tunnel to a centralized location where the IoT servers reside.

This section describes how GBP works in a Foreign-Anchor deployment and will consider four scenarios: Dynamically assigning SGTs to wireless clients and propagating the SGT info from Anchor, East West and North to South policy enforcement at the Anchor.

To understand how policy works in a Foreign – Anchor scenario, there is a simple rule to keep in mind: anything related to client Layer 2 security happens at the foreign, anything related to Layer 3 security and IP happens at the Anchor.

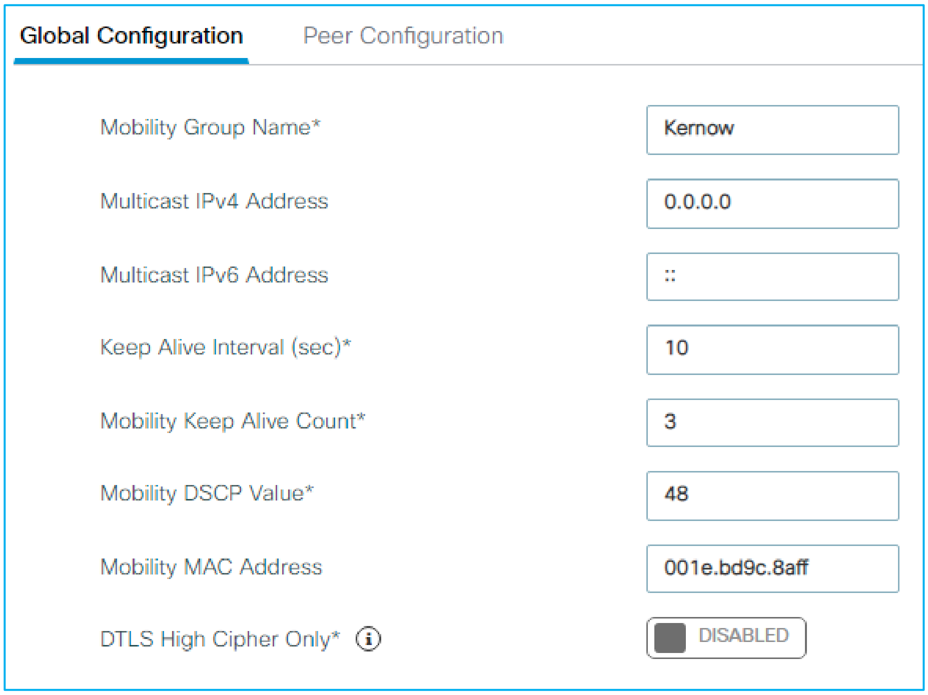
For example, if the SSID is configured with 802.1x security, the Foreign is responsible to talk to ISE to authenticate the user, the Anchor is responsible to bridge the client traffic to the mapped VLAN and handle DHCP and any client traffic.

Before starting to configure the GBP settings, you need to configure the two WLCs to assume the role of Foreign and Anchor. Foreign is the C9800 that has APs connected to it, the Anchor will be the C9800 in the centralized location and usually doesn't have any APs joined.

Here you can find a detailed step by step configuration guide on how to configure Foreign Anchor: https://www.cisco.com/c/en/us/support/docs/wireless/catalyst-9800-series-wireless-WLCs/213912-configure-mobility-anchor-on-catalyst-98.html

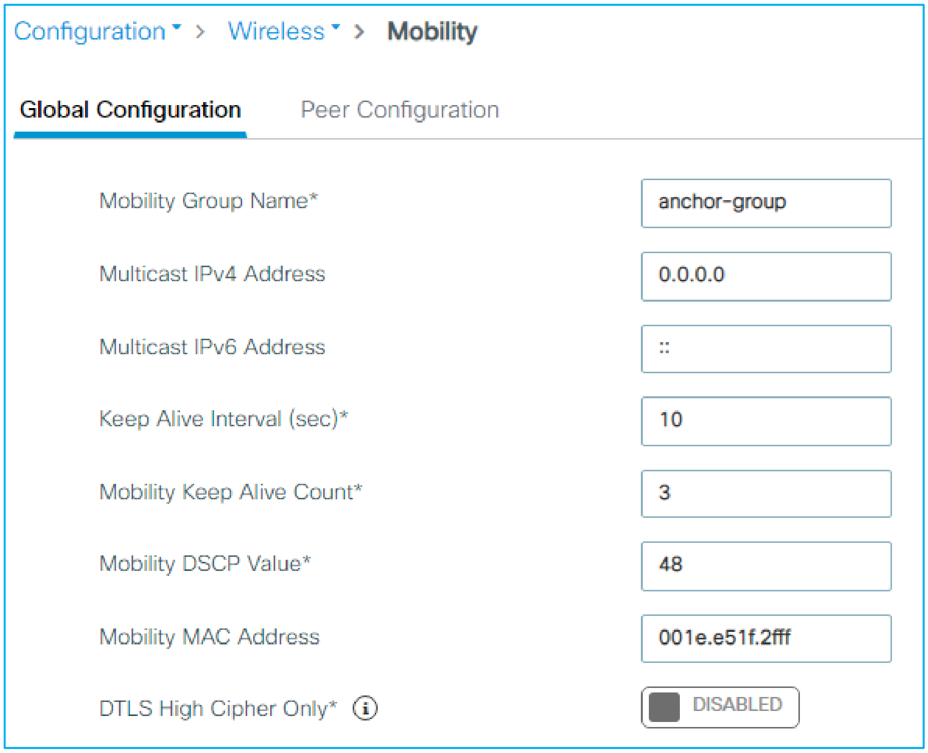
Let's see the most important steps, starting with building the tunnel between the two C9800s.

On the C9800 that you want to configure as Foreign go to Configuration > Wireless > Mobility and set the Mobility Group name (Kernow in this case) and record the Mobility MAC as you will have to use it later.



Mobility Group Name*	Kernow
Multicast IPv4 Address	0.0.0.0
Multicast IPv6 Address	::
Keep Alive Interval (sec)*	10
Mobility Keep Alive Count*	3
Mobility DSCP Value*	48
Mobility MAC Address	001e.bd9c.8aff
DTLS High Cipher Only* ⓘ	DISABLED

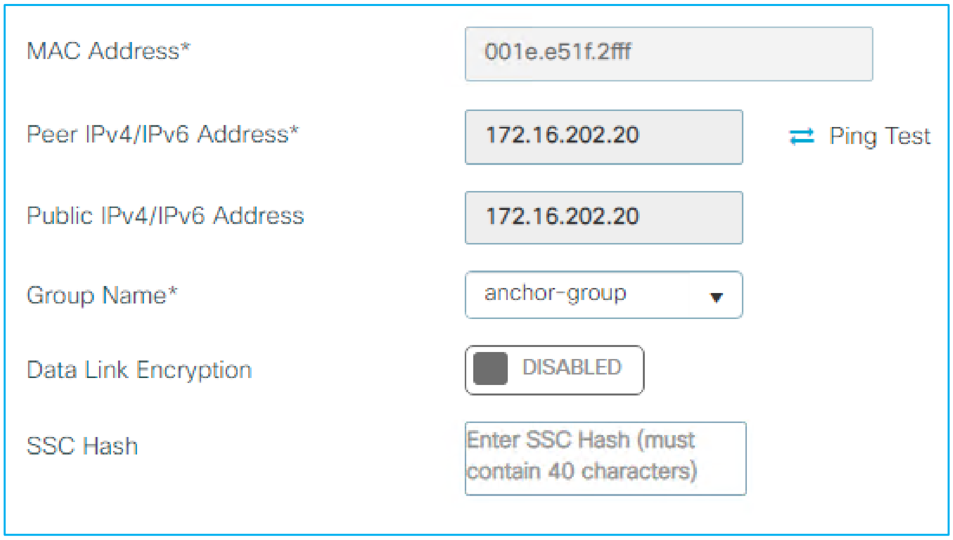
Do the same thing on the Anchor C9800 as shown in the picture below:



Mobility Group Name*	anchor-group
Multicast IPv4 Address	0.0.0.0
Multicast IPv6 Address	::
Keep Alive Interval (sec)*	10
Mobility Keep Alive Count*	3
Mobility DSCP Value*	48
Mobility MAC Address	001e.e51f.2fff
DTLS High Cipher Only* ⓘ	DISABLED

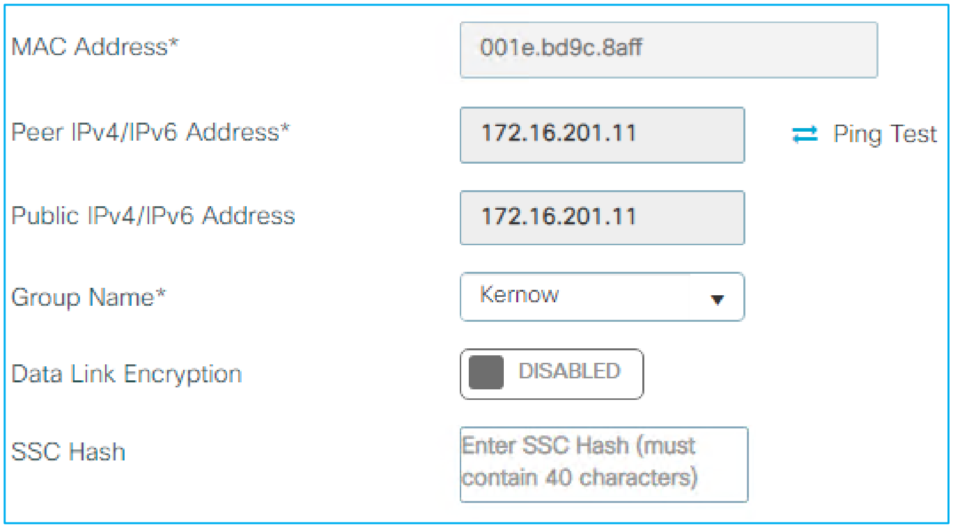
It's a good practice to configure two different mobility group names on Foreign and Anchor, unless you have clients roaming between the two controller, which is usually not the case as the Anchor doesn't have any APs connected; if it does, they are not in the same location as the APs joined to the Foreign, so roaming will not happen between the two networks.

Next, you need to set the other C9800 as peer. On the Foreign, click on the "Peer Configuration" tab and then click on the +add icon. In the popup window enter the information about the anchor C9800: the Mobility MAC previously recorded, the IP address of the Wireless Management interface and then type the mobility group name of the anchor.



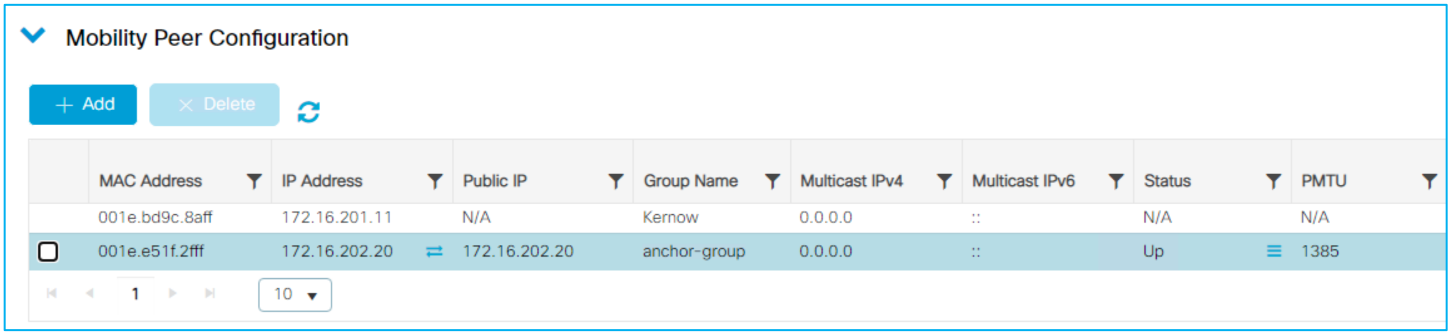
MAC Address*	001e.e51f.2fff
Peer IPv4/IPv6 Address*	172.16.202.20 ⇄ Ping Test
Public IPv4/IPv6 Address	172.16.202.20
Group Name*	anchor-group ▾
Data Link Encryption	DISABLED
SSC Hash	Enter SSC Hash (must contain 40 characters)

Data link encryption is optional and would be required to DTLS encrypt the client traffic between Foreign and Anchor. Repeat the same procedure on the Anchor entering the data related to the remote peer:



MAC Address*	001e.bd9c.8aff
Peer IPv4/IPv6 Address*	172.16.201.11 ⇄ Ping Test
Public IPv4/IPv6 Address	172.16.201.11
Group Name*	Kernow ▾
Data Link Encryption	DISABLED
SSC Hash	Enter SSC Hash (must contain 40 characters)

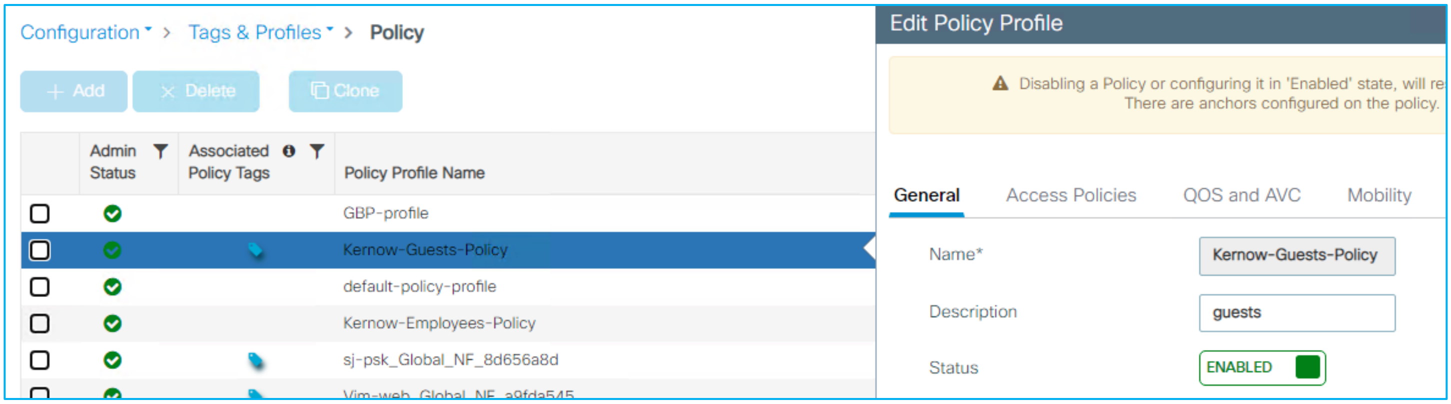
Once this is done, after few seconds, you will see that the CAPWAP tunnel comes up as you can see form the status in the picture below on Foreign:



Mobility Peer Configuration

	MAC Address	IP Address	Public IP	Group Name	Multicast IPv4	Multicast IPv6	Status	PMTU
	001e.bd9c.8aff	172.16.201.11	N/A	Kernow	0.0.0.0	::	N/A	N/A
□	001e.e51f.2fff	172.16.202.20 ⇄	172.16.202.20	anchor-group	0.0.0.0	::	Up	1385

Next step is to configure an SSID to be anchored, so all the traffic from clients connected to that SSID will be automatically tunneled at the Foreign to the Anchor where it would enter the wired network. On the Foreign, no changes are made on the WLAN, you just need to change the associated policy profile. Go to Configuration > Tags & Profiles > Policy, select the Policy profile, Kernow-Guests-Policy in this case:



Configuration > Tags & Profiles > Policy

+ Add | × Delete | Clone

	Admin Status	Associated Policy Tags	Policy Profile Name
□	✓		GBP-profile
□	✓	●	Kernow-Guests-Policy
□	✓		default-policy-profile
□	✓		Kernow-Employees-Policy
□	✓	●	sj-psk_Global_NF_8d656a8d
□	✓	●	Vim-web_Global_NF_a9fda545

Edit Policy Profile

Disabling a Policy or configuring it in 'Enabled' state, will re
There are anchors configured on the policy.

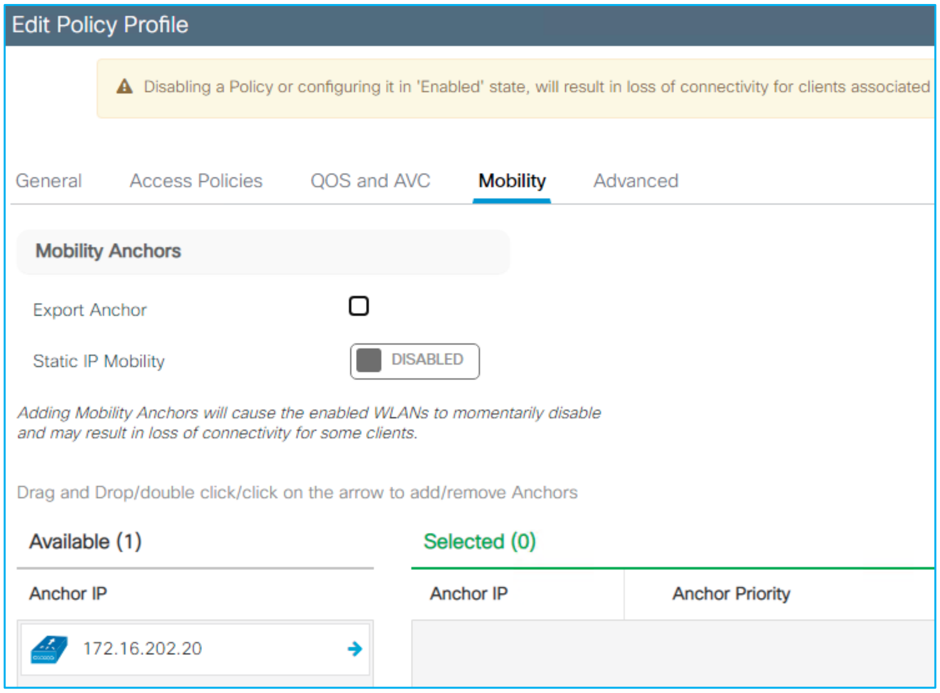
General | Access Policies | QOS and AVC | Mobility

Name*: Kernow-Guests-Policy

Description: guests

Status: ENABLED

Then click on the Mobility tag and click the blue arrow to select the available Anchor IP:



Edit Policy Profile

Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated

General | Access Policies | QOS and AVC | Mobility | Advanced

Mobility Anchors

Export Anchor □

Static IP Mobility: DISABLED

Adding Mobility Anchors will cause the enabled WLANs to momentarily disable and may result in loss of connectivity for some clients.

Drag and Drop/double click/click on the arrow to add/remove Anchors

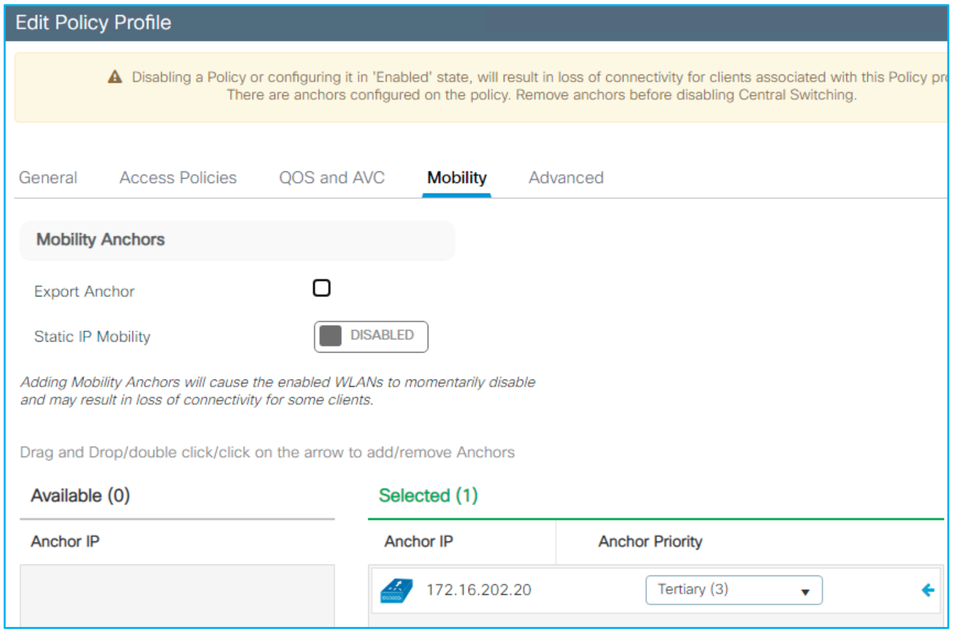
Available (1)

Anchor IP
172.16.202.20 →

Selected (0)

Anchor IP	Anchor Priority

This will select the Anchor C9800 and assign the priority. You can change the priority if you have multiple Anchors and you want a Primary/Secondary/Tertiary:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of connectivity for clients associated with this Policy pr
There are anchors configured on the policy. Remove anchors before disabling Central Switching.

Mobility Anchors

Export Anchor □

Static IP Mobility: DISABLED

Adding Mobility Anchors will cause the enabled WLANs to momentarily disable and may result in loss of connectivity for some clients.

Drag and Drop/double click/click on the arrow to add/remove Anchors

Available (0)

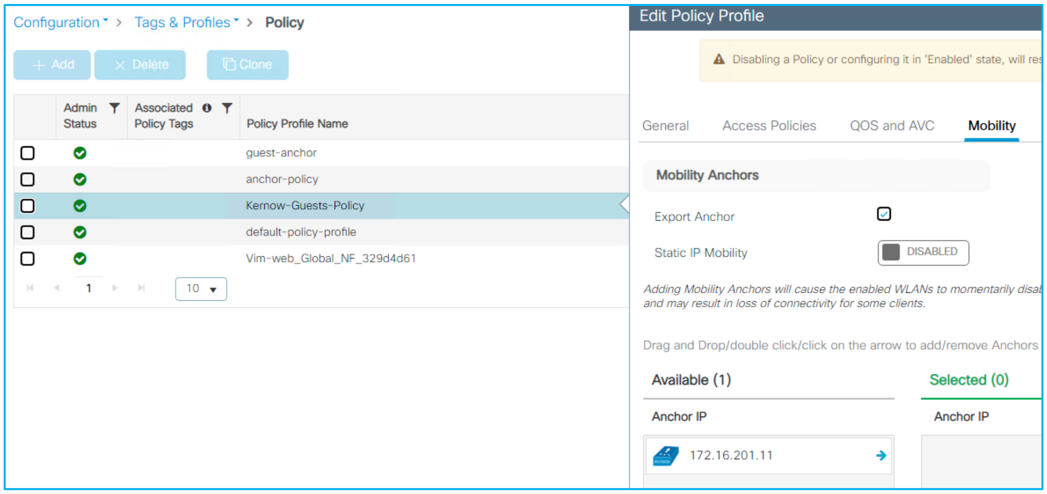
Anchor IP

Selected (1)

Anchor IP	Anchor Priority
172.16.202.20	Tertiary (3)

This is all you must do on the Foreign. On the Anchor, you need to create the WLAN and the policy profile as they are defined on the Foreign. Important: the name of the WLAN, the name of the policy profile need to match; also, the security settings under the WLAN and the DHCP settings in the policy profile, need to be identical.

Once you have created the WLAN and the Policy profile, you need to configure the C9800 as anchor for the selected SSID and hence policy profile. To do this, on the Anchor 9800, go to Configuration > Tags & Profiles > Policy, select the Policy profile, Kernow-Guests-Policy, same name and configuration as the one on the Foreign but the mobility configuration is different:



Configuration > Tags & Profiles > Policy

	Admin Status	Associated Policy Tags	Policy Profile Name
□	✓		guest-anchor
□	✓		anchor-policy
□	✓		Kernow-Guests-Policy
□	✓		default-policy-profile
□	✓		Vim-web_Global_NF_329d4d61

Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will res

Mobility Anchors

Export Anchor ☑

Static IP Mobility: DISABLED

Adding Mobility Anchors will cause the enabled WLANs to momentarily disal and may result in loss of connectivity for some clients.

Drag and Drop/double click/click on the arrow to add/remove Anchors

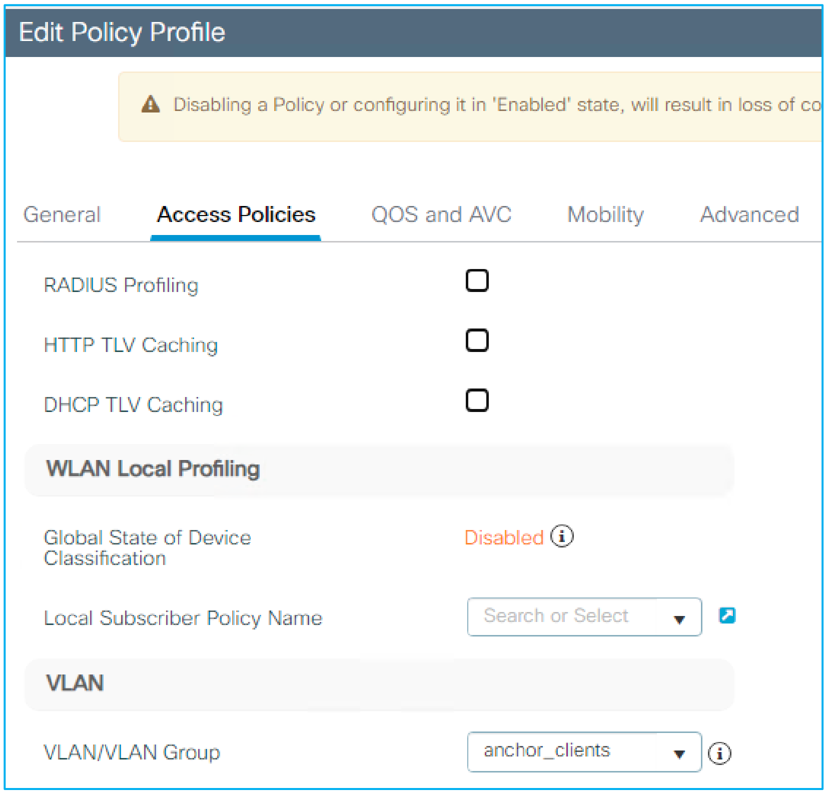
Available (1)

Anchor IP
172.16.201.11

Selected (0)

Anchor IP

As you can see, in this case, you only must check the Export Anchor checkmark. Do not select the anchor IP as it was done on Foreign, as this is the C9800 that must terminate the traffic. It's important to define the VLAN that the anchored clients will be bridged to, and you do this under the policy profile again:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in loss of co

RADIUS Profiling □

HTTP TLV Caching □

DHCP TLV Caching □

WLAN Local Profiling

Global State of Device Classification: Disabled ⓘ

Local Subscriber Policy Name: Search or Select ▾

VLAN

VLAN/VLAN Group: anchor_clients ▾ ⓘ

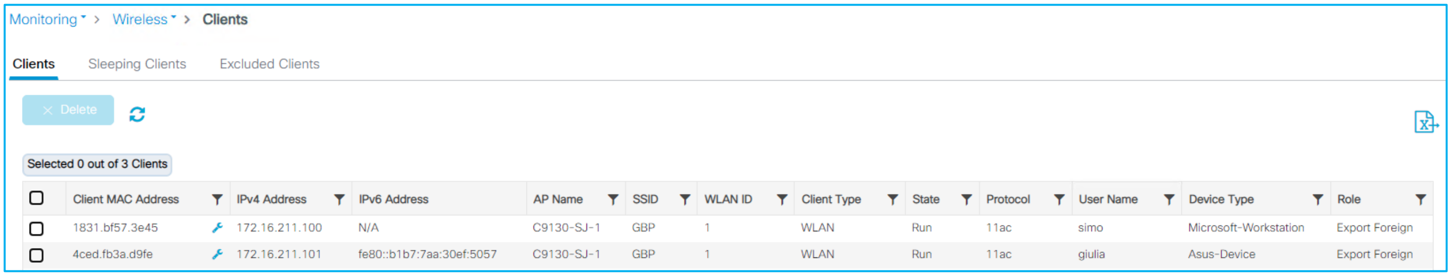
The vlan name anchor_clients is mapped to VLAN 211 in this Lab, but the important thing to remember is that this VLAN has nothing to do with the VLAN you have mapped on the same policy profile on the Foreign. As a matter of fact, the VLAN on the Foreign really doesn't matter as the traffic is tunneled and not bridged locally.

Now, you are ready to configure the policy section, let's consider three different scenarios.

Dynamic SGT assignment in Anchor Scenario.

As stated earlier, L2 client authentication and authorization happens on Foreign, so for dynamic SGT propagation, you don't need to configure anything AAA related in the Anchor. When the client joins the 802.1x SSID, the Foreign acts as Network Access Server (NAS) and retrieves the SGT information from ISE.

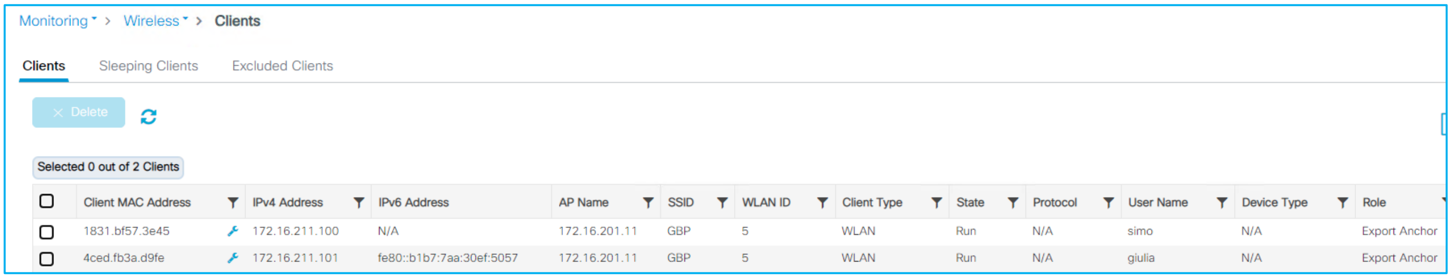
The Foreign then forwards this information to the Anchor together with the WLAN and Profile name, so the Anchor knows how to treat this client. The Anchor will bridge the traffic in VLAN anchor_clients (211) and clients will be receiving an IP address from subnet 172.16.211.0/24 as you can see in the screen shot on Foreign going to Monitoring > Wireless > Clients:



Selected 0 out of 3 Clients

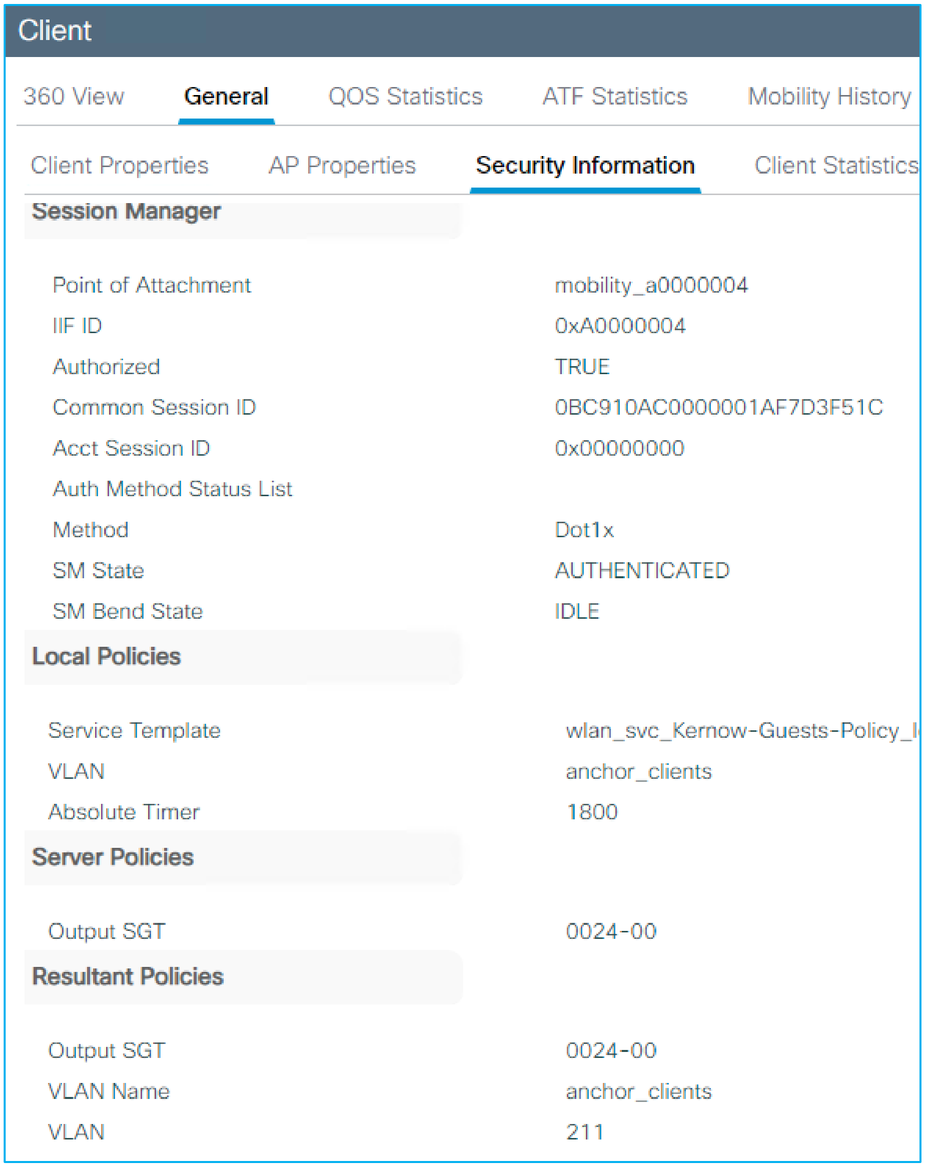
□	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	1831.bf57.3e45	172.16.211.100	N/A	C9130-SJ-1	GBP	1	WLAN	Run	11ac	simo	Microsoft-Workstation	Export Foreign
□	4ced.fb3a.d9fe	172.16.211.101	fe80::b1b7:7aa:30ef:5057	C9130-SJ-1	GBP	1	WLAN	Run	11ac	giulia	Asus-Device	Export Foreign

And on Anchor:



□	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	1831.bf57.3e45	172.16.211.100	N/A	172.16.201.11	GBP	5	WLAN	Run	N/A	simo	N/A	Export Anchor
□	4ced.fb3a.d9fe	172.16.211.101	fe80::b1b7:7aa:30ef:5057	172.16.201.11	GBP	5	WLAN	Run	N/A	giulia	N/A	Export Anchor

The only difference is the client role: in the Foreign it says Export Foreign and in Anchor is Export Anchor. If you click on client “giulia” (the Nurse), you will see under General > Security information that the SGT information is present on the Anchor (SGT is 0024 in hexadecimal, which is SGT = 36)



Session Manager

Point of Attachment	mobility_a0000004
IIF ID	0xA0000004
Authorized	TRUE
Common Session ID	0BC910AC0000001AF7D3F51C
Acct Session ID	0x00000000
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE

Local Policies

Service Template	wlan_svc_Kernow-Guests-Policy_l
VLAN	anchor_clients
Absolute Timer	1800

Server Policies

Output SGT	0024-00

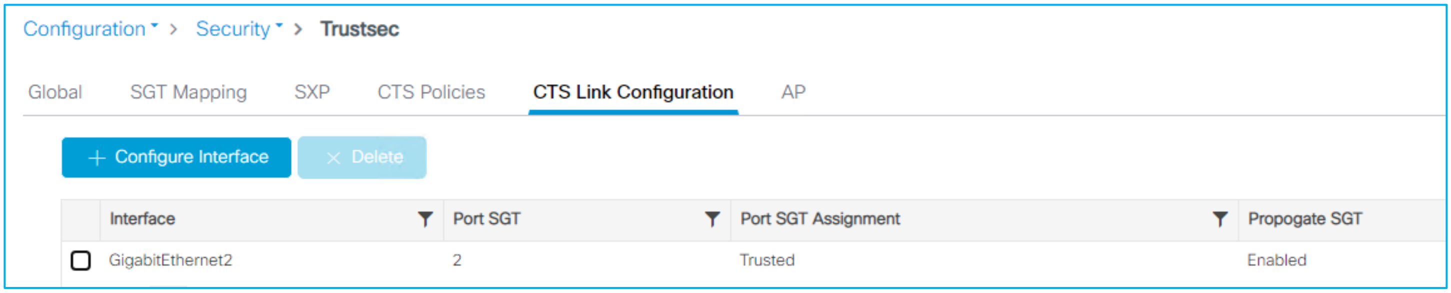
Resultant Policies

Output SGT	0024-00
VLAN Name	anchor_clients
VLAN	211

SGT propagation in Anchor scenario

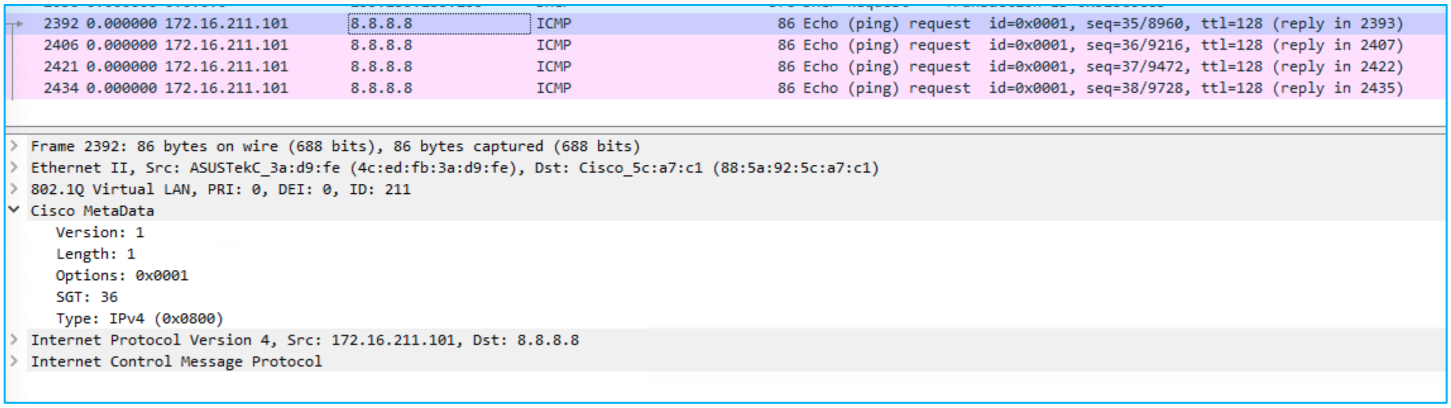
SGT propagation works in the same way as for the standalone controller, the only thing you need to remember is that in this case, you must configure either inline tagging or SXP at the Anchor and not at the Foreign as it’s the Anchor responsible for forwarding traffic to the wired network.

The configuration is the same as seen previously in this document. For inline tagging, we need to configure “cts manual” on the uplink interface. In this case, since it’s a C9800-CL, Gigabit Ethernet 2 is the uplink port to the wired network. As soon as you configure the inline tagging as per picture below:



	Interface	Port SGT	Port SGT Assignment	Propogate SGT
□	GigabitEthernet2	2	Trusted	Enabled

The C9800 starts adding the CMD header in the frames it sends out from wireless client to the wired network. Here is a capture of ping traffic from wireless client to 8.8.8.8. See the Cisco Meta Data (CMD) section the and the SGT info:



```
2392 0.000000 172.16.211.101   8.8.8.8     ICMP     86 Echo (ping) request  id=0x0001, seq=35/8960, ttl=128 (reply in 2393)
2406 0.000000 172.16.211.101   8.8.8.8     ICMP     86 Echo (ping) request  id=0x0001, seq=36/9216, ttl=128 (reply in 2407)
2421 0.000000 172.16.211.101   8.8.8.8     ICMP     86 Echo (ping) request  id=0x0001, seq=37/9472, ttl=128 (reply in 2422)
2434 0.000000 172.16.211.101   8.8.8.8     ICMP     86 Echo (ping) request  id=0x0001, seq=38/9728, ttl=128 (reply in 2435)

> Frame 2392: 86 bytes on wire (688 bits), 86 bytes captured (688 bits)
> Ethernet II, Src: ASUSTekC_3a:d9:fe (4c:ed:fb:3a:d9:fe), Dst: Cisco_5c:a7:c1 (88:5a:92:5c:a7:c1)
> 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 211
˅ Cisco MetaData
    Version: 1
    Length: 1
    Options: 0x0001
    SGT: 36
    Type: IPv4 (0x0800)
> Internet Protocol Version 4, Src: 172.16.211.101, Dst: 8.8.8.8
> Internet Control Message Protocol
```

The other way to propagate the wireless client SGT and IP mapping would be to configure an SXP session to a remote switch. This works on the Anchor the same way it was configured on standalone controller we saw previously.

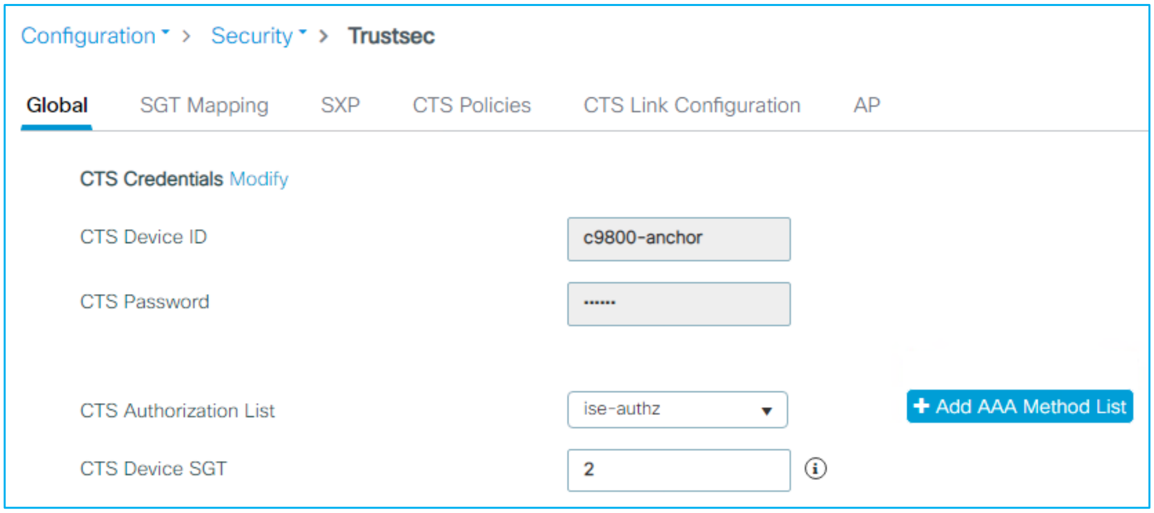
Policy enforcement for East West traffic in Anchor Scenario.

If you want to enforce a GBP, then you need to configure the Anchor controller to talk to ISE and download the environmental data and the policies associated to the anchor clients. The configuration on ISE is the same as seen previously for the standalone controller scenario. Similarly, the AAA configuration on the C9800 Anchor is the same as for the standalone controller, reported here for clarity:

```
!
aaa authentication dot1x ise-auth group my-ise
aaa authorization network default local
aaa authorization network ise-authz group my-ise
!
aaa server radius dynamic-author
 client 172.16.3.4 server-key XXXX
!
!
radius server ise
```

```
 address ipv4 172.16.3.4 auth-port 1812 acct-port 1813
 timeout 4
 retransmit 3
 pac key XXX
!
!
aaa group server radius my-ise
 server name ise
 ip radius source-interface Vlan202
!
aaa new-model
aaa session-id common
!
radius server ise
 address ipv4 172.16.3.4 auth-port 1812 acct-port 1813
 timeout 4
 retransmit 3
 pac key Vimlab123
```

To enable GBP, you need to configure the TrustSec parameters on C9800 Anchor under Configuration > Security > Trustsec > Global:



CTS Device ID: c9800-anchor

CTS Password: ••••••

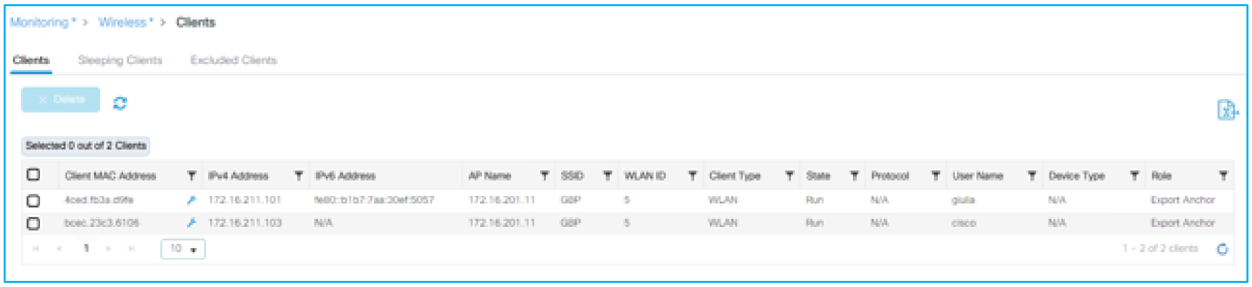
CTS Authorization List: ise-authz

CTS Device SGT: 2

This will trigger the additional two commands in the configurations:

```
cts authorization list ise-authz
cts sgt 2
```

Once this is done, you can test policy enforcement on the same SSID and policy profile between clients with different SGTs. In this case two clients are connected:

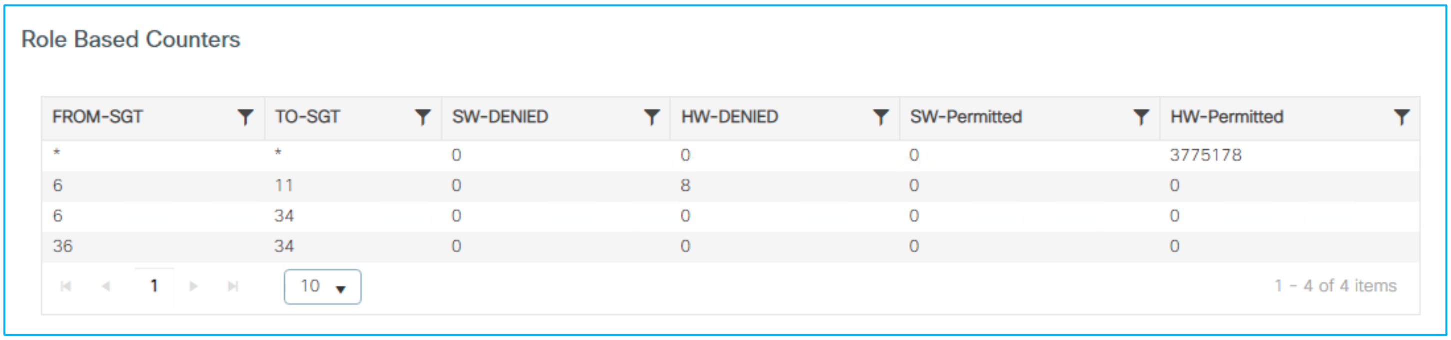


□	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	4ced.fb3a.d9fe	172.16.211.101	fe80::b1b7:7aa:30ef:5057	172.16.201.11	GBP	5	WLAN	Run	N/A	giulia	N/A	Export Anchor
□	bcec.23c3.6106	172.16.211.103	N/A	172.16.201.11	GBP	5	WLAN	Run	N/A	cisco	N/A	Export Anchor

Client with IP 172.16.211.103 is associated to group Doctors and got SGT = 34, the client with IP 172.16.211.100 got assigned SGT = 36. The moment the clients connect, C9800 Anchor downloads the policy from ISE, and you can see it on the box for example here:

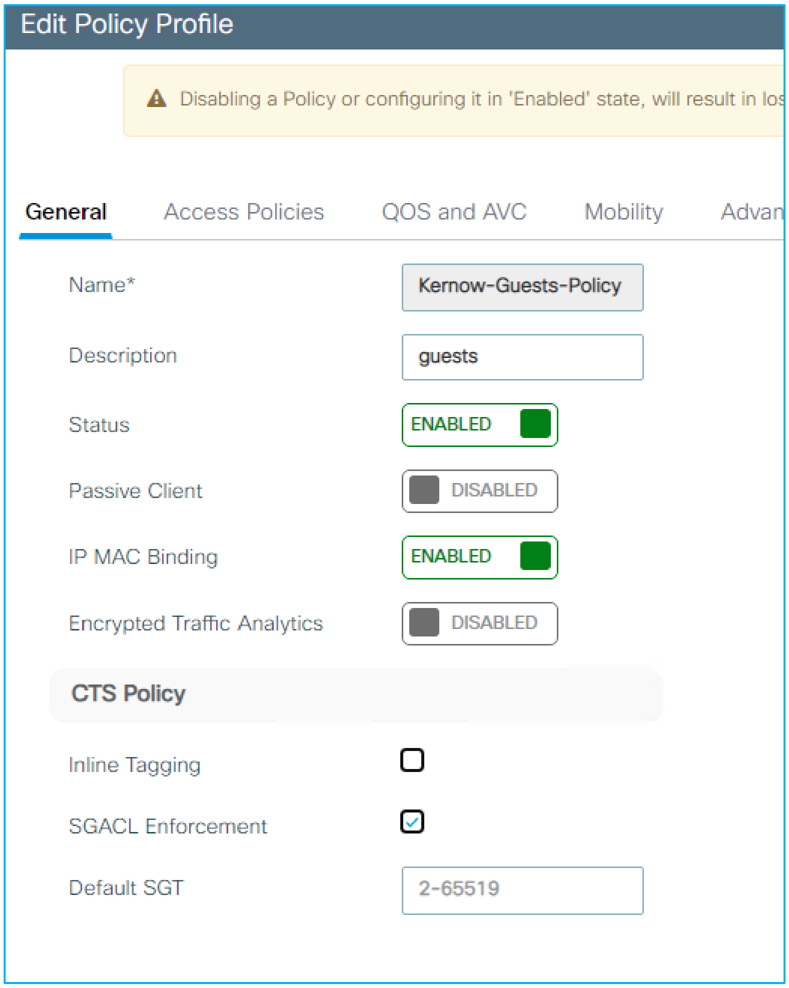
```
c9800-anchor#show cts role-based permissions
IPv4 Role-based permissions default:
        Permit IP-00
IPv4 Role-based permissions from group 6:Guests to group 34:Doctors:
        Deny IP-00
IPv4 Role-based permissions from group 36:Nurses to group 34:Doctors:
        Deny IP-00
```

Before starting the traffic, you see that the counters related to those SGTs are all zeros.


Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	3775178
6	11	0	8	0	0
6	34	0	0	0	0
36	34	0	0	0	0

For policy to be enforced on East West traffic (wireless to wireless) you need to enable SGACL Enforcement under CTS Policy on the Policy Profile:



Edit Policy Profile

⚠ Disabling a Policy or configuring it in 'Enabled' state, will result in los

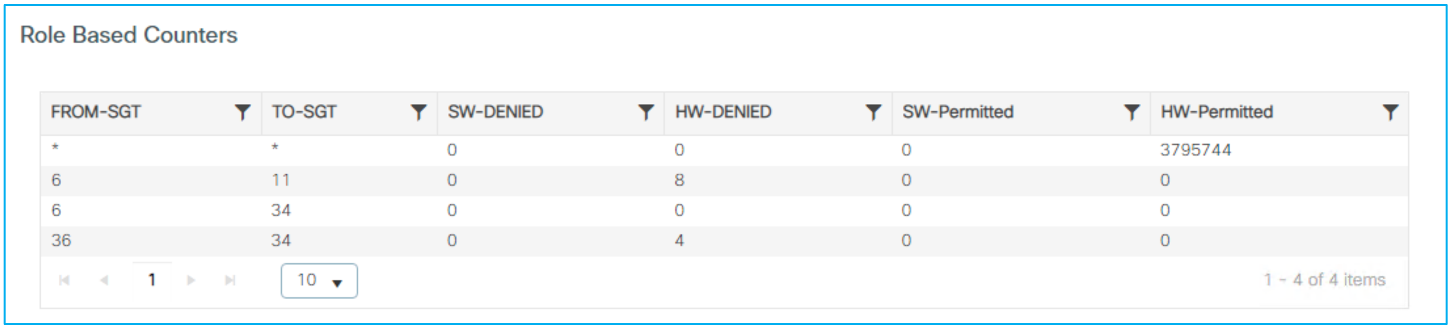
Name*	Kernow-Guests-Policy
Description	guests
Status	ENABLED 🟩
Passive Client	DISABLED
IP MAC Binding	ENABLED 🟩
Encrypted Traffic Analytics	DISABLED

CTS Policy

Inline Tagging	□
SGACL Enforcement	☑
Default SGT	2-65519

This only needs to be done on the Policy Profile on Anchor, not on Foreign.

Then you start a ping from a doctor device (SGT = 36) to a nurse device (SGT = 34) and the ping fails and the counters are increased, so enforcement is happening:

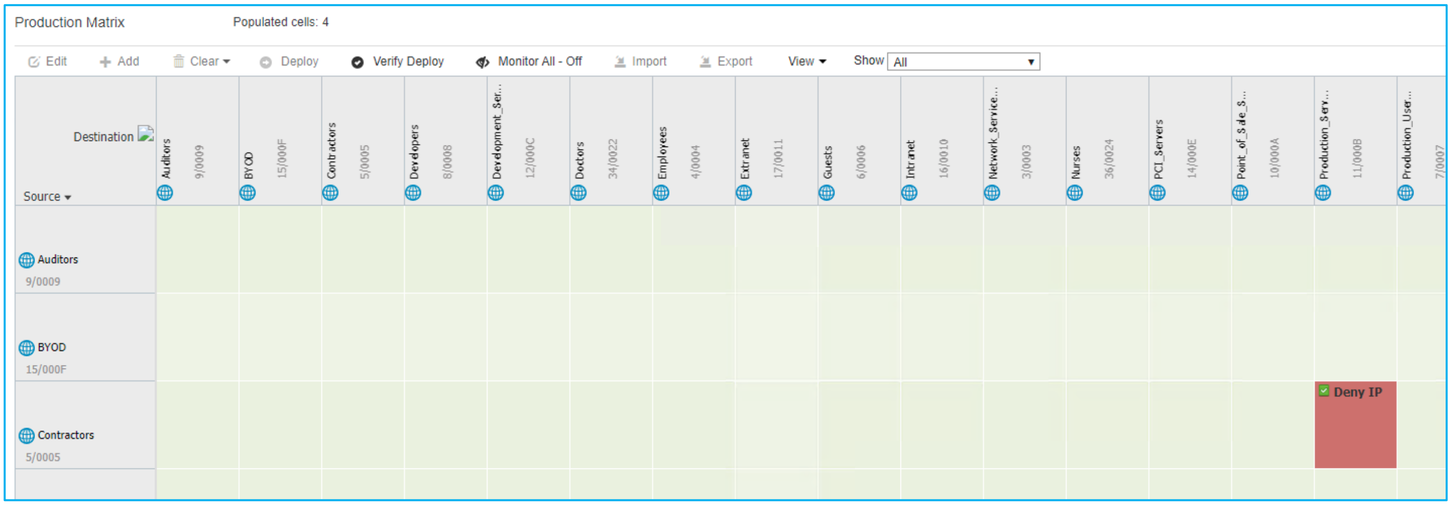


Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	3795744
6	11	0	8	0	0
6	34	0	0	0	0
36	34	0	4	0	0

Policy enforcement for North South traffic in Anchor Scenario.

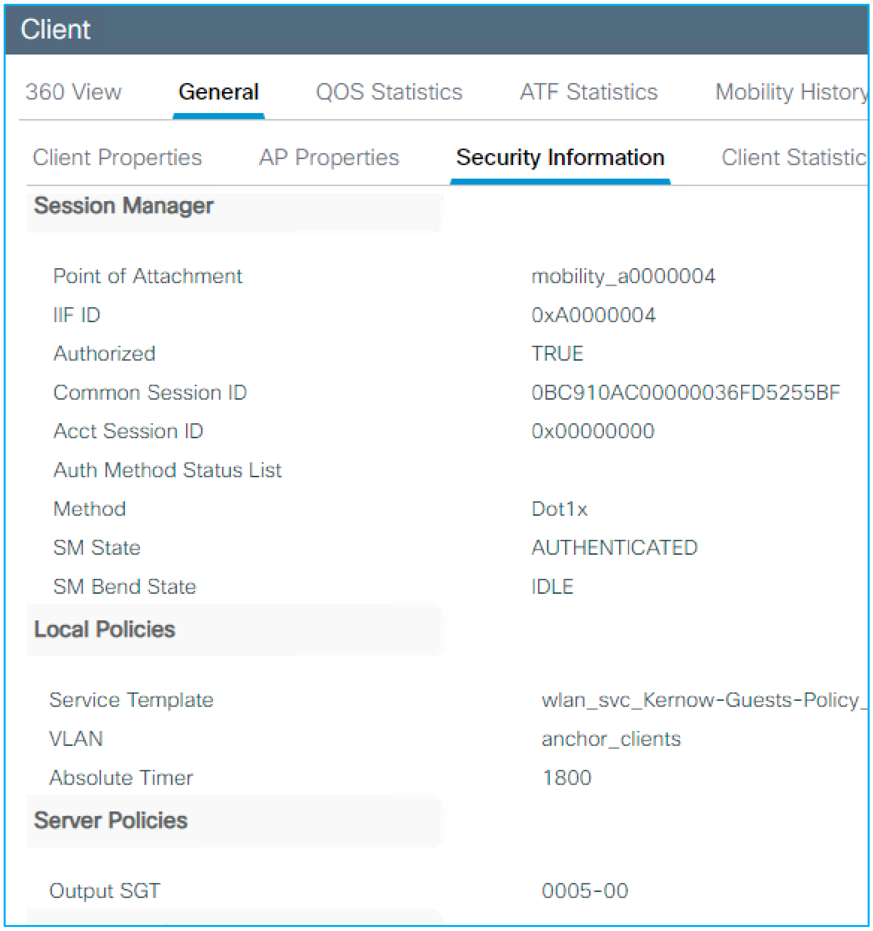
As described in earlier section, C9800 policy enforcement for traffic from wired to wireless (North-South) happens at the controller itself; this is different from AireOS where the enforcement was done on the AP. The Anchor scenario is not different, and the GBP for traffic coming from the wired network and destined to one of the registered clients, is blocked at the Anchor which is the first point of ingress into the wireless network. Let's consider a use case where you want to block contractor wireless users (SGT = 5) to communicate with the production server (SGT = 11 and IP address 172.16.3.4). You set a policy in ISE to deny such traffic:



Production Matrix Populated cells: 4

Destination Source	Auditors 9/0009	BYOD 15/000F	Contractors 5/0005	Developers 8/0008	Development_Ser... 12/000C	Doctors 34/0022	Employees 4/0004	Extranet 17/0011	Guests 6/0006	Intranet 16/0010	Network_Service... 3/0003	Nurses 36/0024	PCI_Servers 14/000E	Point_of_Sale_S... 10/000A	Production_Serv... 11/000B	Production_User... 7/0007
Auditors 9/0009																
BYOD 15/000F																
Contractors 5/0005															☑ Deny IP	

As soon as a wireless client from the Contractor group joins, it gets assigned SGT 5 and the related SGACL policy is downloaded to the C9800. You can get the SGT details from the Monitor > Client page:



Client

Session Manager

Point of Attachment	mobility_a0000004
IIF ID	0xA0000004
Authorized	TRUE
Common Session ID	0BC910AC00000036FD5255BF
Acct Session ID	0x00000000
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE

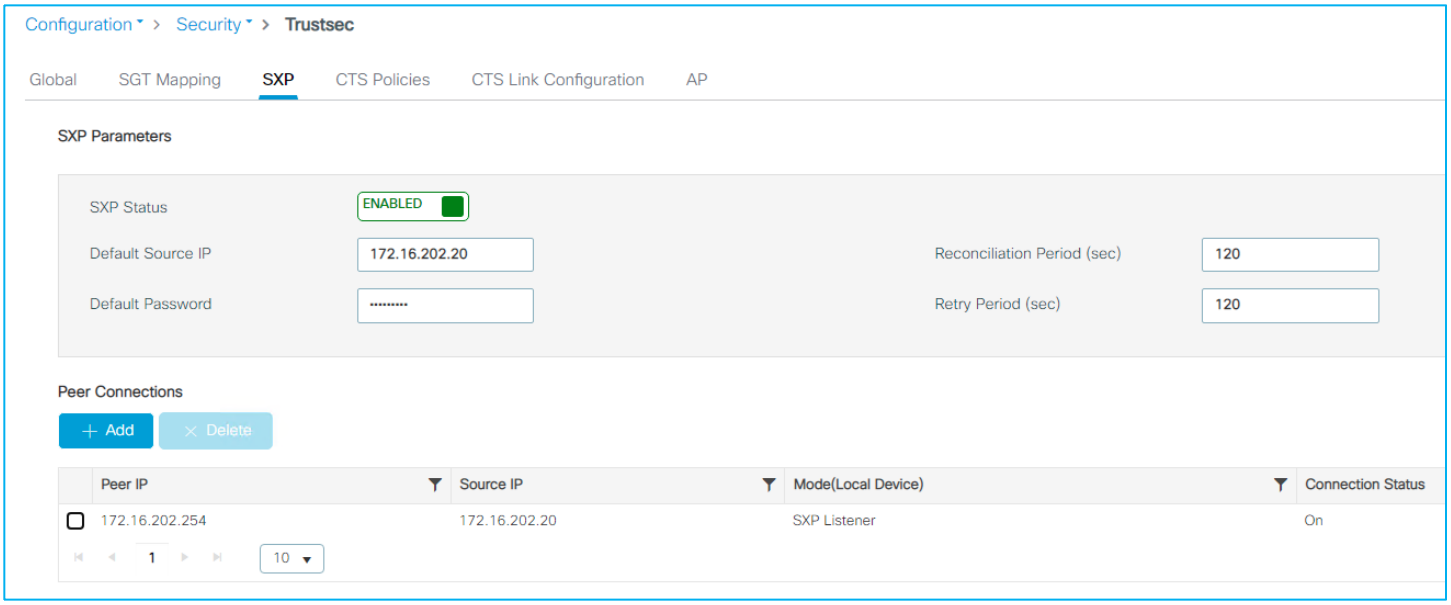
Local Policies

Service Template	wlan_svc_Kernow-Guests-Policy_
VLAN	anchor_clients
Absolute Timer	1800

Server Policies

Output SGT	0005-00

To block the traffic the C9800 needs to know the IP:SGT mapping for the production server (172.16.3.4); this can be learnt via inline tagging or via SXP. Let’s consider SXP for this example. As done in the standalone case, you setup a SXP connection with the switch where the Servers are connected. Go to Configuration > Security > TrustSec > SXP and setup the SXP peer and the C9800 Anchor as a Listener as it has to receive the mapping:



SXP Parameters

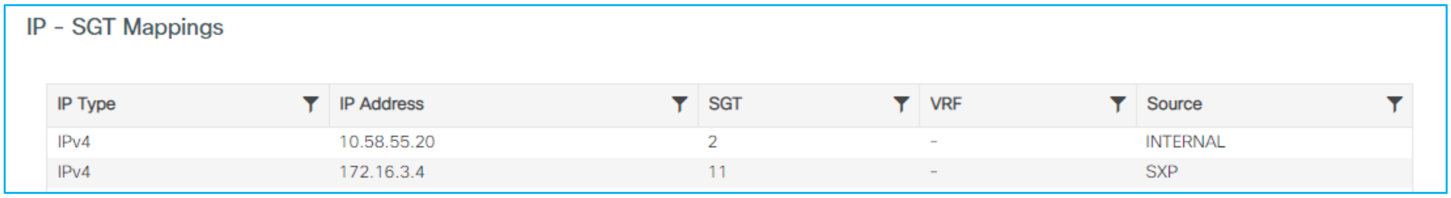
SXP Status	ENABLED		
Default Source IP	172.16.202.20	Reconciliation Period (sec)	120
Default Password	·········	Retry Period (sec)	120

Peer Connections

	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	172.16.202.254	172.16.202.20	SXP Listener	On

In the lab the switch is the default gateway, but in general the SXP peer could be multiple IP hops away.

Once the session is on, the C9800 will start learning the IP:SGT mappings as shown here:

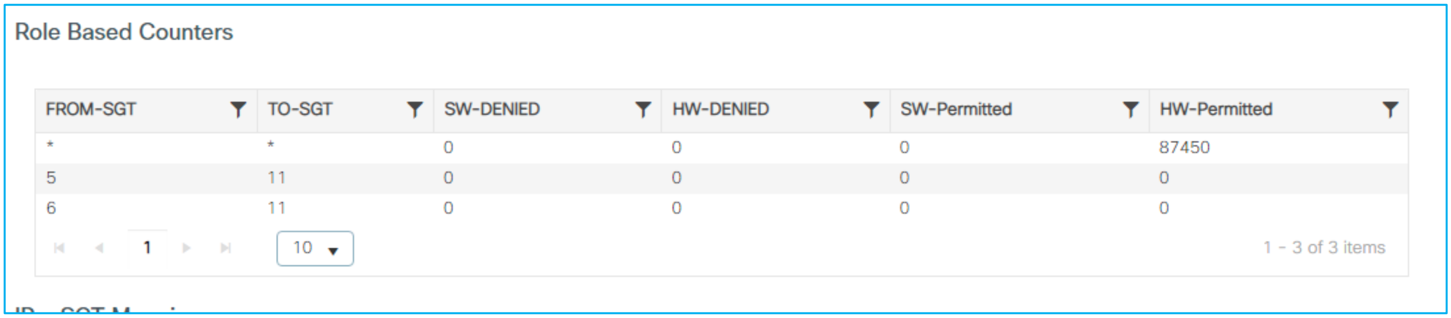


IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.58.55.20	2	-	INTERNAL
IPv4	172.16.3.4	11	-	SXP

As you notice the source is SXP.

Before sending any traffic, the role-based counters are all zero:

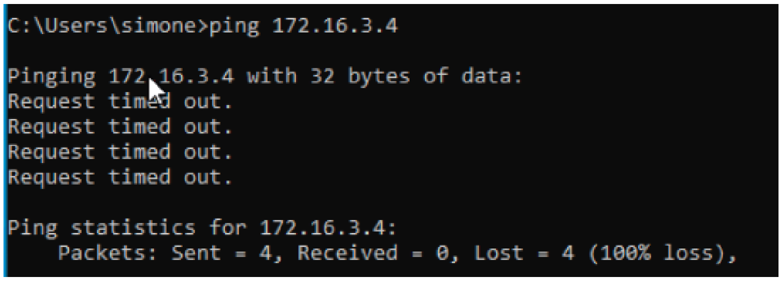


Role Based Counters

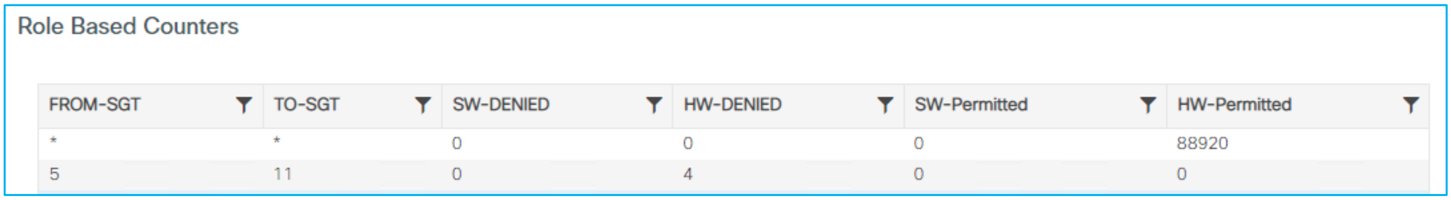
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	87450
5	11	0	0	0	0
6	11	0	0	0	0

1 - 3 of 3 items

Now start a ping from the server or from the client, you will see ping fail and the counters increasing.



```
C:\Users\simone>ping 172.16.3.4

Pinging 172.16.3.4 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 172.16.3.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	88920
5	11	0	4	0	0

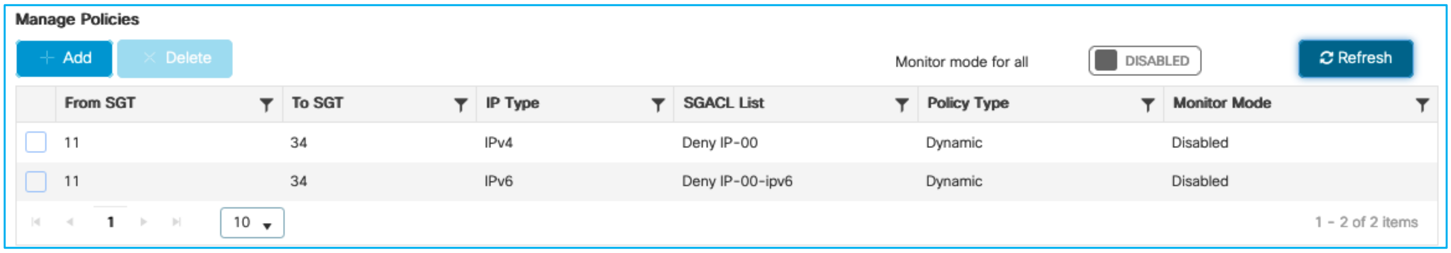
This confirms that the C9800 is blocking the traffic.

SGACL Logging

SGACL Logging on C9800 controller

SGACL logging occurs if the ‘log’ keyword is suffixed to any of the SGACE’s (entries) within an SGACL.

There’s an existing policy in ISE downloaded to the C9800:

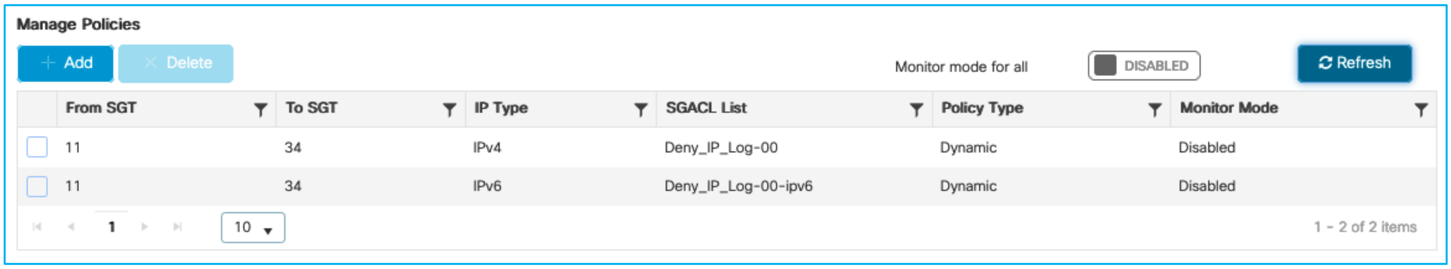


Manage Policies

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny IP-00	Dynamic	Disabled
□	11	34	IPv6	Deny IP-00-ipv6	Dynamic	Disabled

Change the assigned SGACL in ISE (Deny IP) to one with ‘Deny IP log’ and push the change to the C9800.

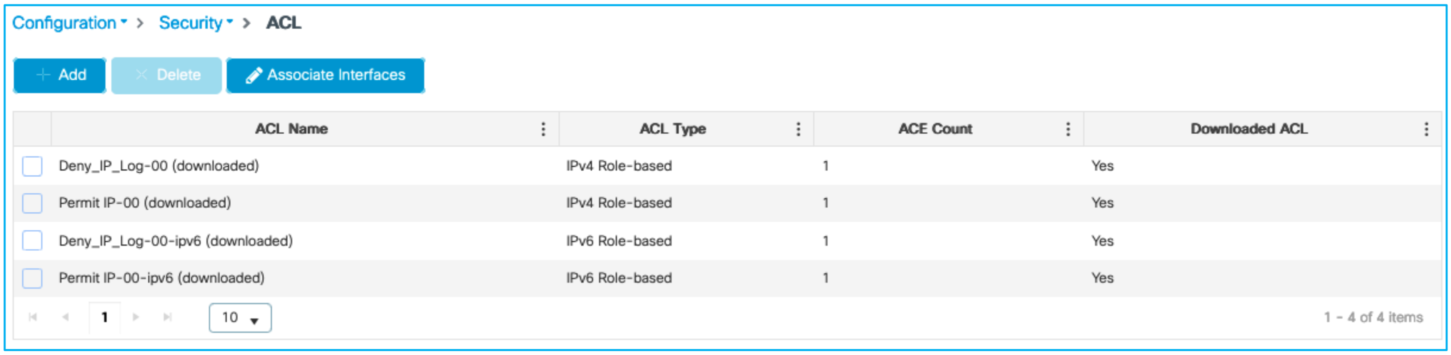
The C9800 is updated and the SGACL List is accurate:



Manage Policies

	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	34	IPv4	Deny_IP_Log-00	Dynamic	Disabled
□	11	34	IPv6	Deny_IP_Log-00-ipv6	Dynamic	Disabled

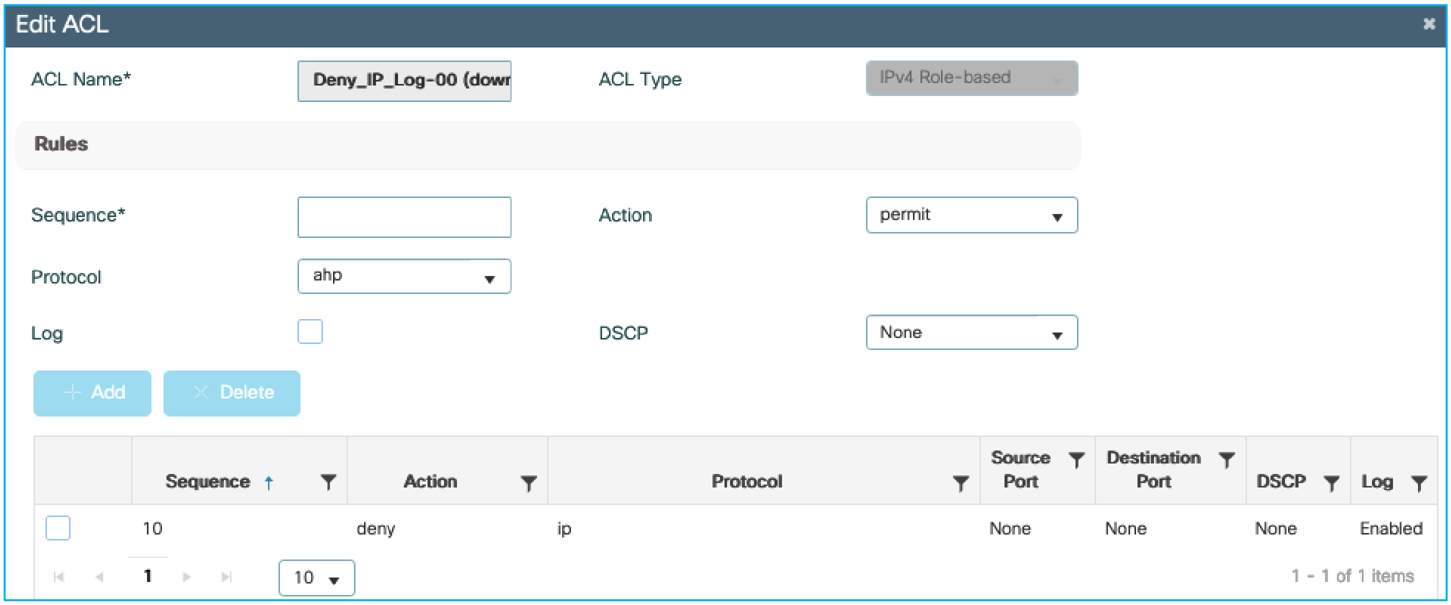
Navigate to Configuration > Security > AAA to see the downloaded SGACLs:



Configuration > Security > ACL

	ACL Name	ACL Type	ACE Count	Downloaded ACL
□	Deny_IP_Log-00 (downloaded)	IPv4 Role-based	1	Yes
□	Permit IP-00 (downloaded)	IPv4 Role-based	1	Yes
□	Deny_IP_Log-00-ipv6 (downloaded)	IPv6 Role-based	1	Yes
□	Permit IP-00-ipv6 (downloaded)	IPv6 Role-based	1	Yes

Click on the Deny_IP_Log entry to see the details, Log is Enabled:



Edit ACL

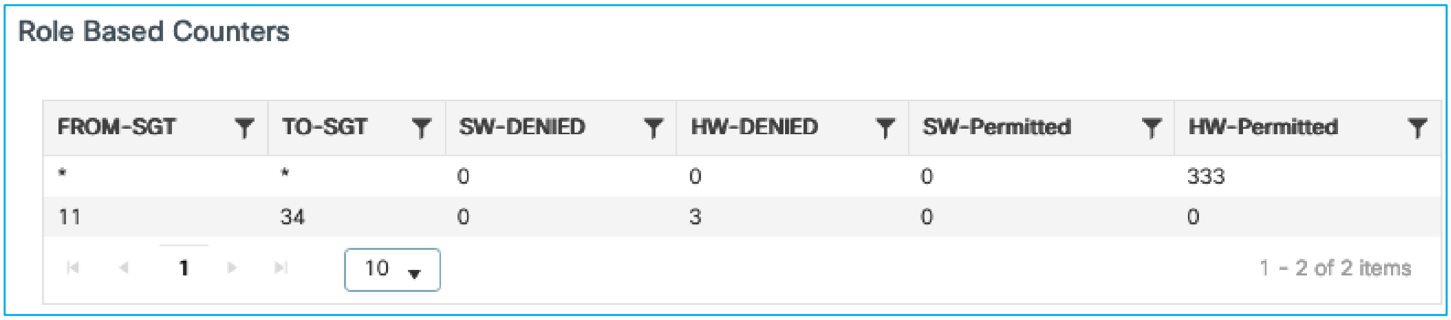
ACL Name*	Deny_IP_Log-00 (dowr	ACL Type	IPv4 Role-based

Rules

Sequence*		Action	permit
Protocol	ahp		
Log	□	DSCP	None

	Sequence	Action	Protocol	Source Port	Destination Port	DSCP	Log
□	10	deny	ip	None	None	None	Enabled

Traffic is actually denied:



Role Based Counters

FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	333
11	34	0	3	0	0

Navigate to Troubleshooting > Logs and entries such as the following will be displayed in the Syslog:

```
Jul  5 15:03:09.837: %FMANFP-6-IPACCESSLOGSGDP: Chassis 1 F0/0: fman_fp_image:
ingress_interface='VLAN-CPPIF-0210' sgacl_name='Deny_IP_Log-00' action='Deny'
protocol='icmp' src-ip='10.1.140.2' dest-ip='10.1.210.100' type='0' code='0' sgt='11'
dgt='34' logging_interval_hits='1'
```

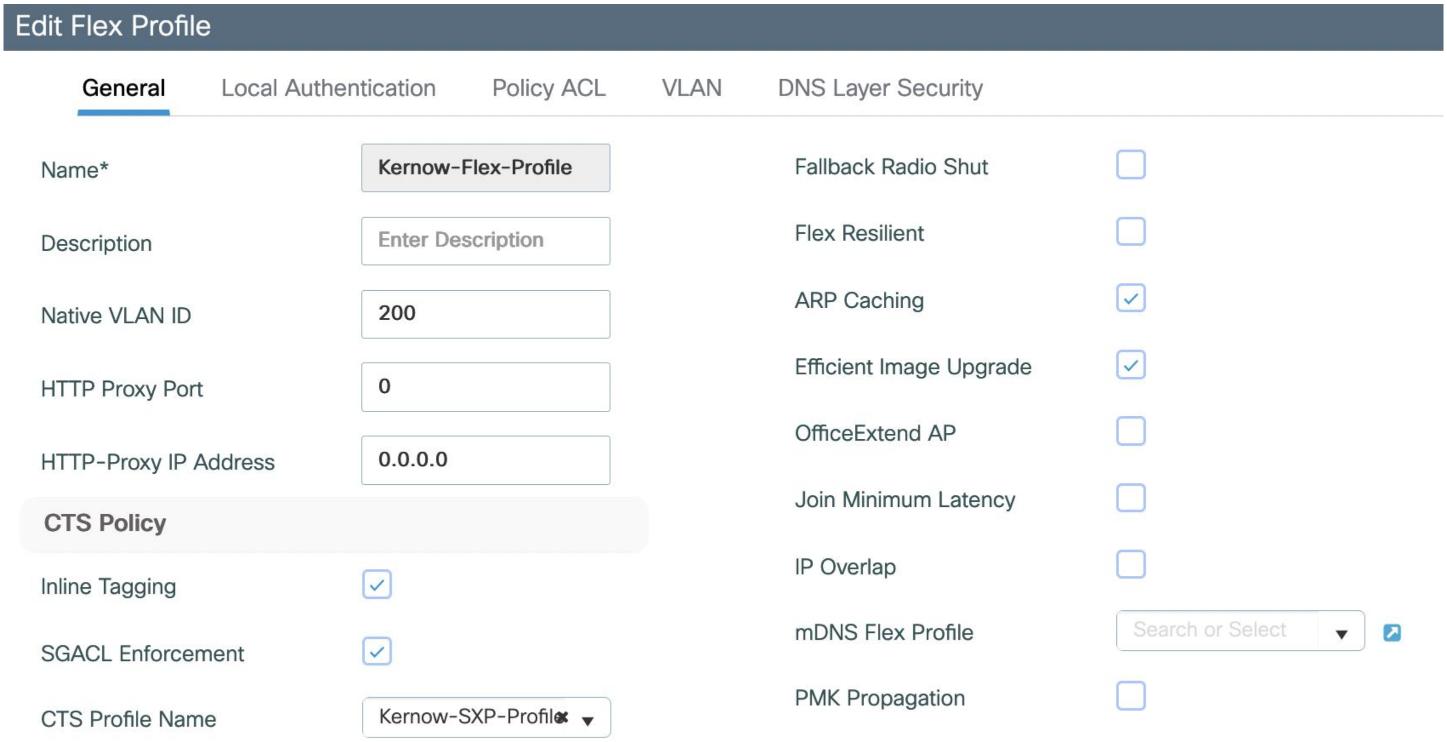
And the following to indicate a number of hits (logging interval):

```
Jul  5 15:11:22.340: %FMANFP-6-IPACCESSLOGSGDP: Chassis 1 F0/0: fman_fp_image:
ingress_interface='VLAN-CPPIF-0210' sgacl_name='Deny_IP_Log-00' action='Deny'
protocol='icmp' src-ip='10.1.140.2' dest-ip='10.1.210.100' type='0' code='0' sgt='11'
dgt='34' logging_interval_hits='61'
```

The conclusion is that SGACL logging works well on the C9800.

SGACL Logging on Flex AP (Not Supported)

As in the case of testing SGACL logging on the C9800, setup wired to wireless enforcement on a Flex AP:



Edit Flex Profile

Name*	Kernow-Flex-Profile	Fallback Radio Shut	□
Description	Enter Description	Flex Resilient	□
Native VLAN ID	200	ARP Caching	☑
HTTP Proxy Port	0	Efficient Image Upgrade	☑
HTTP-Proxy IP Address	0.0.0.0	OfficeExtend AP	□
CTS Policy		Join Minimum Latency	□
Inline Tagging	☑	IP Overlap	□
SGACL Enforcement	☑	mDNS Flex Profile	Search or Select ▾
CTS Profile Name	Kernow-SXP-Profile ✖ ▾	PMK Propagation	□

Tested enforcing from SGT 33 (wired) to SGT 34 (Wireless), and used ‘deny ip log’ as an SGACL to try to generate syslog messages of any hits:

```
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
SGT  DGT          ACL
 11   34       Deny_IP
 23   34  AllowDHCPDNS
 33   34     DenyIPlog
```

Can see enforcement hits:

```
AP0845.D132.75F8#show cts role-based counters from 33 to 34
IPv4 ACL: DenyIPlog
Packets Allowed : 0
Packets Denied  : 484
IPv6 ACL: DenyIPlog
Packets Allowed : 0
Packets Denied  : 0
```

But no syslog messages are generated.

Syslog messages are not supported for enforcement on Flex AP’s.

C9800 NetFlow Supporting SGTS

Configured NetFlow as follows, note the SGT match commands in red. Platforms like Secure Network Analytics (Stealthwatch) can consume this context.

Note: Cisco Catalyst Center does not consume SGT context within NetFlow records. Cisco Catalyst Center along with other platforms including Secure Network Analytics (Stealthwatch) can utilize ISE pxGrid to learn of the SGT information related to traffic flows.

```
flow record NetFlow-in
 match datalink mac source address input
 match datalink mac destination address input
 match ipv4 tos
 match ipv4 ttl
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 match flow direction
 match flow cts source group-tag
 match flow cts destination group-tag
 collect counter bytes long
 collect counter packets long
 collect timestamp absolute first
 collect timestamp absolute last
!
flow record NetFlow-out
 match ipv4 tos
 match ipv4 ttl
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match flow direction
 match flow cts source group-tag
 match flow cts destination group-tag
 collect counter bytes long
 collect counter packets long
 collect timestamp absolute first
 collect timestamp absolute last
!
flow exporter NetFlow-Exp
 destination 10.1.110.3
 source GigabitEthernet1
 transport udp 2055
!
flow monitor NetFlow-mon-in
 exporter NetFlow-Exp
 cache timeout active 60
 record NetFlow-in
!
flow monitor NetFlow-mon-out
 exporter NetFlow-Exp
 cache timeout active 60
 record NetFlow-out
```

Attach the flow monitors to the C9800 controller uplink G2:

```
interface GigabitEthernet2
 switchport trunk allowed vlan 200,210,211
 switchport mode trunk
 switchport nonegotiate
 ip flow monitor NetFlow-mon-in input
 ip flow monitor NetFlow-mon-out output
 negotiation auto
 no mop enabled
 no mop sysid
end
```

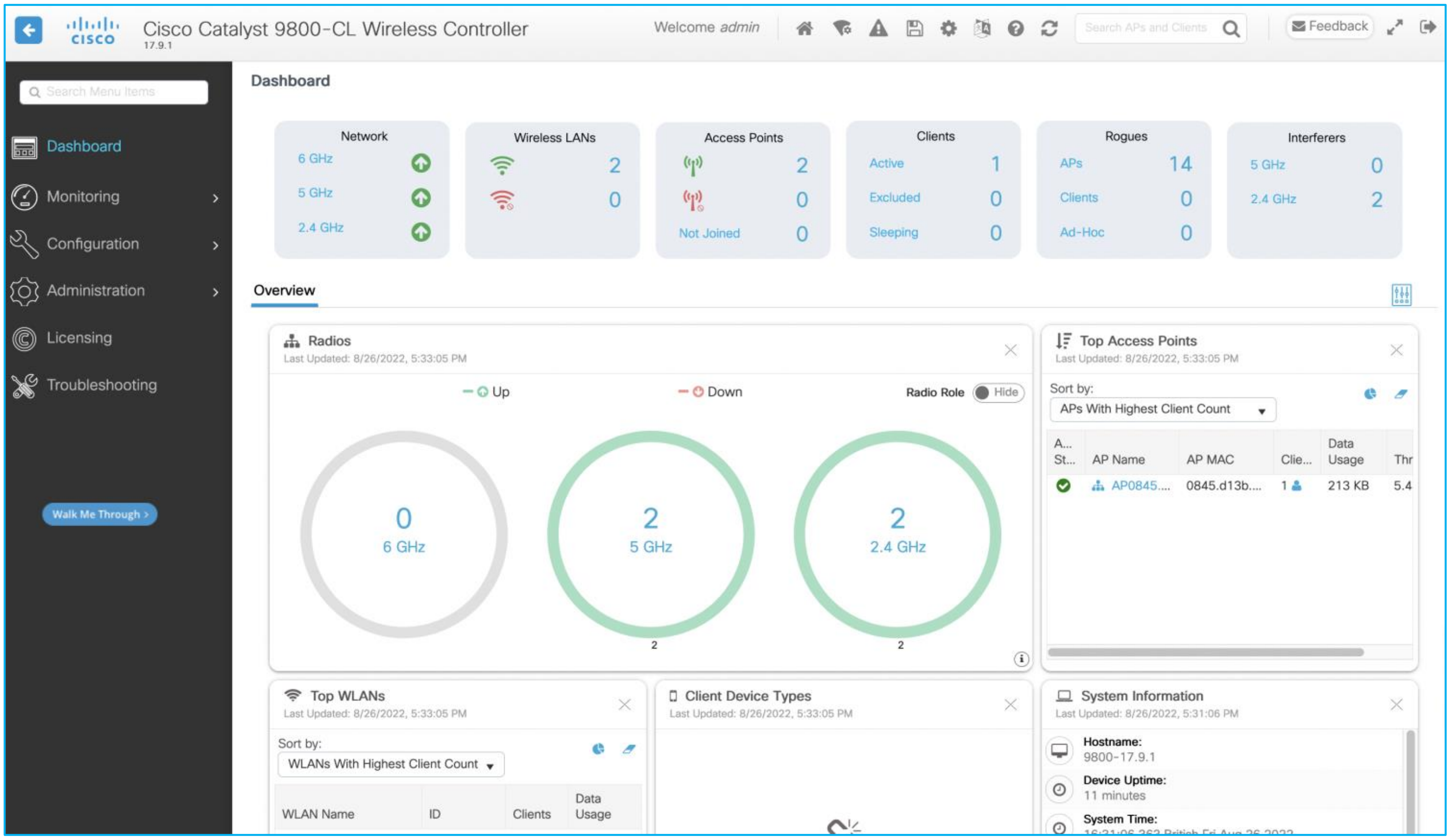
Both source and destination SGTs can be seen to be inserted into the NetFlow packets for a flow between wireless 10.1.210.100 with Doctors SGT 34 and wired 10.1.140.2 with Production_Servers SGT 11:

```
9800-17.9.1#show flow monitor NetFlow-mon-out cache

IPV4 SOURCE ADDRESS:            10.1.210.100
IPV4 DESTINATION ADDRESS:       10.1.140.2
TRNS SOURCE PORT:               0
TRNS DESTINATION PORT:          0
FLOW DIRECTION:                 Output
FLOW CTS SOURCE GROUP TAG:      34
FLOW CTS DESTINATION GROUP TAG: 11
IP TOS:                         0x00
IP PROTOCOL:                    1
IP TTL:                         128
counter bytes long:             2580
counter packets long:           43
timestamp abs first:            16:07:19.902
timestamp abs last:             16:08:01.921
```

Operate

Active Monitoring

The C9800 Dashboard is the main page to investigate the state of the controller and associated AP's including WLANs, Access Points and Clients:



A... St...	AP Name	AP MAC	Clie...	Data Usage	Thr
✓	AP0845....	0845.d13b....	1	213 KB	5.4

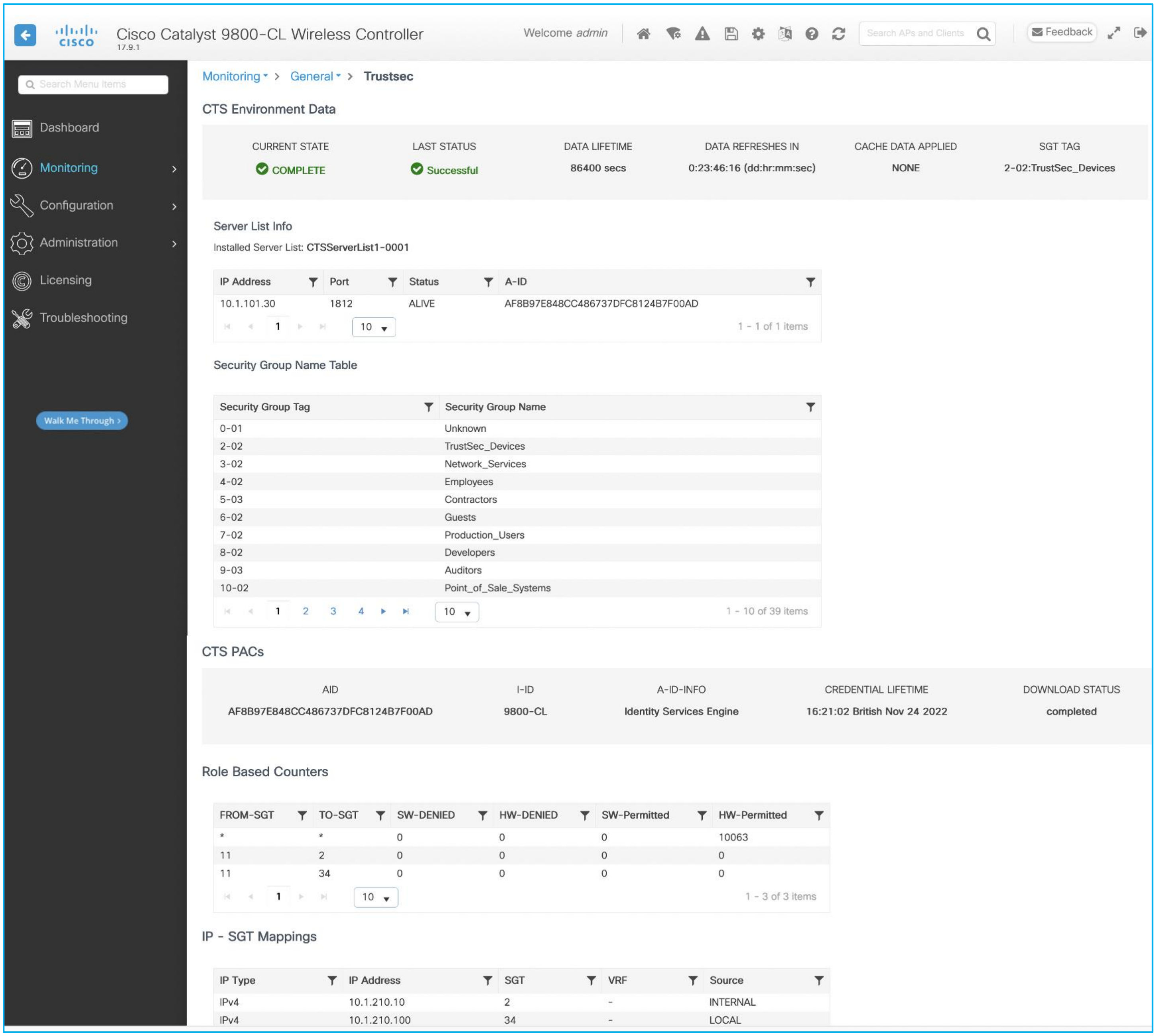
WLAN Name	ID	Clients	Data Usage

Hostname: 9800-17.9.1

Device Uptime: 11 minutes

System Time:

However, to discover the general state of GBP within the controller, navigate to Monitoring > General > TrustSec. This shows whether the PAC and Environment-data has been downloaded, the server list and the SGTs within the Environment-data, all the IP-SGT mappings and the SGACL (Role-Based) Counters:



Monitoring > General > Trustsec

CTS Environment Data

CURRENT STATE	LAST STATUS	DATA LIFETIME	DATA REFRESHES IN	CACHE DATA APPLIED	SGT TAG
✓ COMPLETE	✓ Successful	86400 secs	0:23:46:16 (dd:hr:mm:sec)	NONE	2-02:TrustSec_Devices

Server List Info

Installed Server List: **CTSServerList1-0001**

IP Address	Port	Status	A-ID
10.1.101.30	1812	ALIVE	AF8B97E848CC486737DFC8124B7F00AD

1 - 1 of 1 items

Security Group Name Table

Security Group Tag	Security Group Name
0-01	Unknown
2-02	TrustSec_Devices
3-02	Network_Services
4-02	Employees
5-03	Contractors
6-02	Guests
7-02	Production_Users
8-02	Developers
9-03	Auditors
10-02	Point_of_Sale_Systems

1 2 3 4 · 10 · 1 - 10 of 39 items

CTS PACs

AID	I-ID	A-ID-INFO	CREDENTIAL LIFETIME	DOWNLOAD STATUS
AF8B97E848CC486737DFC8124B7F00AD	9800-CL	Identity Services Engine	16:21:02 British Nov 24 2022	completed

Role Based Counters

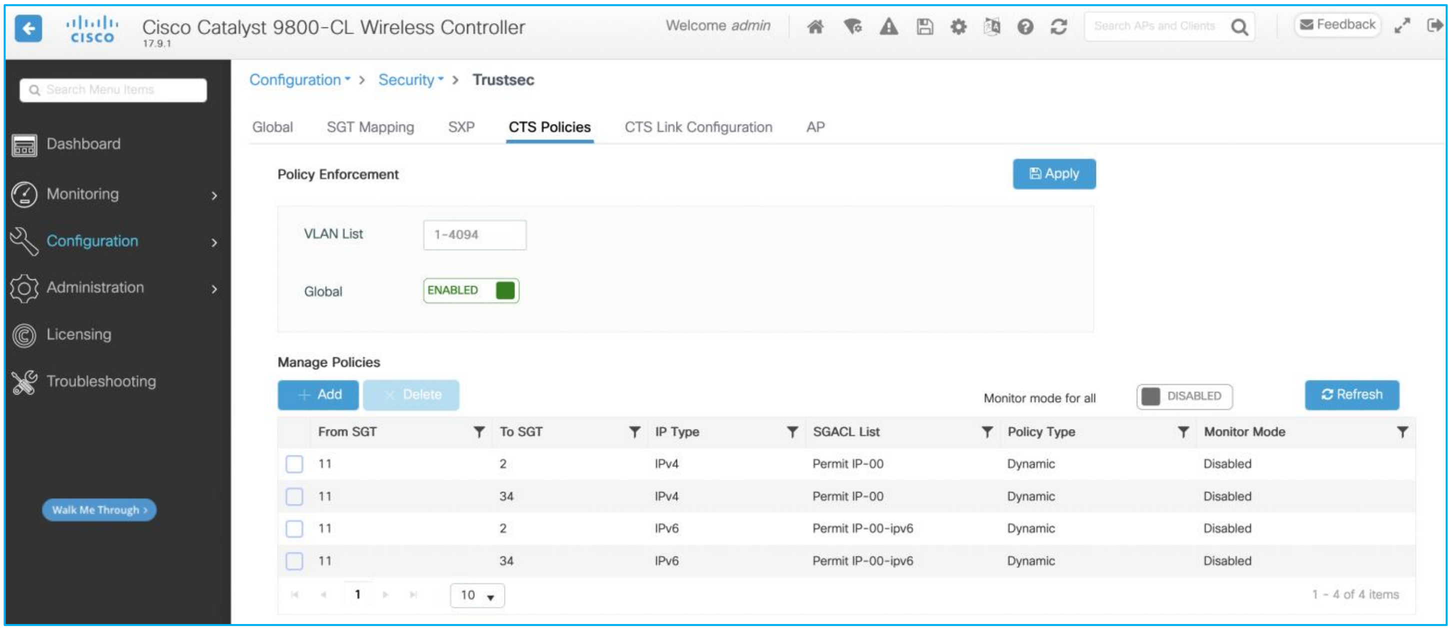
FROM-SGT	TO-SGT	SW-DENIED	HW-DENIED	SW-Permitted	HW-Permitted
*	*	0	0	0	10063
11	2	0	0	0	0
11	34	0	0	0	0

1 - 3 of 3 items

IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	34	-	LOCAL

While good TrustSec information can be gleaned from the Monitoring screen above, the actual policy information is missing from that location. To investigate policies downloaded from ISE, navigate to Configuration > Security > TrustSec > CTS Policies:



Policy Enforcement

VLAN List	1-4094
Global	ENABLED

Manage Policies

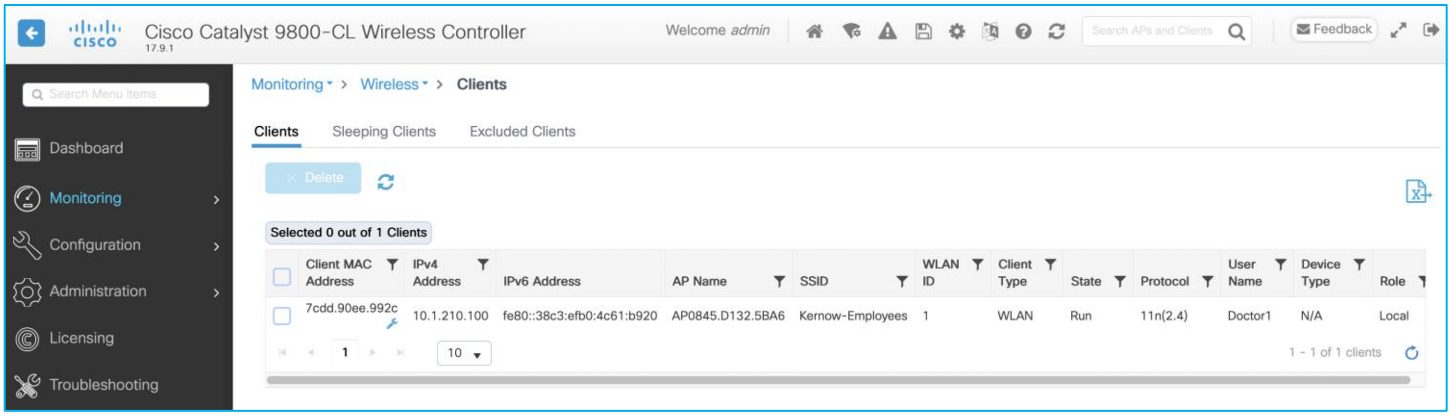
Monitor mode for all: DISABLED

□	From SGT	To SGT	IP Type	SGACL List	Policy Type	Monitor Mode
□	11	2	IPv4	Permit IP-00	Dynamic	Disabled
□	11	34	IPv4	Permit IP-00	Dynamic	Disabled
□	11	2	IPv6	Permit IP-00-ipv6	Dynamic	Disabled
□	11	34	IPv6	Permit IP-00-ipv6	Dynamic	Disabled

1 | 10 ▾ | 1 - 4 of 4 items

Remember, the only policies that will be downloaded from ISE, and therefore present in this table, will be for policies with a destination SGT that the C9800 controller knows about. In the Monitoring > General > TrustSec screen you can see this C9800 knows about IP:SGT mappings for SGT 2 and 34, therefore only policies destined towards those SGTs are downloaded.

Any SGT dynamically assigned to a client will show up in the IP-SGT mappings table within the TrustSec Monitoring screen above but can also be seen in the client information. Navigate to the Dashboard, then click on the active client number, or navigate using Monitoring > Wireless > Clients:

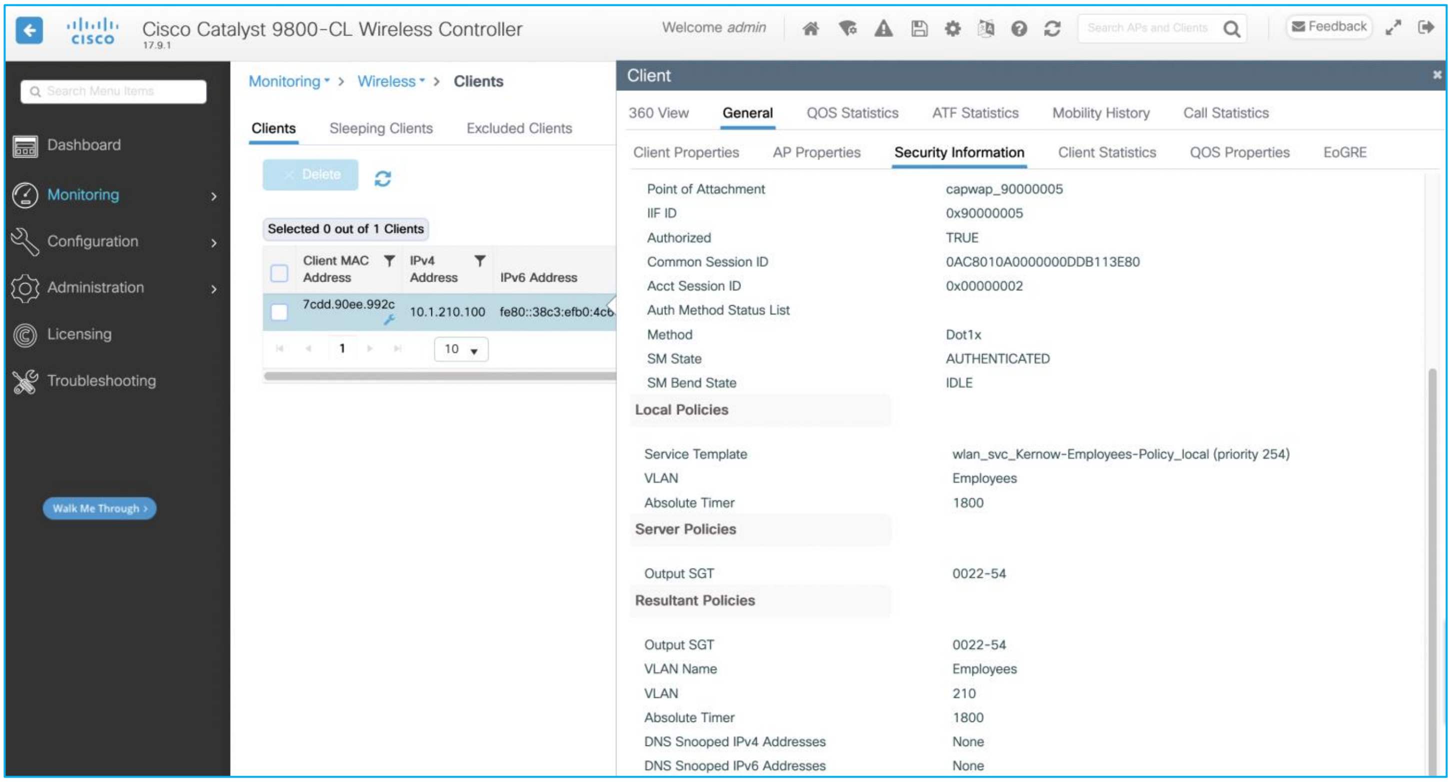


Selected 0 out of 1 Clients

□	Client MAC Address	IPv4 Address	IPv6 Address	AP Name	SSID	WLAN ID	Client Type	State	Protocol	User Name	Device Type	Role
□	7cdd.90ee.992c	10.1.210.100	fe80::38c3:efb0:4c61:b920	AP0845.D132.5BA6	Kernow-Employees	1	WLAN	Run	11n(2.4)	Doctor1	N/A	Local

1 | 10 ▾ | 1 - 1 of 1 clients

To check on the SGT assigned, click the client entry, then the General tab, then 'Security Information', scroll down to Server Policies > Output SGT, or Resultant Policies > Output SGT; (the SGT is shown in Hex in this screen):

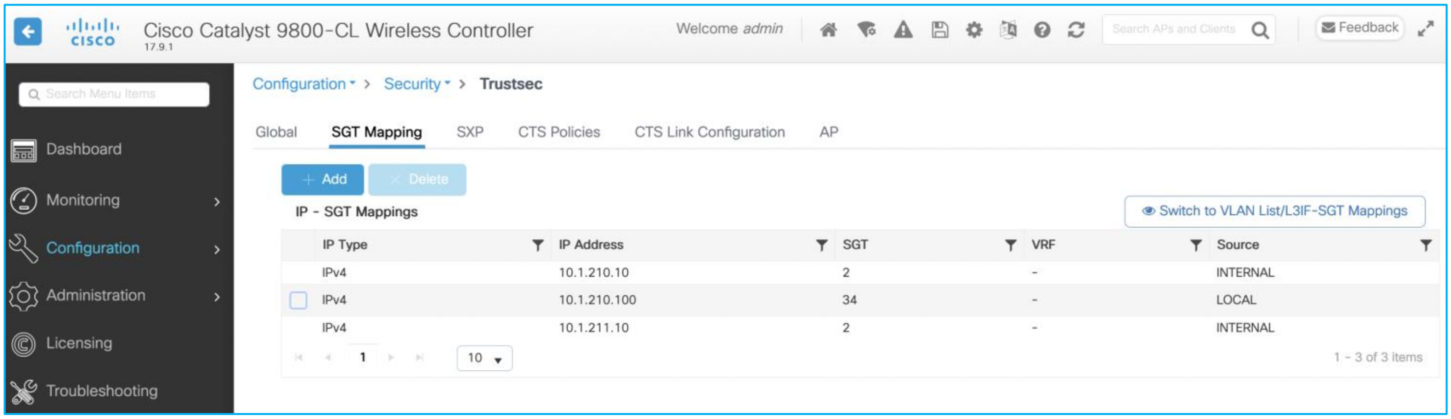


Client MAC Address	IPv4 Address	IPv6 Address
7cdd.90ee.992c	10.1.210.100	fe80::38c3:efb0:4cb

Point of Attachment	capwap_90000005
IIF ID	0x90000005
Authorized	TRUE
Common Session ID	0AC8010A0000000DDB113E80
Acct Session ID	0x00000002
Auth Method Status List	
Method	Dot1x
SM State	AUTHENTICATED
SM Bend State	IDLE
Local Policies	
Service Template	wlan_svc_Kernow-Employees-Policy_local (priority 254)
VLAN	Employees
Absolute Timer	1800
Server Policies	
Output SGT	0022-54
Resultant Policies	
Output SGT	0022-54
VLAN Name	Employees
VLAN	210
Absolute Timer	1800
DNS Snooped IPv4 Addresses	None
DNS Snooped IPv6 Addresses	None

Note: The SGT is shown in the form 22-54 where 22 is the SGT in Hex i.e., 34 Dec, and the 54 is a version number used to help keep the SGT and related data synchronized with ISE.

The IP and the assigned SGT can be gleaned from the client information as seen above, and we have also seen the IP:SGT mapping shown in the Monitoring > General > TrustSec screen. The same information can also be seen at Configuration > Security > TrustSec > SGT Mapping (where static mappings can also be added if required):



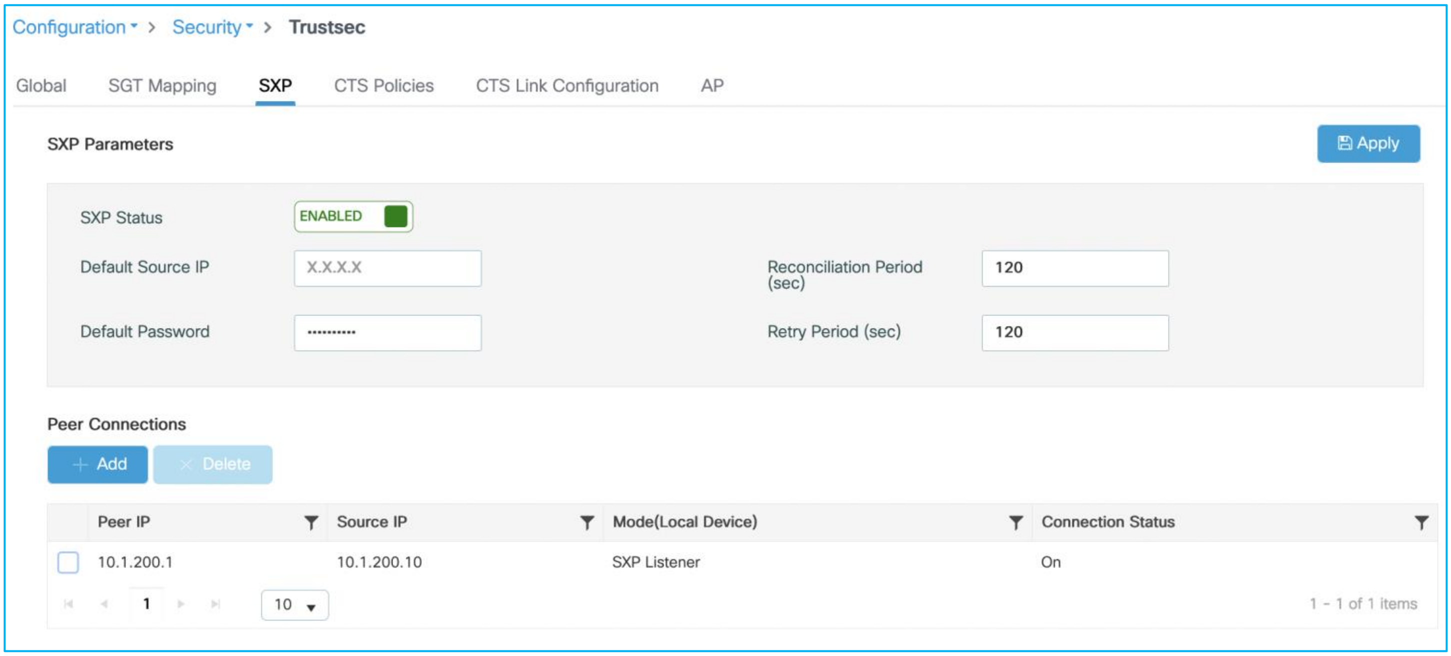
IP - SGT Mappings

IP Type	IP Address	SGT	VRF	Source
IPv4	10.1.210.10	2	-	INTERNAL
IPv4	10.1.210.100	34	-	LOCAL
IPv4	10.1.211.10	2	-	INTERNAL

The C9800 controller can be configured to propagate SGTs via inline tagging or via Security Group Tag Exchange Protocol (SXP). There is no GUI screen which shows the state of inline tagging, but once enabled, the following CLI could be used:

```
9800-17.9.1#show cts interface
Global Dot1x feature is Disabled
Interface GigabitEthernet2:
    CTS is enabled, mode:    MANUAL
    IFC state:               OPEN
    Interface Active for      4d17h
    Authentication Status:   NOT APPLICABLE
        Peer identity:       "unknown"
        Peer's advertised capabilities: ""
    Authorization Status:    SUCCEEDED
        Peer SGT:            2:TrustSec_Devices
        Peer SGT assignment: Trusted
    SAP Status:              NOT APPLICABLE
    Propagate SGT:           Enabled
    Cache Info:
        Expiration            : N/A
        Cache applied to link : NONE
    Statistics:
        authc success:              0
        authc reject:               0
        authc failure:              0
        authc no response:          0
        authc logoff:               0
        sap success:                0
        sap fail:                   0
        authz success:              0
        authz fail:                 0
        port auth fail:             0
    L3 IPM:   disabled.
    CTS sgt-caching Ingress : Disabled
    CTS sgt-caching Egress  : Disabled
```

The state of an SXP connection on the C9800 can be seen within Configuration > Security > TrustSec > SXP where it shows the Connection Status for each added connection:



SXP Parameters

SXP Status	ENABLED		
Default Source IP	X.X.X.X	Reconciliation Period (sec)	120
Default Password	••••••••••	Retry Period (sec)	120

Peer Connections

	Peer IP	Source IP	Mode(Local Device)	Connection Status
□	10.1.200.1	10.1.200.10	SXP Listener	On

1 10 ▾ 1 - 1 of 1 items

SXP state can also be checked using CLI on the C9800:

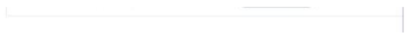
```
9800-17.9.1#show cts sxp connections
 SXP              : Enabled
 Highest Version Supported: 5
 Default Password : Set
 Default Key-Chain: Not Set
 Default Key-Chain Name: Not Applicable
 Default Source IP: Not Set
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
Peer-Sequence traverse limit for export: Not Set
Peer-Sequence traverse limit for import: Not Set
----------------------------------------------
Peer IP          : 10.1.200.1
Source IP        : 10.1.200.10
Conn status      : On
Conn version     : 5
Conn capability  : IPv4-IPv6-Subnet
Conn hold time   : 120 seconds
Local mode       : SXP Listener
Connection inst# : 1
TCP conn fd      : 1
TCP conn password: default SXP password
Hold timer is running
Duration since last state change: 0:00:25:07 (dd:hr:mm:sec)
```

```
Total num of SXP Connections = 1
9800-17.9.1#show cts sxp sgt-map
SXP Node ID(generated):0x0A01D30A(10.1.211.10)
IP-SGT Mappings as follows:
IPv4,SGT: <1.1.1.8 , 2:TrustSec_Devices>
source  : SXP;
Peer IP : 10.1.200.1;
Ins Num : 1;
Status  : Active;
Seq Num : 1
Peer Seq: 01010108,
IPv4,SGT: <10.1.200.1 , 2:TrustSec_Devices>
source  : SXP;
Peer IP : 10.1.200.1;
Ins Num : 1;
Status  : Active;
Seq Num : 3
Peer Seq: 01010108,
Total number of IP-SGT Mappings: 2
```

The following command is useful to determine the details of enforcement, inline tagging and default-SGT for the various profiles:

```
9800-17.9.1#show wireless cts summary
Local Mode CTS Configuration
Policy Profile Name                SGACL Enforcement     Inline-Tagging   Default-Sgt
-----------------------------------------------------------------------------------
Kernow-Flex_Policy                 ENABLED               DISABLED         2
default-policy-profile             DISABLED              DISABLED         0
Kernow-Employees-Policy            ENABLED               DISABLED         0
Flex Mode CTS Configuration
Flex Profile Name                  SGACL Enforcement     Inline-Tagging
-----------------------------------------------------------------------
Kernow-Flex-Profile                ENABLED               ENABLED
default-flex-profile               DISABLED              DISABLED
```

If the mode is Flex, then the SGTs and whether policies are present on an AP can be seen via the C9800 GUI by navigating to Monitoring > Wireless > AP Statistics > Select AP > TrustSec (see ‘Policy Pushed to AP’ column):



The equivalent via CLI is:

```
9800-17.9.1#show cts ap sgt-info AP0845.D132.75F8
Number of SGTs referred by the AP...............: 3
SGT                  PolicyPushedToAP       No.of Clients
------------------------------------------------------------
```

```
UNKNOWN(0)        NO                     0
34                YES                    1
DEFAULT(65535)    YES                    0
```

CLI commands can be used on a Flex AP as follows:

```
AP0845.D132.75F8#show cts sxp connections
SXP              : Enabled
Highest Version Supported: 4
Default Password : Set
SXP Timers:
Connection retry open period:120
Reconcile period:120
Keepalive period:65535
Speaker minimum hold-time:120
Listener minimum hold-time:90
Listener maximum hold-time:120
SXP Connection Info:
peer #0: 10.1.201.1:64999
        1 connection(s) active
        connection status: successful
        hold timer is armed
        peer has speaker role
1 configured peer(s)
AP0845.D132.75F8#show cts sxp sgt-map
IPv4 Binding(s):
Binding #0: 1.1.1.6/32 = 2
Binding #1: 10.1.201.1/32 = 2
Binding #2: 10.1.202.1/32 = 2
Binding #3: 10.3.25.2/32 = 2
Binding #4: 10.4.21.2/32 = 2
Binding #5: 10.6.5.111/32 = 34
Binding #6: 10.6.5.254/32 = 2
IPv6 Binding(s):
AP0845.D132.75F8#show cts role-based sgt-map all
Active IPv4-SGT Bindings Information
         IP SGT SOURCE
10.1.202.10  34  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
Active IPv6-SGT Bindings Information
                       IP SGT SOURCE
```

```
fe80::90de:54f8:a770:5a79  34  LOCAL
IP-SGT Active Bindings Summary
============================================
Total number of LOCAL    bindings = 1
Total number of active   bindings = 1
AP0845.D132.75F8#show cts role-based permissions
IPv4 role-based permissions:
  SGT   DGT       ACL
   11    34 Permit_IP
65535 65535 Permit_IP
IPv6 role-based permissions:
  SGT   DGT       ACL
   11    34 Permit_IP
65535 65535 Permit_IP
AP0845.D132.75F8#show cts role-based counters from 11 to 34
IPv4 ACL: Permit_IP
Packets Allowed : 0
Packets Denied  : 11
IPv6 ACL: Permit_IP
Packets Allowed : 0
Packets Denied  : 0
AP0845.D132.75F8#show cts access-lists
IPv4 role-based ACL:
Permit_IP
        rule 0: allow true
IPv6 role-based ACL:
Permit_IP
        rule 0: allow true
```

There are various CTS debugs that can be set on a C9800 controller. The list below shows the options, choose the relevant debug to match the requirement:

```
9800-17.9.1#debug cts ?
  aaa                        CTS AAA
  all                        all CTS messages
  authentication             CTS authentication
  authorization              CTS authorization
  cache                      CTS Cache
  coa                        CTS Change of Authorization
  critical-authentication    CTS Critical-Authentication
  dp                         CTS Datapath (DP)
  environment-data           CTS environment data operations
  error                      CTS error and warning messages
  ha                         CTS HA
  ifc                        CTS Interface CONTROLLER (IFC)
  layer3-trustsec            CTS Layer3 TrustSec/Policy
  odm                        CTS Operational data modeling debugs
  policy-server              CTS policy server debugs
  provisioning               CTS PAC-provisioning
  rcl-server                 CTS RCL
  relay                      CTS Relay
  sap                        CTS Security Association Protocol (SAP)
  server-list                CTS server list operations
  sgacl-db                   CTS SGACL database debugs
  states                     CTS state change debugs
  sxp                        CTS SXP
  <cr>                       <cr>
```

Similarly, on a Flex AP, here is the debug list:

```
AP0845.D132.75F8#debug cts ?
  enforcement  Enable CTS packet level enforcement debugging
  parser       Enable CTS ACL parser debugging
  sxp          Enable CTS SXP debugging
```

Deployment Guide Summary

As a general summary, here is a table showing where specific functions occur per deployment mode/architecture:

Function\Deployment	Local mode	FlexConnect	SDA	Guest Anchor
Dynamic SGT assignment	C9800	C9800 and pushed to AP	C9800 and pushed to AP	Foreign C9800 and info pushed to Anchor
SGT Propagation using SXP and/or inline tagging (CMD)	C9800	AP	Fabric Edge	Anchor C9800
CTS Provisioning and ISE enrollment	C9800	C9800	C9800 and Fabric Edge	Foreign and Anchor C9800
Change of Authorization (CoA) for client/device SGT	C9800	C9800 and pushed to AP		Foreign C9800 and info pushed to Anchor
East-West policy enforcement	C9800 (client destination Policy Profile)	AP (client destination AP)	Fabric Edge	Anchor C9800 (client destination Policy Profile)

(wireless to wireless)				
North-South policy enforcement (wired to wireless)	C9800	AP	Fabric Edge	Anchor C9800
South-North policy enforcement (wireless to wired)	Upstream switch	Upstream switch	Destination Fabric Edge	Upstream switch

Group-Based Policy works very well on the C9800 controller and associated AP's along with IOS-XE software version 17.9.1. Note the following comments and caveats:

Static IP:SGT sent via SXP. When adding a static IP:SGT on the C9800 controller, it gets propagated off-platform via SXP in this use-case. This is not a very useful capability; there's no added context from a C9800 point of view. If the static mapping is required on the destination platform, then why not just add a static mapping there instead or propagate it there from another source like ISE for example. This is a similar capability that was offered by the Nexus5k; it's just not very useful.

The C9800 controller does not support S-N (wireless to wired) enforcement on-platform at all. If enforcement is required in that direction, then the C9800 can propagate the wireless assigned SGTs to Northbound platforms via inline tagging or SXP.

When propagating IP:SGT mappings via CMD from or to the C9800 controller, the inline tagging setting on the Policy Profile is not used, the SGT is processed if inline tagging is set on the uplink interface. The use of the inline tagging setting on the policy profile will be introduced in a future release.

Inline tagging and SGACL enforcement settings on the Policy Profile are irrelevant in flex mode, it's the settings on the Flex Profile which are used to determine if inline tagging and SGACL enforcement are enabled or not on the Flex AP.

SGACL logging is not supported from Flex AP.

Monitor Mode is not supported on Flex AP.

There are these DDTS entries to consider (not related to any particular use-cases within this guide):

CSCwb11073 AP with LSC support functionality is not complete and needs end-to-end work to be completed.

CSCwa18221 CTS is not supported under RLAN policy in eWLC.

CSCwa65584 C9800 controller does not accept Catalyst APs C91xx series as TrustSec capable platform.

This is fixed and supported from 17.9.1.

The following DDTS entries are related to use-cases in this document and are mentioned in their relevant sections:

This document shows use-cases where CoA messages are successful. Problems in CoA occur in certain circumstances when policies are updated multiple times with CoA instigated each time. The policies are updated on the C9800 ok but not downloaded to the AP. Fixed in release 17.9.2: CSCwc15911 CoA changes are not reflecting in Flex mode APs for TrustSec.

A statically assigned IP:SGT mapping for a wireless client is not propagated via CMD across the uplink. The SGT must be dynamically assigned from ISE for this propagation to occur. This would be a beneficial addition: CSCwd06879 C9800 wireless static IP to SGT mapping not inline tagged over uplink.

If VLAN:SGT classification is meant for statically classifying wireless clients (traffic coming in from the South-bound/wireless direction), then it does not work due to the GUI producing an error in provisioning: CSCwd06900 C9800 wireless static VLAN to SGT mapping GUI provisioning generates error.

It has been decided to temporarily hide the option to 'Switch to VLAN List/L3IF-SGT Mappings' under Configuration > Security > TrustSec > SGT Mapping in ongoing releases. If either of the two features are required in the future, then the functionality can be investigated and re-introduced: CSCwd14077 C9800: Hide the option to switch to VLAN List and L3IF to SGT Mappings in SGT Mapping screen.

L3IF operation. This function is used when a L3 link is connected to a 'partner' and L3 IP prefixes learned and an SGT assigned. The GUI does actually create an SGT under the VLAN and create a Subnet:SGT which does enforce. However, that isn't really the intention of the L3IF function. If a Subnet:SGT mapping is required then why not just use the static Subnet:SGT function?
L3IF:SGT mapping is for the network device to learn of routing prefixes and as the C9800 is largely a L2 platform the full function cannot currently be realised.

It has been decided to temporarily hide the option to 'Switch to VLAN List/L3IF-SGT Mappings' under Configuration > Security > TrustSec > SGT Mapping in ongoing releases. If either of the two features are required in the future, then the functionality can be investigated and re-introduced: CSCwd14077 C9800: Hide the option to switch to VLAN List and L3IF to SGT Mappings in SGT Mapping screen.

Setting 'Monitor Mode for all' results in the generation of 'Error in Configuring'. CSCwd14088 C9800: The option to set CTS Policy Monitor mode for all generates an error.

Monitor Mode on the C9800 works ok but the counters to show traffic hits are only shown in the CLI, not in the webui in release 17.9.1. Monitor Mode counters supported in the webui from 17.11: CSCwc96257 WebUI: SGACL counters is not getting shown for Monitor mode in webui.

Crashes are occasionally experienced on the standby controller in HA mode. Fixed in 17.10.1: CSCwc78021 9800: Standby controller crash @ fman_acl_remove_default_ace

In the past, CTS policies have been seen to remain even after removing enforcement. This is fixed and supported from 17.9.1: CSCwb52864 HCA: 9800L-HA policies were intact even after removing the enforcement from the wireless profile.

Appendix

List of Acronyms

AAA	Authentication, Authorization and Accounting
ACL	Access Control List
AD	Active Directory (Microsoft)
API	Application Programming Interface
ASR	Aggregation Services Router (Cisco)
CDP	Cisco Discovery Protocol
CLI	Command Line Interface

CMD	Cisco Meta Data (field in L2 frame)
CoA	Change of Authorization (RADIUS)
CTS	Cisco Trusted Security
dB	Database
DC	Data Center
DHCP	Dynamic Host Configuration Protocol
DGT	Destination Group Tag
(Cisco) DNA	(Cisco) Digital Network Architecture
(Cisco) DNAC	(Cisco) Digital Network Architecture Center
DNS	Domain Name System
eWLC	C9800 controller
FIB	Forwarding Information Base
GBP	Group-Based Policy
FQDN	Fully Qualified Domain Name
HTTP	HyperText Transfer Protocol
IBNS	Identity-Based Networking Services
IOS	Internetwork Operating System (Cisco)
IP	Internet Protocol
IPDT	IP Device Tracking
ISE	Identity Services Engine (Cisco)
ISR	Integrated Services Router (Cisco)
L2	Layer 2
L3	Layer 3
LAN	Local Area Network
MAB	MAC authentication bypass
MAC	Media Access Control (Address)
PAC	Protected Access Credential
PAN	Policy Administration Node (ISE)
PSN	Policy Services Node (ISE)
pxGrid	Platform Exchange Grid (Cisco)
RADIUS	Remote Authentication Dial-In User Service
SDA	Software Defined Access (Cisco)

SD-Access	Software Defined Access (Cisco)
SGACL	Security Group Access Control List
SGT	Security Group Tag
SNMP	Simple Network Management Protocol
SSH	Secure Shell
SXP	Security Group Tag Exchange Protocol
SXPSN	Security Group Tag Exchange Policy Services Node (ISE)
SYSLOG	System Log
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VLAN	Virtual Local Area Network
VN	Virtual Network
VPN	Virtual Private Network
VRF	Virtual routing and forwarding
VXLAN	Virtual Extensible Local Area Network
WAN	Wide Area Network
WLAN	Wireless Local Area Network
Controller	Wireless Local Area Network controller