

CISCO VALIDATED DESIGN

User-to-Data-Center Access Control Using TrustSec Deployment Guide

April 2016

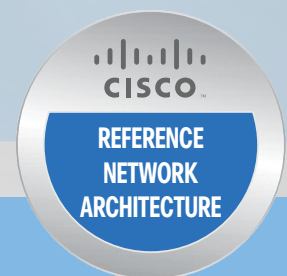


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About This Document

This document describes how Cisco TrustSec provides access control for user to data center (“north to south”) traffic for wired and wireless users. Cisco TrustSec provides software-defined segmentation and enables role-based security policy.

Tech Tip

For more information about Cisco TrustSec, go to:

<http://www.cisco.com/go/trustsec>

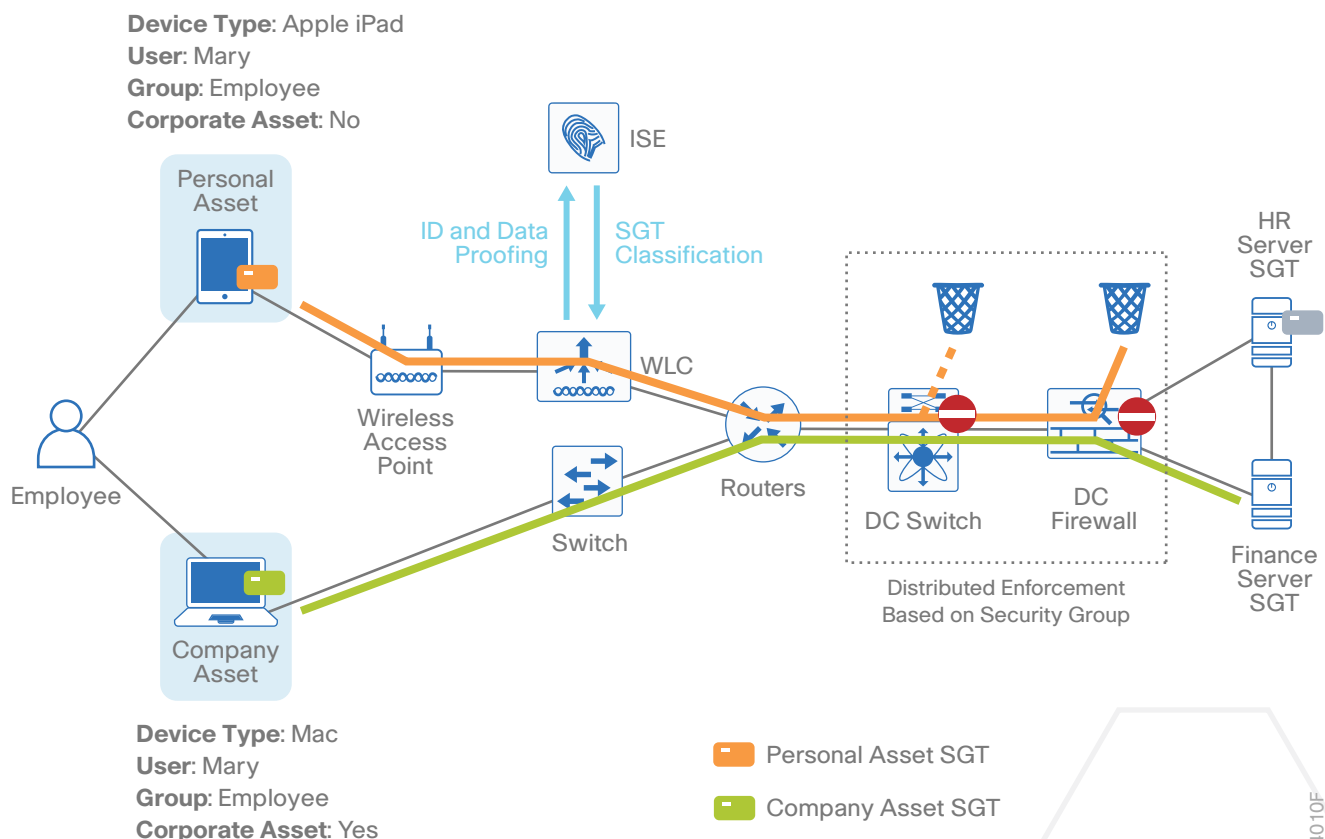


Cisco TrustSec Overview

The Cisco TrustSec solution simplifies the provisioning and management of network access control through the use of software-defined segmentation to classify network traffic and enforce policies for more flexible access controls. Traffic classification is based on endpoint identity, not IP address, enabling policy change without network redesign. A centralized policy management platform 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 TrustSec-enabled network devices, such as switches, routers, and security equipment. This provides better visibility through richer contextual information and allows an organization to be better able to detect threats and accelerate remediation, reducing the impact and costs associated with a potential breach.

Cisco TrustSec technology is embedded in Cisco switches, routers, and firewalls and is defined in three phases: classification, propagation, and enforcement. When the user's traffic enters the network, the traffic is classified based on the results of authentication, such as 802.1X, MAC authentication bypass, or web authentication. After the user's traffic is classified, Cisco switches and routers then propagate the traffic automatically, without any intervention by the network operator until it hits an enforcement point, which can be a Cisco firewall, router, or switch. Based on the classification, the enforcement device determines if the user's traffic should be allowed or denied.

Figure 1 Cisco TrustSec phases: classification, propagation, and enforcement



Use Cases

RETAIL: SEGMENTATION FOR PCI COMPLIANCE

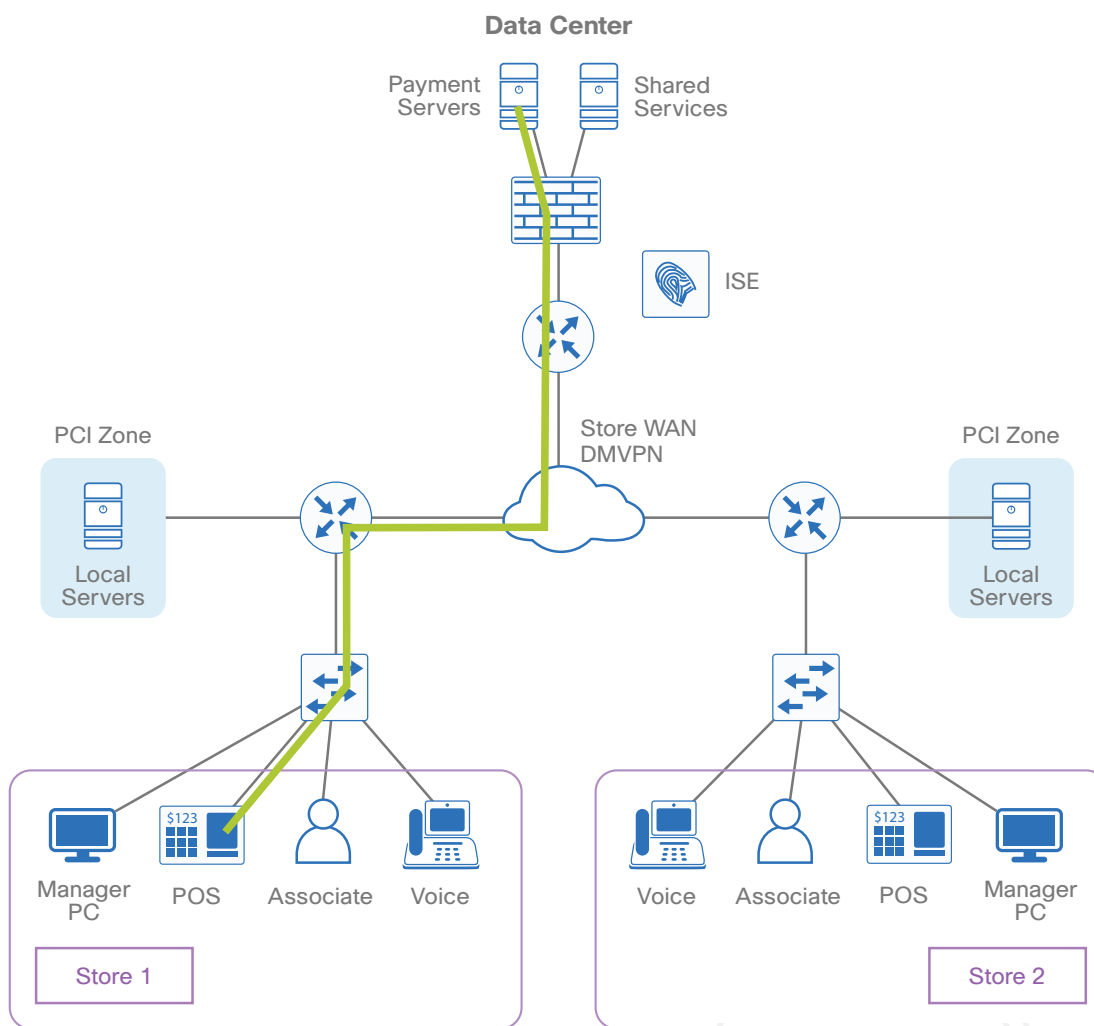
Business Problem

A retail chain is required to comply with Payment Card Industry (PCI) standards where all devices that process credit-card information are in a network that is segmented from other devices.

Solution

The PCI devices are tagged by the switch or router at the store and provided access to the payment servers in the data center, which is enforced at the data center by a data center switch or the data center firewall. The devices on the network that aren't used for processing payment information get an appropriate tag that prevents them from accessing the payment servers but allows them access to shared services provided in the data center.

Figure 2 TrustSec for PCI compliance

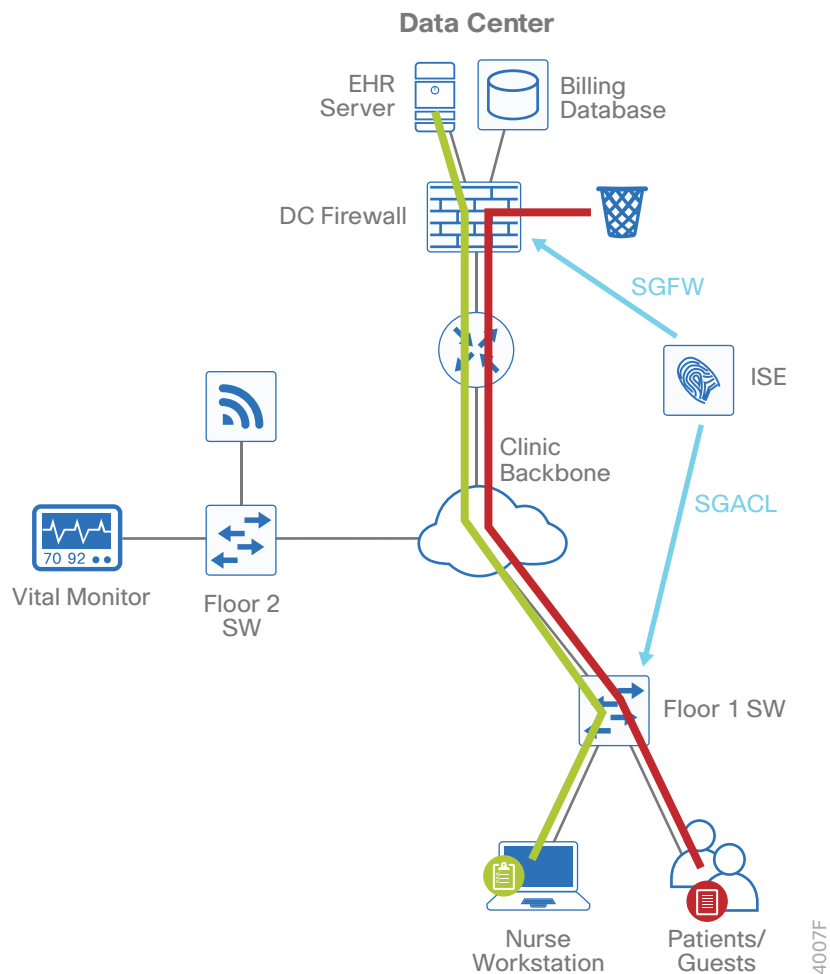


HEALTHCARE: SECURING ACCESS TO MEDICAL DEVICES AND ELECTRONIC HEALTH RECORDS FOR HIPAA COMPLIANCE

Business Problem

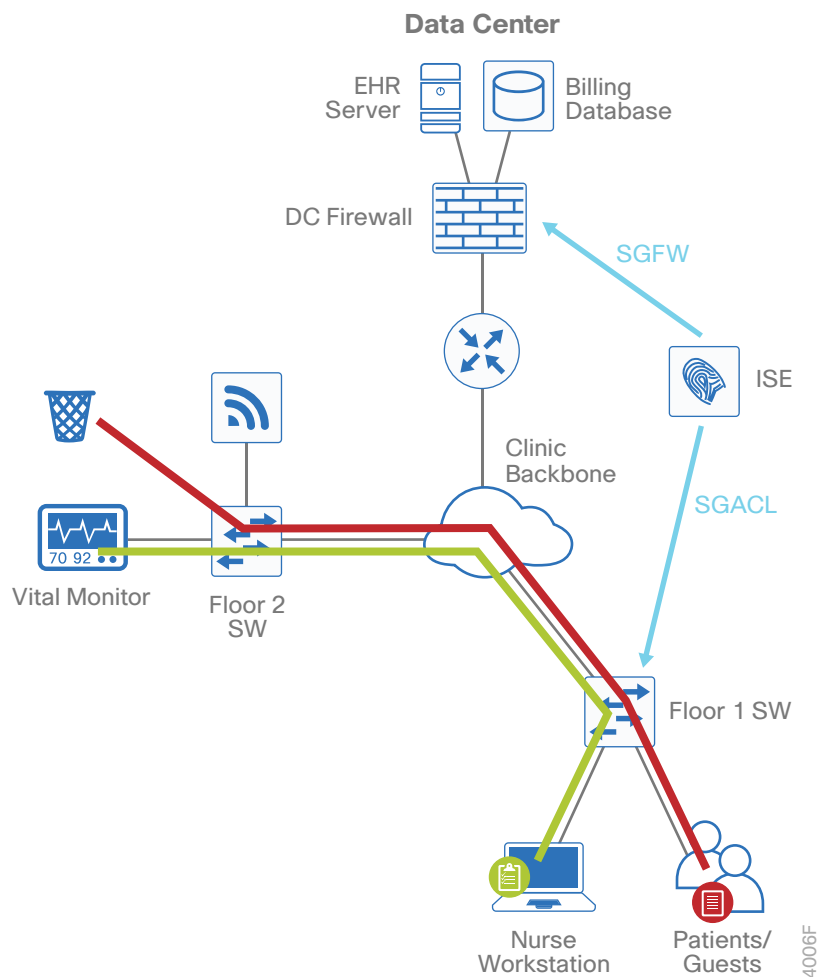
A hospital needs to limit access to electronic health records in order to comply with the Health Insurance Portability and Accountability Act (HIPAA).

Figure 3 TrustSec for HIPAA compliance



The hospital also needs to isolate medical devices used for patient care so that only authorized users, devices and servers have access to these medical devices.

Figure 4 TrustSec for medical device segmentation



Solution

Medical professionals use an authorized workstation in order to gain access to the electronic health records. The user authenticates to Cisco Identity Services Engine (ISE) and the device is verified to make sure it is authorized for access to the health records. The switch or wireless LAN controller (WLC) tags (with an SGT) the traffic from this workstation. The policy is enforced on the DC firewall with a Cisco Security Group Firewall (SGFW) that allows access to the electronic health records server only to those devices and users that are authorized, and all other devices and users are denied access.

SGTs are applied to authenticated users of medical devices and servers in order to explicitly allow access for authorized users by using security group access control Lists (SGACLs). Devices and users on the network that don't receive the SGT assigned are denied access.

FINANCE: BANK BRANCH NEEDS TO PROVIDE DIFFERENTIATED ACCESS FOR THE VARIOUS SERVICES AT A REMOTE SITE

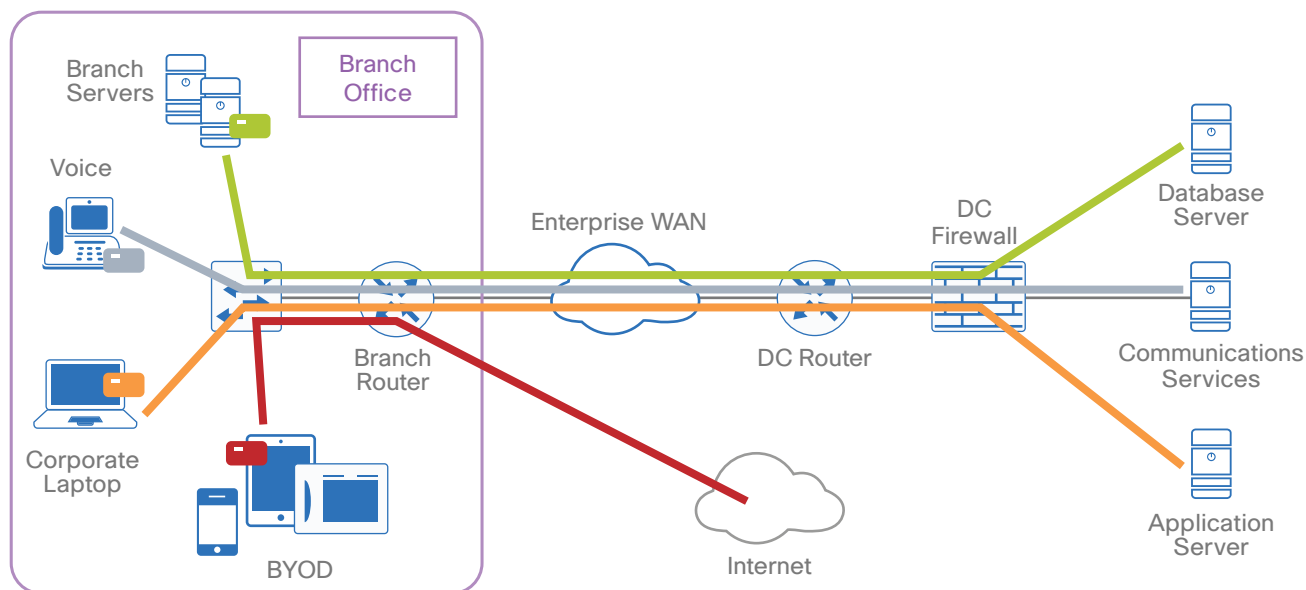
Business Problem

A financial customer requires segmentation of their various services at a remote office. The employee traffic, voice traffic, and server traffic must be in separate networks, as will any guest or bring your own device (BYOD) access. Each individual service must only be given access to the services that are required.

Solution

Each service at the remote site is in its own VLAN. When a device or user accesses the network, ISE authenticates and profiles them. The switch tags the traffic per VLAN, and then the policy is enforced on the remote site router using SGACLs as well as at the DC firewall using SGFW. Corporate traffic is allowed access only to the specific resources required for them. In this case, the employee can access the application server, the phone accesses the communication services, and the remote site server has access only to the database server. The guest or BYOD traffic is given access only to the Internet. With this topology, the VLAN scheme and tagging per VLAN can be replicated at every remote site, making policy configuration simple.

Figure 5 TrustSec for remote site segmentation



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LINE OF BUSINESS ACCESS CONTROL IN LARGE ENTERPRISES

Business Problem

New business risk and regulatory concerns require the business to implement security controls for users to the data center and within the data center:

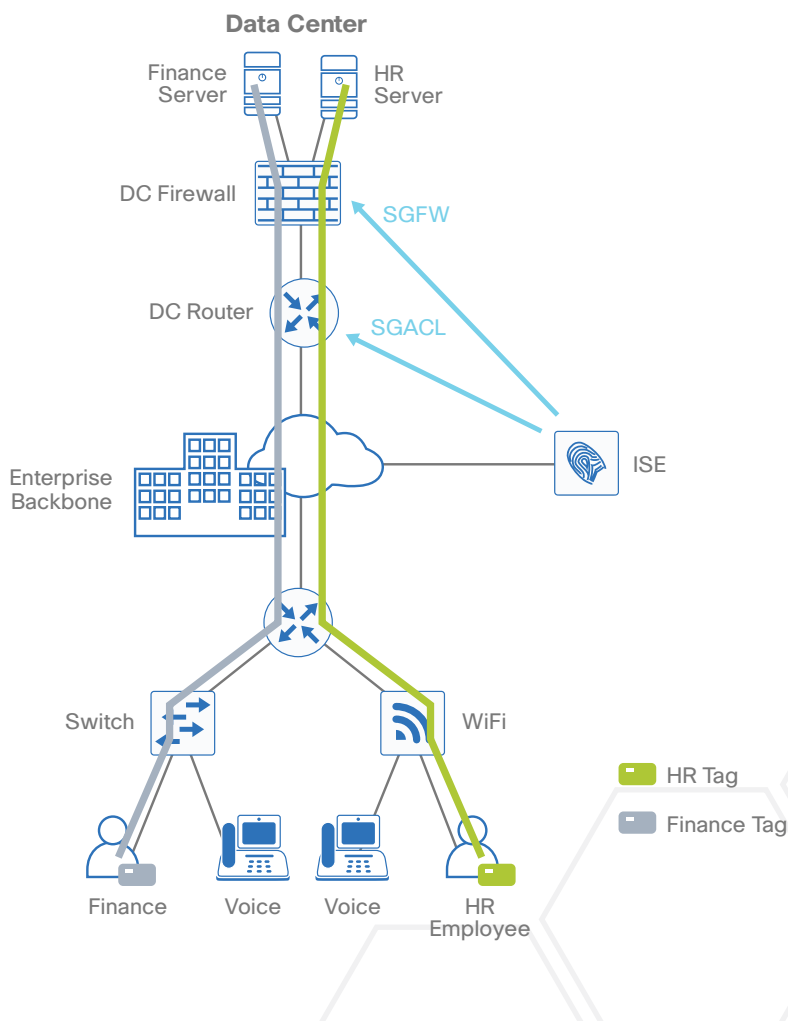
- Users (and devices) should only be allowed to base services and corresponding line of business applications.
- Applications should be segregated by line of business as well as restricted within the line of business.
- Policies are automatically applied for partner/contractors for application and other services.

Solution

Controlling the Services a User Can Access Based on Group Membership

Within the data center, there are specific resources available to different groups of users. For example, there are two servers in the data center, one that only the Finance group can access and another that is only for the Human Resources group. Users identified as members of either group are allowed access to their respective server, and any traffic from any other group is blocked by either the firewall or the data center router.

Figure 6 TrustSec for line-of-business access control

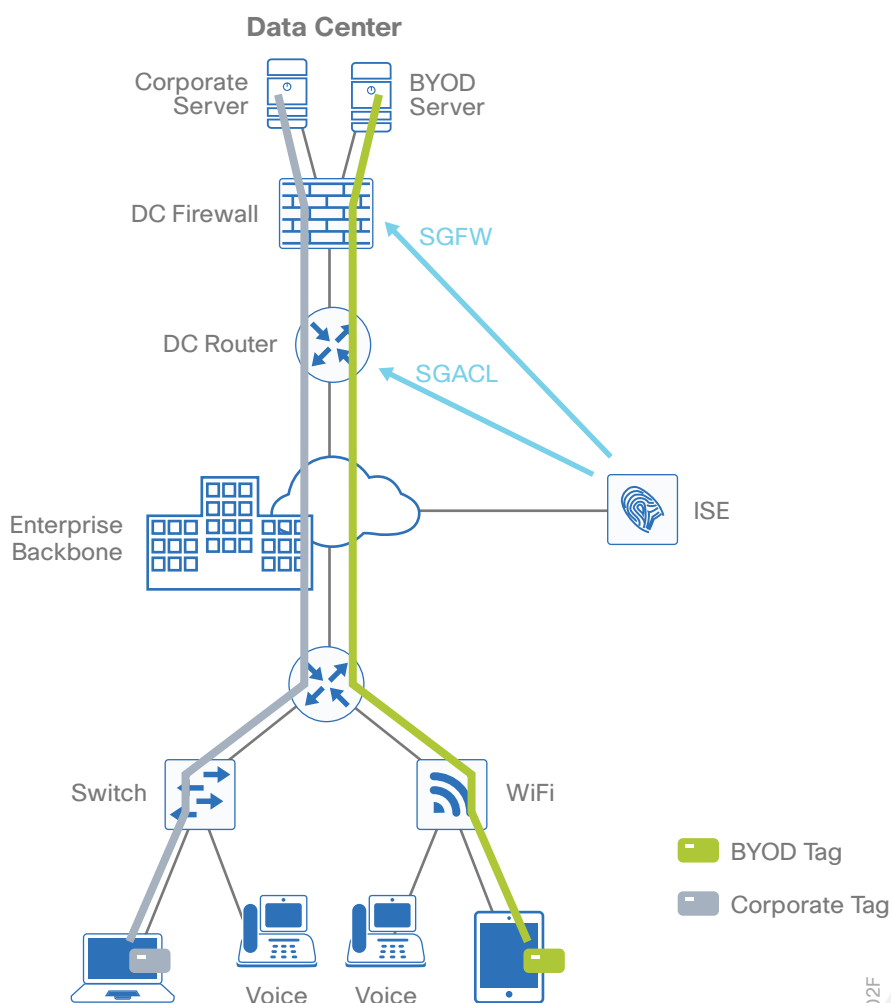


When the user first accesses the network, they authenticate. The switch or the WLC authenticates the user by using Cisco ISE, and the user is assigned a tag. The switch or WLC tags (with the SGT) the traffic from this user. The policy is enforced, based on the SGT, in the data center with an SGACL on the DC router or with an SGFW on the DC firewall.

Permitting Access to Data Center Resources Based on Device Type

An organization may have a BYOD policy that allows employees to use their smartphones and tablets for work. However, some services may not work well on these platforms, or perhaps policy doesn't allow personal devices access to certain resources. These devices are profiled, classified, and prevented from accessing services not intended for their use.

Figure 7 TrustSec for BYOD

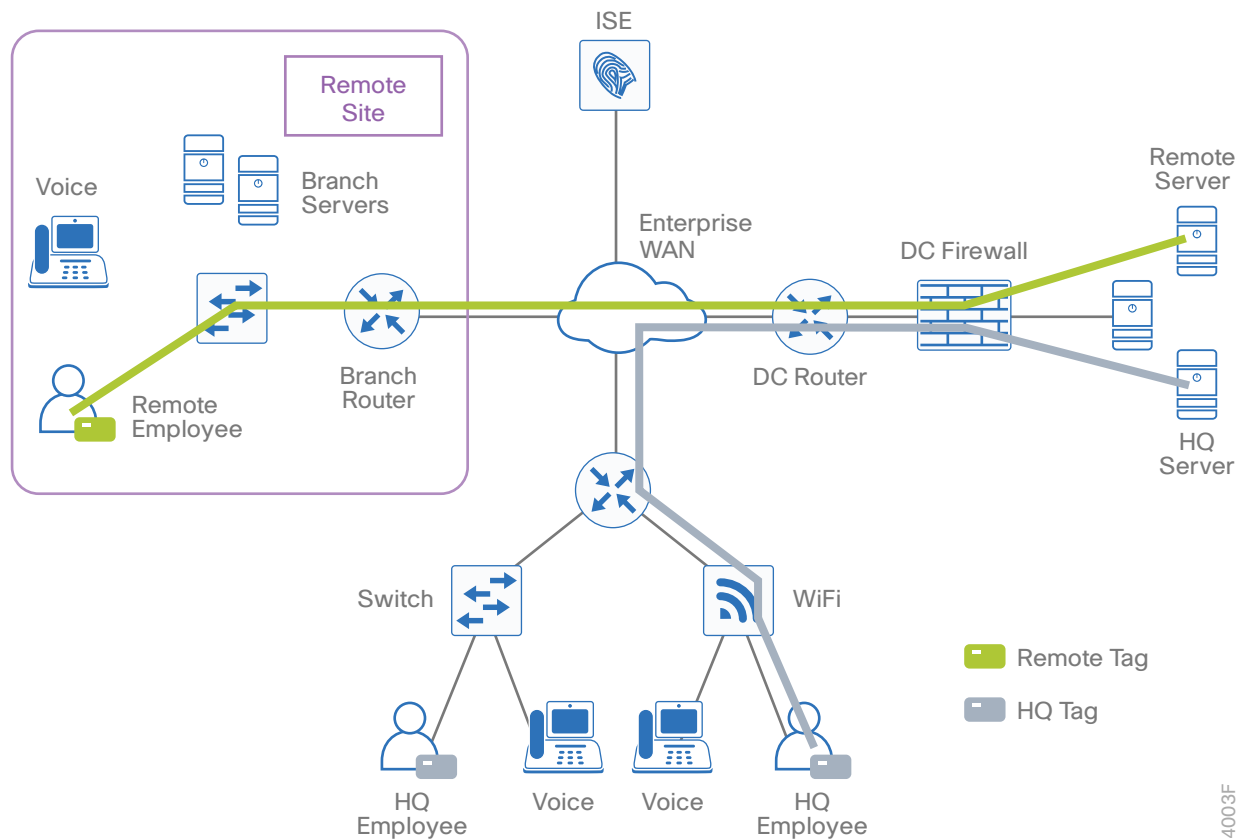


The user accesses the network with their BYOD device and is prompted for authentication credentials. Upon successful authentication, ISE profiles the device in order to determine the type of device, and the user is assigned a tag based on a combination of user and device type. The WLC tags traffic from the BYOD device and the user is limited to the BYOD server in the data center. This is enforced on the DC router with an SGACL or on the DC firewall with an SGFW.

Providing Differentiated Access to Data Center Resources Based on the User and Location

An organization may want to provide different levels of access to services in the data center, depending on where the user is located. There may be a different policy for users at a remote site that limits what the user can access remotely. This policy could also implement different levels of access per remote site or region.

Figure 8 TrustSec for location-based access control

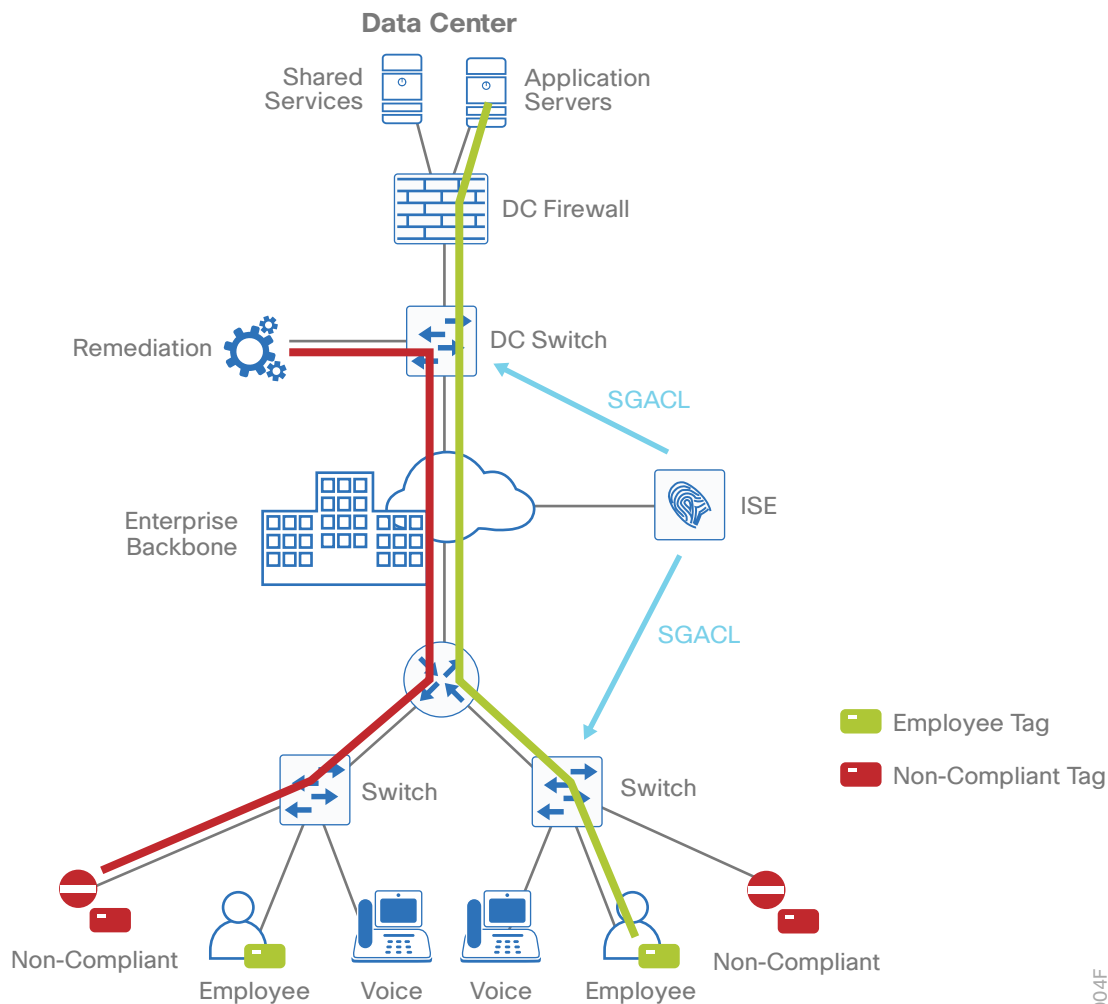


The remote employee accesses the network and authenticates, and the user is assigned a tag. The switch tags this traffic with the SGT, and this tag information is propagated to the DC firewall, where the policy is enforced with an SGFW.

Ensuring That Devices Are Compliant with Security Policy before Accessing Data Center Resources

To comply with security policy, all devices on the network must meet certain requirements, such as running an antivirus application or a minimum version of an OS. Without meeting the policy, the user is denied access to the data center resources and instead given access to remediation services.

Figure 9 TrustSec for security-policy compliance



The user accesses the network with a device that does not comply with the security policy. The user authenticates to the network, and Cisco ISE profiles the device and checks for compliance. After the device is determined to be non-compliant, the device is assigned a tag that indicates it is out of compliance and limits access to the remediation service. The policy is enforced with an SGACL, at the access switch or at the DC switch.

DESIGN OVERVIEW

Cisco ISE is an identity and access control policy platform that enables organizations to enforce compliance, enhance infrastructure security, and streamline their service operations. Cisco ISE is a core component of a Cisco TrustSec network. Its architecture allows an organization to gather real-time contextual information from the network, users, and devices to make proactive policy decisions by tying identity into network elements such as access switches, wireless controllers, and VPN gateways.

This deployment uses Cisco ISE as the authentication, authorization, and accounting server for the wired and wireless networks using RADIUS. Cisco ISE acts as a proxy to the existing Active Directory (AD) services to maintain a centralized identity store for all network services.

In addition to authentication, this deployment uses Cisco ISE to profile devices in order to determine the spe-

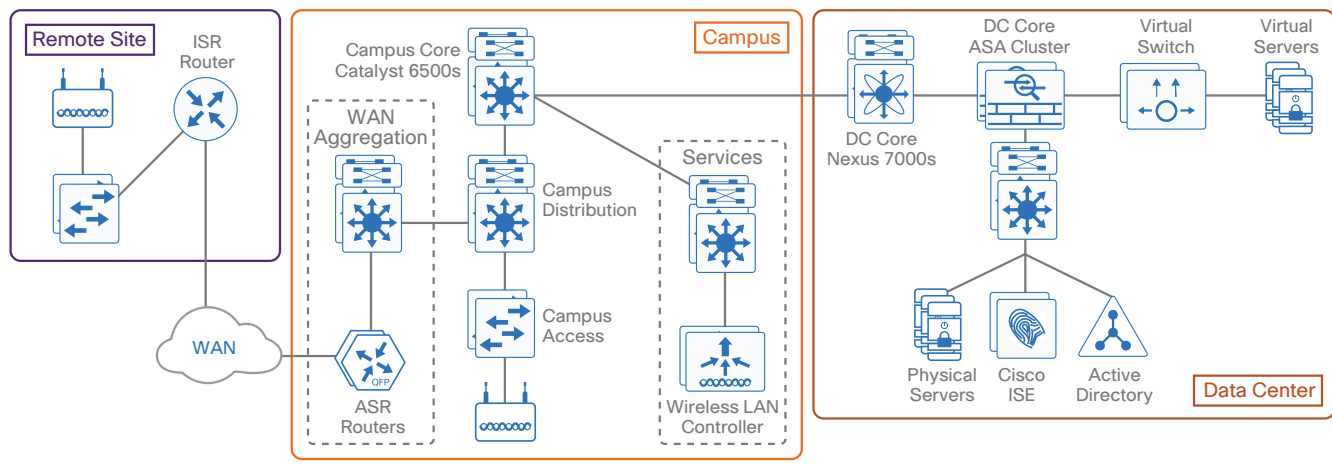
cific type of devices that are accessing the network. This is done by examining network traffic for certain criteria, based on certain characteristics. Cisco ISE currently has probes for Dynamic Host Configuration Protocol (DHCP), HTTP, RADIUS, Domain Name System (DNS), Simple Network Management Protocol (SNMP) traps and queries, Network Mapper (Nmap) scans, and Cisco IOS NetFlow. To analyze the traffic, the engine can be deployed as an inline policy enforcement device, or the traffic can be forwarded to the engine. As an example, the network infrastructure is configured to send DHCP and Cisco Discovery Protocol (CDP) data via RADIUS to Cisco ISE for analysis. The engine then evaluates the RADIUS data and can identify the device based off of the data in the RADIUS packet. For example, Cisco IP Phones are identified by their DHCP class identifier.

This document builds upon the foundation of the [Campus 802.1X Authentication Technology Design Guide](#) where both 802.1X monitor mode and low-impact mode deployments are shown.

The deployment in use will use dynamic classification on the access switches and wireless LAN controllers and assign a tag based on the user's group assignment in Active Directory. The policy deployed restricts the user's access to their specific departmental servers in the data center. For example, users in the Finance group can only access the Finance group's servers. This policy is enforced at the Cisco Nexus 7000 switches and also at the Cisco ASA 5585 cluster in the core of the data center.

To propagate the tags throughout the network, the deployment uses two methods. The first method is using inline tagging in the data plane. The tag is embedded in the Cisco metadata in the Layer 2 header and carried throughout the network. This requires that all infrastructure along the path must support inline tagging. The second is using the SGT Exchange Protocol (SXP), which is a control plane protocol that propagates the IP-to-SGT mapping database from network authentication points such as access layer switches to upstream network devices. SXP is a TCP-based peering protocol and can be used to propagate tags in an environment where all devices do not support inline tagging.

Figure 10 Example network



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Deployment Details

The deployment described is based on several design guides that comprise the reference network architecture. Those guides are the [Campus LAN and Wireless LAN Design Guide](#) and the [WAN Design Guide](#). All IP addressing is based off the [Campus Wired LAN Design Guide](#). IP addresses used in this guide are examples; you should use addressing that is applicable to your architecture.

Cisco ISE has different personas, or modes, for which it can be configured: administration, policy service, and monitoring. For a standalone configuration where the appliance uses all personas, the maximum number of endpoints that can be supported is 10,000—dependent upon the installation hardware. To support a greater number of endpoints, to add additional resiliency, or to distribute policy services, you divide the personas across multiple appliances. In this example, there are six nodes. Two nodes are running both Administration and Monitoring personas: one is primary for these personas and one is secondary. Two additional nodes are running the Policy Service persona. The remaining nodes are for the pxGrid service and the SXP service. This configuration offers resiliency and allows the deployment to scale to 10,000 endpoints for some hardware choices. To scale beyond 10,000 endpoints, you must deploy all personas on dedicated appliances.

You can use shorthand references for the nodes. A node that runs the Administration persona is called a Policy Administration Node (PAN), a node that runs the Monitoring persona is called a Monitoring and Troubleshooting Node (MnT), and a node that runs the Policy Service persona is called a Policy Service Node (PSN).

Table 1 Cisco ISE node IP addresses and hostnames

Device Persona	Shorthand	IP address	Hostname
Cisco ISE primary Policy Administration Node and secondary Monitoring and Troubleshooting node	Primary PAN/Secondary MnT	10.4.48.41	ise-1.cisco.local
Cisco ISE secondary Policy Administration Node and secondary Monitoring and Troubleshooting node	Secondary PAN/Primary MnT	10.4.48.42	ise-2.cisco.local
Cisco ISE Policy Service Node	First PSN	10.4.48.43	ise-3.cisco.local
Cisco ISE additional Policy Service Node	Additional PSN	10.4.48.44	ise-4.cisco.local
Cisco ISE SXP Node	SXP PSN	10.4.48.40	ise-sxp.cisco.local
Cisco ISE pxGrid Node	pxGrid	10.4.48.45	ise-pxgrid.cisco.local

Deploying ISE

1. Configure policy service node for SXP
2. Enable RADIUS profiling
3. Install Cisco ISE license
4. Configure network devices in Cisco ISE
5. Configure advanced TrustSec settings for Catalyst switches
6. Configure advanced TrustSec settings for NX-OS switches
7. Configure advanced TrustSec settings for Cisco ASA firewalls
8. Configure the RADIUS default device
9. Configure Cisco ISE to use Active Directory
10. Configuring ISE for authentication
11. Create security group tags
12. Configure TrustSec AAA servers
13. Configure security group access control lists
14. Create policy
15. Enable device authorization
16. Configure authorization profile
17. Configure authorization policy
18. Verify default policy is closed

In this deployment, the Cisco ISE nodes are running as virtual machines. The installation process is detailed in the [Campus 802.1X Authentication Technology Design Guide](#) and should be used as a reference.

Reader Tip

Instructions for deploying an ISE pxGrid node can be found: http://www.cisco.com/c/dam/en/us/td/docs/security/ise/how_to/HowTo-88-Configuring-pxGrid-in-an-ISE-Distributed-Environment.pdf

Procedure 1 Configure policy service node for SXP

One of the PSNs installed is configured as an SXP node. In a distributed deployment, it is recommended that you deploy the SXP service on a PSN with no other services enabled.

Step 1: Using a browser, connect and log in to the PAN (example: <https://ise-1.cisco.local>).

Step 2: From the **Administration** menu, choose **System**, and then choose **Deployment**.

Step 3: In the **Deployment Nodes** list, choose the name of the node you will configure as the SXP PSN.

Step 4: Select **Policy Service**.

Step 5: In the Policy Service section, select **Enable SXP Service**, and then select the interface to use.

The screenshot shows the 'General Settings' configuration page for a node. The node is named 'ise-sxp' with FQDN 'ise-sxp.cisco.local' and IP address '10.4.48.40'. The node type is 'Identity Services Engine (ISE)'. Under the 'Personas' section, 'Policy Service' is selected. Within 'Policy Service', 'Enable SXP Service' is checked, and the 'Use Interface' is set to 'GigabitEthernet 0'. Other services like 'Administration', 'Monitoring', 'Enable Session Services', 'Enable Profiling Service', 'Enable Device Admin Service', and 'Enable Identity Mapping' are not selected.

Persona	Role	Other Monitoring Node
<input type="checkbox"/> Administration	SECONDARY	
<input type="checkbox"/> Monitoring	SECONDARY	
<input checked="" type="checkbox"/> Policy Service		
<input type="checkbox"/> Enable Session Services		
Include Node in Node Group: None		
<input type="checkbox"/> Enable Profiling Service		
<input checked="" type="checkbox"/> Enable SXP Service		
Use Interface: GigabitEthernet 0		
<input type="checkbox"/> Enable Device Admin Service		
<input type="checkbox"/> Enable Identity Mapping		

Step 6: Click **Save**.

Tech Tip

After you have finished software installation, you should check the release notes to see if there are patches available to apply that are appropriate for the requirements of your organization. After you download any required patches, you can automatically distribute and apply them to all nodes by navigating to **Administration > System > Maintenance**, selecting **Patch Management**, and following the instructions.

Procedure 2 Enable RADIUS profiling

You can use Cisco ISE to profile endpoints in order to determine what types of devices are accessing the network using information contained in the RADIUS transactions. You can use this information to create specific policies for different endpoints. Although enabling profiling is not required in this deployment, it is useful to do so for better visibility into the endpoints accessing the network.

Step 1: Navigate to **Administration > System > Deployment**.

Step 2: In the **Deployment Nodes** list, choose one of the policy service nodes.

Step 3: On the General Setting tab, in the Policy Service section, select **Enable Profiling Service**.

The screenshot shows the configuration interface for a Policy Service. The 'Policy Service' checkbox is checked. Underneath, 'Enable Session Services' is checked, and the 'Include Node in Node Group' dropdown menu is set to 'ISE_Group'. 'Enable Profiling Service' is also checked.

Step 4: On the Profiling Configuration tab, select **RADIUS**.

The screenshot shows the 'RADIUS' section expanded in the Profiling Configuration tab. A description box is visible, stating: 'The RADIUS probe collects RADIUS session attributes as well as CDP, LLDP, DHCP, HTTP and MDM from IOS Sensor.'

Step 5: Click **Save**.

Step 6: For each additional PSN, repeat Step 1 through Step 5.

Procedure 3 Install Cisco ISE license

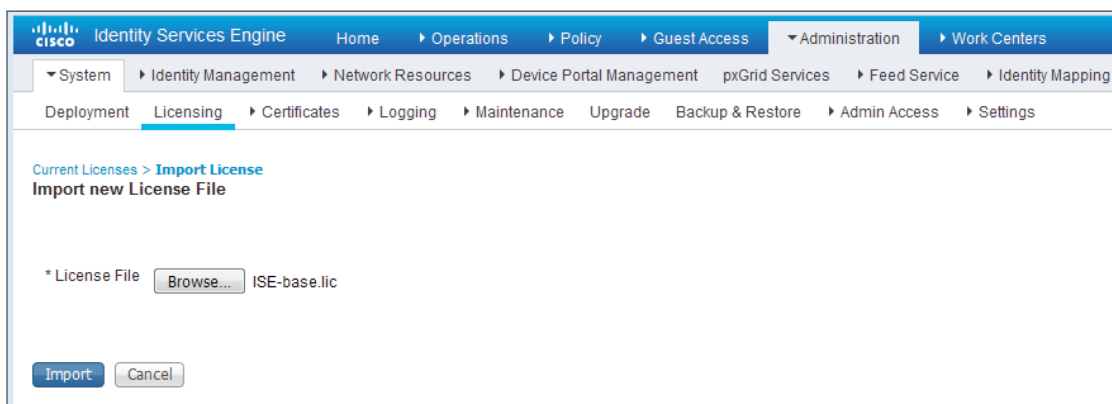
Cisco ISE comes with a 120-day demo license for both the Base and Advanced packages. To go beyond 120 days, you need to obtain a license from Cisco. In a distributed deployment, you need to install only the license on the primary administration node.

Tech Tip

When installing a Base license and an Advanced license, you must install the Base license first.

Step 1: Navigate to **Administration > System > Licensing**.

Step 2: In the License Files section, click **Import License**.



Step 3: Click **Browse**, locate your license file, and then click **Import**.

Step 4: If you have multiple licenses to install, repeat Step 2 and Step 3 for each.

Procedure 4 Configure network devices in Cisco ISE

Configure Cisco ISE to accept authentication requests from network devices. RADIUS requires a shared secret key to enable encrypted communications. Each network device that uses Cisco ISE for authentication need to have this key. You can configure each network device individually or group devices by location, by device type, or by using IP address ranges. The other option is to use the Default Device to configure the parameters for devices that aren't specifically configured.

Step 1: Navigate to **Administration > Network Resources > Network Devices**.

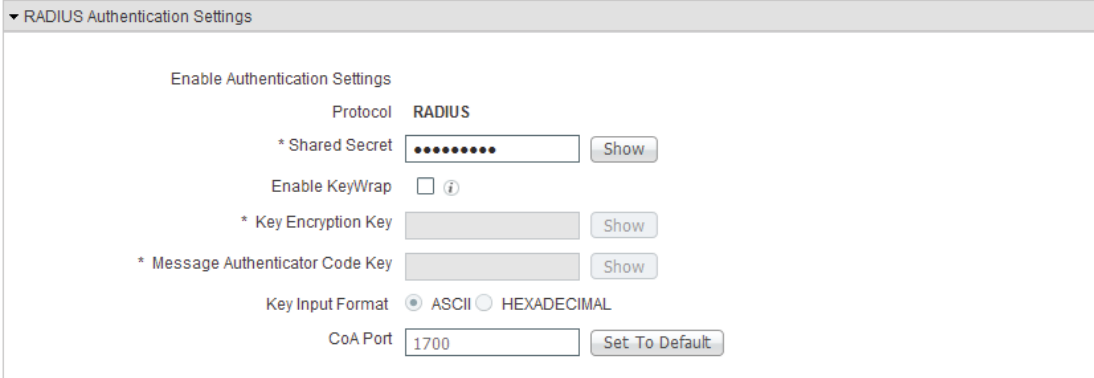
Step 2: Click **Add**.

Step 3: Enter a name, description (optional), and IP address for the device.

Step 4: In the **Device Profile** list, choose **Cisco**.

Step 5: Select **RADIUS Authentication Settings**. The section expands.

Step 6: Enter the RADIUS Shared Secret.



The screenshot shows the 'RADIUS Authentication Settings' configuration window. It includes the following fields and options:

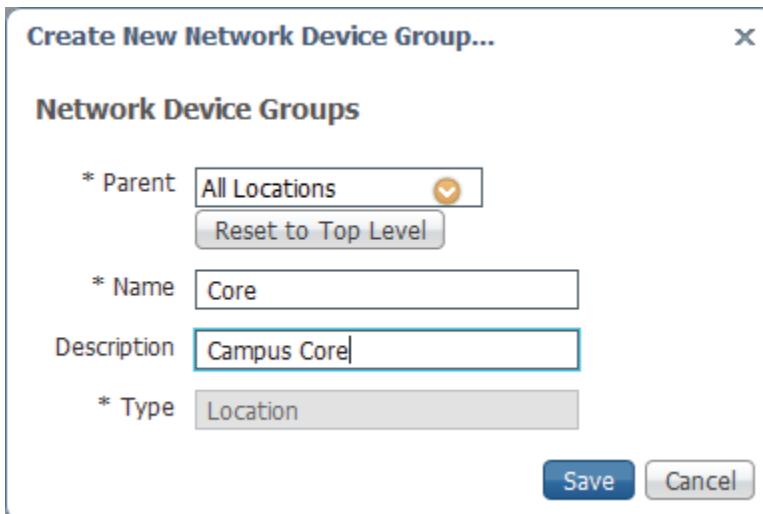
- Enable Authentication Settings:** A checkbox that is currently checked.
- Protocol:** Set to 'RADIUS'.
- * Shared Secret:** A text field containing masked characters (dots) and a 'Show' button.
- Enable KeyWrap:** An unchecked checkbox with an information icon.
- * Key Encryption Key:** A text field and a 'Show' button.
- * Message Authenticator Code Key:** A text field and a 'Show' button.
- Key Input Format:** Radio buttons for 'ASCII' (selected) and 'HEXADECIMAL'.
- CoA Port:** A text field containing '1700' and a 'Set To Default' button.

Step 7: To better organize and identify devices, it's desirable to use Device Groups to identify the type of device as well as its location.

Step 8: In the **Device Type** list, choose a device type. You can create a new device type by clicking on the gear icon in the upper right corner and selecting **Create New Network Device Group**.

Step 9: In the **Parent** list, choose the parent device group.

Step 10: Enter a name and (optionally) description, and then click **Save**.



The screenshot shows the 'Create New Network Device Group' dialog box. It includes the following fields and options:

- Network Device Groups:** The title of the dialog.
- * Parent:** A dropdown menu set to 'All Locations' with a 'Reset to Top Level' button below it.
- * Name:** A text field containing 'Core'.
- Description:** A text field containing 'Campus Core'.
- * Type:** A dropdown menu set to 'Location'.
- Buttons:** 'Save' and 'Cancel' buttons at the bottom right.

Step 11: From the **Device Type** list, choose the newly created device type.

Step 12: In the **Location** list, choose a location. You can create a new location by clicking on the gear icon in the upper right corner and selecting **Create New Network Device Group**.

Step 13: In the **Parent** list, choose the parent device group.

Step 14: Enter a name and (optionally) description, and then click **Save**.

Step 15: From the **Location** list, choose the newly created location.

Tech Tip

You can also configure Network Device Groups by navigating to **Administration > Network Resources > Network Device Groups**. You can define all of the groups prior to adding the network devices.

With the exception of the wireless LAN controllers, when defining a network device for use in a TrustSec environment, you need to configure the Advanced TrustSec Settings section. This allows the network device to download the TrustSec environment data and policy and also to perform enforcement. The options vary depending on the network device, and they are covered below.

Procedure 5 Configure advanced TrustSec settings for Catalyst switches

Step 1: Select **Advanced TrustSec Settings**. The section expands.

Step 2: In the Device Authentication Settings section, make sure **Use Device ID for TrustSec Identification** box is selected (to use the device name defined in the previous procedure), and then enter a password.

Step 3: In the TrustSec Notifications and Updates section, enter the frequency at which environment and policy updates will occur. The default values are 1 day.

Step 4: Select **Other TrustSec devices to trust this device**. Peer devices will not change the SGTs on packets arriving from this network device.

Step 5: If the device will be used to enforce policy, select **Send configuration changes to this device**, and then select **CoA**. This enables ISE to send policy changes to the network device.

Advanced TrustSec Settings

▼ Device Authentication Settings

Use Device ID for TrustSec

Identification

Device Id

* Password

▼ TrustSec Notifications and Updates

* Download environment data every

* Download peer authorization policy every

* Reauthentication every ⓘ

* Download SGACL lists every

Other TrustSec devices to trust this device

Send configuration changes to device Using CoA CLI (SSH)

Ssh Key

Step 6: Click **Submit**.

Procedure 6 Configure advanced TrustSec settings for NX-OS switches

Step 1: Select **Advanced TrustSec Settings**. The section expands.

Step 2: In the Device Authentication Settings section, make sure the **Use Device ID for TrustSec Identification** box is selected (to use the device name defined in the previous procedure), and then enter a password.

Step 3: In the TrustSec Notifications and Updates section, enter the frequency at which environment and policy updates will occur. The default values are 1 day.

Step 4: Select **Other TrustSec devices to trust this device**. Peer devices will not change the SGTs on packets arriving from this network device.

Step 5: If the device will be used to enforce policy, select **Send configuration changes to this device**, and then select **CLI (SSH)**. Leave the **Ssh Key** field blank. This enables ISE to send policy changes to the network device.

Step 6: In the Device Configuration Deployment section, select **Include this device when deploying Security Group Tag Mapping Updates**.

Step 7: Enter the EXEC Mode Username, EXEC Mode Password, and Enable Mode Password. This allows ISE to access the network device.

Advanced TrustSec Settings

Device Authentication Settings

Use Device ID for TrustSec

Identification

Device Id

* Password

TrustSec Notifications and Updates

* Download environment data every

* Download peer authorization policy every

* Reauthentication every ⓘ

* Download SGACL lists every

Other TrustSec devices to trust this device

Send configuration changes to device Using CoA CLI (SSH)

Ssh Key

Device Configuration Deployment

Include this device when deploying Security Group Tag Mapping Updates

Device Interface Credentials

* EXEC Mode Username

* EXEC Mode Password

Enable Mode Password

Step 8: Click Submit.

Procedure 7 Configure advanced TrustSec settings for Cisco ASA firewalls

Step 1: Select **Advanced TrustSec Settings**. The section expands.

Step 2: In the Device Authentication Settings section, make sure **Use Device ID for TrustSec Identification** box is selected (to use the device name defined in the previous procedure), and then enter a **Password**.

Tech Tip

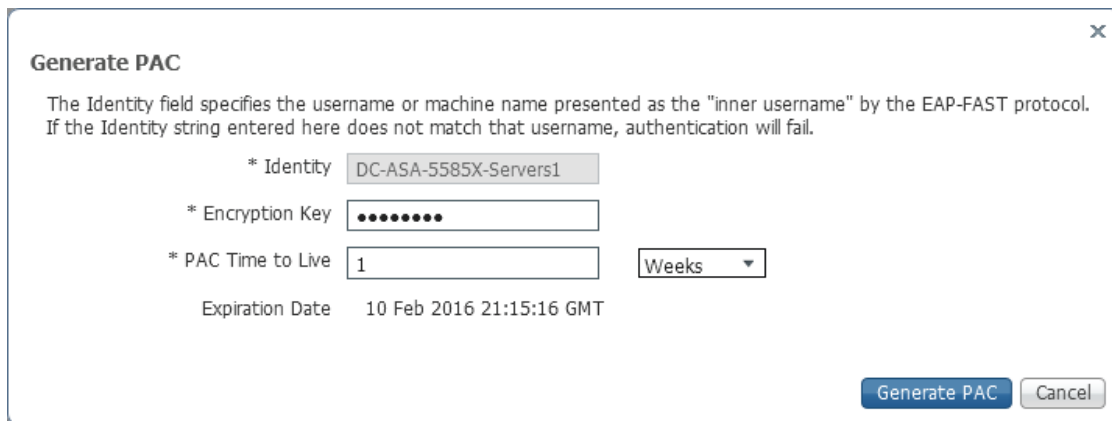
Because Cisco ASA supports out-of-band protected access credentials (PAC) provisioning, the password is not used. However, in order to save the network device configuration, there must be a value in this box.

Step 3: In the TrustSec Notifications and Updates section, enter the frequency environment and policy updates will occur. The default values are 1 day.

Step 4: Select **Other TrustSec devices to trust this device**. Peer devices will not change the SGTs on packets arriving from this network device.

Step 5: In the Out Of Band (OOB) TrustSec PAC section, click **Generate PAC**.

Step 6: Enter an encryption key and the PAC time to live, and then click **Generate PAC**. You are prompted to save the file to your local machine.



Generate PAC

The Identity field specifies the username or machine name presented as the "inner username" by the EAP-FAST protocol. If the Identity string entered here does not match that username, authentication will fail.

* Identity

* Encryption Key

* PAC Time to Live

Expiration Date 10 Feb 2016 21:15:16 GMT

Step 7: Choose a location, and then click **OK**.

Step 8: Click **Submit**.

Step 9: Later in this guide, you will import this PAC into Cisco ASA.

Procedure 8 Configure the RADIUS default device

Step 1: Navigate to **Administration > Network Resources > Network Devices**.

Step 2: In the navigation panel on the left, click **Default Device**.

Step 3: In the **Default Network Device Status** list, choose **Enable**.

Step 4: Enter the RADIUS shared secret, and then click **Save**. The default network device configuration is now saved.

Default Network Device

The default device definition can optionally be used in cases where no specific device definition is found that matches a device IP address

Default Network Device Status

Device Profile Cisco

Protocol **RADIUS**

* Shared Secret

Enable KeyWrap

* Key Encryption Key

* Message Authenticator Code Key

Key Input Format ASCII HEXADECIMAL

TACACS+Authentication Settings

Shared Secret

Enable Single Connect Mode

Legacy Cisco Device
 TACACS+ Draft Compliance Single Connect Support

Procedure 9 Configure Cisco ISE to use Active Directory

Cisco ISE uses the existing AD server as an external authentication server. First, you must configure the external authentication server.

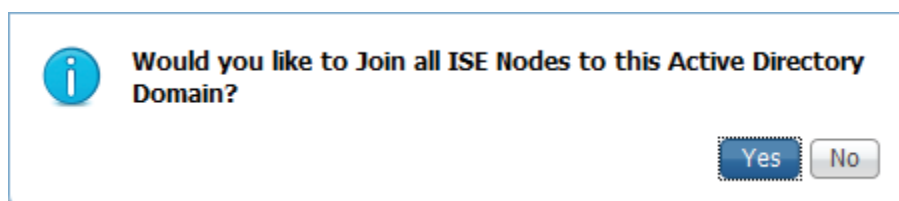
Step 1: Navigate to **Administration > Identity Management > External Identity Sources**.

Step 2: In the left panel, click **Active Directory**, and then click **Add**.

Step 3: Enter a join point name and the Active Directory domain.

Step 4: Click **Submit**.

Step 5: In the message asking if you'd like to join all ISE nodes to the domain, click **Yes**.



Step 6: In the Join Domain window, enter an **AD User Name** and **Password**. If the organizational unit must be provided, select **Specify Organizational Unit** and enter it. Click **OK**.

Step 7: In the Join Operation Status window, click **Close**.

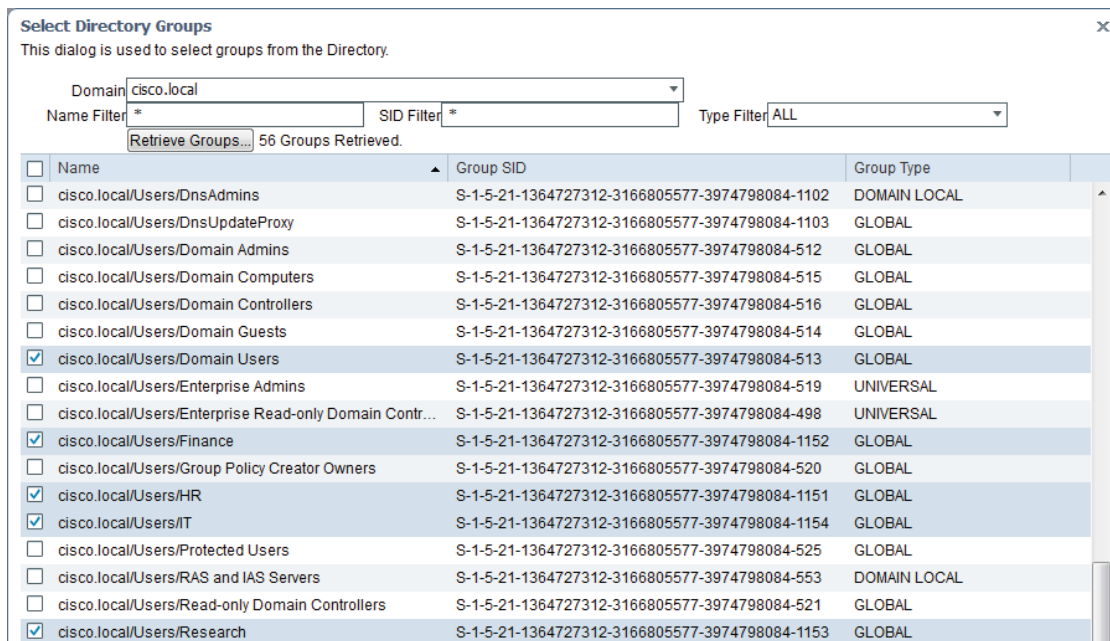
ISE Node	Node Status
ise-1.cisco.local	✓ Completed.
ise-2.cisco.local	✓ Completed.
ise-3.cisco.local	✓ Completed.
ise-4.cisco.local	✓ Completed.
ise-sxp.cisco.local	✓ Completed.
pxgrid.cisco.local	✓ Completed.

Next, you select the AD groups that Cisco ISE uses for authentication.

Step 8: Click on the Groups tab, click **Add**, and then click **Select Groups from Directory**.

Step 9: Search for the groups you wish to add. The domain box is already filled in. The default filter is a wildcard to list all groups. To get a list of all groups in your domain, click **Retrieve Groups**.

Step 10: Select the groups you want to use for authentication, and then click **OK**. For example, for all users in the domain, select the group **<domain>/Users/Domain Users**. In this deployment, there are four groups that are assigned SGTs. They are Finance, HR, IT, and Research. Select those groups as well.



Step 11: Click **Save**.

Procedure 10 Configuring ISE for authentication

Now that ISE has a basic configuration, you configure an authentication policy for devices and users accessing the network.

Step 1: Navigate to **Policy > Authentication**. The Policy Type is Rule-Based.

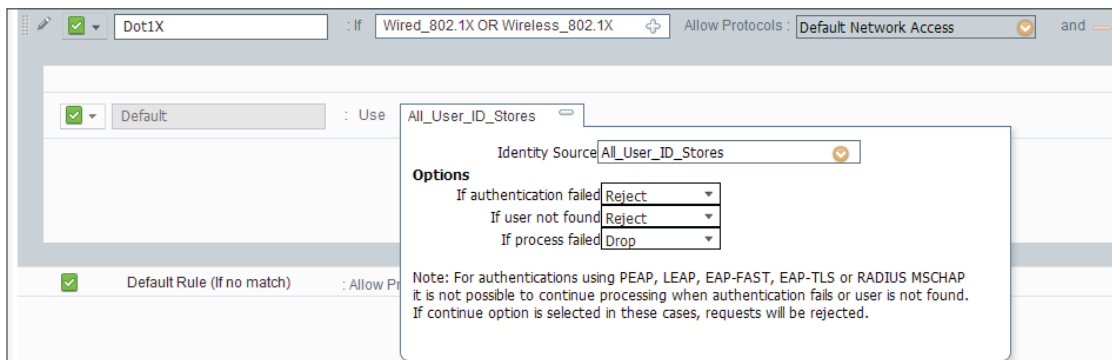
There are already three preconfigured rules in place, MAB, Dot1X, and the default rule, which is the final, catch-all rule.

Step 2: For the **Dot1X** rule, click **Edit**. In the **Use** list, click the **+** symbol. The identity store used for this rule appears.



Step 3: In the **Identity Source** list, choose **All_User_ID_Stores**. This allows you to use both the internal database and the external Active Directory database for 802.1X authentication.

Step 4: Click **Done**, and then click **Save**.



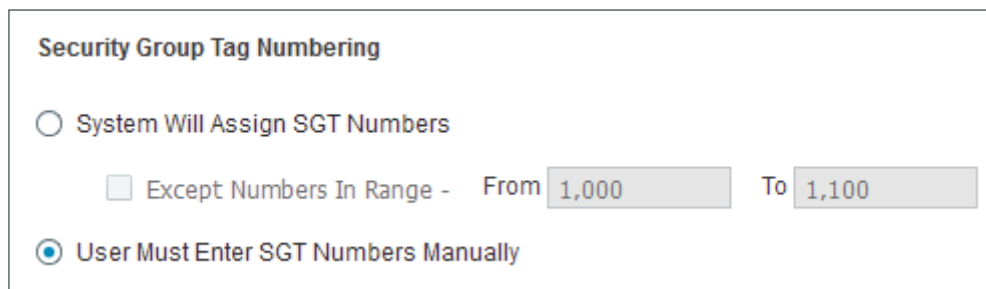
Procedure 11 Create security group tags

With authentication configured, you configure the security group tags (SGTs) used for authorization.

Step 1: Navigate to **Work Centers > TrustSec > Settings**, and then in the left navigation pane, click **General TrustSec Settings**.

Step 2: The default configuration of ISE is for the system to assign the SGT numbers. This example deployment uses manually assigned SGT numbers, which provides more flexibility and aids in troubleshooting.

Step 3: In the **Security Group Tag Numbering** section, select **User Must Enter SGT Numbers Manually**.



Step 4: Click **Save**.

Step 5: Navigate to **Work Centers > TrustSec > Components**, and then in the left navigation pane, click **Security Groups**.

Step 6: For convenience, there are already several security groups defined for some common classifications, such as Employees, Contractors, and Developers.

Step 7: Click **Add**. The New Security Group window opens.

Step 8: In this deployment, there are four departments: Finance, HR, IT, and Research. Each department has two security groups: one for users and one for servers. The security group names and tag values are listed in the table below:

Table 2 Security groups

Security group name	Security group tag value
Finance_Servers	1000
Finance_Users	1001
HR_Servers	2000
HR_Users	2001
IT_Servers	3000
IT_Users	3001
Research_Servers	4000
Research_Users	4001

Step 9: Enter a **Name** for the security group, select an **Icon**, and (optionally) enter an **Description** and **Tag Value**.

Step 10: Click **Submit**.






















Step 11: For each group in Table 2, repeat this procedure.

Security Groups List > **New Security Group**

Security Groups

*** Name**

*** Icon**

Description

Tag Value

(Enter value between 2 and 65519)

Generation Id: 0

Procedure 12 Configure TrustSec AAA servers

In a multinode ISE deployment, each PSN needs to be added as a TrustSec AAA server.

Step 1: Navigate to **Work Centers > TrustSec > Components**, and then in the left navigation pane, click **Trustsec AAA Servers**.

Step 2: Click **Add**.

Step 3: Enter the name of the PSN, (optionally) a description, and the IP address. The default value of 1812 for the port is already entered.

AAA Servers List > New AAA Server

AAA Servers

* Name

Description

* IP (Example: 10.1.1.1)

* Port (Valid Range 1 to 65535)

Step 4: For every PSN in the deployment, repeat this procedure. Also, if the primary PAN is already configured as an AAA server, now you can delete it.

Procedure 13 Configure security group access control lists

Step 1: With security groups defined, you next create Security Group Access Control Lists (SGACLs) that are used to define the policy enforced in the deployment. The policy enforced is that intra-departmental traffic is permitted but inter-departmental traffic is denied. For example, users in HR are able to communicate with each other and with the HR servers. In addition, HR servers can communicate with each other. This policy is just an example and you should create a policy that meets your organization's needs.

Step 2: Navigate to **Work Centers > TrustSec > Components**, and then in the left navigation pane, click **Security Group ACLs**.

Step 3: Click **Add**. The New Security Group ACLs window opens.

Step 4: The following table lists the SGACLs to be configured:

Table 3 SGACLs

Name	IP Version	Security Group ACL Content
Finance_ACL	IPv4	permit ip log
HR_ACL	IPv4	permit ip log
IT_ACL	IPv4	permit ip log
Research_ACL	IPv4	permit ip log
Deny_All	IPv4	deny ip log

Step 5: Enter the name and (optionally) description, and under **IP Version**, select **IPv4**.

Step 6: In the **Security Group ACL content** field, enter in the ACL to be used.

Step 7: Click **Submit**.

Step 8: For each ACL in Table 3, repeat this procedure .

Security Groups ACLs List > [New Security Group ACLs](#)

Security Group ACLs

* Name Generation ID: 0

Description

IP Version IPv4 IPv6 Agnostic

* Security Group ACL content

Procedure 14 Create policy

With the SGTs and SGACLs defined, you now create the policy by assigning the SGACLs to source and destination group pairs. In this deployment, the policy enforced is that intra-departmental traffic is permitted but inter-departmental traffic is denied. For example, users in HR are able to communicate with each other and with the HR servers. In addition, HR Servers can communicate with each other. The policy is defined in a matrix where the source is listed on the left and the destination is listed on the top. At the intersection for a given pair, the SGACL listed is the enforced policy.

Table 4 TrustSec egress policy matrix

Source	Destination							
	Finance_Servers	Finance_Users	HR_Servers	HR_Users	IT_Servers	IT_Users	Research_Servers	Research_Users
Finance_Servers	Finance_ACL	Finance_ACL	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All
Finance_Users	Finance_ACL	Finance_ACL	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All
HR_Servers	Deny_All	Deny_All	HR_ACL	HR_ACL	Deny_All	Deny_All	Deny_All	Deny_All
HR_Users	Deny_All	Deny_All	HR_ACL	HR_ACL	Deny_All	Deny_All	Deny_All	Deny_All
IT_Servers	Deny_All	Deny_All	Deny_All	Deny_All	IT_ACL	IT_ACL	Deny_All	Deny_All
IT_Users	Deny_All	Deny_All	Deny_All	Deny_All	IT_ACL	IT_ACL	Deny_All	Deny_All
Research_Servers	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All	Research_ACL	Research_ACL
Research_Users	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All	Deny_All	Research_ACL	Research_ACL

Step 1: Navigate to **Work Centers > TrustSec > Policy**, and then in the left navigation pane, in the Egress Policy section, click **Matrix**.

Step 2: Double-click in the intersection of the source and destination groups to edit the policy.

Step 3: Verify that the Status is **Enabled** and optionally provide a description.

Step 4: On the Assigned Security Group ACLs section, in the list, choose the previously defined SGACL.

Step 5: Click Save.

Edit Permissions...

Source Security Group **Finance_Users (1001/03E9)**

Destination Security Group **Finance_Servers (1000/03E8)**

Status Enabled

Description

Assigned Security Group ACLs

Finance_ACL

Final Catch All Rule None

Save Cancel

Step 6: For every source and destination group pair in Table 4, repeat this procedure.

Procedure 15 Enable device authorization

Now that policy has been created, you need to enable authorization for the devices where policy is to be enforced. In this deployment, enforcement is going to occur at the Nexus 7000s in the data center.

Step 1: Navigate to **Work Centers > TrustSec > Policy**, and then in the left navigation pane, click **Network Device Authorization**.

Step 2: On the right of the default rule, click the black triangle, and then select **Insert new row above**.

Step 3: Enter a name for the rule, and then click the + symbol next to Condition(s).

Step 4: Click **Create New Condition (Advance Option)**.

Step 5: You need to identify the switches defined previously as a network device. In this deployment, they were added to the DC Switch group, and this is what this rule uses.

Step 6: In the **Expression** list, choose **Device Type**.

Step 7: In the second list, make sure **Equals** is chosen.

Step 8: In the third list, choose **All Device Types#DC Switch**.

Step 9: In the **Security Group** list, choose **TrustSec_Devices**.

Step 10: Click **Done**, and then click **Save**.

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
<input checked="" type="checkbox"/> TrustSec Devices	If	DEVICE:Device Type equals to Device Type#All Device Types#DC Switch	then	TrustSec_Devices Edit ▼
<input checked="" type="checkbox"/> Default Rule	If	no rules defined or no match	then	Unknown Edit ▼

Procedure 16 Configure authorization profile

This deployment is using 802.1X in what is called *low-impact mode*. In low-impact mode, the wired port is configured with a pre-authentication access list that limits what the endpoint connected to the port can access in an unauthenticated state. Once the endpoint passes authentication, a downloadable access list is passed from ISE to the switch. In this deployment, the access list simply permits all traffic, but you can tailor this to suit the needs of your deployment. For wireless endpoints, the access list is configured on the WLAN controller and the authorization policy instructs the WLC to use that ACL after authentication.

Step 1: Navigate to **Policy > Policy Elements > Results**, and then in the left navigation pane, expand the Authorization section and click **Authorization Profiles**.

Step 2: Click **Add**.

Step 3: Name the profile and (optionally) description, and then in the **Access Type** list, choose **ACCESS_ACCEPT**.

Authorization Profiles > **New Authorization Profile**

Authorization Profile

* Name

Description

* Access Type

Network Device Profile

Service Template

Track Movement

Step 4: In the Common Tasks section, select **DACL Name**, and then in the list, choose **PERMIT_ALL_TRAFFIC**.

▼ **Common Tasks**

DACL Name

Step 5: In the Common Tasks section, select **Airespace ACL Name**, and then in the box, type a name for the ACL you will configure on the WLC. This is covered in a later section of this guide.

▼ **Common Tasks**

Web Authentication (Local Web Auth)

Airespace ACL Name

Step 6: Click **Submit**.

Step 7: For each group for which you have defined policy, repeat this procedure. In this deployment, the groups are Finance, HR, IT, and Research.

Procedure 17 Configure authorization policy

All of the elements of the authorization policy are defined, and now you configure the authorization policy that assigns SGTs to users when they authenticate to the network.

Step 1: Navigate to **Policy > Authorization**.

Step 2: For the existing Profiled Non Cisco IP Phones rule, on the right, click the black triangle symbol, and then select **Insert New Rule Below**. A new rule named **Standard Rule 1** is created.

Step 3: Rename the newly created rule to match one of the groups for which you will define policy. (Example: **HR Users**)

Step 4: In the **Condition(s)** list, choose the **+** symbol, and then click **Create New Condition (Advance Option)**.

Step 5: In the next column, choose **Equals**.

Step 6: In the final column, choose **cisco.local/Users/HR**.

Step 7: In the Permissions column, next to AuthZ Profile(s), click the **+** symbol.

Step 8: In the **Select an item** list, choose **Standard**, and then select the authorization profile that was created in Procedure 16, "Configure authorization profile": (Example: **HR**)

Step 9: Click the **+** symbol to add another entry.

Step 10: In the **Select an item** list, choose Security Group, and then select the SGT that was created in Procedure 11, "Create security group tags." (Example: **HR_Users**)

Step 11: Click **Done**, and then click **Save**.

Step 12: For each group that requires an authorization policy, repeat this procedure. In this deployment the groups are Finance, HR, IT, and Research.

Authorization Policy
Define the Authorization Policy by configuring rules based on identity groups and/or other conditions. Drag and drop rules to change the order.
For Policy Export go to Administration > System > Backup & Restore > Policy Export Page

First Matched Rule Applies

▶ Exceptions (1)

Standard

Status	Rule Name	Conditions (identity groups and other conditions)	Permissions	
	Wireless Black List Default	if Blacklist AND Wireless_Access	then Blackhole_Wireless_Access	Edit
	Profiled Cisco APs	if Cisco-Access-Point	then PermitAccess	Edit
✓	Profiled Cisco IP Phones	if Cisco-IP-Phone	then Cisco_IP_Phones	Edit
✓	Profiled Non Cisco IP Phones	if Non_Cisco_Profiled_Phones	then Non_Cisco_IP_Phones	Edit
✓	Finance Users	if AD.ExternalGroups EQUALS cisco.local/Users/Finance	then Finance AND Finance_Users	Edit
✓	HR Users	if AD.ExternalGroups EQUALS cisco.local/Users/HR	then HR AND HR_Users	Edit
✓	IT Users	if AD.ExternalGroups EQUALS cisco.local/Users/IT	then IT AND IT_Users	Edit
✓	Research Users	if AD.ExternalGroups EQUALS cisco.local/Users/Research	then Research AND Research_Users	Edit

Procedure 18 Verify default policy is closed

The default rule at the end of the authorization policy specifies the action to take if an incoming authorization request doesn't match one of the specific rules defined. Since you have created rules for users, you want to make sure the default action is to deny access if the request didn't match any other rules.

Step 1: Navigate to **Policy > Authorization**.

Step 2: In the row for the default rule, click **Edit**.

Step 3: If the action listed in the Conditions column is PermitAccess, then click the **+** symbol. A selection box opens.

Step 4: In the list, choose **Standard**, and then choose **DenyAccess**.

Step 5: Click **Done**, and then click **Save**. The updated authorization policy appears.

<input checked="" type="checkbox"/>	Default	if no matches, then	DenyAccess	Edit ▾
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PROCESS

Enabling Wired Authentication

1. Enable RADIUS in the wired access layer
2. Enable identity on the wired access ports
3. Disable port security timers

The policy for network access is now defined and the next step is to enable 802.1X in the wired access layer to authenticate and authorize the users.

Procedure 1 Enable RADIUS in the wired access layer

Step 1: Identify switches in the access layer, connect to the console of each access switch, and configure each with the following RADIUS and AAA global configuration commands.

```
radius server ise-3
  address ipv4 10.4.48.43 auth-port 1812 acct-port 1813
  key [radius key]
radius server ise-4
  address ipv4 10.4.48.44 auth-port 1812 acct-port 1813
```

```
key [radius key]
aaa group server radius ISE_GROUP
server name ise-3
server name ise-4

aaa authentication dot1x default group ISE_GROUP
aaa authorization network default group ISE_GROUP
aaa authorization configuration default group ISE_GROUP
aaa accounting dot1x default start-stop group ISE_GROUP

radius-server vsa send accounting
radius-server vsa send authentication
radius-server attribute 6 on-for-login-auth
radius-server attribute 8 include-in-access-req
radius-server attribute 25 access-request include
```

Tech Tip

For consistency among this guide and other CVD guides, we have standardized on these well-known TCP ports for RADIUS authentication and accounting: 1812 and 1813. Cisco ISE supports both the older IOS default of 1645/1646 ports and the newer standardized 1812/1813 ports.

Procedure 2 Enable identity on the wired access ports

Step 1: Connect to the console of each access switch, and configure each with the following identify global configuration commands. The device-sensor command is not available on all switches.

```
authentication mac-move permit
dot1x system-auth-control
device-sensor accounting
```

Tech Tip

The device sensor functionality is only available for switches that use specific software versions and feature sets. If available, it should be enabled to add additional profiling visibility by gathering data gleaned from traffic coming from endpoints.

Step 2: Enable device tracking. Device tracking populates the dynamically learned IP address into the downloadable ACL.

```
ip device tracking
```

Step 3: You create an access list to limit traffic that is permitted on a port before it is authenticated, to allow only the traffic that is required for the port to go through the authentication process. Permitted traffic typically includes DHCP, DNS, TFTP for Preboot Execution Environment, and access to the AD domain controller. For troubleshooting, you also allow ICMP echo and echo-reply traffic. The list denies all other traffic.

```
ip access-list extended PreAuth
  remark Pre-authorization ACL for 802.1X
  permit ip any host 10.4.48.10
  permit udp any eq bootpc any eq bootps
  permit udp any any eq domain
  permit udp any any eq tftp
  permit icmp any any echo
  permit icmp any any echo-reply
  deny ip any any
```

Step 4: Authorization requires the use of RADIUS Change of Authorization (CoA) in order to change the state of the port after authentication. This is not enabled by default, so you enable it.

```
aaa server radius dynamic-author
  client 10.4.48.43 server-key [radius key]
  client 10.4.48.44 server-key [radius key]
  auth-type any
```

To make configuration easier when the same configuration is applied to multiple interfaces on the switch, use the **interface range** command. This command allows you to issue a command once and have it apply to many interfaces at the same time. Because most of the interfaces in the access layer are configured identically, it can save a lot of time. For example, the following command allows you to enter commands on all 24 interfaces (Gig 0/1 to Gig 0/24) simultaneously.

```
interface range GigabitEthernet 0/1-24
```

Step 5: Connect to the console of each access switch, and configure all host access ports on each. These commands should not be configured on infrastructure-facing ports, such as uplinks.

```
interface range [interface type] [port number]-[port number]
 ip access-group PreAuth in
 authentication host-mode multi-domain
 authentication open
 authentication order dot1x mab
 authentication port-control auto
 mab
 dot1x pae authenticator
```

Tech Tip

On the Catalyst 3650/3850, there is a caveat where TrustSec inline tagging is incompatible with IP Source Guard (ip verify source). If you plan on using inline tagging, you need to disable IP Source Guard on the access port. This will be resolved in a future software release.

Procedure 3 Disable port security timers

The [Campus Wired LAN Technology Design Guide](#) incorporates the use of port security to provide a level of security and prevent rogue devices from being connected. However, 802.1X also provides similar functionality and there can be conflicts when both are enabled on a port at the same time. As an example, both port security and 802.1X each have their own set of inactivity timers. Enabling both simultaneously causes 802.1X to re-authenticate every time the port security timeout is reached. To avoid this issue and other potential conflicts, disable port security.

Step 1: Remove the port security configuration.

```
interface range [interface type] [port number]-[port number]
 no switchport port-security aging time
 no switchport port-security aging type
 no switchport port-security violation
 no switchport port-security
```

PROCESS

Enabling Wireless Authentication

1. Add ISE as RADIUS authentication server
2. Add Cisco ISE as RADIUS accounting server
3. Enable client profiling
4. Configure WLC for authorization

To authenticate wireless clients, you need to configure the WLC to use the new Cisco ISE servers as RADIUS servers for authentication and accounting. The existing entry is disabled so that if there are any issues after moving to Cisco ISE, you can quickly restore the original configuration. Additionally, you configure the WLCs for device profiling so that profiling information can be obtained from the DHCP and HTTP requests from these clients and sent to the Cisco ISE.

Procedure 1 Add ISE as RADIUS authentication server

Perform this procedure for every WLAN controller used for employee access.

Step 1: Use a web browser to connect and log in to the WLC console. (Example: <https://wlc1.cisco.local>)

Step 2: On the top menu bar, click **Security**.

Step 3: In the left pane, under the **AAA > RADIUS** section, click **Authentication**.

Step 4: Do not make changes to any preexisting RADIUS servers yet. Click **New**. You can now configure a new RADIUS Authentication server.

Step 5: In the **Server IP Address** box, enter your primary ISE policy service node IP address, **10.4.48.43**.

Step 6: In the **Shared Secret** box, enter your RADIUS shared secret, and then in the **Confirm Shared Secret** box, re-enter it.

Step 7: In the Support for CoA list, choose **Enabled**.

Step 8: Next to Management, clear **Enable**, and then click **Apply**.

Security | RADIUS Authentication Servers > New

Server Index (Priority): 4

Server IP Address(Ipv4/Ipv6): 10.4.48.43

Shared Secret Format: ASCII

Shared Secret: [Masked]

Confirm Shared Secret: [Masked]

Key Wrap: (Designed for FIPS customers and requires a key wrap compliant RADIUS server)

Port Number: 1812

Server Status: Enabled

Support for CoA: Enabled

Server Timeout: 2 seconds

Network User: Enable

Management: Enable

Management Retransmit Timeout: 2 seconds

Tunnel Proxy: Enable

IPSec: Enable

Step 9: Repeat Step 4 through Step 8 in order to add the additional ISE policy service node **10.4.48.44** to the WLC configuration.

If a RADIUS server was previously configured on the WLC, you disable the preexisting RADIUS server. By disabling the server instead of deleting it, you can easily switch back, if needed.

Step 10: If you have a preexisting RADIUS server, on the RADIUS Authentication Servers screen under Server Index, click the number of the preexisting RADIUS server. On the Edit screen, change **Server Status** to **Disabled**, and then click **Apply**.

You are returned to the RADIUS Authentication Servers screen, where you can see the Admin Status for the pre-existing server is Disabled.

Security | RADIUS Authentication Servers

Auth Called Station ID Type: AP MAC Address:SSID

Use AES Key Wrap: (Designed for FIPS customers and requires a key wrap compliant RADIUS server)

MAC Delimiter: Hyphen

Framed MTU: 1300

Network User	Management	Tunnel Proxy	Server Index	Server Address(Ipv4/Ipv6)	Port	IPSec	Admin Status
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1	10.4.48.43	1812	Disabled	Enabled
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2	10.4.48.44	1812	Disabled	Enabled
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3	10.4.48.14	1812	Disabled	Disabled

Step 11: For every remaining WLC in your network, repeat this procedure.

Procedure 2 Add Cisco ISE as RADIUS accounting server

Step 1: On the menu bar, click **Security**.

Step 2: In the left pane, under the RADIUS section, click **Accounting**.

Step 3: Do not make changes to any preexisting RADIUS servers yet. Click **New**. You can now configure a new RADIUS accounting server.

Step 4: In the **Server IP Address** box, enter your primary ISE policy service node IP address, **10.4.48.43**.

Step 5: In the **Shared Secret** box, enter your RADIUS shared secret, and then in the **Confirm Shared Secret** box, re-enter it.

The screenshot shows the Cisco ISE configuration interface. The top navigation bar includes 'MONITOR', 'WLANS', 'CONTROLLER', 'WIRELESS', 'SECURITY' (highlighted), 'MANAGEMENT', 'COMMANDS', 'HELP', 'FEEDBACK', and 'Home'. The left sidebar shows a tree view with 'AAA' expanded to 'RADIUS' and 'Accounting'. The main content area is titled 'RADIUS Accounting Servers > New' and contains the following configuration fields:

Server Index (Priority)	4
Server IP Address(Ipv4/Ipv6)	10.4.48.43
Shared Secret Format	ASCII
Shared Secret
Confirm Shared Secret
Port Number	1813
Server Status	Enabled
Server Timeout	2 seconds
Network User	<input checked="" type="checkbox"/> Enable
Tunnel Proxy	<input type="checkbox"/> Enable
IPSec	<input type="checkbox"/> Enable

Step 6: Repeat Step 3 through Step 5 and add the additional ISE policy service node **10.4.48.44** to the WLC configuration.

Step 7: If you have a preexisting RADIUS server, on the RADIUS Accounting Servers screen under Server Index, click the number of the preexisting RADIUS server. On the Edit screen, change **Server Status** to **Disabled**, and then click **Apply**.

You are returned to the RADIUS Accounting Servers screen, where you can see the Admin Status for the pre-existing server is Disabled.

Network User	Tunnel Proxy	Server Index	Server Address(Ipv4/Ipv6)	Port	IPSec	Admin Status
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1	10.4.48.43	1813	Disabled	Enabled
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2	10.4.48.44	1813	Disabled	Enabled
<input type="checkbox"/>	<input type="checkbox"/>	3	10.4.48.14	1813	Disabled	Disabled

Procedure 3 Enable client profiling

You need to enable client profiling on the WLC in order to send DHCP and HTTP information to the engine for endpoint profiling.

Step 1: On the WLC, navigate to **WLANs**, and then select the WLAN ID underlined number for an SSID you wish to monitor.

Step 2: On the Advanced tab, in the Radius Client Profiling section, select **DHCP Profiling**.

Step 3: Select **HTTP Profiling**, click **Apply**, and then click **OK** in order to acknowledge there may be a WLAN connectivity disruption.

The screenshot shows the 'Advanced' configuration tab for a WLAN. In the 'Radius Client Profiling' section, the following options are checked:

- DHCP Profiling
- HTTP Profiling

Step 4: At the top right, click **Save Configuration**, and then click **OK** to confirm.

Procedure 4 Configure WLC for authorization

The WLC does not support downloadable ACLs like the switches. Instead, you define the ACL on the WLC. and when clients connect to the WLC and authenticate, in the campus and at remote sites with a local controller, Cisco ISE passes a RADIUS attribute requesting that the ACL be applied for this client.

Step 1: On the WLC, navigate to **Security**.

Step 2: In the left pane, in **Access Control Lists**, choose **Access Control Lists**, and then click **New**.

Step 3: Name the access list, and then click **Apply**.

Step 4: Click the name in the list. This allows you to edit the newly created access list.

Step 5: Click **Add New Rule**.

Step 6: Create a new access list rule based on your security policy, and then click **Apply**. This example deployment allows full access to authenticated users.

Seq	Action	Source IP/Mask	Destination IP/Mask	Protocol	Source Port	Dest Port	DSCP	Direction	Number of Hits
1	Permit	0.0.0.0 / 0.0.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any	Any	Inbound	0
2	Permit	0.0.0.0 / 0.0.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any	Any	Outbound	0

Tech Tip

The access list needs to have entries for the traffic in both directions, so make sure you have pairs of access list rules for both inbound and outbound traffic. Also, there is an implicit “deny all” rule at the end of the access list, so any traffic not explicitly permitted is denied.

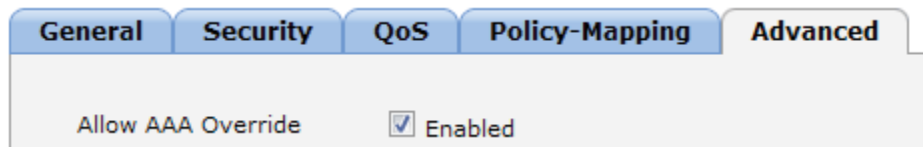
Step 7: For each access list that you defined in the authorization profiles in Cisco ISE, repeat Step 2 through Step 6.

Next, you enable WLC to allow Cisco ISE to use RADIUS to override the current settings, so that the access list can be applied to the WLAN.

Step 8: On the WLC menu bar, click **WLANs**.

Step 9: Click the WLAN ID of the wireless network that the wireless personal devices are accessing.

Step 10: Click **Advanced**, and then select **Allow AAA Override**.



Step 11: Click **Apply**, and then click **Save Configuration**.

Step 12: The infrastructure is now configured to assign tags to users when they login to the network. Below shows the authentication session details for a logged in wired user on a Catalyst switch and a logged in wireless user on a WLC. You can see the assigned SGT and dACL associated with these users.

Step 13: Example on a Catalyst Switch:

```
AD5-3650#show authentication sessions interface gigabitEthernet 1/0/2 details
```

```

    Interface: GigabitEthernet1/0/2
      IIF-ID: 0x1076B4000000260
    MAC Address: 0050.5689.5190
    IPv6 Address: Unknown
    IPv4 Address: 10.4.112.182
    User-Name: CISCO\hr_user
      Status: Authorized
      Domain: DATA
    Oper host mode: multi-auth
    Oper control dir: both
    Session timeout: N/A
    Restart timeout: N/A
    Session Uptime: 235050s
    Common Session ID: 0A047F050000117012E1599E
    Acct Session ID: 0x00001702
      Handle: 0xCF00019C
    Current Policy: POLICY_Gi1/0/2
    Local Policies:
      Service Template: DEFAULT_LINKSEC_POLICY_SHOULD_SECURE (priority 150)
    Server Policies:
      ACS ACL: xACSACLx-IP-PERMIT_ALL_TRAFFIC-56161e32
      SGT Value: 2001
    Method status list:
      Method      State
    dot1x        Authc Success
  
```

Step 14: Example on a WLC:

The screenshot shows the Cisco WLC configuration interface for a client's AV Statistics. The 'CTS Security Group Tag' is set to 2001 and the 'IPv4 ACL Name' is set to HR. Other fields include Security Policy (Yes), Policy Type (RSN (WPA2)), Auth Key Mgmt (802.1x), Encryption Cipher (CCMP (AES)), EAP Type (PEAP), SNMP NAC State (Access), RADIUS NAC State (RUN), AAA Override (none), ACL Name (none), ACL Applied (Unavailable), AAA Override Flex ACL (none), AAA Override Flex ACL Applied (Unavailable), and Redirect URL (none).

PROCESS

Assigning SGTs to Servers

1. Enable TrustSec on NX-OS switches
2. Configure IP-to-SGT binding on the NX-OS switch
3. Configure IP-to-SGT binding in ISE

Now that the users are assigned SGTs, you need to assign SGTs to the servers in the data center. Depending on the deployment, you can do this on the Nexus 7000s in the data center for physical servers or on a Nexus 1000v switch in a virtualized environment. For the physical servers, either you can define the SGT directly on the switch or you can use ISE to assign it.

Procedure 1 Enable TrustSec on NX-OS switches

Step 1: Connect to the console of the Nexus 7000 or Nexus 1000v in the data center, and then enable TrustSec.

```
feature dot1x
feature cts
```

Step 2: Enable TrustSec device authentication. The device-id and password you use are the ones defined in Procedure 6, "Configure advanced TrustSec settings for NX-OS switches".

```
cts device-id DC-N7004-1 password [password]
```

Step 3: Define the RADIUS servers and AAA parameters.

```
radius-server host 10.4.48.43 key [RADIUS key] pac authentication accounting
radius-server host 10.4.48.44 key [RADIUS key] pac authentication accounting
aaa group server radius ISE_Group
    server 10.4.48.43
    server 10.4.48.44
    use-vrf management
aaa authorization cts default group ISE_Group
aaa accounting default group ISE_Group
```

Procedure 2 Configure IP-to-SGT binding on the NX-OS switch

Step 1: Connect to the console of the Nexus 7000 or Nexus 1000v in the data center, and then create an IP-to-SGT binding.

```
cts role-based sgt-map [IP address of server] [SGT]
```

Step 2: For every server you will assign an SGT, repeat this procedure.

Procedure 3 Configure IP-to-SGT binding in ISE

Step 1: Connect and login to the PAN (example: <https://ise-1.cisco.local>).

Step 2: Navigate to **Work Centers > TrustSec > Policy**. In the left navigation pane, expand Security Group Mappings, and then click **Hosts**.

Step 3: Click **Add**.

Step 4: Select **IP address**, and then enter the address of the server.

Step 5: Select **Security Group Tag**, and then select the **SGT** from the list.

Step 6: Select **Network Device Group**.

Step 7: In the drop-down list, click the arrow next to All Device Types, and then select the group to deploy the binding. In this deployment, the group is **DC Switch**.

Step 8: Click Submit.

[Hosts List](#) > **New Host**

Hosts

Hostname

IP Address / (Example: 10.1.1.1/32)

Mapping Group

Security Group Tag

Deploy to

All TrustSec devices

Network Device Group

Network Device

Step 9: For every server you will assign an SGT, repeat this procedure.

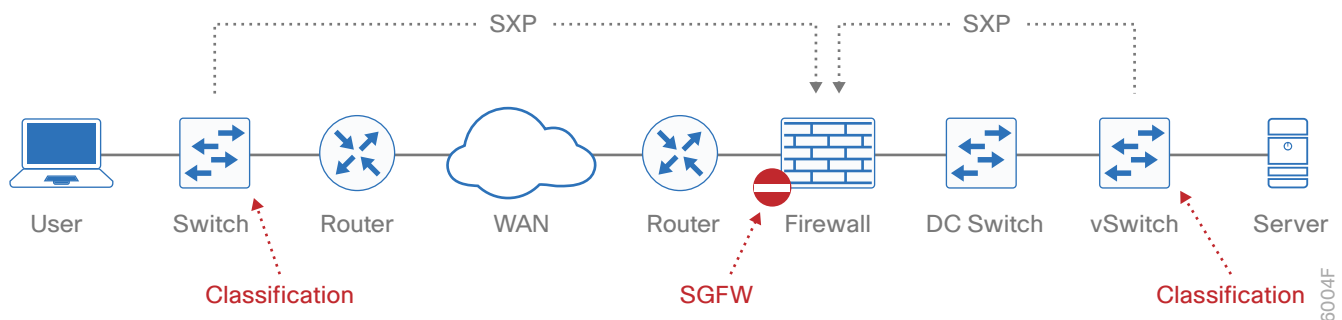
PROCESS

Configuring SGT Propagation

1. Configure SXP on IOS devices
2. Configure SXP on WLCs
3. Configure SXP on ISE
4. Configure SXP on Cisco ASA
5. Configure SXP in NX-OS
6. Configure inline tagging in IOS switches
7. Configure inline tagging in NX-OS switches
8. Configure inline tagging on the Nexus 1000v with port profiles
9. Enable SXP on ISR
10. Enable inline tagging on the ISR
11. Enable inline tagging over DMVPN
12. Enable inline tagging over GET VPN

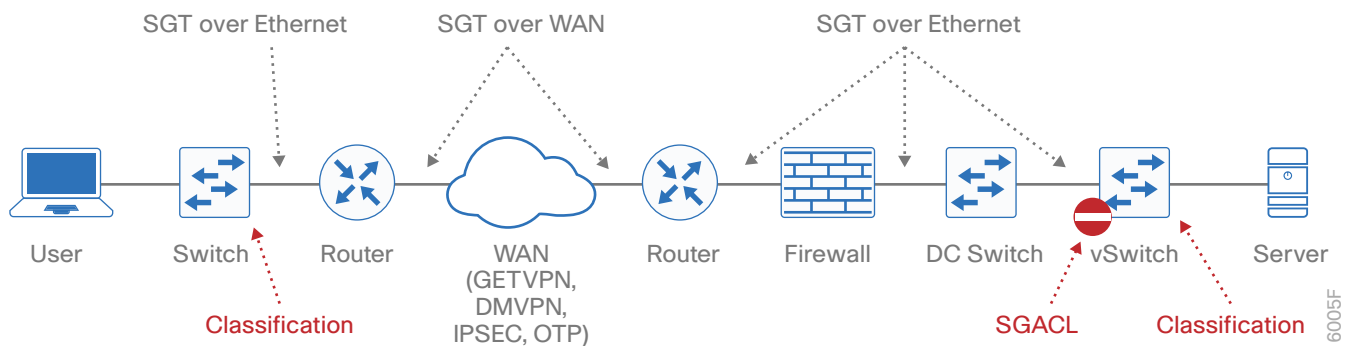
Now that tags are assigned to the users and servers, you need to propagate them to devices on the network. As discussed earlier in this guide, there are two methods of propagation. The first is SXP, and the second is via inline tagging in the data plane.

Figure 11 Propagation using SXP

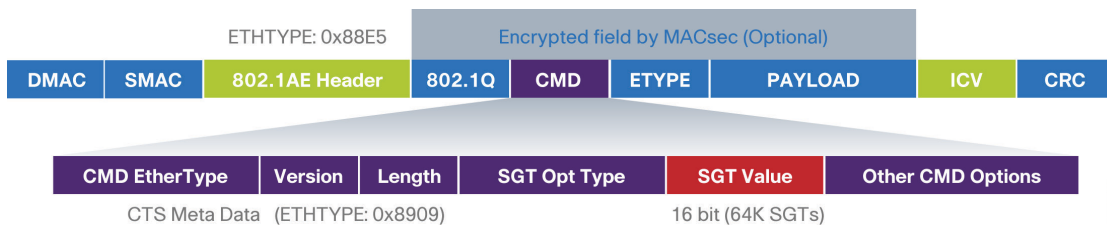


SXP is a control plane protocol that propagates the IP-to-SGT mapping database from network authentication points such as access layer switches to upstream network devices. SXP is a TCP-based peering protocol. You can use SXP to propagate tags in an environment where all devices do not support inline tagging. It operates based on a peering relationship between two devices. One device is the speaker and sends IP-to-SGT bindings to the other peer. The second device is the listener and it receives the bindings from the speaker. A single device can have multiple peers and be both a speaker and a listener. A typical deployment has the access switch or WLC peer with a distribution switch, and then the distribution switch peers with the DC core to provide hierarchy.

Figure 12 Propagation using inline tagging



Inline tagging occurs in the data plane, and the tag is embedded in the Cisco metadata in the Layer 2 header and carried throughout the network. This requires that all infrastructure along the path must support inline tagging and the configuration is placed on the interfaces connecting the devices.



TrustSec in the Campus

Procedure 1 Configure SXP on IOS devices

Step 1: Connect to the console of the switch and configure SXP. The role of the device is either speaker or listener, depending on if the device is sending or receiving IP-to-SGT bindings.

```
cts sxp enable
cts sxp default source-ip [IP address of device]
cts sxp default password [password]
cts sxp connection peer [IP address of peer device] password default mode local
[speaker|listener]
```

Tech Tip

The source IP address is typically the management IP address of the device or a loopback address.

An example configuration from a distribution switch that is a speaker to the DC switch and a listener to two access switches.

```
cts sxp enable
cts sxp default source-ip 10.4.15.254
```

```
cts sxp default password [password]
cts sxp connection peer 10.4.63.2 password default mode local speaker
cts sxp connection peer 10.4.15.5 password default mode local listener
cts sxp connection peer 10.4.15.6 password default mode local listener
```

Step 2: Verify the SXP connection.

```
D1-6807-VSS#show cts sxp connection
SXP                : Enabled
Highest Version Supported: 4
Default Password   : Set
Default Source IP: 10.4.15.254
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is running
-----
Peer IP           : 10.4.15.5
Source IP         : 10.4.15.254
Conn status       : On
Conn version      : 4
Conn capability   : IPv4-IPv6-Subnet
Conn hold time    : 120 seconds
Local mode        : SXP Listener
Connection inst#  : 9
TCP conn fd       : 3
TCP conn password: default SXP password
Hold timer is running
Duration since last state change: 30:19:50:34 (dd:hr:mm:sec)
-----
Peer IP           : 10.4.15.6
Source IP         : 10.4.15.254
Conn status       : On
Conn version      : 4
Conn capability   : IPv4-IPv6-Subnet
Conn hold time    : 120 seconds
Local mode        : SXP Listener
```

```
Connection inst# : 9
TCP conn fd      : 2
TCP conn password: default SXP password
Hold timer is running
Duration since last state change: 9:16:54:20 (dd:hr:mm:sec)
```

```
-----
Peer IP          : 10.4.63.3
Source IP        : 10.4.15.254
Conn status      : Off
Conn version     : 4
Local mode       : SXP Speaker
Connection inst# : 1
TCP conn fd      : -1
TCP conn password: none
Duration since last state change: 0:00:01:57 (dd:hr:mm:sec)
```

Total num of SXP Connections = 3

Step 3: For each SXP device you add, repeat this procedure.

Procedure 2 Configure SXP on WLCs

Step 1: Use a web browser to connect and login to the WLC console (example: <https://wlc1.cisco.local>).

Step 2: Navigate to **Security > TrustSec SXP**.

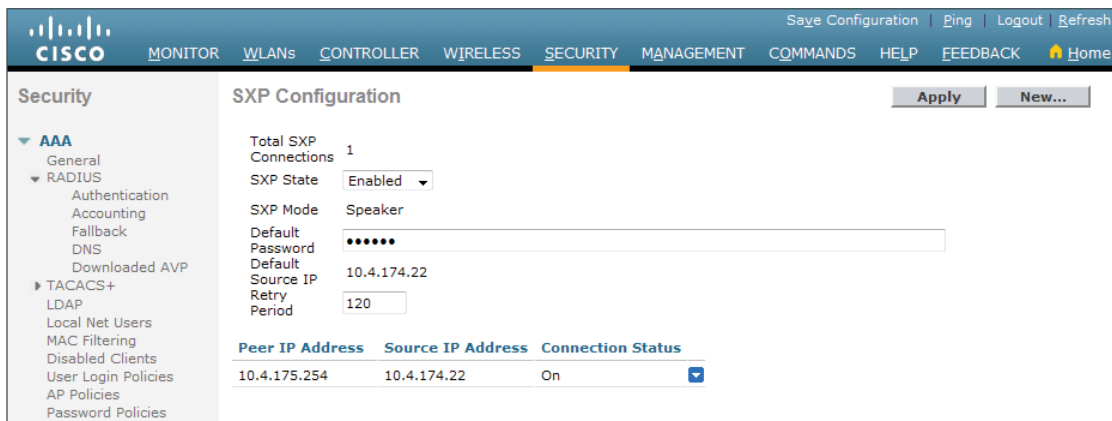
Step 3: In the SXP State list, choose **Enabled**.

Step 4: Enter a default password.

Step 5: Click **New**.

Step 6: Enter the peer IP address for the peer device, and then click **Apply**.

Step 7: On the SXP Configuration screen, click **Apply**, and then click **Save Configuration**.



The screenshot shows the Cisco ISE Security Configuration page. The left navigation pane is expanded to show the Security configuration tree, with the following items visible: AAA, General, RADIUS, Authentication, Accounting, Fallback, DNS, Downloaded AVP, TACACS+, LDAP, Local Net Users, MAC Filtering, Disabled Clients, User Login Policies, AP Policies, and Password Policies. The main content area is titled "SXP Configuration" and contains the following settings:

- Total SXP Connections: 1
- SXP State: Enabled
- SXP Mode: Speaker
- Default Password: [Redacted]
- Default Source IP: 10.4.174.22
- Retry Period: 120

Below the settings is a table with the following data:

Peer IP Address	Source IP Address	Connection Status
10.4.175.254	10.4.174.22	On

Step 8: For each SXP device you will add, repeat this procedure.

Procedure 3 Configure SXP on ISE

A new feature in ISE 2.0 is the ability to run SXP on a PSN. This allows ISE to send and receive IP-to-SGT bindings. It also allows ISE to create IP to SGT bindings based on RADIUS sessions. An access device that then does 802.1X authentication or MAB using ISE but does not support TrustSec is able to participate in a TrustSec environment using this method. In the User-to-DC scenario with enforcement being done on the DC switches, ISE propagates these RADIUS session bindings to DC switches using SXP, without the need to configure any propagation method on the access switch.

Step 1: Using a browser, connect and login to the PAN (example: <https://ise-1.cisco.local>).

Step 2: Navigate to **Work Centers > TrustSec > Settings**, and in the left navigation pane, click **SXP Settings**.

Step 3: To place RADIUS mappings into the IP-SGT binding table, select **Add radius mappings into SXP IP SGT mapping table**.

Step 4: Enter the global password to be used for SXP connections.

Step 5: Click **Save**.

The screenshot shows the Cisco Identity Services Engine (ISE) configuration interface. The breadcrumb navigation is: Home > Operations > Policy > Guest Access > Administration > Work Centers > TrustSec > Device Administration > Settings. The left navigation pane shows: General TrustSec Settings, TrustSec Matrix Settings, and SXP Settings. The main content area is titled "SXP Settings" and contains the following configuration options:

- Publish SXP bindings on PxGrid
- Add radius mappings into SXP IP SGT mapping table
- Global Password**
 - Global Password: [password field]
 - This global password will be overridden by the device specific password
- Timers**
 - Minimum Acceptable Hold Time: [120] Seconds (1-65534, 0 to disable)
 - Reconciliation Timer: [120] Seconds (0-64000)
 - Minimum Hold Time: [90] Seconds (3-65534, 0 to disable)
 - Maximum Hold Time: [180] Seconds (4-65534)
 - Retry Open Timer: [120] Seconds (0-64000)

At the bottom right, there are two buttons: "Set Default" and "Save".

Step 6: You are prompted to restart the SXP service. Click **Yes**.

Step 7: Navigate to **Work Centers > TrustSec > SXP**, and in the left navigation pane, click **SXP Devices**.

Step 8: Click **Add**.

Step 9: Enter a name for the SXP device and the IP address.

Step 10: In the **Peer Role** list, choose the appropriate SXP role for this device. For example, the DC switches are listeners and the distribution switches are speakers.

Step 11: Click in the **Connected PSNs** box, and then select the SXP PSN configured in Procedure 1, "Configure policy service node for SXP."

Step 12: In the **Status** list, choose **Enabled**.

Step 13: In the **Password Type** list, choose **DEFAULT**.

Step 14: In the **Version** list, choose **V4**.

Tech Tip

SXP negotiates the version to use between devices and selects the highest version available. Selecting SXP V4 ensures that the device negotiates the highest version it supports.

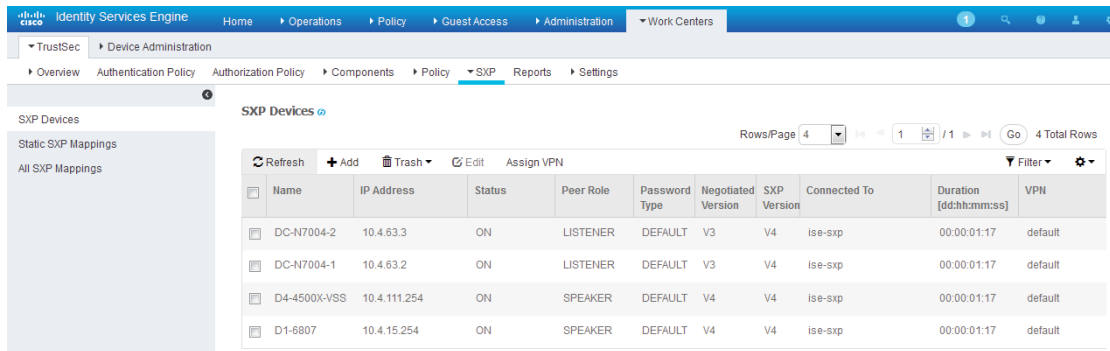
Step 15: Click **Save**.

The screenshot displays the Cisco Identity Services Engine (ISE) web interface for configuring a new SXP device. The breadcrumb trail is: Home > Operations > Policy > Guest Access > Administration > Work Centers > TrustSec > Device Administration > SXP. The left sidebar shows 'SXP Devices', 'Static SXP Mappings', and 'All SXP Mappings'. The main content area is titled 'SXP Devices > New' and includes an 'Upload from a CSV file' option and an 'Add Single Device' section. A note states: 'Input fields marked with an asterisk (*) are required.' The form fields are as follows:

Field	Value
Name	DC-N7004-1
IP Address *	10.4.63.2
Peer Role *	LISTENER
Connected PSNs *	* ise-sxp
VPN *	default
Status *	Enabled
Password Type *	DEFAULT
Global Password	
Version *	V4

At the bottom of the form, there is an 'Advanced Settings' section and two buttons: 'Cancel' and 'Save'.

Step 16: For each SXP device you will add, repeat this procedure .



Name	IP Address	Status	Peer Role	Password Type	Negotiated Version	SXP Version	Connected To	Duration [dd:hh:mm:ss]	VPN
DC-N7004-2	10.4.63.3	ON	LISTENER	DEFAULT	V3	V4	ise-sxp	00:00:01:17	default
DC-N7004-1	10.4.63.2	ON	LISTENER	DEFAULT	V3	V4	ise-sxp	00:00:01:17	default
D4-4500X-VSS	10.4.111.254	ON	SPEAKER	DEFAULT	V4	V4	ise-sxp	00:00:01:17	default
D1-6807	10.4.15.254	ON	SPEAKER	DEFAULT	V4	V4	ise-sxp	00:00:01:17	default

Procedure 4 Configure SXP on Cisco ASA

Step 1: In a browser, navigate to the Cisco ASA management console (example: <https://DC-ASA5585X.cisco.local>), and then click **Run ASDM**.

Step 2: If you are using virtual contexts on your firewall, in the Device List, choose the context.

Step 3: Navigate to **Configuration > Firewall > Identity by TrustSec**.

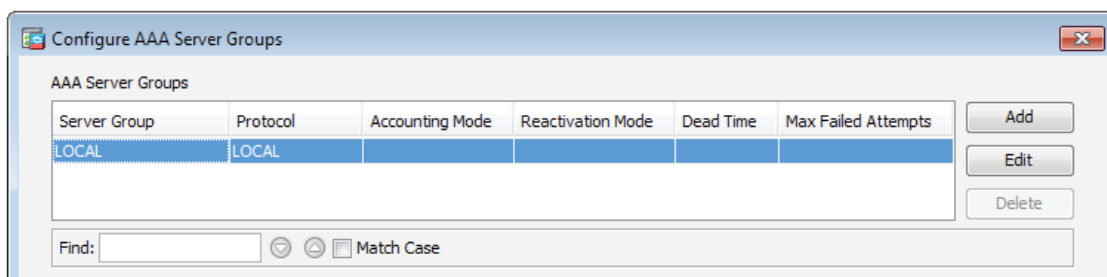
Step 4: Select **Enable SGT Exchange Protocol (SXP)**.

Step 5: In the **Default Source** box, enter the IP address of the interface of the Cisco ASA appliance used for management.

Step 6: Enter a password, and then confirm it.

Step 7: In the Server Group Setup section, click **Manage**.

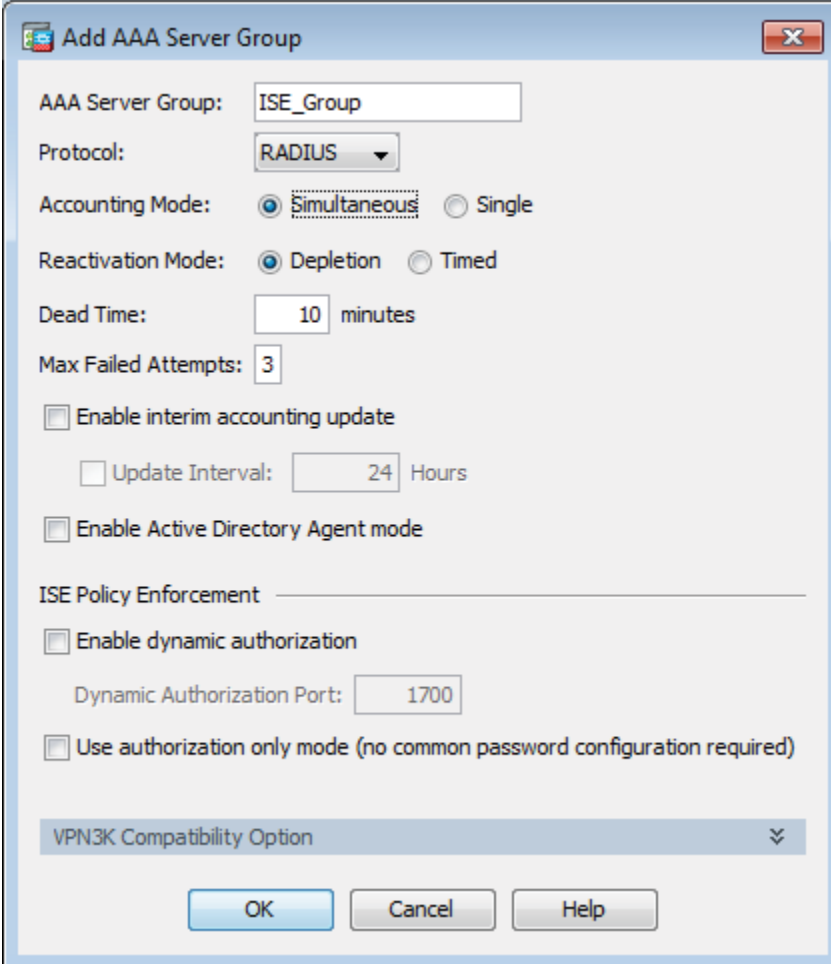
Step 8: In the Configure AAA Server Group window, click **Add**.



Server Group	Protocol	Accounting Mode	Reactivation Mode	Dead Time	Max Failed Attempts
LOCAL	LOCAL				

Step 9: In the AAA Server Group box, enter a group name. (Example: **ISE_Group**)

Step 10: For Accounting Mode, select **Simultaneous**, and then click **OK**.



Add AAA Server Group

AAA Server Group: ISE_Group

Protocol: RADIUS

Accounting Mode: Simultaneous Single

Reactivation Mode: Depletion Timed

Dead Time: 10 minutes

Max Failed Attempts: 3

Enable interim accounting update

Update Interval: 24 Hours

Enable Active Directory Agent mode

ISE Policy Enforcement

Enable dynamic authorization

Dynamic Authorization Port: 1700

Use authorization only mode (no common password configuration required)

VPN3K Compatibility Option

OK Cancel Help

Step 11: In the Servers in the Selected Group section, click **Add**.

Step 12: In the **Interface Name** list, choose the firewall interface **mgmt**.

Step 13: In the **Server Name or IP Address** box, enter **ise-3.cisco.local**.

Step 14: In the RADIUS Parameters section, in **Server Authentication Port**, replace 1645 with **1812**.

Step 15: In **Server Accounting Port**, replace 1646 with **1813**.

Step 16: Enter the **Server Secret Key**.

Step 17: Accept the defaults for the remaining parameters, and then click **OK**.

The screenshot shows the 'Add AAA Server' configuration window. The fields are as follows:

- Server Group: ISE_Group
- Interface Name: mgmt
- Server Name or IP Address: ise-3.cisco.local
- Timeout: 10 seconds
- RADIUS Parameters:
 - Server Authentication Port: 1812
 - Server Accounting Port: 1813
 - Retry Interval: 10 seconds
 - Server Secret Key: [Masked]
 - Common Password: [Empty]
 - ACL Netmask Convert: Standard
 - Microsoft CHAPv2 Capable:
- SDI Messages: Message Table

Buttons: OK, Cancel, Help

Step 18: For the remaining PSNs in the deployment, repeat Step 11 through Step 17.

Step 19: Click **OK**. The Configure AAA Server Groups window closes.

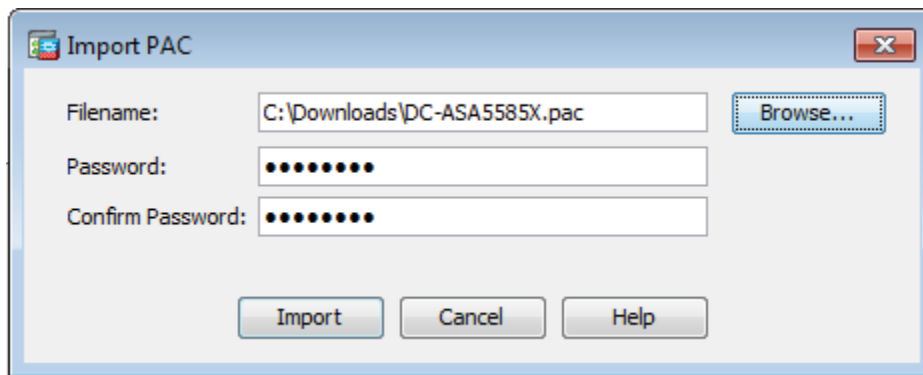
Step 20: Click **Import PAC**.

Step 21: Click **Browse**.

Step 22: Locate the PAC file you saved to your machine in Procedure 7, “Configure Advanced TrustSec Settings for Cisco ASA Firewalls.”

Step 23: Enter the PAC password, and then confirm it.

Step 24: Click **Import**.



Step 25: When the import is complete, acknowledge the "PAC Imported Successfully" message. Now you add SXP peers to Cisco ASA.

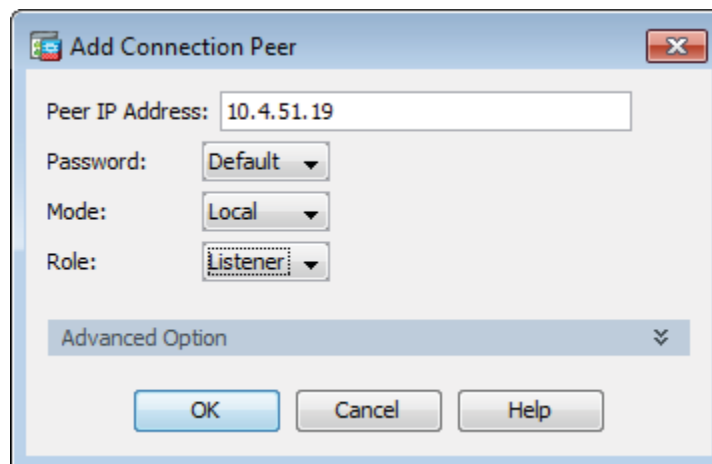
Step 26: Click **Add**.

Step 27: Enter the IP address of the peer.

Step 28: In the **Password** list, choose **Default**.

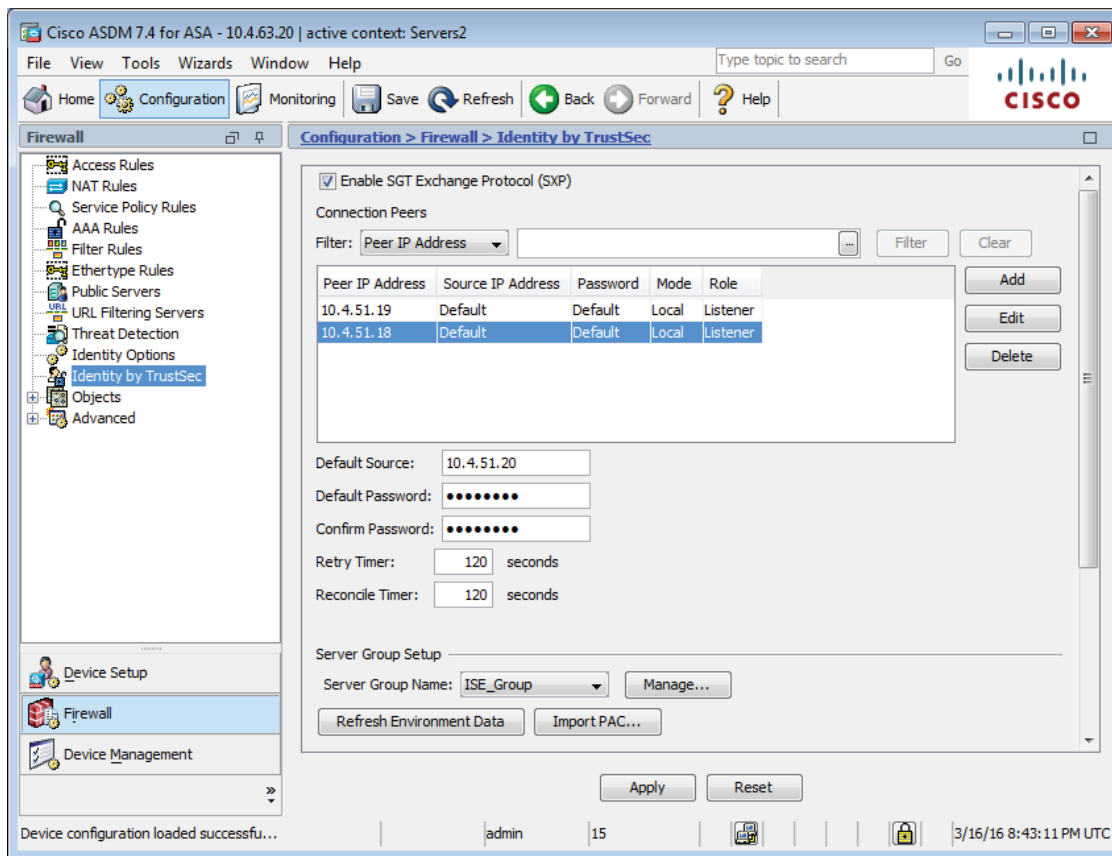
Step 29: In the **Mode** list, choose **Local**.

Step 30: In the **Role** list, choose **Listener**, and then click **OK**.



Step 31: For each peer you need to add, repeat Step 26 through Step 30.

Step 32: Click Apply.



Procedure 5 Configure SXP in NX-OS

Step 1: Connect to the console of the switch and configure SXP. The role of the device is either speaker or listener, depending on if the device is sending or receiving IP-to-SGT bindings.

```
cts sxp enable
cts sxp default password <password>
cts sxp default source-ip [IP address of device]
cts sxp connection peer [IP address of peer device] password default mode local
[speaker|listener] vrf [VRF for this connection]
```

Tech Tip

In a User-to-DC deployment, the Nexus 7000 is typically just an SXP listener and learns all of the IP-to-SGT bindings from other devices on the network. The Nexus 1000v supports speaker mode only.

Step 2: If you have a Nexus 1000v, configure IP device tracking.

```
cts device tracking
```

Below is an example configuration from a data center switch that is a listener to two distribution switches and a speaker to two ASA firewalls. Note that the firewalls are using different source interfaces.

```
cts sxp enable
cts sxp default source-ip 10.4.63.2
cts sxp default password [password]
cts sxp connection peer 10.4.15.254 password default mode local listener vrf
default
cts sxp connection peer 10.4.175.254 password default mode local listener vrf
default
cts sxp connection peer 10.4.51.20 source 10.4.51.19 password default mode lo-
cal speaker vrf default
cts sxp connection peer 10.4.51.36 source 10.4.51.35 password default mode
speaker vrf default
```

Step 3: Verify the SXP connection.

```
DC-N7004-1# show cts sxp connection
```

PEER_IP_ADDR	VRF	PEER_SXP_MODE	SELF_SXP_MODE	CONNECTION STATE	VERS
10.4.15.254	default	speaker	listener	connected	3
10.4.48.40	default	speaker	listener	connected	3
10.4.51.20	default	listener	speaker	connected	1
10.4.51.36	default	listener	speaker	connected	1
10.4.175.254	default	speaker	listener	connected	3

Step 4: For each SXP device you will add, repeat this procedure.

Tech Tip

For MD5 authentication, SXP makes use of TCP option field. If you have SXP peers that establish a connection through a firewall, you need to make sure that the firewall does not strip the TCP options and to also not perform TCP sequence number randomization. The following commands allow SXP peers to establish a connection through a Cisco ASA firewall.

```
access-list SXP-MD5-ACL extended permit tcp host <SXP_Peer_A> host <SXP_Peer_B>
eq 64999
access-list SXP-MD5-ACL extended permit tcp host <SXP_Peer_B> host <SXP_Peer_A>
eq 64999

tcp-map SXP-MD5-OPTION-ALLOW
tcp-options range 19 19 allow
```

```
class-map SXP-MD5-CLASSMAP
match access-list SXP-MD5-ACL

policy-map global_policy
class SXP-MD5-CLASSMAP
set connection random-sequence-number disable
set connection advanced-options SXP-MD5-OPTION-ALLOW
set connection advanced-options tcp-state-bypass
service-policy global_policy global
```

Procedure 6 Configure inline tagging in IOS switches

Step 1: Connect to the console of the switch and configure inline tagging.

```
interface [interface type] [port number]
shutdown
no cts role-based enforcement
cts manual
policy static sgt 2 trusted
no shutdown
```

Tech Tip

To ensure the new TrustSec policy takes effect, you need to reset the interface by shutting it down and then re-enabling it. To use TrustSec in the most scalable manner, we recommend turning off enforcement on links between TrustSec-capable devices in order to ensure that filtering is done on egress from the TrustSec environment.

SGT 2 is the tag reserved for TrustSec Devices, and the keyword **trusted** tells this switch to trust tags coming into this interface and not overwrite an existing tag.

Tech Tip

If you are configuring inline tagging on a port-channel interface, you need to first remove the interfaces from the port-channel and then apply the TrustSec configuration to each physical interface.

Step 2: Verify the inline configuration. You'll see that TrustSec is in manual mode and that authorization was successful, using an SGT of 2.

```
show cts interface [interface type] [port number]
```

Example:

```
C1-6807-VSS#show cts interface TenGigabitEthernet 1/5/1
Global Dot1x feature is Disabled
Interface TenGigabitEthernet1/5/1:
  CTS is enabled, mode:    MANUAL
  IFC state:              OPEN
  Interface Active for    1w0d
  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
```

Step 3: For each interface you wish to configure for inline tagging, repeat this procedure.

Procedure 7 Configure inline tagging in NX-OS switches

Step 1: Connect to the console of the switch and configure inline tagging.

```
interface [interface type] [port number]
shutdown
cts manual
policy static sgt 2 trusted
no shutdown
```

Tech Tip

To ensure the new TrustSec policy takes effect, you need to reset the interface by shutting it down and then re-enabling it.

SGT 2 is the tag reserved for TrustSec Devices and the keyword trusted tells this switch to trust tags coming into this interface and not overwrite an existing tag.

Tech Tip

If you are configuring inline tagging on a port-channel interface, you can configure it directly on the port-channel interface, and the configuration is copied to the physical interface.

Step 2: Verify the inline configuration. You'll see that TrustSec is in manual mode and that authorization was successful, using an SGT of 2.

```
show cts interface [interface type] [port number]
```

As an example:

```
DC-N7004-1# show cts interface Ethernet 3/41
CTS Information for Interface Ethernet3/41:
CTS is enabled, mode: CTS_MODE_MANUAL
IFC state: CTS_IFC_ST_CTS_OPEN_STATE
Authentication Status: CTS_AUTHC_SKIPPED_CONFIG
Peer Identity:
Peer is: Unknown in manual mode
802.1X role: CTS_ROLE_UNKNOWN
Last Re-Authentication:
Authorization Status: CTS_AUTHZ_SKIPPED_CONFIG
PEER SGT: 2 (TrustSec_Devices)
Peer SGT assignment: Trusted
SAP Status: CTS_SAP_SKIPPED_CONFIG
Version:
Configured pairwise ciphers:
Replay protection:
Replay protection mode:
Selected cipher:
Propagate SGT: Enabled
```

Step 3: For each interface you wish to configure for inline tagging, repeat this procedure.

Procedure 8 Configure inline tagging on the Nexus 1000v with port profiles

To configure the switchport on the Nexus 1000v to assign an SGT, you use a port profile.

Step 1: Configure the port profile.

```
port-profile type vethernet [name]
  switchport mode access
  switchport access vlan [VLAN number]
  cts manual
    policy static sgt [SGT value in hex] trusted
    role-based enforcement
    propagate-sgt
  no shutdown
  state enabled
  vmware port-group
```

Step 2: Assign the port profile to the virtual ethernet interface.

```
interface Vethernet [interface number]
  inherit port-profile [name]
```

As an example, this is how a server for the HR group is configured:

```
port-profile type vethernet HR
  switchport mode access
  switchport access vlan 149
  cts manual
    policy static sgt 0x7d0 trusted
    role-based enforcement
    propagate-sgt
  no shutdown
  state enabled
  vmware port-group
interface Vethernet8
  inherit port-profile HR
  description TrustSec-HR-Server, Network Adapter 1
```

Step 3: Verify the inline configuration. You'll see that TrustSec is in manual mode and that authorization was successful, using the SGT configured in the port profile.

```
show cts interface [interface type] [port number]
```

Example:

```
DC-N1Kv# show cts interface vethernet 8
CTS Information for Interface Vethernet8:
CTS is enabled, mode: CTS_MODE_MANUAL
IFC state: Unknown
Authentication Status: CTS_AUTHC_INIT
Peer Identity:
Peer is: Unknown in manual mode
802.1X role: CTS_ROLE_UNKNOWN
Last Re-Authentication:
Authorization Status: CTS_AUTHZ_INIT
PEER SGT: 2000
Peer SGT assignment: Trusted
SAP Status: CTS_SAP_INIT
Configured pairwise ciphers:
Replay protection:
Replay protection mode:
Selected cipher:
Current receive SPI:
Current transmit SPI:
Propagate SGT: Enabled
```

Step 4: For every server you will assign an SGT, repeat this procedure.

TrustSec across the WAN

The campus is configured to support TrustSec, and now you extend that to remote sites across the WAN. As in the campus, there are two ways to propagate SGTs across the WAN: SXP and inline tagging. SXP over the WAN functions the same as it does in the campus. You configure SXP on the remote site router and have it peer with the access switch and WLC at the remote site and the WAN aggregation router at the campus. The remote site router propagates tags learned from the access switch and WLC to the WAN aggregation router. Configuring SXP on the access switch is covered in Procedure 1, "Configure SXP on IOS devices" and configuring SXP on the WLC is covered in Procedure 2, "Configure SXP on WLCs".

Inline tagging over the WAN is supported in a few different mechanisms: Dynamic Multipoint VPN (DMVPN), Group Encrypted Transport VPN (GET VPN), Generic Routing Encapsulation (GRE), and Enhanced Interior Gateway Routing Protocol Over the Top (EIGRP OTP). This design deploys DMVPN and GET VPN. The remote site access switch propagates the tag inline to the remote site router, and that tag is propagated over the WAN via encapsulation to the WAN aggregation router. Configuring inline tagging on the access switch is covered in Procedure 6, “Configure Inline tagging in IOS switches.”

Procedure 9 Enable SXP on ISR

Configuring SXP on the Cisco Integrated Services Router (ISR) family is the same as configuring it on Cisco Catalyst switches.

Step 1: Connect to the console of the router and configure SXP. The role of the device is either speaker or listener, depending on if the device is sending or receiving IP-to-SGT bindings.

```
cts sxp enable
cts sxp default source-ip [IP address of device]
cts sxp default password [password]
cts sxp connection peer [IP address of peer device] password default mode local
[speaker|listener]
```

Tech Tip

The source IP address is typically the management IP address of the device or a loopback address.

An example configuration from a remote site router that is a speaker to the WAN aggregation router and a listener to an access switch.

```
cts sxp enable
cts sxp default source-ip 10.255.243.47
cts sxp default password [password]
cts sxp connection peer 10.5.58.5 password default mode local listener
cts sxp connection peer 10.4.32.243 password default mode local speaker
```

Step 2: Verify the SXP connection.

```
show cts sxp connections
```

Example:

```
RS47-1921#show cts sxp connections
SXP                : Enabled
Highest Version Supported: 4
Default Password   : Set
Default Source IP: 10.255.243.47
Connection retry open period: 120 secs
Reconcile period: 120 secs
Retry open timer is not running
-----
Peer IP           : 10.4.32.243
Source IP         : 10.255.243.47
Conn status       : On
Conn version      : 4
Conn capability   : IPv4-IPv6-Subnet
Conn hold time    : 120 seconds
Local mode        : SXP Speaker
Connection inst#  : 1
TCP conn fd       : 2
TCP conn password: default SXP password
Keepalive timer is running
Duration since last state change: 0:00:08:51 (dd:hr:mm:sec)
-----
Peer IP           : 10.5.58.5
Source IP         : 10.255.243.47
Conn status       : On
Conn version      : 4
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: 0:00:12:16 (dd:hr:mm:sec)
Total num of SXP Connections = 2
```

Step 3: For each SXP remote site router you will add, repeat this procedure.

Procedure 10 Enable inline tagging on the ISR

Configure the router to support inline on the link to the access switch.

Step 1: Connect to the console of the router and configure inline tagging.

```
interface [interface type] [port number]
  shutdown
  no cts role-based enforcement
cts manual
  policy static sgt 2 trusted
no shutdown
```

Tech Tip

To ensure the new TrustSec policy takes effect, you need to reset the interface by shutting it down and then re-enabling it. To use TrustSec in the most scalable manner, we recommend turning off enforcement on links between TrustSec-capable devices in order to ensure that filtering is done on egress from the TrustSec environment.

SGT 2 is the tag reserved for TrustSec Devices and the keyword trusted tells this switch to trust tags coming into this interface and not overwrite an existing tag.

Procedure 11 Enable inline tagging over DMVPN

To support inline tagging over DMVPN, you configure the GRE tunnel on both the remote site and WAN aggregation routers to add the tag to the Cisco Metadata (CMD) in the GRE payload. Support for this is determined during tunnel negotiation. The endpoints exchange capabilities using Next Hop Resolution Protocol (NHRP), and if both endpoints are configured to propagate SGTs, the tags are added. This allows you to migrate remote sites gradually to support inline tagging.

Step 1: Connect to the console of the router and configure inline tagging for DMVPN.

```
interface Tunnel <number>
  cts sgt inline
```

Step 2: Verify the inline configuration. TrustSec is enabled using an SGT of 2 on both the remote site and the WAN aggregation router.

```
show tunnel endpoints tunnel [tunnel number]
```

As an example:

```
RS15-4331#show tunnel endpoints tunnel 20
```

```
Tunnel20 running in multi-GRE/IP mode
```

```
Endpoint transport 172.18.140.20 Refcount 3 Base 0x7F3F8C7D3AC0 Create Time 00:04:07
```

```
overlay 10.6.38.1 Refcount 2 Parent 0x7F3F8C7D3AC0 Create Time 00:04:07
```

```
Tunnel Subblocks:
```

```
Tunnel TrustSec:
```

```
1 metadata enabled (CTS-SGT:2 )
```

```
tunnel-nhrp-sb:
```

```
NHRP subblock has 1 entries; TrustSec enabled; Services/Metadata: CTS-SGT
```

```
WE2-INET1-4451-1#show tunnel endpoints tunnel 20
```

```
Tunnel20 running in multi-GRE/IP mode
```

```
Endpoint transport 172.18.200.18 Refcount 3 Base 0x7FEDB2CD3DD0 Create Time 00:12:18
```

```
Tunnel Subblocks:
```

```
tunnel-qos (Extend Forwarding):
```

```
Tunnel-QoS subblock, QoS policy applied: RS-GROUP-20MBPS-POLICY
```

```
overlay 10.6.38.15 Refcount 2 Parent 0x7FEDB2CD3DD0 Create Time 00:12:18
```

```
Tunnel Subblocks:
```

```
tunnel-nhrp-sb:
```

```
NHRP subblock has 1 entries; TrustSec enabled; Services/Metadata: CTS-SGT
```

```
Tunnel TrustSec:
```

```
1 metadata enabled (CTS-SGT:2 )
```

Procedure 12 Enable inline tagging over GET VPN

To support inline tagging over GET VPN, you configure the key server to add the tag to the Cisco Metadata (CMD) in the IPSec payload. When the key server receives a request from a group member router, the tagging capability is negotiated. If both endpoints are configured to propagate SGTs, the tags are added. This allows you to migrate remote sites gradually to support inline tagging.

Step 1: Connect to the console of the router and configure inline tagging for GET VPN.

```
crypto gdoi group [group name]
server local
sa ipsec [sequence number]
tag cts sgt
```

Example:

```
crypto gdoi group GETVPN-GROUP
identity number 65511
server local
rekey algorithm aes 256
rekey retransmit 40 number 3
rekey authentication mypubkey rsa GETVPN-REKEY-RSA
rekey transport unicast
sa ipsec 10
profile GETVPN-PROFILE
match address ipv4 GETVPN-POLICY-ACL
replay time window-size 20
tag cts sgt
address ipv4 10.4.32.1 52
redundancy
local priority 75
peer address ipv4 10.4.32.151
```

Tech Tip

The configuration for inline tagging support is applied at the group level for GET VPN and enables the feature for every group member. If you want to migrate remote sites you need to create another group that supports inline tagging and move remote sites from the original group to this new group.

Step 2: Connect to the console of the remote site router and verify the inline configuration. You'll see the tag method is using SGTs.

```
show crypto gdoi
```

Step 3: As an example (output edited for brevity):

```
RS35-4331#show crypto gdoi
GROUP INFORMATION

Group Name           : GETVPN-GROUP
Group Identity       : 65511
Group Type           : GDOI (ISAKMP)
Crypto Path          : ipv4
Key Management Path  : ipv4
Rekeys received      : 99
IPSec SA Direction  : Both

Group Server list    : 10.4.32.151
                    : 10.4.32.152
```

<Output deleted>

TEK POLICY for the current KS-Policy ACEs Downloaded:

GigabitEthernet0/0/0:

IPsec SA:

```
spi: 0xA1B3796E(2712893806)
KGS: Disabled
transform: esp-256-aes esp-sha-hmac
sa timing:remaining key lifetime (sec): (5766)
Anti-Replay(Time Based) : 20 sec interval
tag method : cts sgt
alg key size: 32 (bytes)
sig key size: 20 (bytes)
encaps: ENCAPS_TUNNEL
```

IPsec SA:

```
spi: 0xFBDEC3C6(4225680326)
```



```

KGS: Disabled
transform: esp-256-aes esp-sha-hmac
sa timing:remaining key lifetime (sec): expired
Anti-Replay(Time Based) : 20 sec interval
tag method : cts sgt
alg key size: 32 (bytes)
sig key size: 20 (bytes)
encaps: ENCAPS_TUNNEL

```

PROCESS

Enabling Enforcement in the DC

1. Configure Nexus 7000 for enforcement
2. Configure Cisco ASA for enforcement

The TrustSec policy has been configured and the infrastructure has been configured to propagate tags throughout the network. The next step is to enable enforcement in the data center. There are two places where enforcement can be enabled. The first is on the Nexus 7000 switches used for the data center core. The other is on the Cisco ASA firewalls in the data center.

Procedure 1 Configure Nexus 7000 for enforcement

Step 1: To obtain the policy from Cisco ISE, the Nexus 7000 switches need to be authenticated and authorized. This was configured in Procedure 1, “Enable TrustSec on NX-OS Switches”.

Step 2: Connect to the console of the switch and enable TrustSec enforcement and counters.

```

cts role-based counters enable
cts role-based enforcement

```

Step 3: Verify the policy is downloaded.

```
show cts role-based policy
```

This shows the entire policy. To show a portion of the policy, you can add the source tag, the destination tag, or both.

```

show cts role-based policy sgt [source tag number]
show cts role-based policy dgt [destination tag number]
show cts role-based policy sgt [source tag number] dgt [destination tag number]

```

Example:

```
DC-N7004-2# show cts role-based policy sgt 4001 dgt 4000
```

```
sgt:4001 (Research_Users)
dgt:4000 (Research_Servers)      rbacl:Research_ACL
    permit ip log
```

```
DC-N7004-2# show cts role-based policy sgt 4001 dgt 3000
```

```
sgt:4001 (Research_Users)
dgt:3000 (IT_Servers)          rbacl:Deny_All
    deny ip log
```

Procedure 2 Configure Cisco ASA for enforcement

Cisco ASA allows you to use SGTs in the firewall policy rules. You configured the appliance to retrieve the Trust-Sec environment data, which is the table of SGT names and numbers, in Procedure 4, “Configure SXP on Cisco ASA,” and you configure firewall rules using this data. In this deployment, the appliance provides more granular enforcement than what is being done on the Cisco Nexus 7000 switches by limiting access to the servers to allow only web traffic and ICMP from the users.

Step 1: In a browser, navigate to the Cisco ASA management console (example: <https://DC-ASA5585X.cisco.local>), and then click **Run ASDM**.

Step 2: If you are using virtual contexts on your firewall, in the Device List, choose the context.

Step 3: To verify the TrustSec environment data has been downloaded, navigate to **Monitoring > Properties > Identity by TrustSec > Environment Data**.

The screenshot shows the Cisco ASDM 7.4 interface for ASA - 10.4.63.20. The breadcrumb navigation is **Monitoring > Properties > Identity by TrustSec > Environment Data**. The main content area displays the following information:

Environment Data:

- Status: Active
- Last download attempt: Successful
- Environment Data Lifetime: 86400 secs
- Last update time: 11:48:23 UTC Mar 22 2016
- Env-data expires in: 0:21:12:59 (dd:hr:mm:sec)
- Env-data refreshes in: 0:21:02:59 (dd:hr:mm:sec)

Security Group Table:

Valid until: 11:48:23 UTC Mar 23 2016
Total entries: 34

Name	Tag	Type
ANY	65535	unicast
Auditors	9	unicast
BYOD	15	unicast
Contractors	5	unicast
Developers	8	unicast
Development_Servers	12	unicast
Employees	4	unicast
Finance_Servers	1000	unicast
Finance_Users	1001	unicast
Guests	6	unicast
HR_Servers	2000	unicast
HR_Users	2001	unicast
IT_Servers	3000	unicast
IT_Users	3001	unicast

The interface also shows a 'Refresh' button and a status bar at the bottom indicating 'Data Refreshed Successfully.' and 'Last Updated: 3/22/16 10:45:03 AM'.

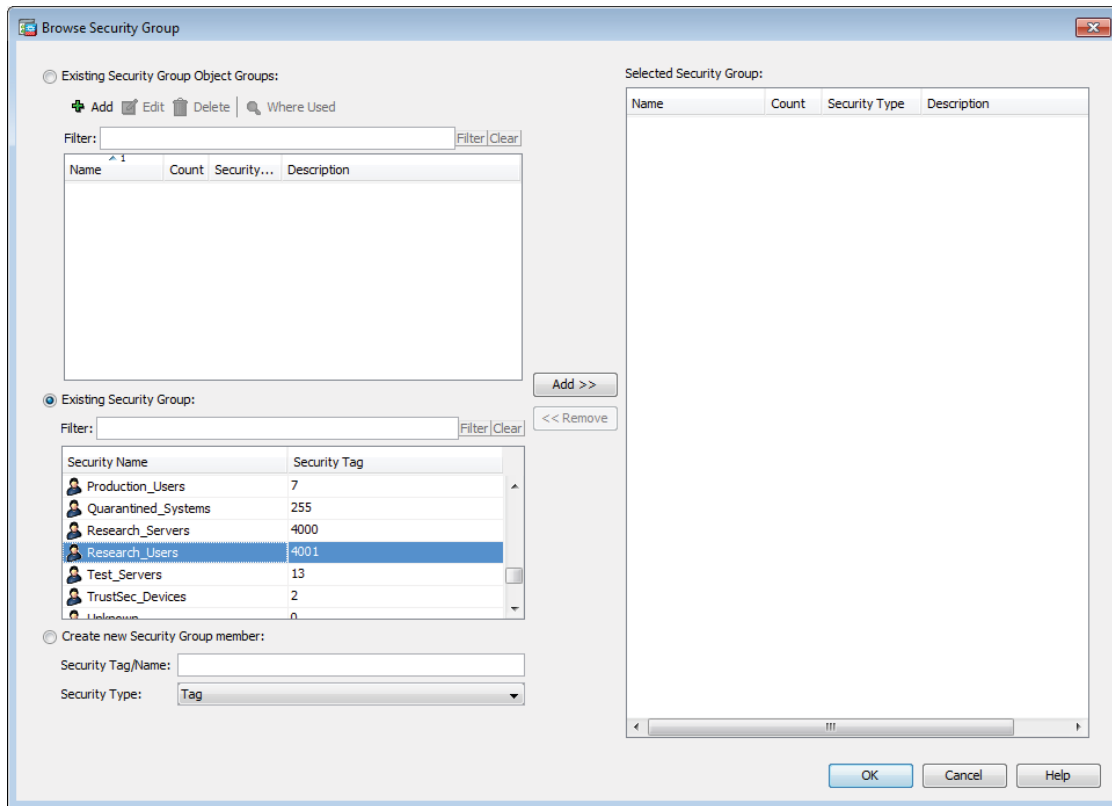
Step 4: Navigate to **Configuration > Firewall > Access Rules**.

Step 5: Click **Add**.

Step 6: Select interface **outside** and the Action **permit**.

Step 7: In the Source criteria section, in the Security Group field, click the ellipsis (...). The Browse Security Group window opens.

Step 8: In the Existing Security Group section, locate the user group you want to configure (example: **Research_Users**), and then click **Add**.



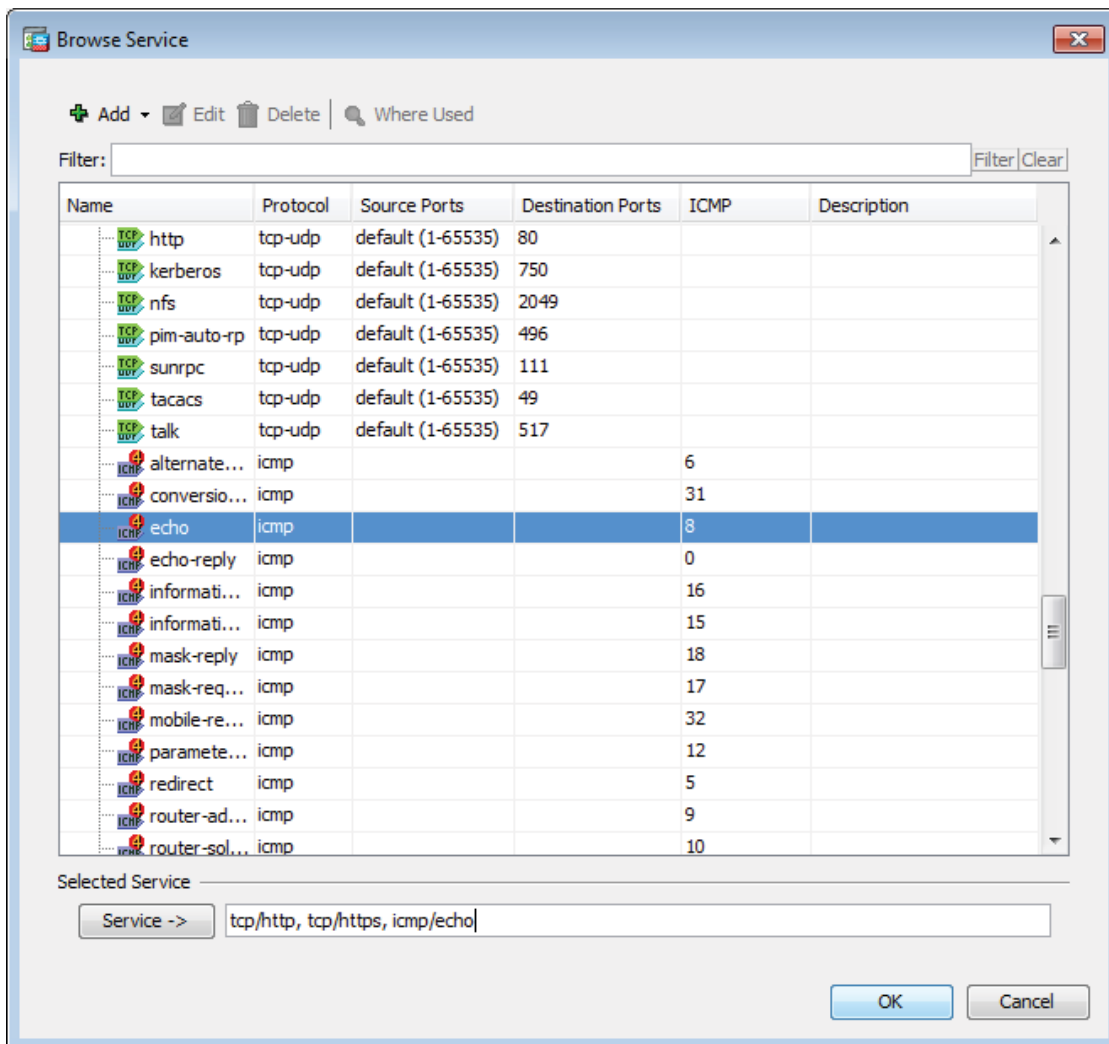
Step 9: Click **OK**. The window closes.

Step 10: In the Destination criteria section, in the Security Group field, click the ellipsis (...). The Browse Security Group window opens.

Step 11: In the Existing Security Group section, locate the user group you want to configure (example: **Research_Servers**), and then click **Add**. Click **OK**. The window closes.

Step 12: In the Service field, click the ellipsis (...). The Browse Service window opens.

Step 13: Select the services you want to permit. (Examples: **tcp/http**, **tcp/https**, **icmp/echo**)



Step 14: Click OK. The window closes.

Step 15: Select **Enable Logging**, and then click OK.

Step 16: For each rule you will configure, repeat Step 4 through Step 15.

#	Enabled	Source Criteria:			Destination Criteria:		Service	Action
		Source	User	Security Group	Destination	Security Group		
inside (1 incoming rule)								
mgmt (0 implicit incoming rules)								
outside (2 incoming rules)								
1	<input checked="" type="checkbox"/>	any		Research_Users	any	Research_Servers	echo http https	Permit
2	<input checked="" type="checkbox"/>	any		IT_Users	any	IT_Servers	echo http https	Permit
Global (1 implicit rule)								

Step 17: Click **Apply**, and then click **Save**.

Appendix A: Product List

IDENTITY MANAGEMENT

Functional Area	Product Description	Part Numbers	Software
Cisco ISE Server	Cisco Identity Services Engine Virtual Appliance	ISE-VM-K9=	2.0.0.306 Cumulative Patch 2
	Cisco Identity Services Engine 10000 EndPoint Base License	L-ISE-BSE-10K=	
	Cisco Identity Services Engine 5000 EndPoint Base License	L-ISE-BSE-5K=	
	Cisco Identity Services Engine 3500 EndPoint Base License	L-ISE-BSE-3500=	
	Cisco Identity Services Engine 2500 EndPoint Base License	L-ISE-BSE-2500=	
	Cisco Identity Services Engine 1500 EndPoint Base License	L-ISE-BSE-1500=	
	Cisco Identity Services Engine 1000 EndPoint Base License	L-ISE-BSE-1K=	
	Cisco Identity Services Engine 500 EndPoint Base License	L-ISE-BSE-500=	
	Cisco Identity Services Engine 250 EndPoint Base License	L-ISE-BSE-250=	
	Cisco Identity Services Engine 100 EndPoint Base License	L-ISE-BSE-100=	
	Cisco ISE 10K Endpoint Plus Subscription License	L-ISE-PLS-S-10K=	
	Cisco ISE 5K Endpoint Plus Subscription License	L-ISE-PLS-S-5K=	
	Cisco ISE 3500 Endpoint Plus Subscription License	L-ISE-PLS-S-3500=	
	Cisco ISE 2500 Endpoint Plus Subscription License	L-ISE-PLS-S-2500=	
	Cisco ISE 1500 Endpoint Plus Subscription License	L-ISE-PLS-S-1500=	
	Cisco ISE 1K Endpoint Plus Subscription License	L-ISE-PLS-S-1K=	
	Cisco ISE 500 Endpoint Plus Subscription License	L-ISE-PLS-S-500=	
	Cisco ISE 250 Endpoint Plus Subscription License	L-ISE-PLS-S-250=	
Cisco ISE 100 Endpoint Plus Subscription License	L-ISE-PLS-S-100=		

DATA CENTER

Functional Area	Product Description	Part Numbers	Software
Core Switch	Cisco Nexus 7000 Series 4-Slot Chassis	N7K-C7004	NX-OS 7.3(0)D1(1)
	Cisco Nexus 7000 - Supervisor 2	N7K-SUP2	
	Cisco Nexus 7000 F2-Series 48 Port 1/10G (SFP+) Enhanced	N7K-F248XP-25E	
Distribution Switch	Cisco Nexus 5672UP 1RU, 32 p 10-Gbps SFP+, 16 Unified Ports, 6p 40G QSFP+	N5K-C5672UP	NX-OS 7.1(0) N1(1b)
	Nexus 5600 VM-FEX license	N56-VMFEX9	

Functional Area	Product Description	Part Numbers	Software
Ethernet Extension	Cisco Nexus 2000 Series 48 Ethernet 100/1000BASE-T (enhanced) Fabric Extender	N2K-C2248TP-E	-
	Cisco Nexus 2000 Series 48 Ethernet 100/1000BASE-T Fabric Extender	N2K-C2248TP-1GE	
	Cisco Nexus 2000 Series 32 1/10 GbE SFP+, FCoE capable Fabric Extender	N2K-C2232PP-10GE	
Firewall	Cisco ASA 5585-X Security Plus Firewall Edition SSP-20 bundle includes 8 Gigabit Ethernet interfaces, 2 10 Gigabit Ethernet SFP+ interfaces, 2 Gigabit Ethernet management interfaces, 10,000 IPsec VPN peers, 2 SSL VPN peers, dual AC power, 3DES/AES license	ASA5585-S20X-K	9.4(1), ASDM 7.4(1)
	Cisco ASA 5585-X Security Services Processor-20 with firewall services, 10,000 IPsec VPN peers, 2 SSL VPN peers, 8 Gigabit Ethernet interfaces, 2 Gigabit Ethernet SFP interfaces, DES	ASA-SSP-20-K8	
	Cisco ASA 5585-X Security Plus License	ASA5585-SEC-PL	
	Cisco ASA 5500 5 Security Contexts License	A5500-SC-5	
	Cisco ASA 5500 10 Security Contexts License	A5500-SC-10	
	Cisco ASA 5500 20 Security Contexts License	A5500-SC-20	
	Cisco ASA 5500 50 Security Contexts License	A5500-SC-50	

DATA CENTER VIRTUALIZATION

Functional Area	Product Description	Part Numbers	Software
Virtual Switch	Cisco Nexus 1000v Advanced Edition CPU License 1-pack	N1K-VLCPU-01=	5.2(1)SV3(1.15)
	Cisco Nexus 1000v Advanced Edition CPU License 4-pack	N1K-VLCPU-04=	
	Cisco Nexus 1000v Advanced Edition CPU License 16-pack	N1K-VLCPU-16=	
	Cisco Nexus 1000v Advanced Edition CPU License 32-pack	N1K-VLCPU-32=	
	Cisco Nexus 1000v Advanced Edition CPU License 64-pack	N1K-VLCPU-64=	
	Cisco Nexus 1000v Advanced Edition CPU License 128-pack	N1K-VLCPU-128=	
VMWare	ESXi	ESXi	5.5
	VMware vSphere	ESXi	

LAN ACCESS LAYER

Functional Area	Product Description	Part Numbers	Software
Modular Access Layer Switch	Cisco Catalyst 4500E Series 4507R+E 7-slot Chassis with 48Gbps per slot	WS-C4507R+E	3.6.4.E(15.2.2E4) IP Base license
	Cisco Catalyst 4500E Supervisor Engine 8-E, Unified Access, 928Gbps	WS-X45-SUP8-E	
	Cisco Catalyst 4500E 12-port 10GbE SFP+ Fiber Module	WS-X4712-SFP+E	
	Cisco Catalyst 4500E 48-Port 802.3at PoE+ 10/100/1000 (RJ-45)	WS-X4748-RJ45V+E	
Stackable Access Layer Switch	Cisco Catalyst 3850 Series Stackable 48 Ethernet 10/100/1000 PoE+ ports	WS-C3850-48F	3.6.4.E(15.2.2E4) IP Base license
	Cisco Catalyst 3850 Series Stackable 24 Ethernet 10/100/1000 PoE+ Ports	WS-C3850-24P	
	Cisco Catalyst 3850 Series 2 x 10GE Network Module	C3850-NM-2-10G	
	Cisco Catalyst 3850 Series 4 x 1GE Network Module	C3850-NM-4-1G	
	Cisco Catalyst 3650 Series 24 Ethernet 10/100/1000 PoE+ and 2x10GE or 4x1GE Uplink	WS-C3650-24PD	3.6.4.E(15.2.2E4) IP Base license
	Cisco Catalyst 3650 Series 24 Ethernet 10/100/1000 PoE+ and 4x1GE Uplink	WS-C3650-24PS	
	Cisco Catalyst 3650 Series Stack Module	C3650-STACK	
	Cisco Catalyst 2960-X Series 24 10/100/1000 Ethernet and 2 SFP+ Uplink	WS-C2960X-24PD	15.2(3)E1 LAN Base license
	Cisco Catalyst 2960-X FlexStack-Plus Hot-Swappable Stacking Module	C2960X-STACK	
Standalone Access Layer Switch	Cisco Catalyst 3650 Series 24 Ethernet 10/100/1000 PoE+ and 4x1GE Uplink	WS-C3650-24PS	3.6.4.E(15.2.2E4) IP Base license

LAN DISTRIBUTION LAYER

Functional Area	Product Description	Part Numbers	Software
Modular Distribution Layer Virtual Switch Pair	Cisco Catalyst 6800 Series 6807-XL 7-Slot Modular Chassis	C6807-XL	15.2(1)SY1 IP Services license
	Cisco Catalyst 6500 VSS Supervisor 2T with 2 ports 10GbE and PFC4	VS-S2T-10G	
	Cisco Catalyst 6500 4-port 40GbE/16-port 10GbE Fiber Module w/DFC4	WS-X6904-40G-2T	
	Cisco Catalyst 6500 4-port 10GbE SFP+ adapter for WX-X6904-40G module	CVR-CFP-4SFP10G	
	Cisco Catalyst 6800 32 port 10GE with integrated dual DFC4	C6800-32P10G	
	Cisco Catalyst 6500 Distributed Forwarding Card 4	WS-F6K-DFC4-E	
Modular Distribution Layer Virtual Switch Pair	Cisco Catalyst 4500E Series 4507R+E 7-slot Chassis with 48Gbps per slot	WS-C4507R+E	3.6.4.E(15.2.2E4) Enterprise Services license
	Cisco Catalyst 4500E Supervisor Engine 7-E, 848Gbps	WS-X45-SUP7-E	
	Cisco Catalyst 4500E 12-port 10GbE SFP+ Fiber Module	WS-X4712-SFP+E	
	Cisco Catalyst 4500E 48-Port 802.3at PoE+ 10/100/1000 (RJ-45)	WS-X4748-RJ45V+E	
Fixed Distribution Layer Virtual Switch Pair	Cisco Catalyst 4500-X Series 32 Port 10GbE IP Base Front-to-Back Cooling	WS-C4500X-32SFP+	3.6.4.E(15.2.2E4) Enterprise Services license
Stackable Distribution Layer Switch	Cisco Catalyst 3850 Series Stackable Switch with 12 SFP Ethernet	WS-C3850-12S	3.6.4.E(15.2.2E4) IP Services license
	Cisco Catalyst 3850 Series 4 x 1GE Network Module	C3850-NM-4-1G	
	Cisco Catalyst 3850 Series 2 x 10GE Network Module	C3850-NM-2-10G	

LAN CORE LAYER

Functional Area	Product Description	Part Numbers	Software
Modular Core Layer Virtual Switch Pair	Cisco Catalyst 6800 Series 6807-XL 7-Slot Modular Chassis	C6807-XL	15.2(1)SY1 IP Services license
	Cisco Catalyst 6500 VSS Supervisor 2T with 2 ports 10GbE and PFC4	VS-S2T-10G	
	Cisco Catalyst 6500 4-port 40GbE/16-port 10GbE Fiber Module w/DFC4	WS-X6904-40G-2T	
	Cisco Catalyst 6500 Distributed Forwarding Card 4	WS-F6K-DFC4-E	

LAN DISTRIBUTION – SERVICES BLOCK

Functional Area	Product Description	Part Numbers	Software
Modular Distribution Layer Virtual Switch Pair	Cisco Catalyst 6800 Series 6807-XL 7-Slot Modular Chassis	C6807-XL	15.2(1)SY1 IP Services license
	Cisco Catalyst 6500 VSS Supervisor 2T with 2 ports 10GbE and PFC4	VS-S2T-10G	
	Cisco Catalyst 6500 4-port 40GbE/16-port 10GbE Fiber Module w/DFC4	WS-X6904-40G-2T	
	Cisco Catalyst 6500 4-port 10GbE SFP+ adapter for WX-X6904-40G module	CVR-CFP-4SFP10G	
	Cisco Catalyst 6800 32 port 10GE with integrated dual DFC4	C6800-32P10G	
	Cisco Catalyst 6500 Distributed Forwarding Card 4	WS-F6K-DFC4-E	

WIRELESS LAN CONTROLLERS

Functional Area	Product Description	Part Numbers	Software
Remote Site Controller	Cisco 7500 Series Wireless Controller for up to 6000 Cisco access points	AIR-CT7510-6K-K9	8.2.100.0
	Cisco 7500 Series Wireless Controller for up to 3000 Cisco access points	AIR-CT7510-3K-K9	
	Cisco 7500 Series Wireless Controller for up to 2000 Cisco access points	AIR-CT7510-2K-K9	
	Cisco 7500 Series Wireless Controller for up to 1000 Cisco access points	AIR-CT7510-1K-K9	
	Cisco 7500 Series Wireless Controller for up to 500 Cisco access points	AIR-CT7510-500-K9	
	Cisco 7500 Series Wireless Controller for up to 300 Cisco access points	AIR-CT7510-300-K9	
	Cisco 7500 Series High Availability Wireless Controller	AIR-CT7510-HA-K9	
	Cisco Virtual Wireless Controller for up to 5 Cisco access points	L-AIR-CTVM-5-K9	
	Cisco Virtual Wireless Controller 25 Access Point Adder License	L-LIC-CTVM-25A	
	Cisco Virtual Wireless Controller 5 Access Point Adder License	L-LIC-CTVM-5A	
	Cisco Virtual Wireless Controller 1 Access Point Adder License	L-LIC-CTVM-1A	
On Site, Remote Site, or Guest Controller	Cisco 5520 Series Wireless Controller for up to 50 Cisco access points	AIR-CT5520-50-K9	8.2.100.0
	Cisco 5520 Wireless Controller 100 AP License	LIC-CTS5520-100A	
	Cisco 5520 Wireless Controller 50 AP License	LIC-CTS5520-50A	
	Cisco 5520 Wireless Controller 1 AP Adder License	LIC-CT5520-1A	
	Cisco 5500 Series Wireless Controller for up to 500 Cisco access points	AIR-CT5508-500-K9	
	Cisco 5500 Series Wireless Controller for up to 250 Cisco access points	AIR-CT5508-250-K9	
	Cisco 5500 Series Wireless Controller for up to 100 Cisco access points	AIR-CT5508-100-K9	
	Cisco 5500 Series Wireless Controller for up to 50 Cisco access points	AIR-CT5508-50-K9	
	Cisco 5500 Series Wireless Controller for up to 25 Cisco access points	AIR-CT5508-25-K9	
	Cisco 5500 Series Wireless Controller for up to 12 Cisco access points	AIR-CT5508-12-K9	
	Cisco 5500 Series Wireless Controller for High Availability	AIR-CT5508-HA-K9	
	On Site Controller, Guest Controller	Cisco 2500 Series Wireless Controller for up to 50 Cisco access points	
Cisco 2500 Series Wireless Controller for up to 25 Cisco access points		AIR-CT2504-25-K9	
Cisco 2500 Series Wireless Controller for up to 15 Cisco access points		AIR-CT2504-15-K9	
Cisco 2500 Series Wireless Controller for up to 5 Cisco access points		AIR-CT2504-5-K9	

WIRELESS LAN ACCESS POINTS

Functional Area	Product Description	Part Numbers	Software
Wireless Access Points	Cisco 3700 Series Access Point 802.11ac and CleanAir with Internal Antennas	AIR-CAP3702I-x-K9	8.2.100.0
	Cisco 3700 Series Access Point 802.11ac and CleanAir with External Antenna	AIR-CAP3702E-x-K9	
	Cisco 3600 Series Access Point Dual Band 802.11a/g/n and CleanAir with Internal Antennas	AIR-CAP3602I-x-K9	
	Cisco 3600 Series Access Point Dual Band 802.11a/g/n and CleanAir with External Antennas	AIR-CAP3602E-x-K9	
	Cisco 2600 Series Access Point Dual Band 802.11a/g/n and CleanAir with Internal Antennas	AIR-CAP2602I-x-K9	
	Cisco 2600 Series Access Point Dual Band 802.11a/g/n and CleanAir with External Antennas	AIR-CAP2602E-x-K9	
	Cisco 1600 Series Access Point Dual-band controller-based 802.11a/g/n with Internal Antennas	AIR-CAP1602I-x-K9	
	Cisco 1600 Series Access Point Dual-band controller-based 802.11a/g/n with External Antennas	AIR-CAP1602E-x-K9	

WIRELESS LAN

Functional Area	Product Description	Part Numbers	Software
Wireless LAN	Cisco 802.11ac Wave 1 Module for 3600 Series Access Point	AIR-RM3000AC-x-K9=	8.2.100.0
	Cisco 802.11ac Wave 1 Module for 3600 Series Access Point 10 Pack	AIR-RM3000ACxK910=	

WAN AGGREGATION

Functional Area	Product Description	Part Numbers	Software
WAN-aggregation Router	Cisco Aggregation Services 1002X Router	ASR1002X-5G-VPNK9	IOS-XE 03.16.01a.S Advanced Enterprise
	Cisco Aggregation Services 1001X Router	ASR1001X-5G-VPN	IOS-XE 03.16.01a.S Advanced Enterprise
	Cisco ISR 4451-X Security Bundle with SEC License	ISR4451-X-SEC/K9	IOS-XE 03.16.01a.S securityk9

WAN REMOTE SITE

Functional Area	Product Description	Part Numbers	Software
Modular WAN Remote-site Router	Cisco ISR 4451 AX Bundle with APP and SEC License	ISR4451-X-AX/K9	IOS-XE 03.16.01a.S securityk9, appxk9
	Cisco ISR 4431 AX Bundle with APP and SEC License	ISR4431-AX/K9	IOS-XE 03.16.01a.S securityk9, appxk9
	Cisco ISR 4351 AX Bundle with APP and SEC License	ISR4351-AX/K9	IOS-XE 03.16.01a.S securityk9, appxk9
	Cisco ISR 4331 AX Bundle with APP and SEC License	ISR4331-AX/K9	IOS-XE 03.16.01a.S securityk9, appxk9
	Cisco ISR 4321 AX Bundle with APP and SEC License	ISR4321-AX/K9	IOS-XE 03.16.01a.S securityk9, appxk9
	Cisco ISR 3945 AX Bundle with APP and SEC License	C3945-AX/K9	15.5(3)M1 securityk9, datak9, uck9
	Cisco ISR 3925 AX Bundle with APP and SEC License	C3925-AX/K9	15.5(3)M1 securityk9, datak9, uck9
	Cisco ISR 2951 AX Bundle with APP and SEC License	C2951-AX/K9	15.5(3)M1 securityk9, datak9, uck9
	Cisco ISR 2921 AX Bundle with APP and SEC License	C2921-AX/K9	15.5(3)M1 securityk9, datak9, uck9
	Cisco ISR 2911 AX Bundle with APP and SEC License	C2911-AX/K9	15.5(3)M1 securityk9, datak9, uck9
	Cisco ISR 1941 AX Bundle with APP and SEC License	C1941-AX/K9	15.5(3)M1 securityk9, datak9



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