PART 4

BYOD Use Cases

CHAPTER 14

Summary of BYOD Use Cases

Revised: August 7, 2013

This part of the CVD focuses on implementing the rules previously defined in business policies. These rules translate into four different use cases that focus in providing differentiated access to corporate, personal-owned, and guest devices and highlight the network infrastructure as the enforcement point for BYOD policies.

There are numerous ways to enable a BYOD solution based on the unique business requirements of a specific organization. While some organizations may take a more open approach and rely on basic authentication, other organizations will prefer more secure ways to identify, authenticate, and authorize devices. A robust network infrastructure with the capabilities to manage and enforce these policies is critical to a successful BYOD deployment.

The following components and configuration steps are discussed to support different BYOD use cases:

- Digital Certificates
- Microsoft Active Director authentication
- Wireless Controllers (Unified and Converged Access)
- Identity Services Engine
- Access Layer Switches
- API Integration with Mobile Device Managers

This part of the CVD includes the following chapters:

- BYOD Enhanced Use Case—Personal and Corporate Devices—This use case provides network access for personal devices and corporate-issued devices. It provides unique access (Full, Partial, and Internet Only) based on different conditions analyzed by the ISE. ISE relies on the network infrastructure to enforce unique permissions.
- BYOD Limited Use Case—Corporate Devices—This use case focuses on identifying corporate-issued devices and providing Full Access to Network Resources.
- BYOD Advanced Use Case—Mobile Device Manager Integration—The API integration with third party Mobile Device Managers allows the ISE to query for additional posture information on endpoints. This information translates into more granular authorization rules and allows for more visibility into the endpoint.
- BYOD Basic Access Use Case—An extension all the traditional wireless guest access, this use case presents an alternative where the business policy is not to on-board personal wireless devices but still provides access to network resources.

- User Experience—How To On-board a BYOD Device—Providing a positive user experience is important for any BYOD deployment. Employees should be provided with a simple way to on-board their devices and enable the necessary security features with minimum manual intervention. This chapter captures a typical user interaction with ISE during the on-boarding process.

CHAPTER 15

BYOD Enhanced Use Case—Personal and Corporate Devices

Revised: August 7, 2013

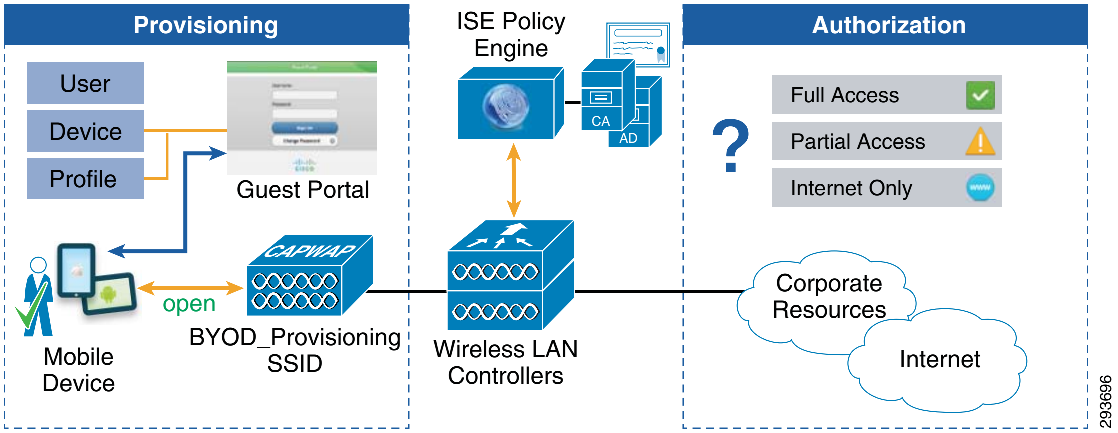
The BYOD Enhanced use case is a super-set of the BYOD Limited use case, covering both personal and corporate devices. This chapter defines the design scenarios for deploying BYOD for personal device access and the design considerations for each scenario. It also highlights how to deny access to personal devices based on their device type. Since Chapter 16, “BYOD Limited Use Case—Corporate Devices” provides design guidance for corporate devices, that design information for corporate devices is not duplicated in this chapter.

One of the main objectives of a BYOD solution is to provide a simple way for employees to on-board their personal devices without requiring assistance from IT. Since the BYOD needs of the majority of employees will be met with either simple Internet access or Partial access, the only time an employee requires assistance from IT is when they require full access to corporate resources.

Cisco ISE provides different ways to define security policies and determine what network resources each employee is allowed to access. The security policies are then enforced throughout the network infrastructure. The ISE feature set is extremely flexible, enabling different business policies to be enforced. This chapter explains the steps to on-board personal devices and how to apply different policies.

Figure 15-1 shows how a personal device is profiled and registered by ISE and the different network components (WLC, AD, CA) that play a role in the process. Different conditions are evaluated to provide the proper authorization and access to network resources, including digital certificates, Active Directory groups, etc.

Figure 15-1 Provisioning Personal Devices



Note Unless otherwise specified, in the figures throughout this chapter “Wireless LAN Controllers” refers to either standalone devices such as the Cisco Flex 7500, CT5508, and CT5760 wireless controller or to wireless LAN controller functionality integrated within Catalyst 3850 Series converged access switches.

Figure 15-2 shows how a personal device is restricted from accessing the network. Once the device connects and regardless of user authentication, ISE profiles the device and enforces the DenyAccess authorization rule.

Figure 15-2 Deny Access

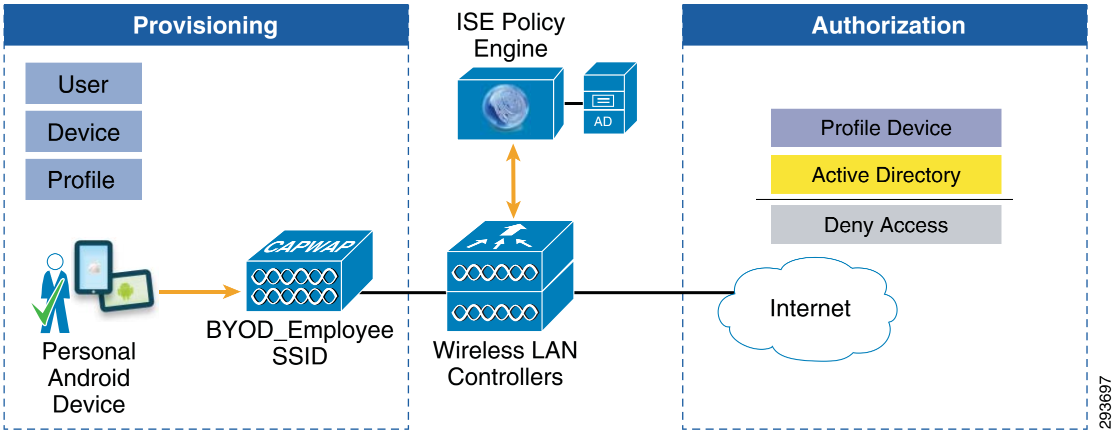
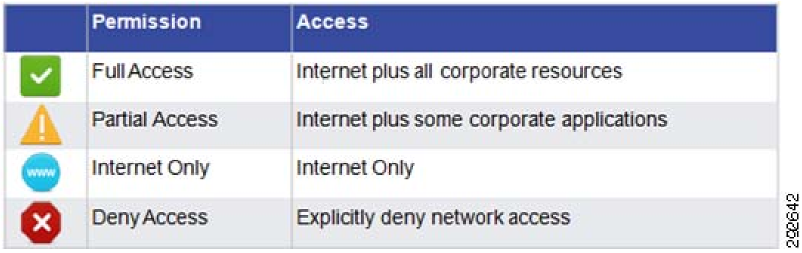


Figure 15-3 shows the different permission levels configured in this chapter. These access levels are enforced using various mechanisms, including Access Control Lists (ACLs) in the Wireless LAN Controllers (WLCs) or Catalyst switches, Security Group Tag (SGT) assignment in the WLCs, and VLAN assignment in the Catalyst switches along with FlexConnect ACLs in access points.

Figure 15-3 Permission Levels for Personal Devices



	Permission	Access
✓	Full Access	Internet plus all corporate resources
⚠	Partial Access	Internet plus some corporate applications
www	Internet Only	Internet Only
✗	Deny Access	Explicitly deny network access

Active Directory Groups

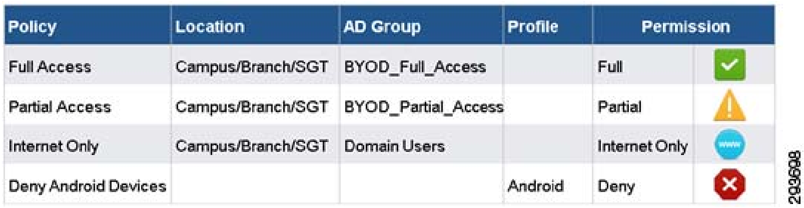
Active Directory groups can be used as an additional way to grant differentiated access to users. This chapter relies on the following three AD groups:

- BYOD_Full_Access—Members of this group are granted full access to network resources.
- BYOD_Partial_Access—Members of this group are granted partial access to network resources. With this permission, users are able to access the Internet and a subset of corporate applications, such as email, corporate directory, travel tools, etc.
- Domain Users—All users are members of this system-generated group by default. Employees that are not members of the above mentioned groups are granted Internet access.

This model could easily be expanded to include other user groups with similar access requirements. A good example would be to create a new group and access list to grant access to contractors or partners.

Figure 15-4 highlights the different access policies validated for this chapter, along with the different requirements and permissions granted by each policy. These policies, along with detailed configurations, are explained later in this chapter.

Figure 15-4 Access Policies and Permissions

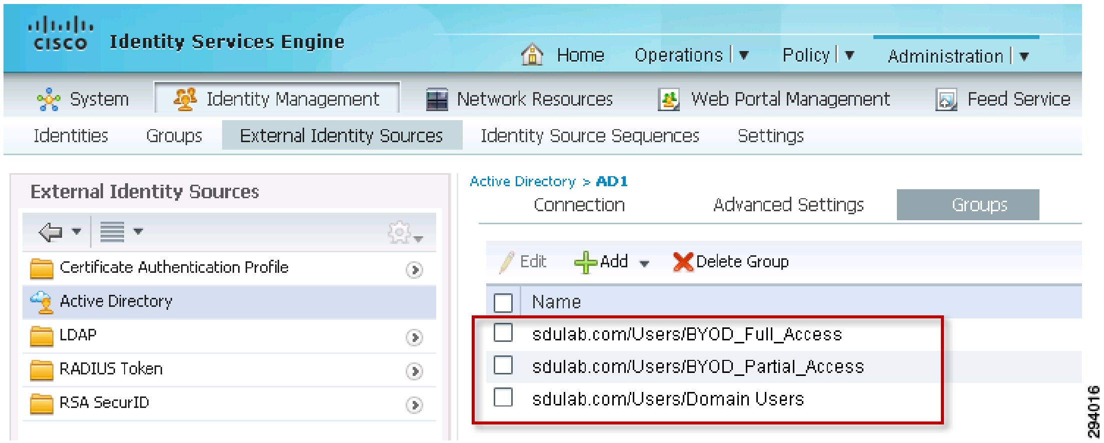


Policy	Location	AD Group	Profile	Permission	
Full Access	Campus/Branch/SGT	BYOD_Full_Access		Full	✓
Partial Access	Campus/Branch/SGT	BYOD_Partial_Access		Partial	⚠
Internet Only	Campus/Branch/SGT	Domain Users		Internet Only	www
Deny Android Devices			Android	Deny	✗

Note The location SGT refers to a Wireless LAN Controller which is dedicated for the purpose doing SGT only.

To configure the Active Directory groups that can be available for use in the authorization policy conditions, click **Administration > Identity Management > External Identity Sources > Active Directory > Groups** and check the boxes next to the groups that will be used in the policy conditions and rules. Figure 15-5 includes the groups used in this design guide.

Figure 15-5 Active Directory Groups



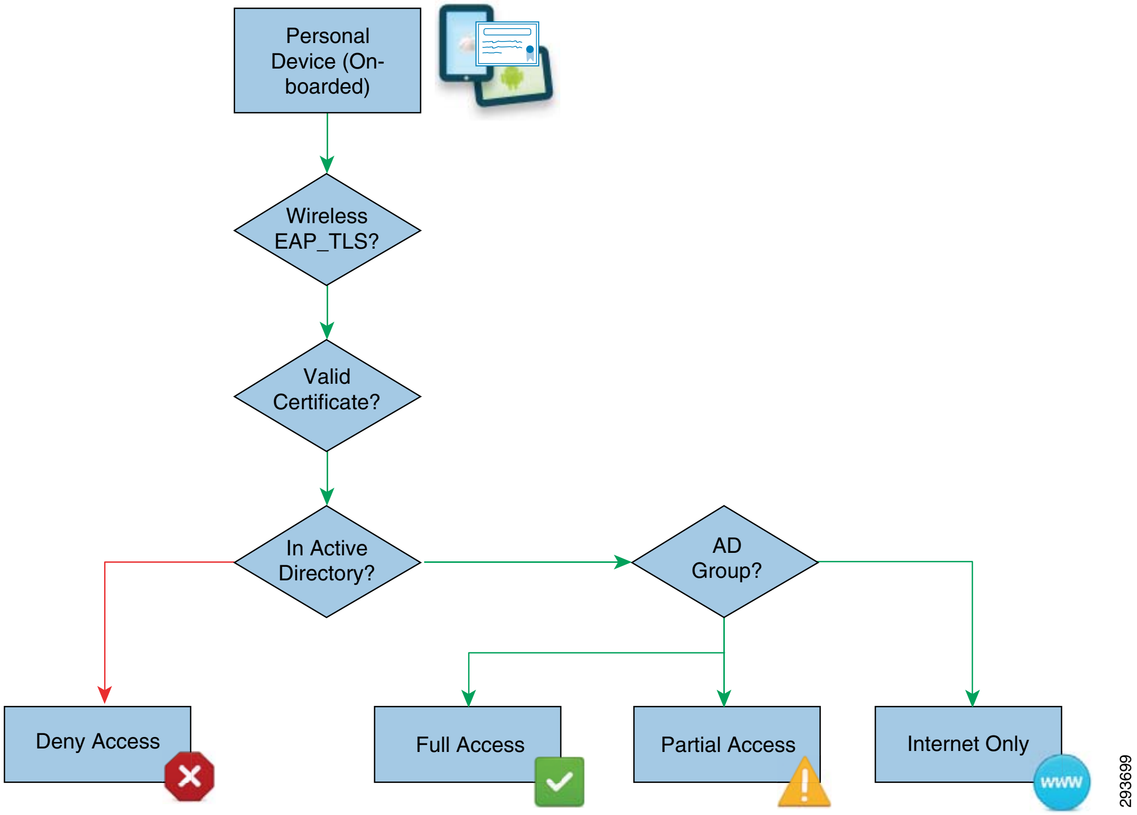
□	Name
□	sdulab.com/Users/BYOD_Full_Access
□	sdulab.com/Users/BYOD_Partial_Access
□	sdulab.com/Users/Domain Users

This chapter assumes that after employees have on-boarded their devices, they will connect to the BYOD_Employee SSID. Figure 15-6 highlights the connectivity flow for personal devices.

If the endpoint connected from a wireless 802.1X EAP-TLS SSID and has a valid certificate, based on their AD group membership, employees will get:

- Full Access if they belong to the BYOD_Full_Access group.
- Partial Access if they belong to the BYOD_Partial_Access group.
- Internet Access if they are a valid Active Directory member (Domain Users group)

Figure 15-6 Personal Device BYOD Access



Distributing Digital Certificates

Digital signatures, enabled by public key cryptography, provide a means to authenticate devices and users. In public key cryptography, such as the RSA encryption system, each user has a key pair containing both a public and a private key. The keys act as complements and anything encrypted with one of the keys can be decrypted with the other.

A digital signature is encrypted with the sender's private key. The signature must be verified to confirm the sender's identity. This is done by the receiver, who decrypts the signature with the sender's public key. If the signature sent with the data matches the result of applying the public key to the data, the validity of the message is established.

This process relies on the receiver having a copy of the public key of the sender and a high degree of certainty that this key belongs to the sender, not to someone pretending to be the sender.

Deploying digital certificates on mobile devices requires a unique process, as many of these devices do not natively support all the features and functionality to create, download, and install digital client certificates in the same manner as traditional PC-based devices. At the same time, some endpoints do not support Simple Certificate Enrollment Protocol (SCEP) natively.

For example, for users to install digital client certificates using SCEP on Apple iOS devices, the IT administrator needs to manually create the configuration profile using the iPhone Configuration Utility and distribute the profile to user devices via email, USB, or web pages.

Traditional full-featured PC-based devices are more apt to take advantage of the many services, such as Microsoft's NDES, to provide certificate enrollment. However, with the onset of many Android and Apple iOS devices on the market, it cannot be assumed that these devices can natively interoperate with many of the enterprise services currently deployed.

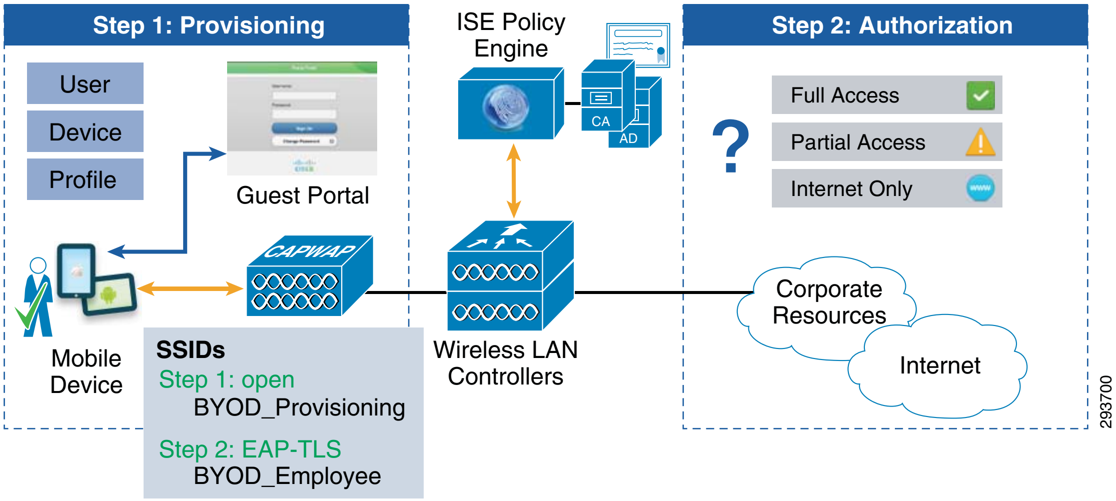
ISE solves this problem by distributing digital certificates to endpoints using the SCEP Proxy feature, which allows endpoints to obtain digital certificates through ISE. Moreover, this feature is combined during the initial registration process, thereby preventing different registration steps. The next section on mobile devices discusses how the endpoints obtain their digital certificates during the registration process.

Mobile Device On-boarding

Deploying digital certificates to endpoint devices requires a network infrastructure that provides the security and flexibility to enforce different security policies. Figure 15-7 highlights the general steps that are followed when a mobile device connects to the network using dual SSIDs.

1. A new device connects to a provisioning SSID. This SSID (open or secured with PEAP) is configured to redirect the user to the Guest Registration portal.
2. The certificate enrollment and profile provisioning begins once the user is properly authenticated.
3. The provisioning service requests information from the mobile device user and provisions the configuration profile, which includes a WiFi profile with the required parameters to connect to the secured Employee SSID.
4. For subsequent connections, the device uses the Employee SSID and is granted access to network resources based on different ISE authorization rules.

Figure 15-7 Enrollment and Provisioning—Dual SSID



The on-boarding steps may also be configured with a single SSID used for provisioning and secure access. The general steps followed when the mobile device connects are similar, redirecting the user to the Guest registration portal and provisioning the device with a digital certificate and configuration profiles.

Provisioning Flows

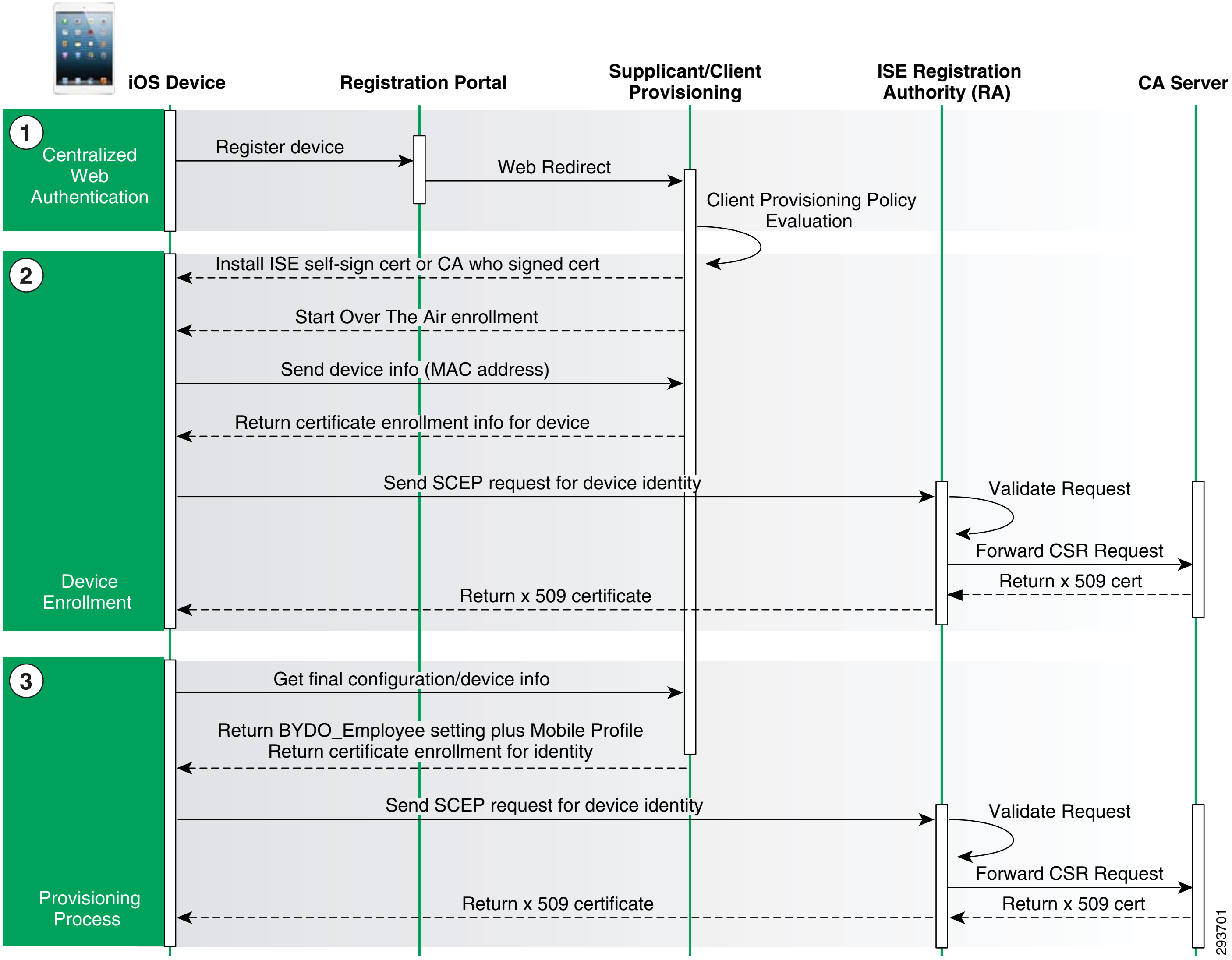
This section explains the interaction between the endpoints and the Guest Registration portal and the steps required to enroll the digital certificate and configuration profile. The way Windows and Mac devices are provisioned is similar. Chapter 8, "Summary of Configuring the Infrastructure" points to the chapters with the steps required to configure the different network components.

Provisioning Apple iOS Devices

The following steps take place while provisioning Apple iOS devices:

1. The device is redirected to the Guest Registration Portal.
2. After successful authentication, the Over-The-Air (OTA) enrollment begins.
3. Device sends unique identifier (MAC address) and other information.
4. Certificate enrollment information is sent to the device.
5. A SCEP request is made to ISE, which returns a certificate.
6. Wireless profile for BYOD_Employee is sent to the device.
7. Once the enrollment is complete, the user manually connects to BYOD_Employee SSID.

Figure 15-8 Provisioning Flow for Apple iOS Devices


iOS Device
Registration Portal
Supplicant/Client Provisioning
ISE Registration Authority (RA)
CA Server
1
Centralized Web Authentication
Register device
Web Redirect
Client Provisioning Policy Evaluation
2
Install ISE self-sign cert or CA who signed cert
Start Over The Air enrollment
Send device info (MAC address)
Return certificate enrollment info for device
Send SCEP request for device identity
Validate Request
Forward CSR Request
Return x 509 cert
Return x 509 certificate
Device Enrollment
3
Get final configuration/device info
Return BYDO_Employee setting plus Mobile Profile
Return certificate enrollment for identity
Send SCEP request for device identity
Validate Request
Forward CSR Request
Return x 509 cert
Return x 509 certificate
Provisioning Process
293701

For more details on Over-the-Air Enrollment and configuration for iOS devices, review the iPhone OS Enterprise Deployment Guide:
http://manuals.info.apple.com/en_US/Enterprise_Deployment_Guide.pdf.

Provisioning Android Devices

The following steps take place while provisioning Android devices:

1. The device is redirected to the Guest Registration portal.
2. After successful authentication, the self-registration portal page redirects the user to the Google Play.
3. The user installs the Supplicant Provisioning Wizard (SPW).
4. The SPW is launched to perform provisioning of the supplicant. The SPW performs the following functions:

a. Discovers the ISE and downloads the profile from the ISE.

b. Creates a certificate/key pair for EAP TLS.

c. Makes a SCEP proxy request to ISE and gets the certificate.

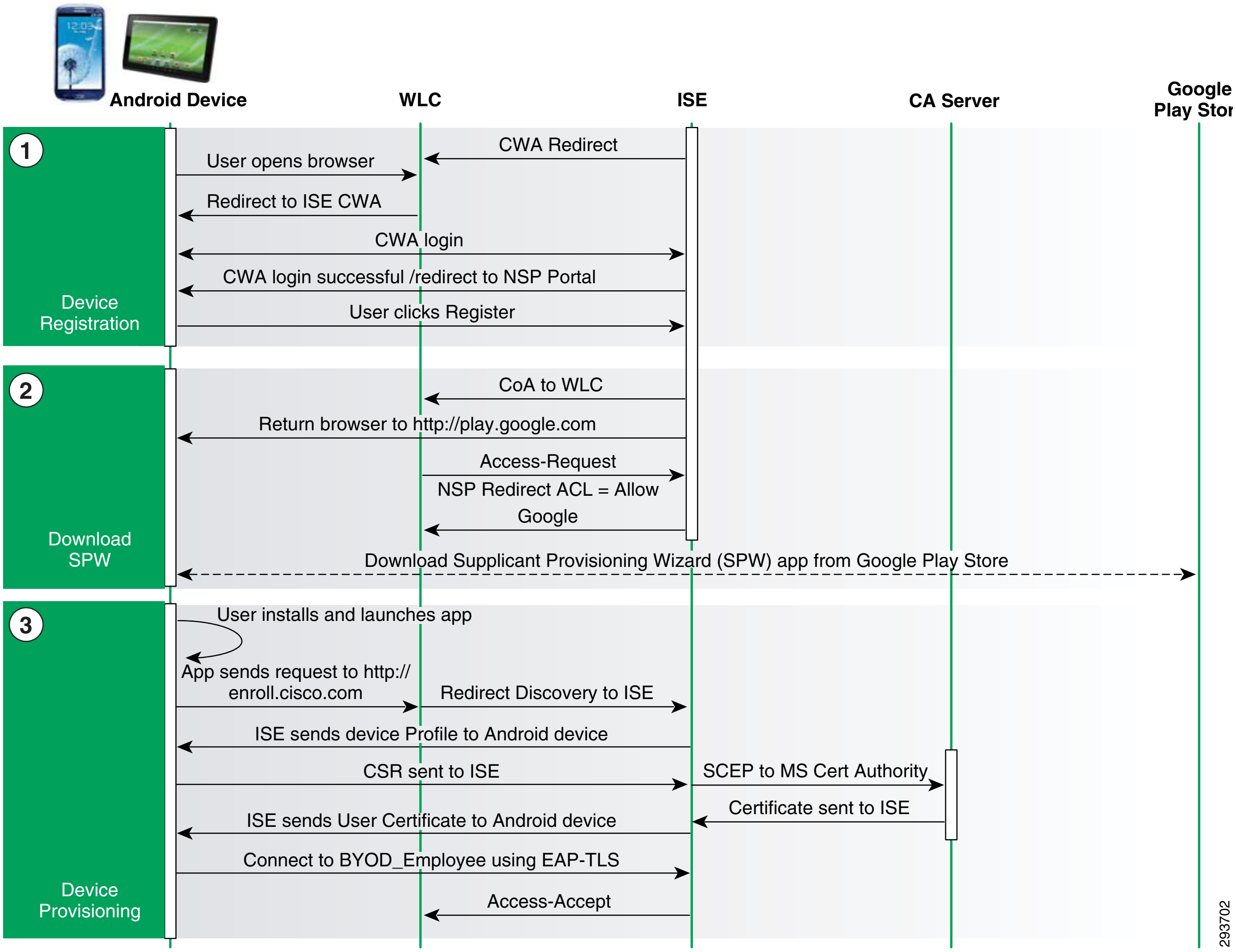
d. Applies the wireless profile to allow connectivity to BYOD_Employee SSID.

5. The SPW triggers re-authentication and connects to BYOD_Employee SSID automatically.

Note The Android agent must be downloaded from Google Play and is not provisioned by the ISE. Endpoints must be able to reach Google Play on the Internet.

Note ACL_Provisioning_Redirect must redirect all traffic sent to enroll.cisco.com. The Cisco Configuration Assistant for Android devices requires this redirect to discover the ISE server. This is shown as part of step 3 in Figure 15-9. This is not a concern if the guidance presented in the CVD is followed since all Internet traffic except Google Play is redirected back to ISE.

Figure 15-9 Provisioning Flow for Android Devices


Android Device
WLC
ISE
CA Server
Google
Play Stor
1
Device
Registration
CWA Redirect
User opens browser
Redirect to ISE CWA
CWA login
CWA login successful /redirect to NSP Portal
User clicks Register
2
Download
SPW
CoA to WLC
Return browser to http://play.google.com
Access-Request
NSP Redirect ACL = Allow
Google
Download Supplicant Provisioning Wizard (SPW) app from Google Play Store
3
Device
Provisioning
User installs and launches app
App sends request to http://
enroll.cisco.com
Redirect Discovery to ISE
ISE sends device Profile to Android device
CSR sent to ISE
SCEP to MS Cert Authority
Certificate sent to ISE
ISE sends User Certificate to Android device
Connect to BYOD_Employee using EAP-TLS
Access-Accept
293702

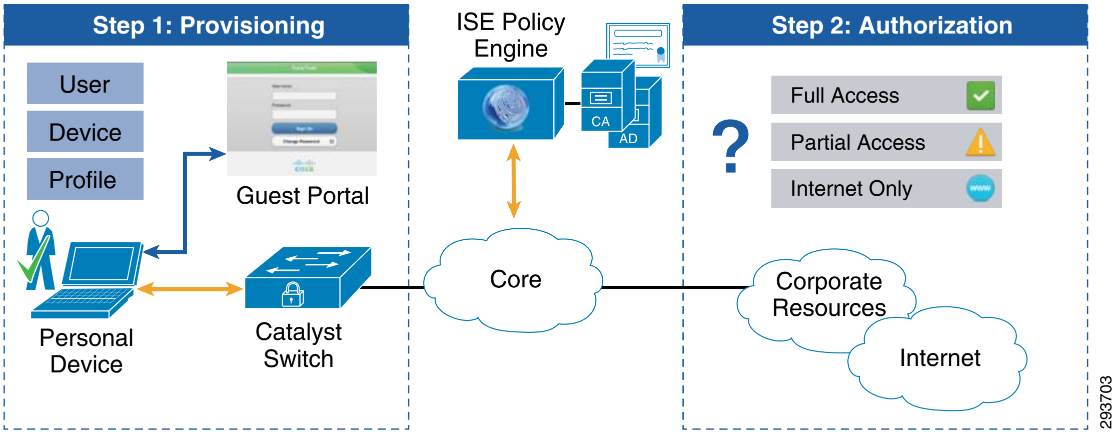
Provisioning Wired Devices

BYOD applies to both wired and wireless devices. Wired devices can be provisioned, registered, authenticated, and authorized in much the same way as wireless devices. The following are some of the advantages of provisioning wired devices:

- Certificate provisioning can be done during the provisioning process, which alleviates the burden on IT to support another model to provision certificates on the devices.
- The native supplicants on the device can be configured with the right protocols during the provisioning process. If this is left to the user, it may often lead to incorrect configurations and additional management overhead for IT.
- Provides easier methods for IT to obtain visibility into who is accessing the network and also methods to remove network access for devices that are lost or stolen.

Figure 15-10 shows a high-level overview of the components used to deploy wired devices. ISE uses several building blocks, such as AD group membership, the EndPoints:BYODRegistration attribute, and Digital Certificates to authenticate and authorize devices. Examples on how to construct these polices are explained in this design guide.

Figure 15-10 Wired Device Deployment



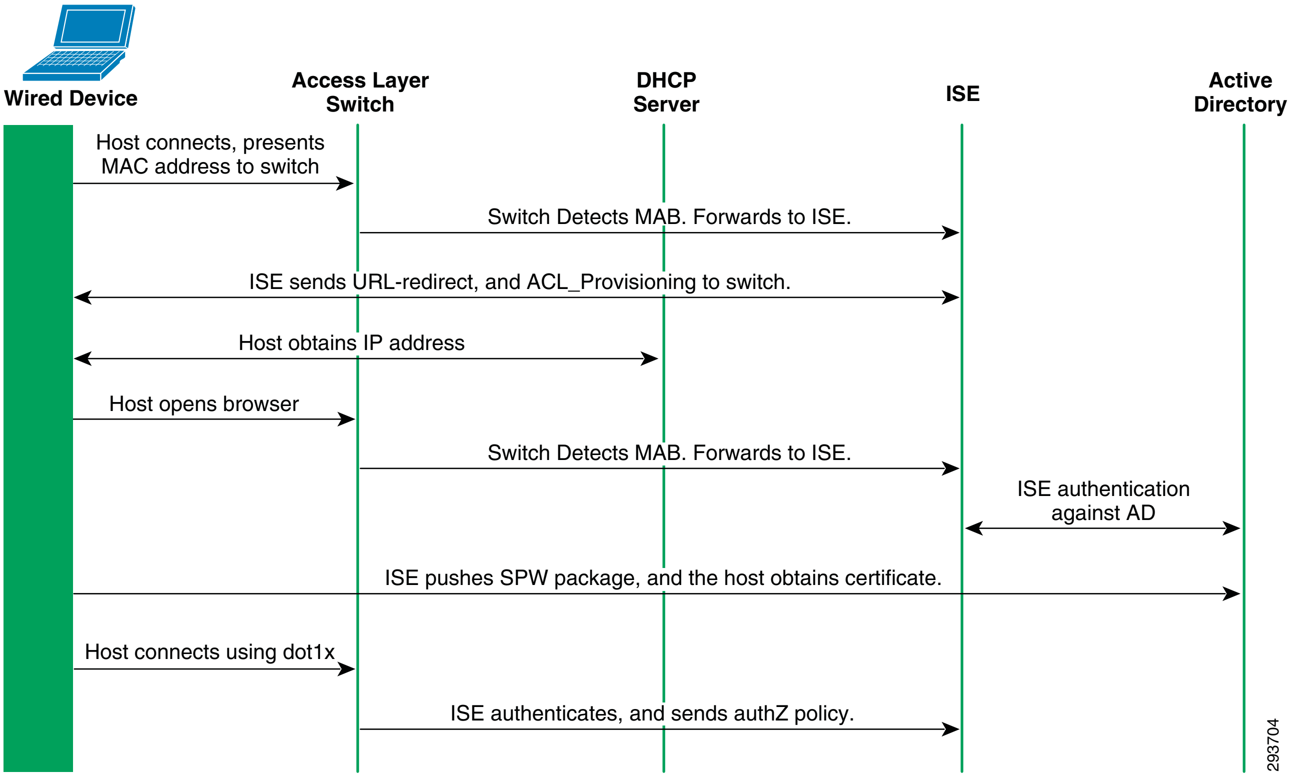
Note Unless otherwise specified, in the figures throughout this chapter "Access Layer Switches" refers to either switches such as the Catalyst 3750X Series and Catalyst 4500 Series or to Catalyst 3850 Series converged access switches.

The following are high-level steps that occur when a wired device connects to the access layer switch:

1. The switch must detect that the wired endpoint is not configured for dot1x and should authenticate using MAB.
2. The ACL_Provisioning_Redirect ACL is used to match web traffic.
3. The URL redirect must point to the ISE Guest Registration portal.
4. The ACL_Provisioning ACL must be downloaded on the port that restricts access in this state.
5. The user opens a browser and attempts to access any resource.
6. The switch redirects the user to an ISE self-registration portal.
7. ISE authenticates the user against AD and pushes the SPW package.
8. The SPW package helps the user register and obtain a digital certificate from ISE.
9. CoA occurs and the user reconnects to the network using the obtained digital certificate.

Figure 15-11 illustrates the flow for wired device provisioning.

Figure 15-11 Wired Device Provisioning Flow


Wired Device
Access Layer Switch
DHCP Server
ISE
Active Directory
Host connects, presents MAC address to switch
Switch Detects MAB. Forwards to ISE.
ISE sends URL-redirect, and ACL_Provisioning to switch.
Host obtains IP address
Host opens browser
Switch Detects MAB. Forwards to ISE.
ISE authentication against AD
ISE pushes SPW package, and the host obtains certificate.
Host connects using dot1x
ISE authenticates, and sends authZ policy.
293704

Key and Certificate Storage

Being able to store digital certificates and their associated keys safely is critical for every device. Storage is implemented differently, depending on the operating system or media used. Table 15-1 shows the different platforms tested in this design guide and their certificate stores.

Table 15-1 Platform and Certificate Storage

Device	Certificate Store	How to Access
Microsoft Windows	Machine Certificate Store	Use the Certificates snap-in from the mmc.exe utility
Mac OS	Device Certificate Store	Use the Keychain Access application
Apple iPad	Device Certificate Store	Settings > General > Profile
Android	Credential Storage	Settings > Location & Security

Once provisioned, the certificates have the following attributes, which can be used by ISE to enforce different permissions:

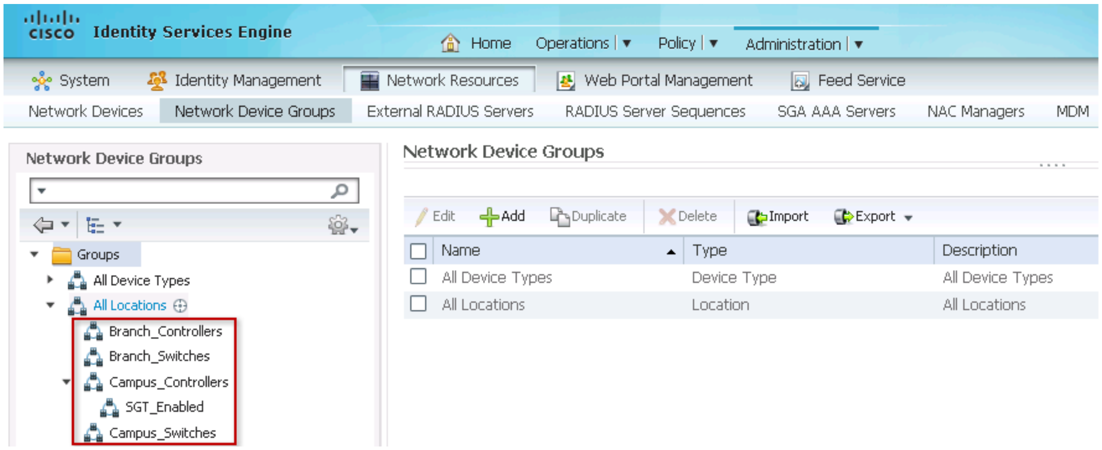
```
Common Name (CN) of the Subject:
    User identity used for authentication

Subject Alternative Name:
    MAC address(es) of the endpoint.
```

Network Device Groups

To differentiate these connections, the ISE relies on Network Device Groups to group WLCs based on their location or device type. This allows a single ISE to enforce policies across different groups of devices. Click **Administration > Network Resources > Network Device Groups** to define locations for branch, campus, and SGT enabled controllers.

Figure 15-12 shows the different locations used in the authorization policy.

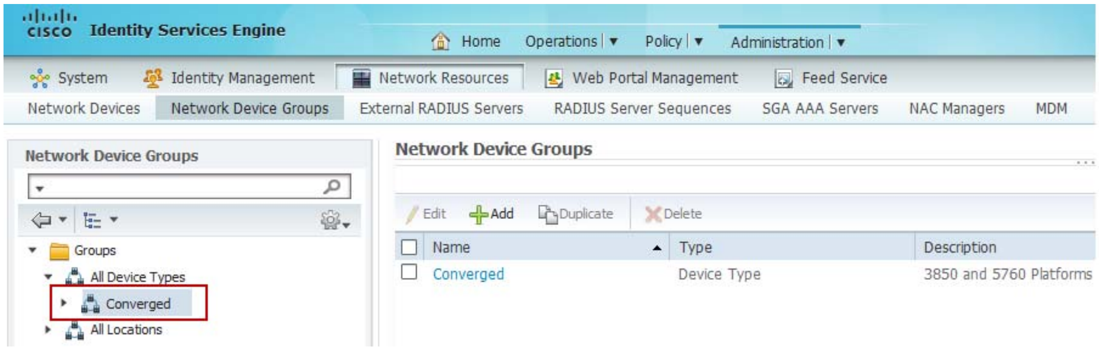
Figure 15-12 ISE Device Groups—Locations



Name	Type	Description
All Device Types	Device Type	All Device Types
All Locations	Location	All Locations

Similarly, Figure 15-13 shows a device type called **Converged** which can be created for Catalyst 3850 Series switches and CT5760 wireless controllers and used in the authorization policy.

Figure 15-13 ISE Device Groups—Device Types

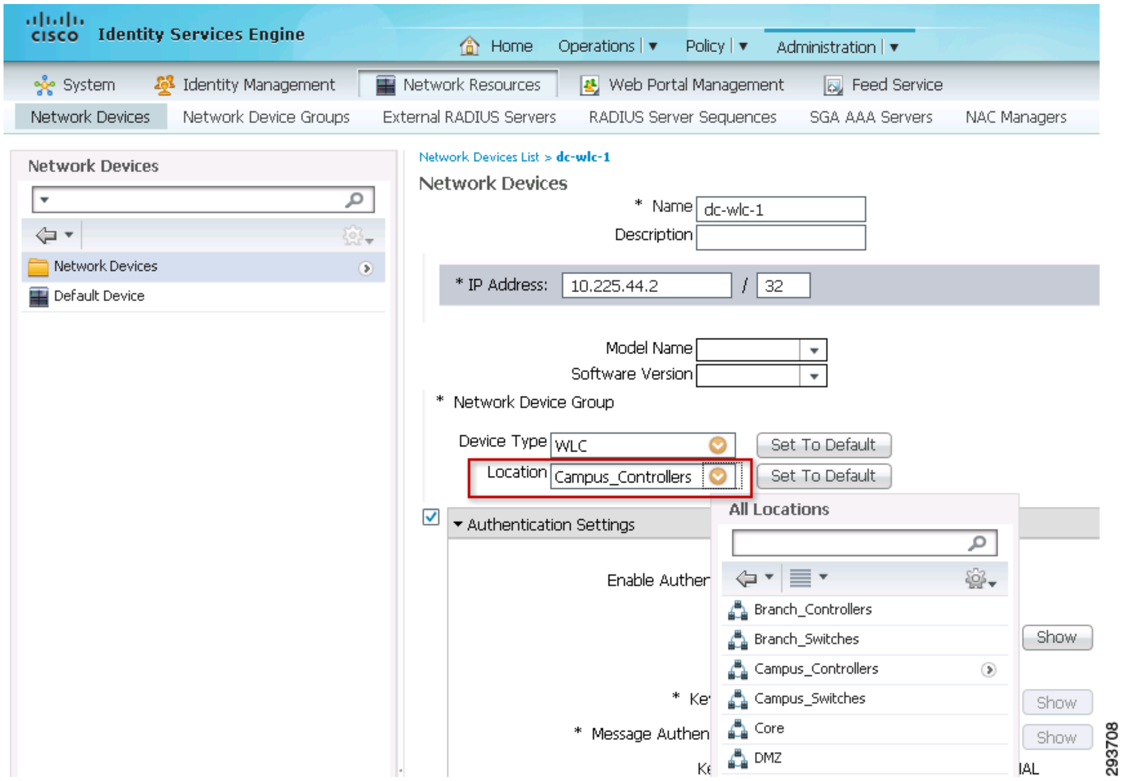


Name	Type	Description
Converged	Device Type	3850 and 5760 Platforms

Note One of the reasons a device type is used instead of a location for Converged Access designs is that the same authorization policy rules are used for Converged Access branch and campus designs within this design guide. Hence location—campus versus branch—is not particularly relevant from a Cisco ISE perspective to Converged Access designs presented in this design guide. Note that if location is relevant, the customer can always modify the design presented here and choose to deploy separate authorization policy rules for branch and campus Converged Access designs as well.

Each Wireless LAN Controller, previously defined as a Network Device, needs to be added to the proper device group by clicking **Administration > Network Resources > Network Devices** and specifying the proper location or device type from the pull-down menu.

Figure 15-14 shows how the dc-wlc-1 Wireless LAN Controller belongs to the Campus_Controllers Network Device Group.



* Name: dc-wlc-1

Description:

* IP Address: 10.225.44.2 / 32

* Network Device Group

Device Type: WLC

Location: Campus_Controllers

Figure 15-14 ISE Network Devices—Campus Controller

Policy Enforcement for Security Group Access

Enforcing policies for SGA in BYOD architecture consist of two main components:

- Defining tags for the endpoints and the destination servers.
- Defining and implementing the Security Group ACL or Security Group Firewall (SG-FW) policy.

In this design, the Security Group ACL is implemented either on the Catalyst and Nexus Data Center switching infrastructure or on the ASA Firewall as an SG-FW policy. These two choices are discussed in Chapter 23, "BYOD Policy Enforcement Using Security Group Access" as two different deployment scenarios.

Security Group Access Tags

The basic idea of Security Group Access is to associate a device or server's IP address with a Security Group Tag and then create role-based policies that either permit or deny traffic flows based on these source and destination SGTs. For example: are devices tagged with an SGT 10 allowed to communicate with a server tagged with an SGT 40? This flow is either allowed or blocked at the enforcement point.

Using this tagging concept, unique tags have been defined for each device accessing the network as a client. As explained in Chapter 4, "BYOD Use Cases," unique permissions are granted to personal and corporate devices and hence unique tags have been defined for each use case.

Table 15-2 illustrates how tags are assigned to different devices.

Table 15-2 Source Tags

Device Type	Tag
Corporate device with Full Access	SGT 10
Personal device with Full Access	SGT 11
Personal device with Partial Access	SGT 12

Similarly, the destination servers also need to be associated with a particular tag. Table 15-3 illustrates how based on their role, servers are assigned with a different tag.

Table 15-3 Destination Tags

Destination Server	Tag
Open Access	SGT 40
Corporate Server	SGT 50

Security Group ACL

After defining the source tags and destination tags, the next logical step is to define the egress policy matrix that defines the enforcement policy between a source and destination tag. Table 15-4 illustrates the egress policy matrix.

Table 15-4 Egress Policy Matrix

	Device Type	SGT 40	SGT 50
SGT 10	Corporate device with Full Access	Yes	Yes
SGT 11	Personal device with Full Access	Yes	Yes
SGT 12	Personal device with Partial Access	Yes	No

As shown in Table 15-4, corporate or personal devices granted full access will be allowed to reach servers that have been tagged with SGT 40 or SGT 50. Similarly, a personal device with partial access is only allowed to connect with a server tagged with SGT 40.

The implementation of the SGACL depends upon the type of the deployment scenario. For the deployment scenario where Nexus is the enforcement point the SGACL is defined in ISE and pushed to the Nexus switch whereas when the deployment scenario is using ASA as the enforcement point then an SGT-based access rule is configured manually on the ASA firewall.

Authorization Polices for SGT

Based on policy matches and authorization profiles, the ISE assigns an SGT tag to endpoints. Centralized Campus with SGT, found later in this chapter, provides information as to the criteria used to determine when an ACL versus an SGT should be returned upon successful authorization based on the network device type of the wireless controller defined in ISE.

For the destination tags assigned to servers, the configuration is done manually at the data center switch, and the actual enforcement happens based on the deployment scenario. To obtain more information on how to configure tags for servers and on the ASA, refer to Chapter 23, "BYOD Policy Enforcement Using Security Group Access."

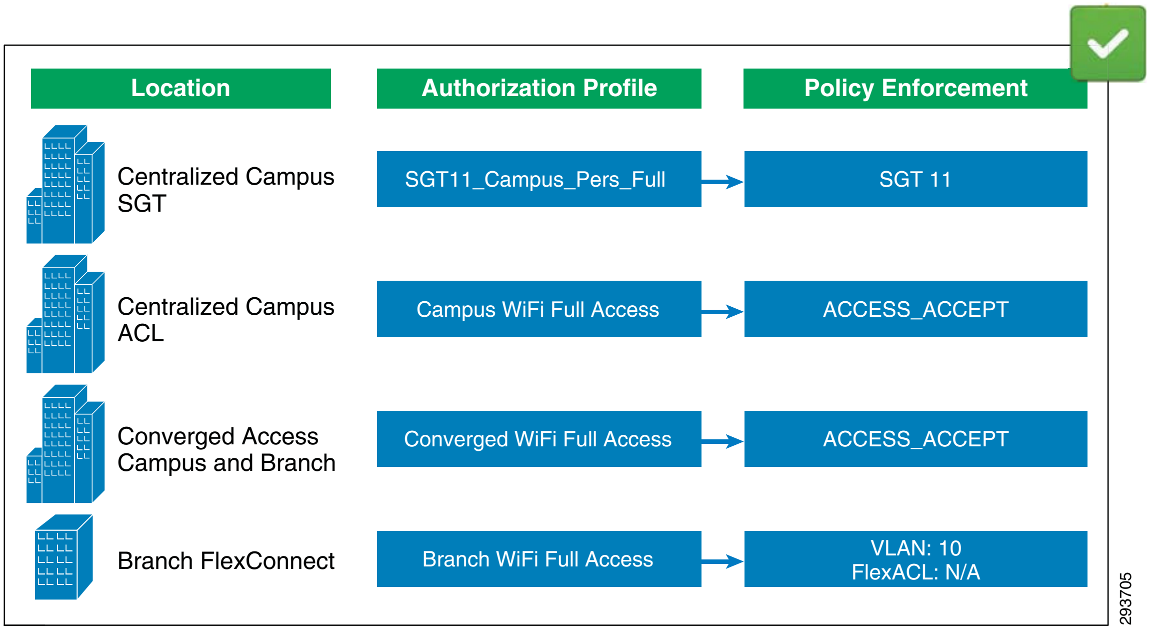
Personal Wireless Devices—Full Access

To provide full access to personal devices, the Cisco ISE verifies the following:

- The employee has completed the on-boarding process through the Guest Registration portal.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate.
- The connection originated using EAP-TLS authentication.
- The user is a member of the BYOD_Full_Access Active Directory group.

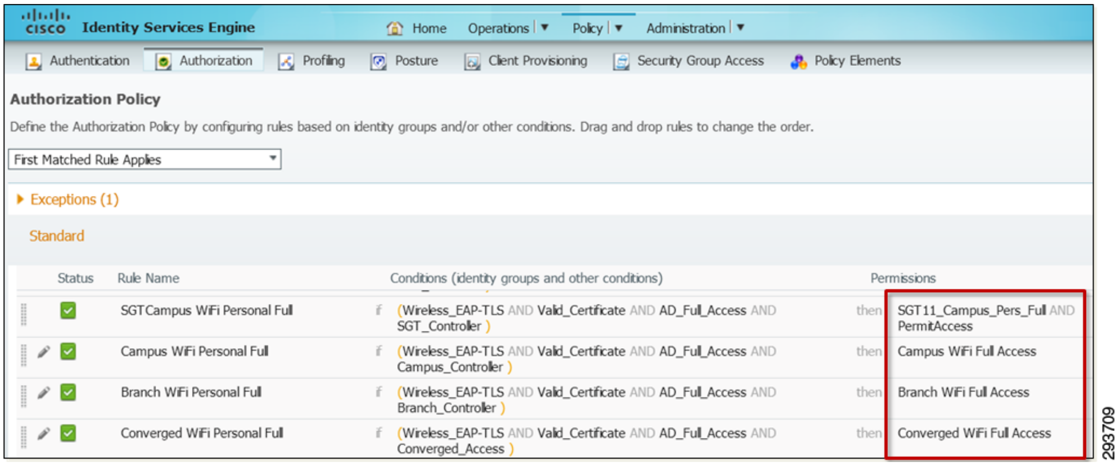
Since the wireless designs presented in this design guide rely on different WLCs for FlexConnect branches, centralized controller campuses, and Converged Access campuses and branches; unique authorization rules are created for connections originating from each design. At a high level, Figure 15-15 shows how different authorization profiles are selected for connections originating from different locations with different wireless designs. Each authorization profile in turn enforces a unique permission.

Figure 15-15 Full Access Enforcement



To configure the authorization rules in ISE, click **Policy > Authorization**. Figure 15-16 highlights the authorization policy to grant full access to personal devices.

Figure 15-16 Authorization Policies for Full Access



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.

First Matched Rule Applies

Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
✓	SGTCampus WiFi Personal Full	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND SGT_Controller)	then	SGT11_Campus_Pers_Full AND PermitAccess
✓	Campus WiFi Personal Full	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Campus_Controller)	then	Campus WiFi Full Access
✓	Branch WiFi Personal Full	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Branch_Controller)	then	Branch WiFi Full Access
✓	Converged WiFi Personal Full	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then	Converged WiFi Full Access

Looking at the rules in more detail, ISE evaluates the following conditions:

- Wireless_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name. (defined as a simple condition).
- The user belongs to a specific Active Directory group (defined as a simple condition).
- The RADIUS authentication originated from a wireless controller which was a member of one of the following device groups—Campus_Controller, SGT_Controller, Branch_Controller, or Converged_Access (defined as a simple condition).

Note A wireless controller which is a member of the Converged_Access device group could be either a standalone device, such as a Cisco CT5760 wireless controller, or a switch with integrated wireless controller functionality, such as the Catalyst 3850.

Simple and Compound Conditions

To improve the readability of the authorization policy, simple and compound authorization conditions were defined to group different conditions. These conditions may be reused and modified without changing every authorization rule.

Table 15-5 shows the conditions used in the authorization rules:

Table 15-5 Simple and Compound Conditions

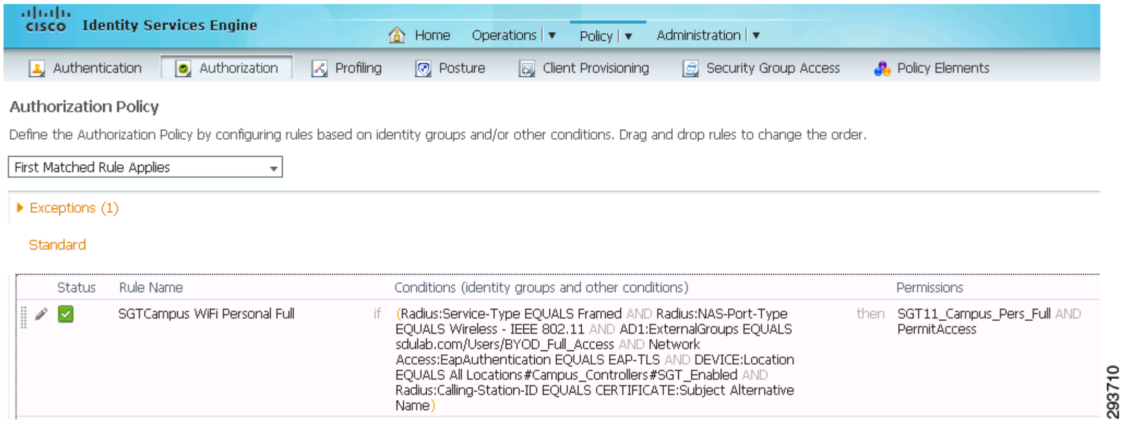
Wireless EAP-TLS (Compound)	
Wireless_EAP-TLS (See Figure 15-18)	Radius:Service-Type Equals Framed AND Radius:NAS-Port-Type Equals Wireless - IEEE 802.11 AND Network Access:EapAuthentication Equals EAP-TLS

Table 15-5 Simple and Compound Conditions

Check for Valid Certificate (Simple)	
Valid_Certificate (See Figure 15-19)	Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name
Active Directory Group (Simple)	
AD_ Full_Access	AD1:ExternalGroups EQUALS sdulab.com/Users/BYOD_Full_Access
AD_ Partial_Access	AD1:ExternalGroups EQUALS sdulab.com/Users/BYOD_Partial_Access
AD_Domain_users	AD1:ExternalGroups EQUALS sdulab.com/Users/Domain User
WLC Location or Device Type (Simple)	
SGT_Controller	DEVICE:Location EQUALS All Locations#Campus_Controllers#SGT_Enabled
Campus_Controller	DEVICE:Location EQUALS All Locations#Campus_Controllers
Branch_Controller	DEVICE:Location EQUALS All Locations#Branch_Controllers
Converged_Access	DEVICE:Device Type EQUALS All Device Types#Converged

To illustrate the value of using simple/compound conditions, Figure 15-17 shows how much longer and harder to read a rule can be when simple/compound conditions are not implemented.

Figure 15-17 Authorization Rule without Conditions



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.

First Matched Rule Applies

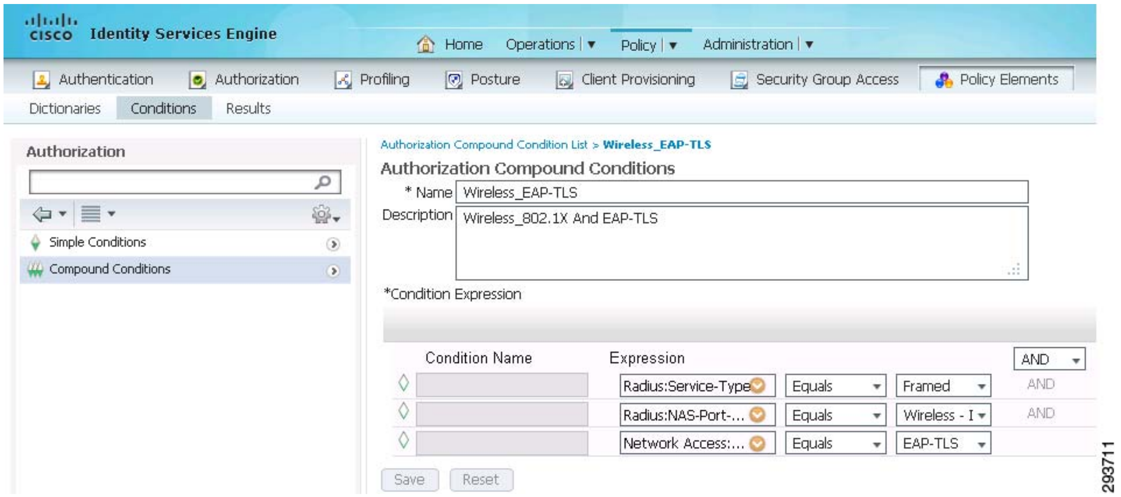
Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
✓	SGTCampus WiFi Personal Full	if	(Radius:Service-Type EQUALS Framed AND Radius:NAS-Port-Type EQUALS Wireless - IEEE 802.11 AND AD1:ExternalGroups EQUALS sdulab.com/Users/BYOD_Full_Access AND Network Access:EapAuthentication EQUALS EAP-TLS AND DEVICE:Location EQUALS All Locations#Campus_Controllers#SGT_Enabled AND Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name)	then	SGT11_Campus_Pers_Full AND PermitAccess

To define a new compound condition, click **Policy > Conditions > Authorization > Compound Conditions**. Figure 15-18 shows how the Wireless_EAP-TLS condition combines several conditions into one.

Figure 15-18 Wireless_EAP-TLS Condition



Authorization Compound Condition List > Wireless_EAP-TLS

Authorization Compound Conditions

* Name: Wireless_EAP-TLS

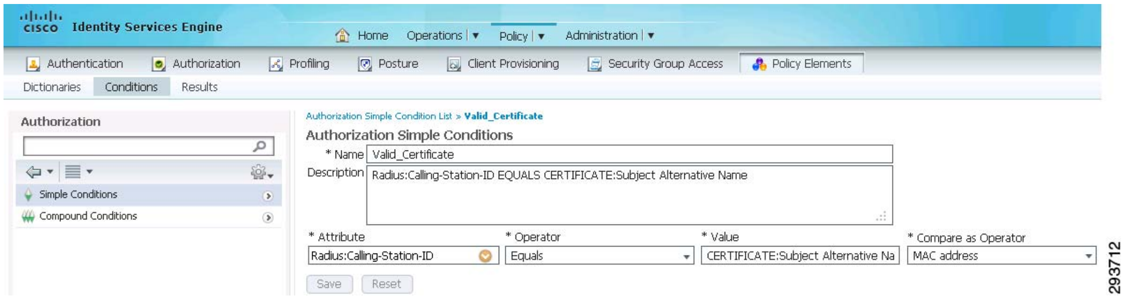
Description: Wireless_802.1X And EAP-TLS

*Condition Expression

Condition Name	Expression			AND
	Radius:Service-Type	Equals	Framed	AND
	Radius:NAS-Port-...	Equals	Wireless - I	AND
	Network Access:...	Equals	EAP-TLS	

[Figure 15-19](#) shows the Valid_Certificate simple condition.

Figure 15-19 Valid_Certificate Condition



Authorization Simple Condition List > Valid_Certificate

Authorization Simple Conditions

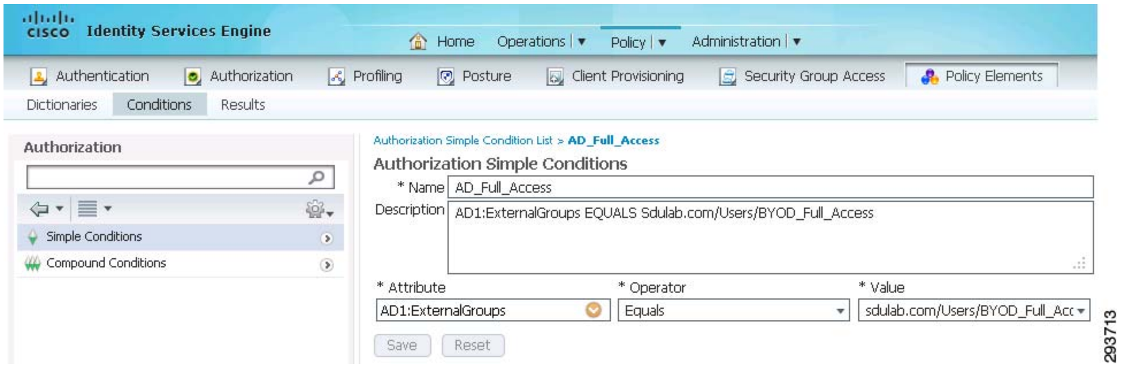
* Name: Valid_Certificate

Description: Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name

* Attribute	* Operator	* Value	* Compare as Operator
Radius:Calling-Station-ID	Equals	CERTIFICATE:Subject Alternative Na	MAC address

[Figure 15-20](#) shows the AD_Full_Access simple condition.

Figure 15-20 AD_Full_Access Condition



Authorization Simple Condition List > AD_Full_Access

Authorization Simple Conditions

* Name: AD_Full_Access

Description: AD1:ExternalGroups EQUALS Sdulab.com/Users/BYOD_Full_Access

* Attribute	* Operator	* Value
AD1:ExternalGroups	Equals	sdulab.com/Users/BYOD_Full_Acc

The remaining conditions mentioned in Table 5 are defined in a similar way.

Permissions

Permission is a result of an authorization policy match, and the permission can be of different types such as an authorization profile, or a standard result. Table 15-6 explains the permissions used for full access.

Table 15-6 Permissions for Full Access

Permission name	Permission type	Purpose
SGT11_Campus_Pers_Full	Standard result	To Assign a SGT for 802.1X wireless devices connecting from an SGT-enabled controller allowing full access.
Campus WiFi Full Access	Authorization profile	Provides Full Access for 802.1X wireless devices connecting from a centralized campus controller.
Branch WiFi Full Access	Authorization profile	To push a VLAN for 802.1X wireless devices connecting from a FlexConnect branch controller
Converged WiFi Full Access	Authorization profile	Provides Full Access for 802.1X wireless devices connecting from a Converged Access controller.

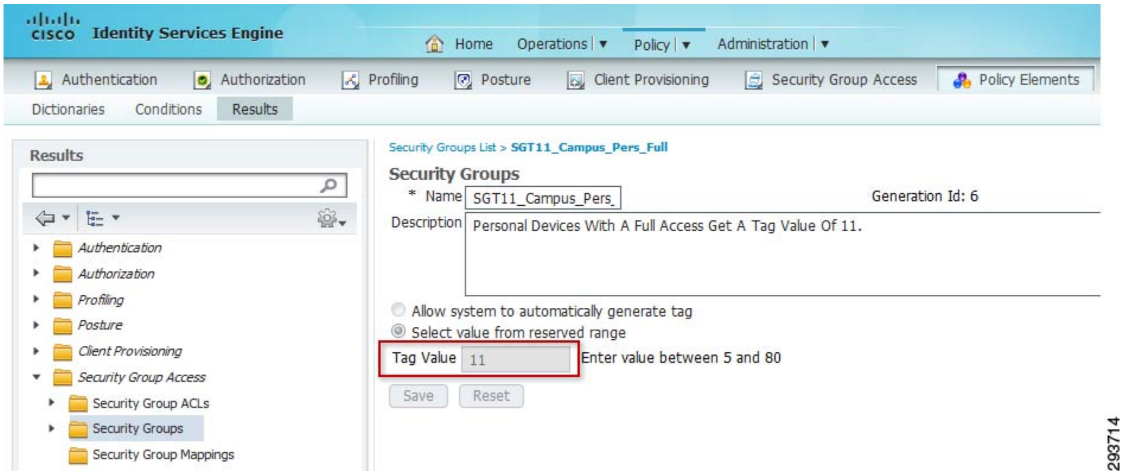
Note A Converged Access infrastructure refers to a branch or campus deployment with Catalyst 3850 Series switches and/or CT5760 wireless controllers within this design guide.

Centralized Campus with SGT

As explained in Policy Enforcement for Security Group Access, the personal device with permissions for full access will be assigned an SGT value of 11. Once the personal device obtains the tag value of 11, it can then connect with all the servers in the data center.

Figure 15-21 shows how the SGT11_Campus_Pers_Full authorization profile uses SGT 11 for personal devices granted full access.

Figure 15-21 SGT11_Campus_Pers_Full



Security Groups List > SGT11_Campus_Pers_Full

Security Groups

* Name: SGT11_Campus_Pers_ Generation Id: 6

Description: Personal Devices With A Full Access Get A Tag Value Of 11.

○ Allow system to automatically generate tag
● Select value from reserved range

Tag Value: 11 Enter value between 5 and 80

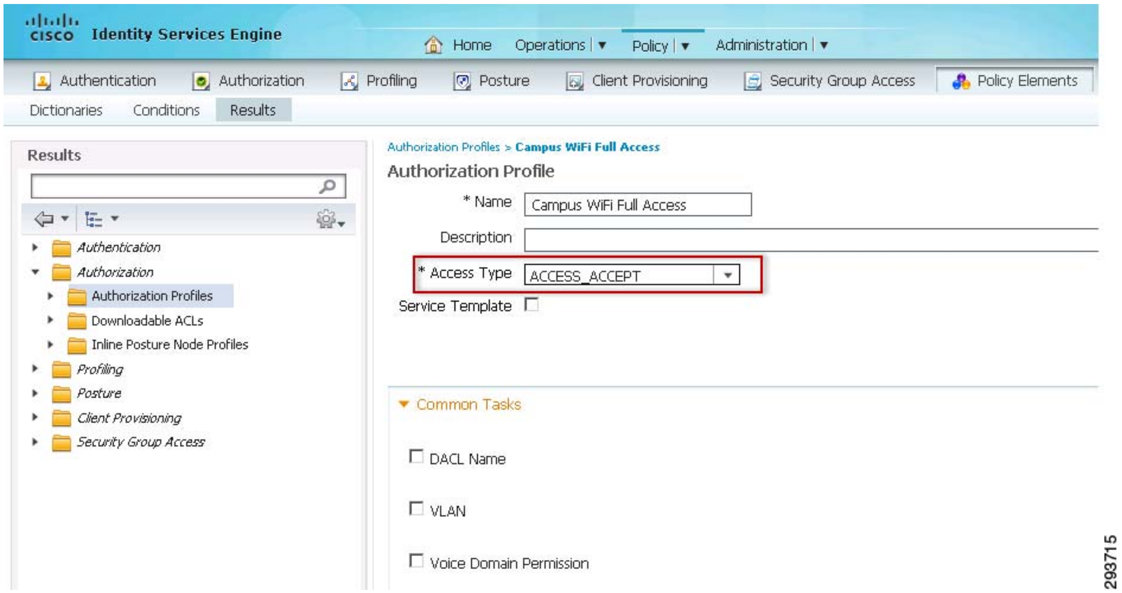
Save Reset

See Policy Enforcement for Security Group Access for details regarding the SGT egress policy matrix which defines the permissions for SGT11 allowing full access for a campus which implements a centralized controller (Local Mode) design with SGTs.

Centralized Campus with ACLs

Figure 15-22 shows how the Campus WiFi Full Access authorization profile is using the ACCESS_ACCEPT Access Type to allow full access.

Figure 15-22 Campus WiFi Full Access



Authorization Profiles > Campus WiFi Full Access

Authorization Profile

* Name: Campus WiFi Full Access

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

▾ Common Tasks

□ DACL Name

□ VLAN

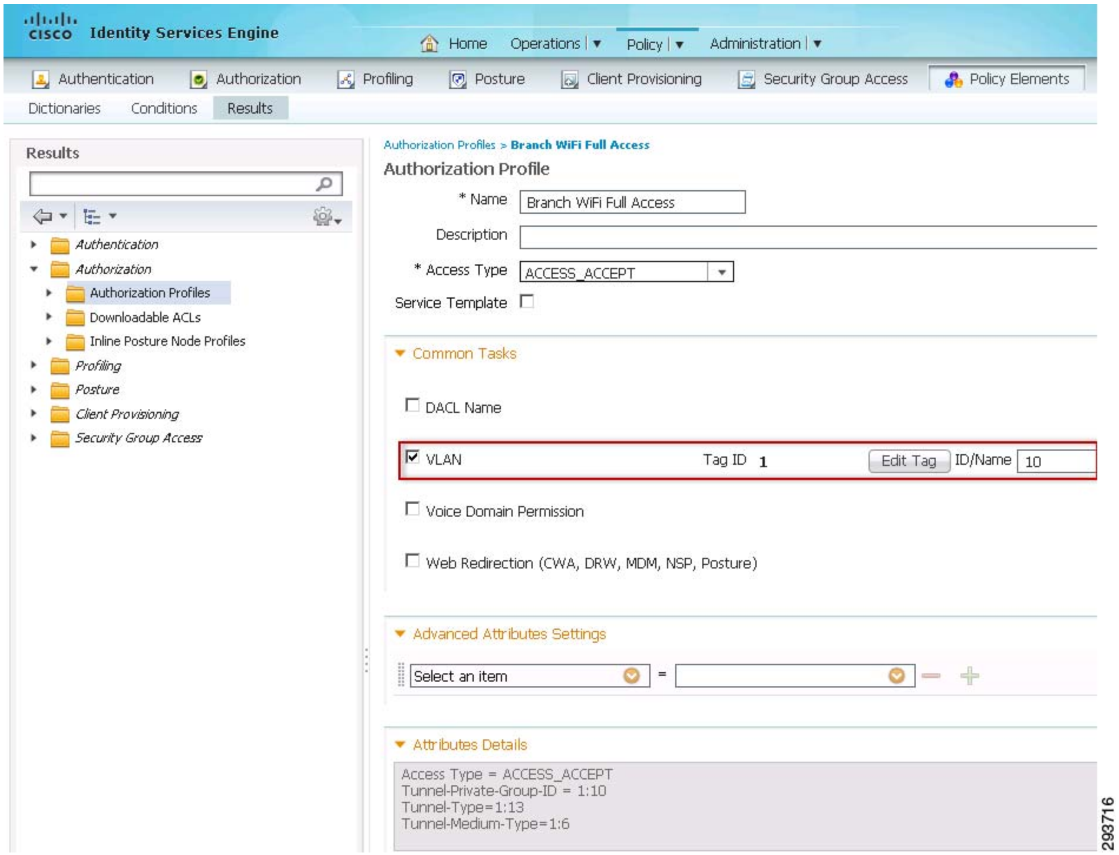
□ Voice Domain Permission

Since full access is allowed with this authorization profile, no Named ACL for access control needs to be specified by ISE.

Branch with FlexConnect

Endpoints connecting from a branch location which implements FlexConnect dynamically get assigned to VLAN 10, which has been configured to provide full access. Figure 15-23 shows the Branch WiFi Full Access authorization profile.

Figure 15-23 Branch WiFi Full Access



Authorization Profile

* Name: Branch WiFi Full Access

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

□ DACL Name

☑ VLAN Tag ID 1 ID/Name 10

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

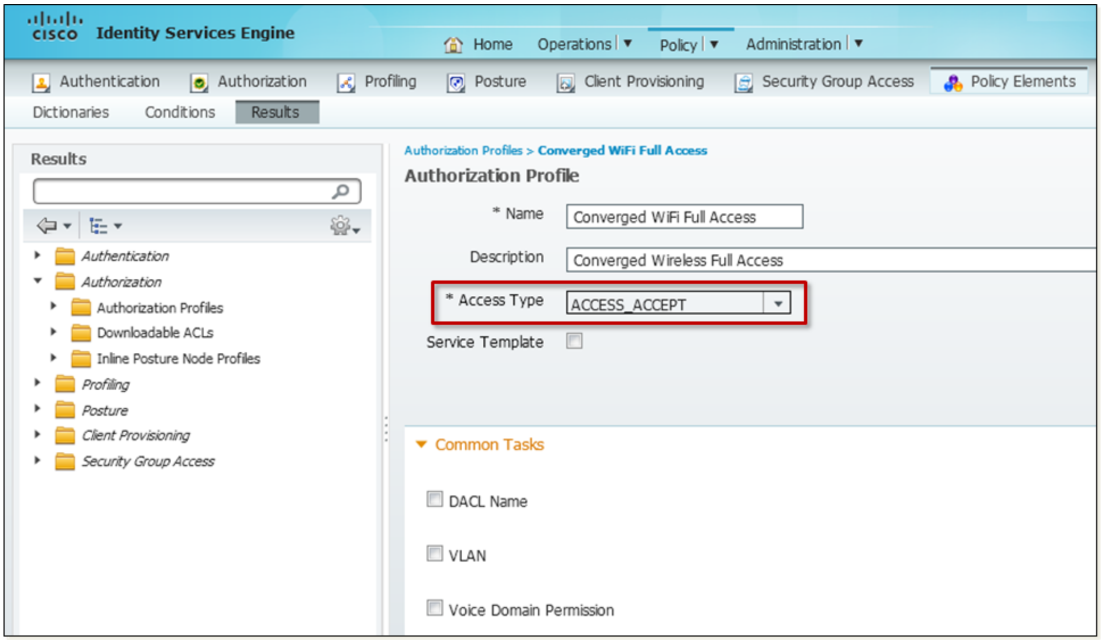
```
Access Type = ACCESS_ACCEPT
Tunnel-Private-Group-ID = 1:10
Tunnel-Type=1:13
Tunnel-Medium-Type=1:6
```

Since full access is allowed with this authorization profile, no FlexConnect ACL for access control needs to be associated with VLAN 10 on the access point.

Converged Access Branch or Campus

Figure 15-24 shows how the Converged WiFi Full Access authorization profile is using the ACCESS_ACCEPT Access Type to allow full access.

Figure 15-24 Converged WiFi Full Access



* Name: Converged WiFi Full Access

Description: Converged Wireless Full Access

* Access Type: ACCESS_ACCEPT

Service Template □

□ DACL Name

□ VLAN

□ Voice Domain Permission

Again, since full access is allowed with this authorization profile, no Named ACL for access control needs to be specified by ISE.

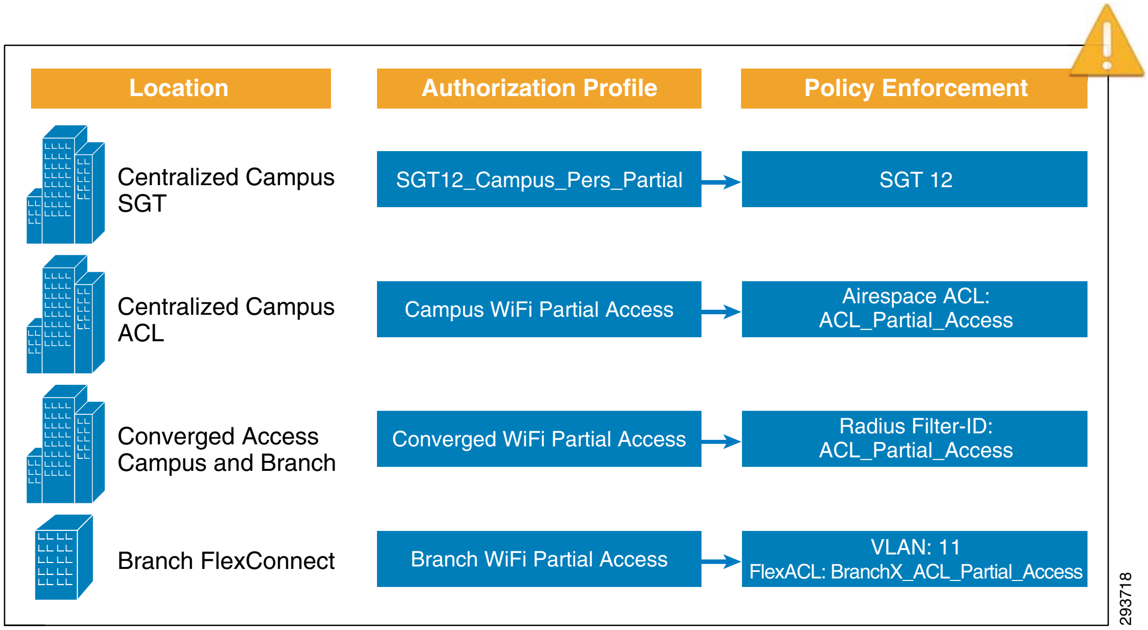
Personal Wireless Devices—Partial Access

To provide partial access to personal devices, the Cisco ISE verifies the following:

- The employee has completed the on-boarding process through the Guest Registration portal.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate, in this case, the MAC address of the endpoint.
- The connection originated using EAP-TLS authentication.
- The user is member of the BYOD_Partial_Access Active Directory group.

At a high level, Figure 15-25 shows how different authorization profiles are selected for devices accessing the network from different locations with different wireless designs. Each authorization profile in turn enforces a unique permission using either VLANs, SGTs, dynamic ACLs, FlexConnect ACLs, etc.

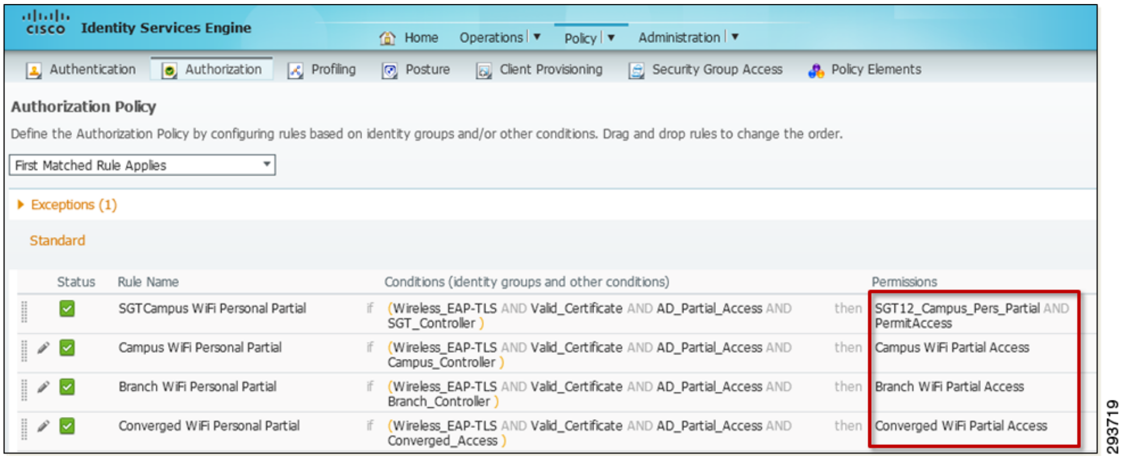
Figure 15-25 Partial Access Enforcement



Location	Authorization Profile	Policy Enforcement
Centralized Campus SGT	SGT12_Campus_Pers_Partial	SGT 12
Centralized Campus ACL	Campus WiFi Partial Access	Airspace ACL: ACL_Partial_Access
Converged Access Campus and Branch	Converged WiFi Partial Access	Radius Filter-ID: ACL_Partial_Access
Branch FlexConnect	Branch WiFi Partial Access	VLAN: 11 FlexACL: BranchX_ACL_Partial_Access

To configure the authorization rules in ISE, click **Policy > Authorization**. Figure 15-26 highlights the authorization policy to grant partial access to personal devices.

Figure 15-26 Authorization Policies for Partial Access



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.

First Matched Rule Applies ▼

▸ Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	SGTCampus WiFi Personal Partial	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND SGT_Controller)	then	SGT12_Campus_Pers_Partial AND PermitAccess
☑	Campus WiFi Personal Partial	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Controller)	then	Campus WiFi Partial Access
☑	Branch WiFi Personal Partial	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Controller)	then	Branch WiFi Partial Access
☑	Converged WiFi Personal Partial	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then	Converged WiFi Partial Access

Looking at the rules in more detail, ISE evaluates the following conditions:

- Wireless_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name. (defined as a simple condition).
- The user belongs to a specific Active Directory group (defined as a simple condition).
- The RADIUS authentication originated from a wireless controller which was a member of one of the following device groups—Campus_Controller, SGT_Controller, Branch_Controller, or Converged_Access (defined as a simple condition).

Simple and Compound Conditions explains the different conditions used in the rules.

Permissions

Permission is a result of an authorization policy match and the permission can be of different types such as an authorization profile or a standard result. Table 15-7 explains the permissions used for partial access.

Table 15-7 Permissions Used for Wireless Partial Access

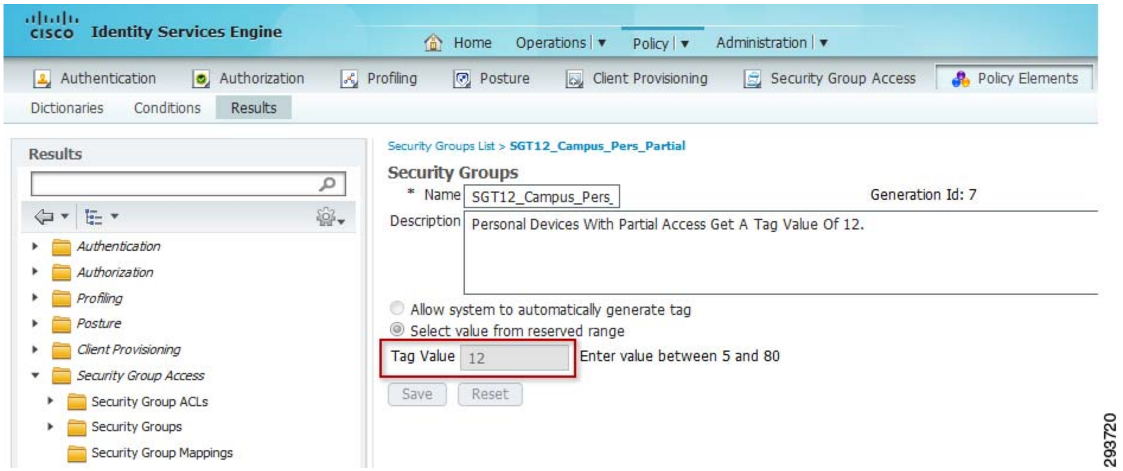
Permission name	Permission type	Purpose
SGT12_Campus_Pers_partial	Standard result	To Assign a SGT for 802.1X wireless devices connecting from an SGT-enabled controller granting partial access to some servers in the data center.
Campus WiFi Partial Access	Authorization profile	To push a named ACL for 802.1X wireless devices connecting from a centralized campus controller.
Branch WiFi Partial Access	Authorization profile	To push a VLAN for 802.1X wireless devices connecting from a FlexConnect branch controller
Converged WiFi Partial Access	Authorization profile	To push a named ACL for 802.1X wireless devices connecting from either a campus or branch location with Converged Access

Centralized Campus with SGT

As explained in Policy Enforcement for Security Group Access, the personal device with permissions for partial access will be assigned an SGT value of 12. Once the personal device obtains the tag value of 12 it can then connect with only those servers with an SGT of 50 in the data center.

Figure 15-27 shows how the SGT12_Campus_Pers_Partial authorization profile is configured to assign SGT 12 to personal devices thus allowing partial access.

Figure 15-27 SGT12_Campus_Pers_Partial



Security Groups List > SGT12_Campus_Pers_Partial

Security Groups

* Name SGT12_Campus_Pers_ Generation Id: 7

Description Personal Devices With Partial Access Get A Tag Value Of 12.

○ Allow system to automatically generate tag

● Select value from reserved range

Tag Value 12 Enter value between 5 and 80

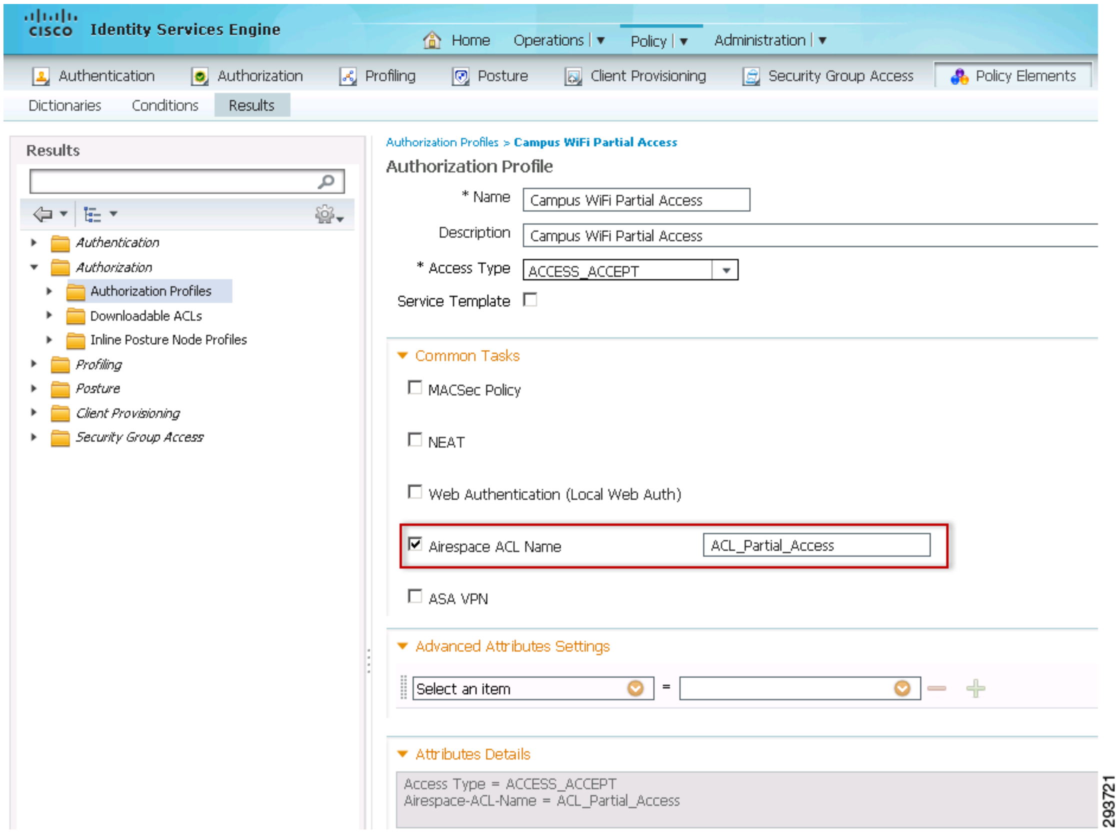
Save Reset

See Policy Enforcement for Security Group Access for details regarding the SGT egress policy matrix which defines the permissions for SGT12 allowing full access for a campus which implements a centralized controller (Local Mode) design with SGTs.

Centralized Campus with ACLs

For devices connecting from a campus location which implements a centralized (Local Mode) wireless design, the Campus WiFi Partial Access authorization profile relies on the ACL_Partial_Access access list, enforced by the WLC. Figure 15-28 shows the authorization profile.

Figure 15-28 Campus WiFi Partial Access



Authorization Profile

* Name: Campus WiFi Partial Access

Description: Campus WiFi Partial Access

* Access Type: ACCESS_ACCEPT

Service Template □

Common Tasks

□ MACSec Policy

□ NEAT

□ Web Authentication (Local Web Auth)

☑ Airespace ACL Name: ACL_Partial_Access

□ ASA VPN

Advanced Attributes Settings

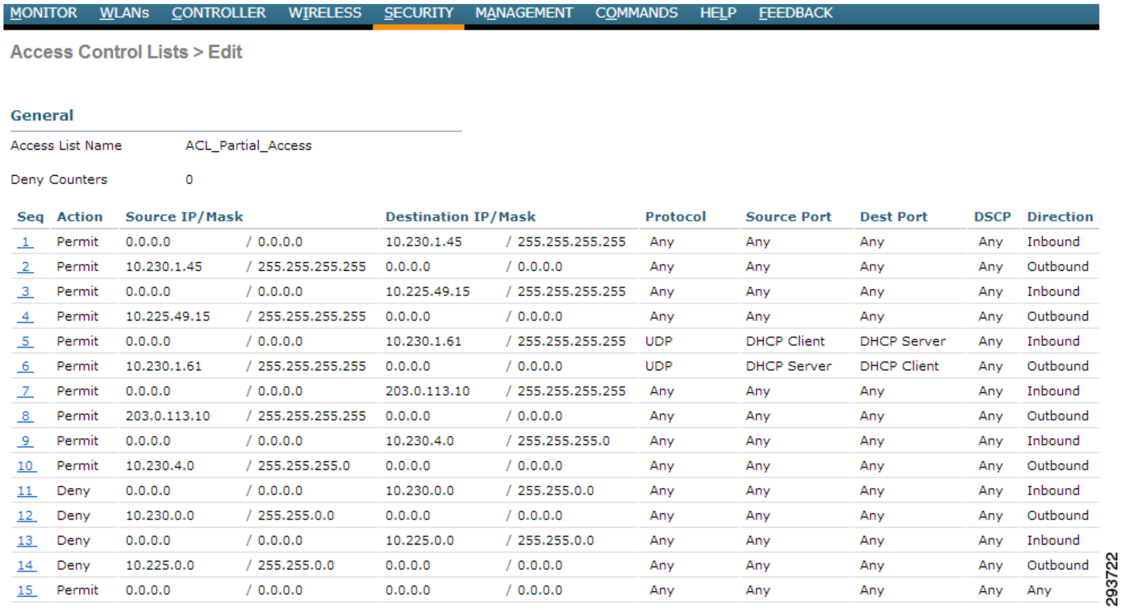
Select an item =

Attributes Details

Access Type = ACCESS_ACCEPT
Airespace-ACL-Name = ACL_Partial_Access

Cisco Wireless LAN Controllers support named ACLs, meaning that the ACL must be previously configured on the controller rather than being downloaded from ISE. Using the RADIUS Airespace-ACL Name attribute-value pair, ISE instructs the WLC to apply the ACL_Partial_Access ACL. Figure 15-29 shows the contents of this ACL, as defined in the CT5508 WLC campus controller.

Figure 15-29 ACL_Partial_Access on Wireless Controller



Access Control Lists > Edit

General

Access List Name ACL_Partial_Access

Deny Counters 0

Seq	Action	Source IP/Mask		Destination IP/Mask		Protocol	Source Port	Dest Port	DSCP	Direction
1	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.45	/ 255.255.255.255	Any	Any	Any	Any	Inbound
2	Permit	10.230.1.45	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
3	Permit	0.0.0.0	/ 0.0.0.0	10.225.49.15	/ 255.255.255.255	Any	Any	Any	Any	Inbound
4	Permit	10.225.49.15	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
5	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.61	/ 255.255.255.255	UDP	DHCP Client	DHCP Server	Any	Inbound
6	Permit	10.230.1.61	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	UDP	DHCP Server	DHCP Client	Any	Outbound
7	Permit	0.0.0.0	/ 0.0.0.0	203.0.113.10	/ 255.255.255.255	Any	Any	Any	Any	Inbound
8	Permit	203.0.113.10	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
9	Permit	0.0.0.0	/ 0.0.0.0	10.230.4.0	/ 255.255.255.0	Any	Any	Any	Any	Inbound
10	Permit	10.230.4.0	/ 255.255.255.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
11	Deny	0.0.0.0	/ 0.0.0.0	10.230.0.0	/ 255.255.0.0	Any	Any	Any	Any	Inbound
12	Deny	10.230.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
13	Deny	0.0.0.0	/ 0.0.0.0	10.225.0.0	/ 255.255.0.0	Any	Any	Any	Any	Inbound
14	Deny	10.225.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
15	Permit	0.0.0.0	/ 0.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Any

The access-list shown in Figure 15-29 specifies the following access:

- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the DHCP server (10.230.1.61).
- Allow IP access to and from the MDM Server (203.0.113.10).
- Allow IP access to and from specific subnet (10.230.4.0 /24).
- Deny IP access to and from data center subnets (10.230.0.0 /16).
- Deny IP access to and from campus subnets (10.225.0.0 /16).
- Allow access to and from all other subnets (Internet access).

Note Note that Access Control Entries (ACEs) for the MDM server are included within the ACLs in this chapter. These are not used for the Enhanced Access use case discussed within this chapter. The Advanced Access use case, discussed in Chapter 17, “BYOD Advanced Use Case—Mobile Device Manager Integration,” makes use of the same authorization policy rules and authorization profiles.

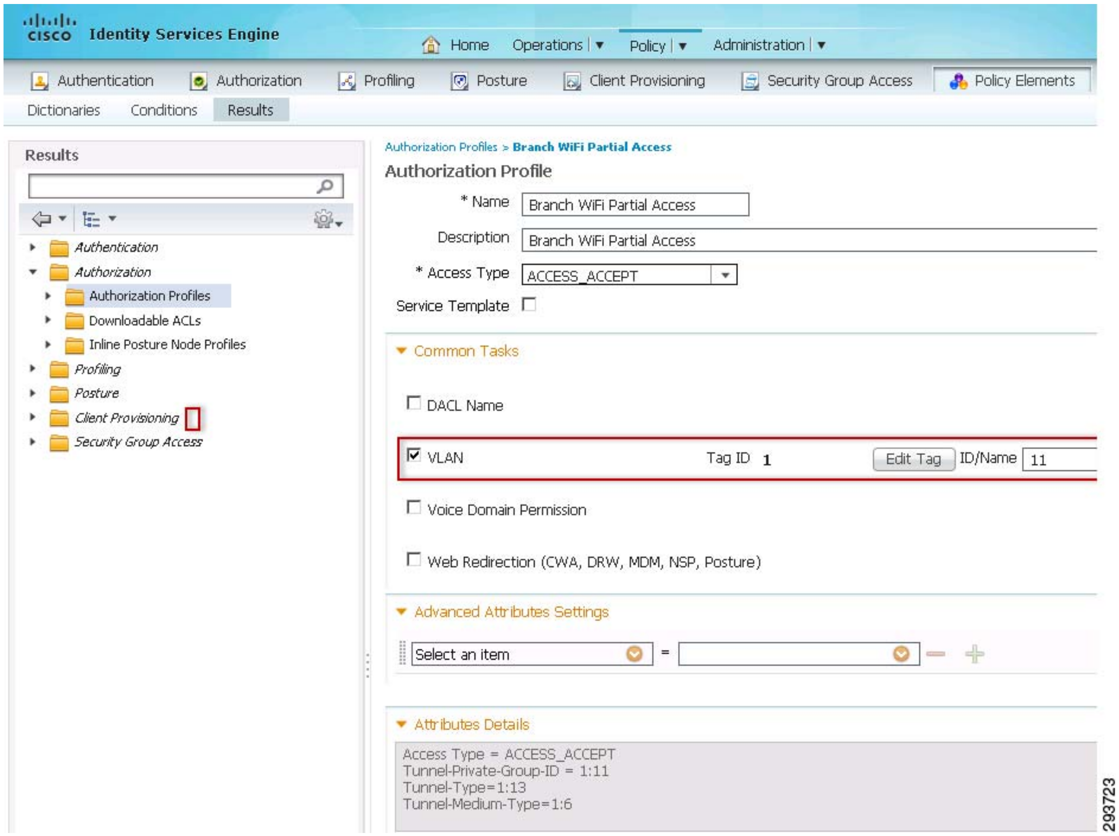
The access list shown in Figure 15-29 is a generic example used to enforce a hypothetical use case and is not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

Note The CT5508 WLC supports a maximum of 64 ACLs with a maximum of 64 lines per ACL.

Branches with FlexConnect

For devices connecting from a branch location which implements a FlexConnect wireless design, the Branch WiFi Partial Access authorization profile dynamically assigns the device to VLAN11, which is dedicated for devices obtaining Partial Access. Figure 15-30 shows this authorization profile.

Figure 15-30 Branch WiFi Partial Access



Authorization Profile

* Name: Branch WiFi Partial Access

Description: Branch WiFi Partial Access

* Access Type: ACCESS_ACCEPT

Service Template ☐

☐ DACL Name

☑ VLAN Tag ID 1 Edit Tag ID/Name 11

☐ Voice Domain Permission

☐ Web Redirection (CWA, DRW, MDM, NSP, Posture)

Access Type = ACCESS_ACCEPT
Tunnel-Private-Group-ID = 1:11
Tunnel-Type=1:13
Tunnel-Medium-Type=1:6

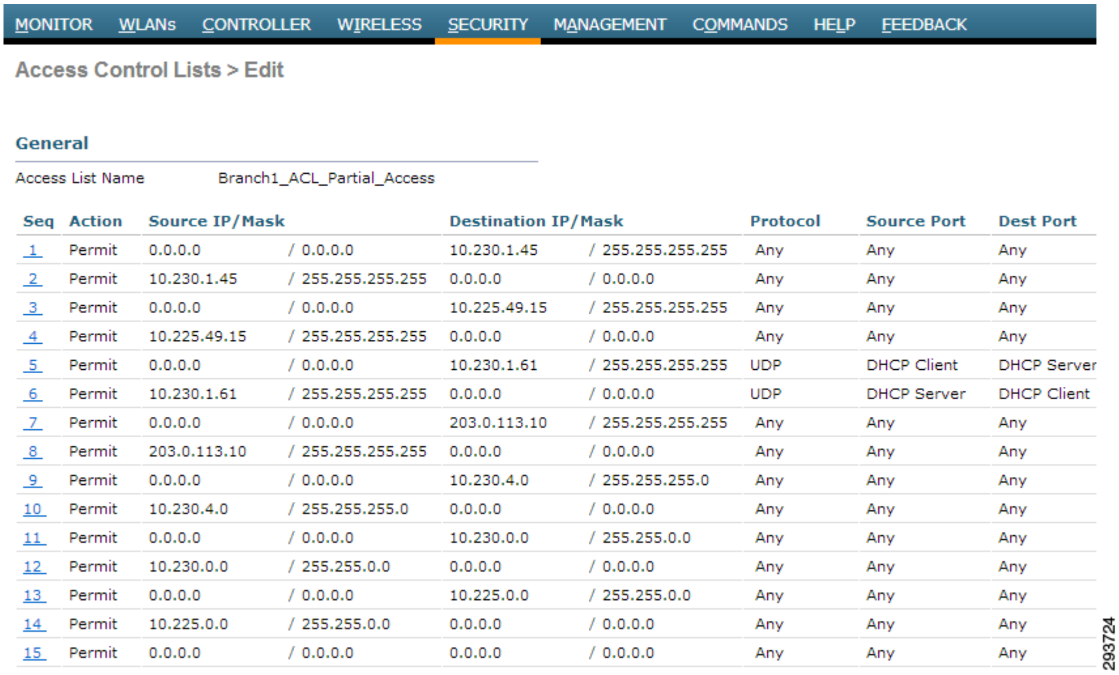
Deploying ACLs on the branch is slightly different than using ACLs with a centralized WLC. For branch locations, the Cisco 7500 Flex Wireless Controller relies on FlexConnect ACLs to enforce policy permissions within this design guide. FlexConnect ACLs are created on the WLC and configured with the VLAN defined on the AP or the FlexConnect Group using the VLAN-ACL mapping for dynamic or AAA override VLANs. These FlexConnect ACLs are pushed to the APs when the authorization policy matches. This design guide relies on FlexConnect groups to enforce Flex ACLs for each VLAN. The steps are as follows:

1. Create a FlexConnect ACL for each branch.
2. Apply the FlexConnect ACL on the FlexConnect group for each branch.
3. Define the VLAN-ACL mapping for each VLAN.

On the FlexConnect 7500 Controller, click **Security > Access Control Lists > FlexConnect ACLs** and define the ACL rules for Partial Access. Figure 15-31 shows the Branch1_ACL_Partial_Access ACL, which allows access to the Internet and some internal resources.

Note A unique ACL may be needed for each branch since each branch location may have its own local resources and unique IP address space.

Figure 15-31 Branch1_ACL_Partial_Access



Access Control Lists > Edit

General

Access List Name Branch1_ACL_Partial_Access

Seq	Action	Source IP/Mask		Destination IP/Mask		Protocol	Source Port	Dest Port
1	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.45	/ 255.255.255.255	Any	Any	Any
2	Permit	10.230.1.45	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
3	Permit	0.0.0.0	/ 0.0.0.0	10.225.49.15	/ 255.255.255.255	Any	Any	Any
4	Permit	10.225.49.15	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
5	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.61	/ 255.255.255.255	UDP	DHCP Client	DHCP Server
6	Permit	10.230.1.61	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	UDP	DHCP Server	DHCP Client
7	Permit	0.0.0.0	/ 0.0.0.0	203.0.113.10	/ 255.255.255.255	Any	Any	Any
8	Permit	203.0.113.10	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
9	Permit	0.0.0.0	/ 0.0.0.0	10.230.4.0	/ 255.255.255.0	Any	Any	Any
10	Permit	10.230.4.0	/ 255.255.255.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
11	Permit	0.0.0.0	/ 0.0.0.0	10.230.0.0	/ 255.255.0.0	Any	Any	Any
12	Permit	10.230.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
13	Permit	0.0.0.0	/ 0.0.0.0	10.225.0.0	/ 255.255.0.0	Any	Any	Any
14	Permit	10.225.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
15	Permit	0.0.0.0	/ 0.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any

The above ACL specifies the following access:

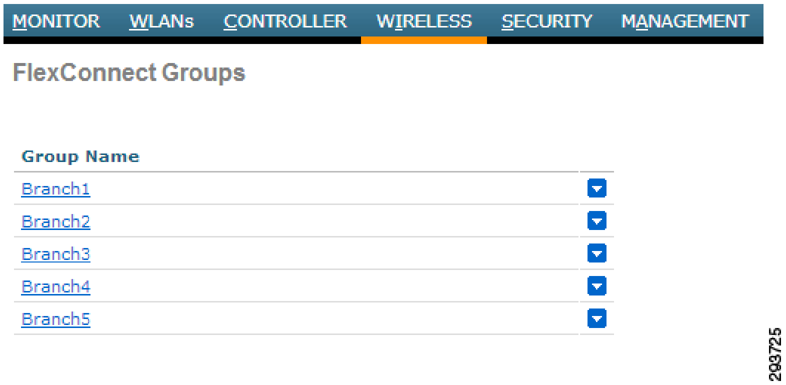
- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the DHCP server (10.230.1.61).
- Allow IP access to and from the MDM Server (203.0.113.10).
- Allow IP access to and from specific subnet (10.230.4.0 /24). Similar ACL entries could be added to allow access to Branch1 subnets/servers.
- Deny IP access to and from data center subnets (10.230.0.0 /16).
- Deny IP access to and from campus subnets (10.225.0.0 /16).
- Allow access to and from all other subnets (Internet access).

Note The access list shown is a generic example used to implement an arbitrary use case and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

For the purposes of this design guide, a FlexConnect group is defined for each branch, which allows for multiple FlexConnect access points in the branch to share configuration parameters.

On the FlexConnect 7500 controller, click **Wireless > FlexConnect Groups** and select the FlexConnect group for a particular branch location, as shown in Figure 15-32.

Figure 15-32 FlexConnect Groups

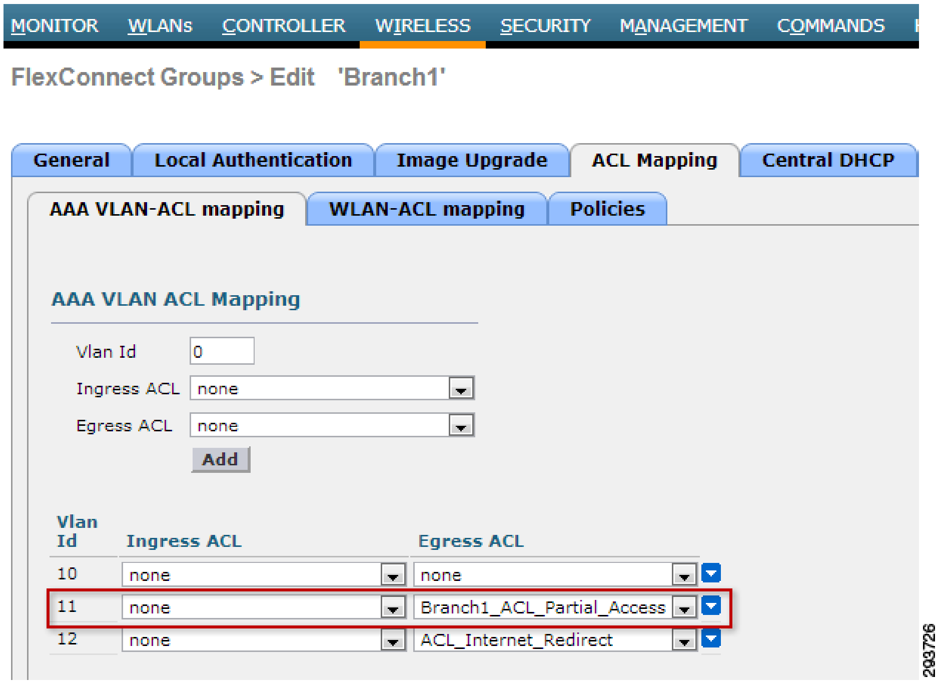


FlexConnect Groups

Group Name
Branch1
Branch2
Branch3
Branch4
Branch5

In Figure 15-33, the FlexConnect group for Branch1 is applying the Branch1_ACL_Partial_Access ACL to endpoints connecting to VLAN 11.

Figure 15-33 FlexConnect Group for Branch1



FlexConnect Groups > Edit 'Branch1'

AAA VLAN ACL Mapping

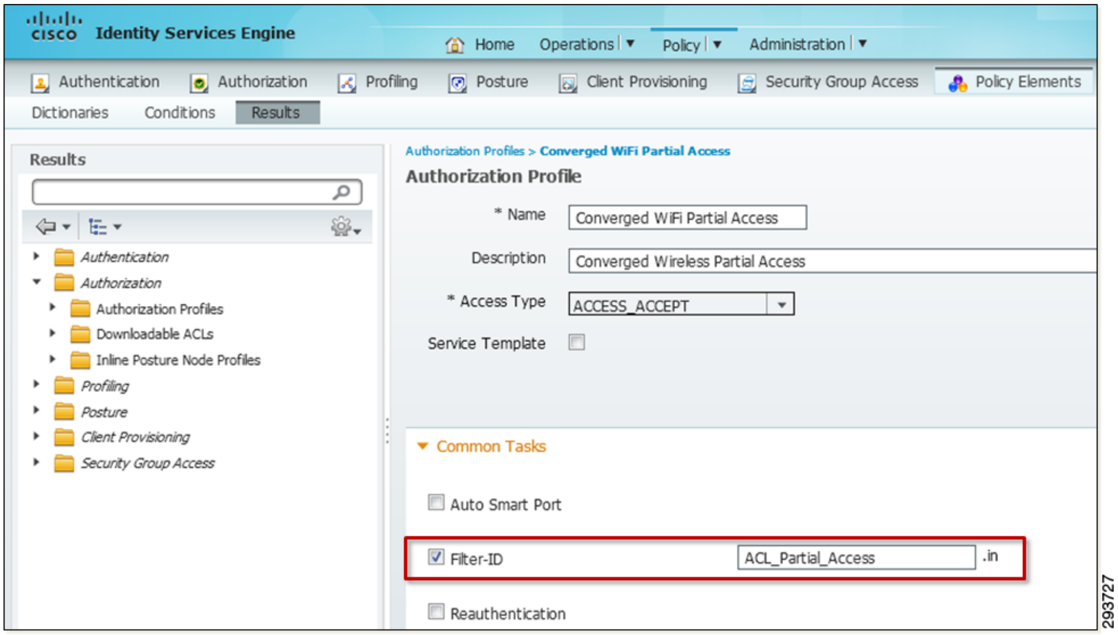
Vlan Id 0
Ingress ACL none
Egress ACL none

Vlan Id	Ingress ACL	Egress ACL
10	none	none
11	none	Branch1_ACL_Partial_Access
12	none	ACL_Internet_Redirect

Converged Access Branch or Campus

For devices connecting from campus or branch locations which implement a Converged Access design, the Converged WiFi Partial Access authorization profile relies on the ACL_Partial_Access access list, enforced by the Catalyst 3850 Series switch. Figure 15-34 shows the authorization profile.

Figure 15-34 Converged WiFi Partial Access



Authorization Profile

* Name: Converged WiFi Partial Access

Description: Converged Wireless Partial Access

* Access Type: ACCESS_ACCEPT

Service Template □

□ Auto Smart Port

☑ Filter-ID ACL_Partial_Access .in

□ Reauthentication

Cisco Catalyst 3850 Series switches (and CT5760 wireless controllers) support both named ACLs and downloadable ACLs. For the Converged Access design a named ACL is implemented, meaning that the ACL must be configured on the Catalyst 3850 switch rather than being downloaded from ISE. Using the RADIUS Filter-ID attribute-value pair, ISE instructs the WLC to apply the ACL_Partial_Access ACL. The following configuration example shows the contents of this ACL, as defined in the Catalyst 3850 switch.

```
!
ip access-list extended ACL_Partial_Access
 permit udp any eq bootpc any eq bootps
 permit ip any host 10.230.1.45
 permit ip any host 10.225.49.15
 permit ip any host 203.0.113.10
 permit ip any 10.230.4.0 0.0.0.255
 permit ip any host 10.230.6.2
 permit ip any host 10.225.100.10
 deny   ip any 10.230.0.0 0.0.255.255
 deny   ip any 10.225.0.0 0.0.255.255
 deny   ip any 10.200.0.0 0.0.255.255
 permit ip any any
!
```

The access list shown in above similar to the access list shown in Figure 29, but configured on a Catalyst switch instead of a wireless controller. Hence the structure of the access list is slightly different. The access list specifies the following access:

- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the MDM Server (203.0.113.10).
- Allow IP access to and from specific servers (10.230.6.2 and 10.225.100.10).
- Deny IP access to and from data center subnets (10.230.0.0 /16).
- Deny IP access to and from campus subnets (10.225.0.0 /16).

- Deny IP access to and from branch subnets (10.200.0.0 /16).
- Allow access to and from all other subnets (Internet access).

Again, the access list shown in this example is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

Note This design guide shows the use of the Radius:Airespace-ACL-Name AV pair for specifying a named ACL on CUWN wireless controller platforms, such as the CT5508 and Flex 7500 wireless controllers. However, it shows the use of the Radius:Filter-Id AV pair for specifying a named ACL on Cisco IOS-based wireless controller platforms, such as the CT5760 wireless controller and Catalyst 3850 Series switch. For wireless devices, this is simply to highlight the fact that the network administrator can utilize the legacy Airespace-ACL-Name AV pair or the RADIUS standard method of the Filter-Id AV pair within the BYOD implementation. It is recommended that the network administrator standardize on one of the two methods to specify a named ACL where possible in actual deployments.

Since a single ISE policy rule is defined for partial access of personal wireless devices from either a branch or campus with a converged access infrastructure, the access list can be customized to the specific branch or campus location as needed. The specific example ACL shown above is consistent with the ACL discussed in the campus centralized (Local Mode) controller design previously discussed.

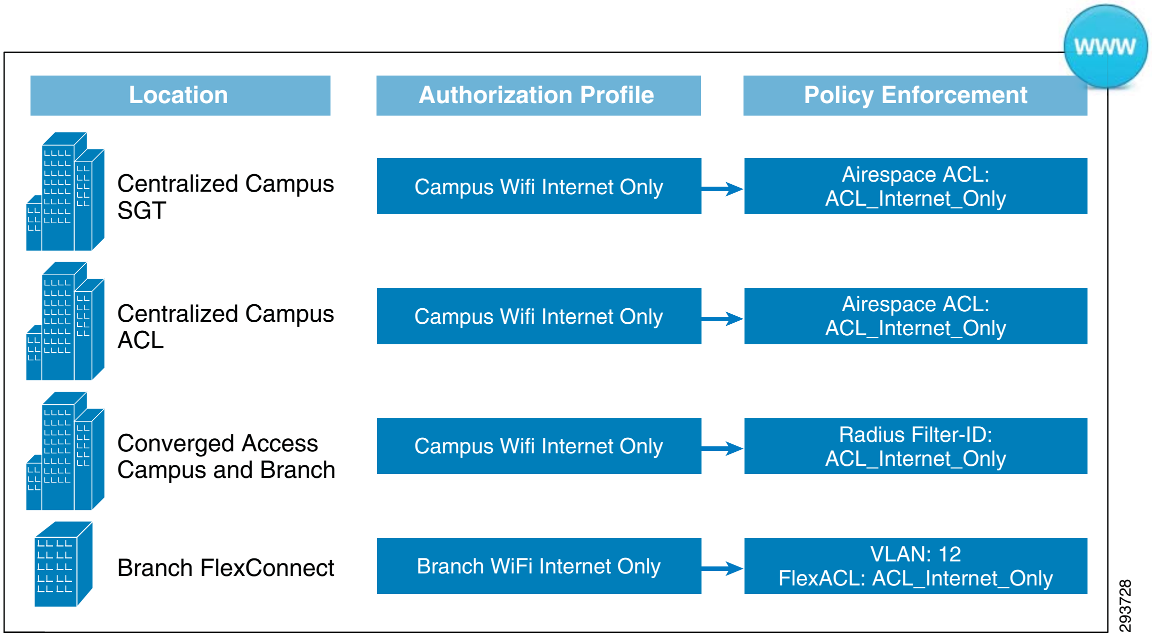
Personal Wireless Devices—Internet Only Access

To provide Internet Only access to personal devices, the Cisco ISE verifies the following:

- The employee has completed the on-boarding process through the Guest Registration portal.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate, in this case, the MAC address of the endpoint.
- The connection originated using EAP-TLS authentication.
- The user is a member of the Domain Users Active Directory group.

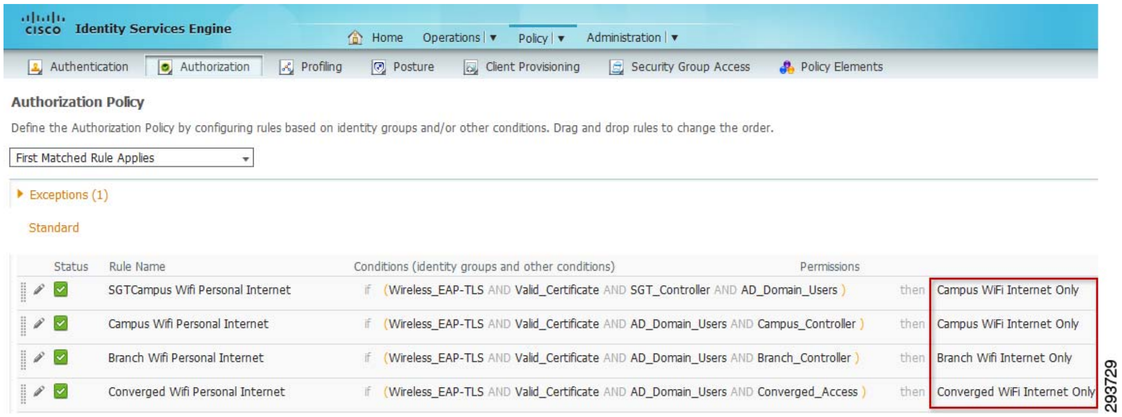
At a high level, Figure 15-35 shows how different authorization profiles are selected for devices coming from different locations with different wireless designs. Each authorization profile in turn enforces a unique permission using VLANs, SGTs, named ACLs, FlexConnect ACLs, etc.

Figure 15-35 Internet Only Enforcement


WWW
Location
Authorization Profile
Policy Enforcement
Centralized Campus SGT
Campus Wifi Internet Only
Airespace ACL: ACL_Internet_Only
Centralized Campus ACL
Campus Wifi Internet Only
Airespace ACL: ACL_Internet_Only
Converged Access Campus and Branch
Campus Wifi Internet Only
Radius Filter-ID: ACL_Internet_Only
Branch FlexConnect
Branch WiFi Internet Only
VLAN: 12 FlexACL: ACL_Internet_Only
293728

To configure the authorization rules in ISE, click **Policy > Authorization**. Figure 15-36 highlights the authorization policy to grant Internet Only access to personal devices.

Figure 15-36 Authorization Policies for Internet Only Access



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.

First Matched Rule Applies ▾

▸ Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	SGTCampus Wifi Personal Internet	if	(Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Domain_Users)	then	Campus WiFi Internet Only
☑	Campus Wifi Personal Internet	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Controller)	then	Campus WiFi Internet Only
☑	Branch Wifi Personal Internet	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Controller)	then	Branch Wifi Internet Only
☑	Converged Wifi Personal Internet	if	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then	Converged WiFi Internet Only

Looking at the rules in more detail, ISE evaluates the following conditions:

- Wireless_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name (defined as a simple condition).
- The user belongs to the Domain Users Active Directory group (defined as a simple condition).
- The RADIUS authentication originated from a wireless controller which was a member of one of the following device groups—Campus_Controller, SGT_Controller, Branch_Controller, or Converged_Access (defined as a simple condition).

Simple and Compound Conditions explains the different conditions used in the rules.

Permissions

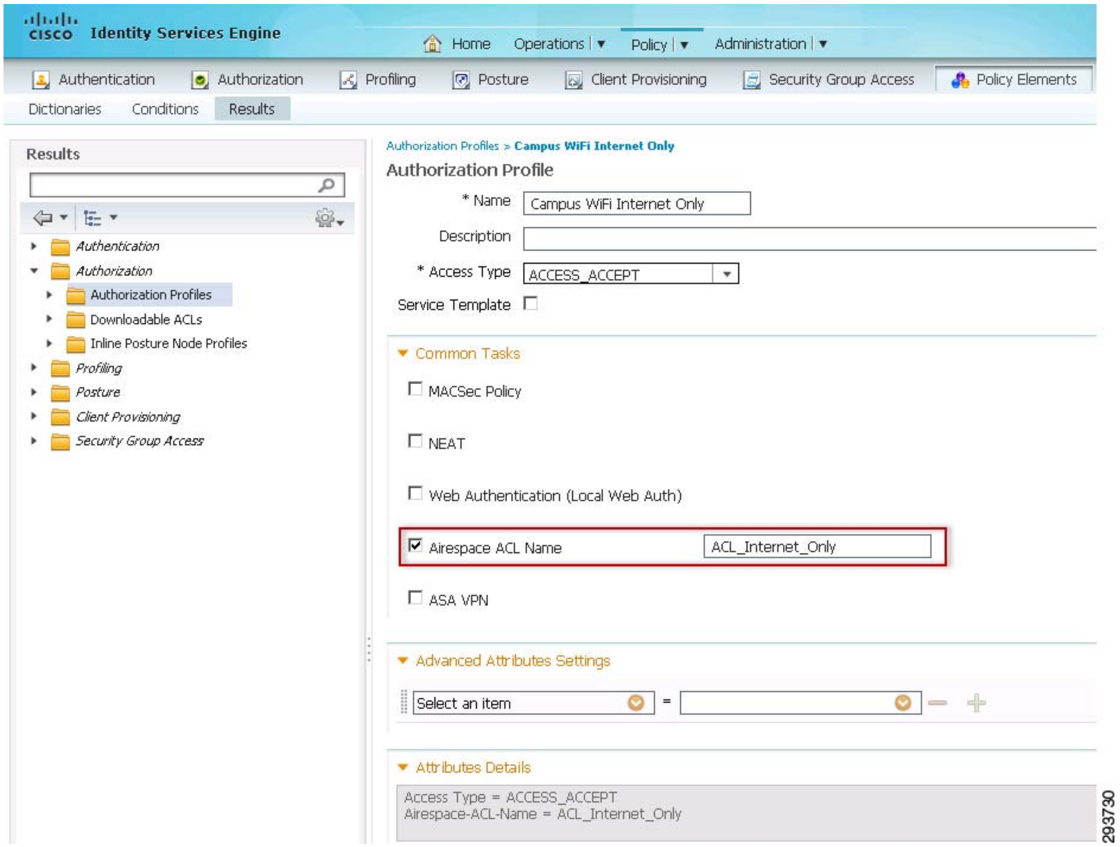
When all conditions in the authorization policy rules match, the rule invokes the proper permission. In the previous sections the permission result was either an authorization profile (non-SGT based access), or a standard result for SGT based access. However, in this section only the authorization profile will be used for the reasons explained below.

- Campus WiFi Internet Only for 802.1X wireless devices connecting from a SGT_Enabled controller or from a campus location with a centralized (Local Mode) wireless design. Both the campus controller and the SGT_Enabled controller use the same authorization profiles. SGTs are not used to tag Internet only traffic since SGT relies on source and destination tags and the destination tag for the Internet is unknown.
- Branch Wireless Internet Only for 802.1X wireless devices connecting from a branch location which implements a Flexconnect wireless design.
- Converged WiFi Internet Only for 802.1X wireless devices connecting from either a campus or branch location which implements a Converged Access infrastructure design.

Centralized Campus with SGT or ACLs

For devices connecting from a campus location which implements a centralized (Local Mode) wireless design or from a SGT_Enabled controller, the Campus WiFi Internet Only authorization profile relies on the ACL_Internet_Only access list enforced by the WLC. Figure 15-37 shows how the authorization profile instructs the WLC to apply the ACL.

Figure 15-37 Campus WiFi Internet Only



Authorization Profiles > Campus WiFi Internet Only

Authorization Profile

* Name: Campus WiFi Internet Only
Description:
* Access Type: ACCESS_ACCEPT
Service Template □

Common Tasks

□ MACSec Policy
□ NEAT
□ Web Authentication (Local Web Auth)
☑ Airespace ACL Name: ACL_Internet_Only
□ ASA VPN

Advanced Attributes Settings

Select an item =

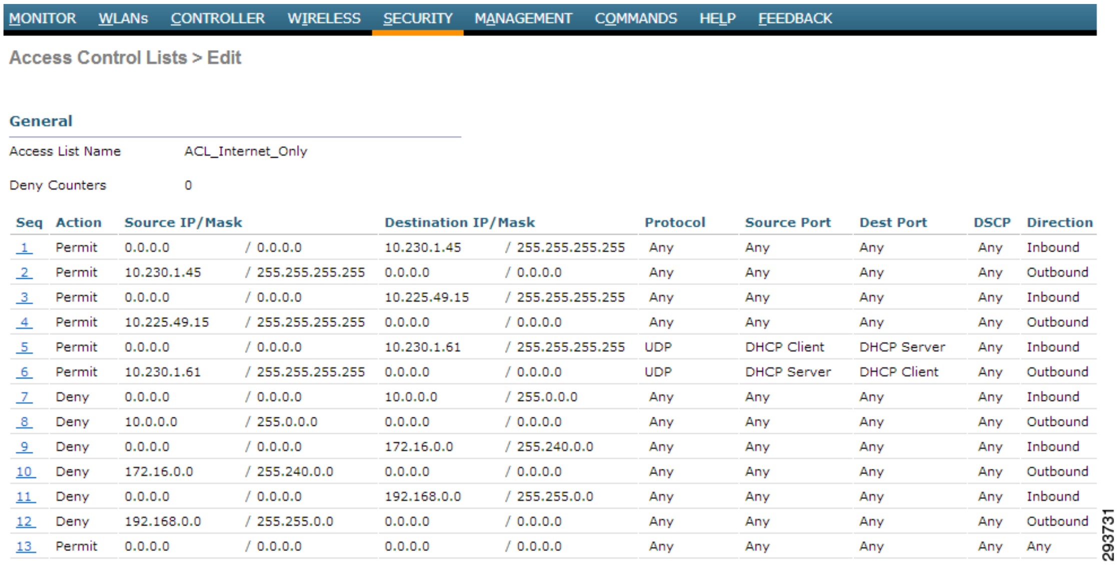
Attributes Details

Access Type = ACCESS_ACCEPT
Airespace-ACL-Name = ACL_Internet_Only

Cisco Wireless LAN Controllers support named ACLs, meaning the ACL must be previously configured on the controller, rather than being downloaded from ISE. Using the RADIUS Airespace-ACL Name attribute-value pair, ISE instructs the WLC to apply the ACL_Internet_Only ACL.

Figure 15-38 shows the contents of this ACL, as defined in the CT5508 WLC campus controller.

Figure 15-38 ACL_Internet_Only



Access Control Lists > Edit

General

Access List Name ACL_Internet_Only

Deny Counters 0

Seq	Action	Source IP/Mask		Destination IP/Mask		Protocol	Source Port	Dest Port	DSCP	Direction
1	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.45	/ 255.255.255.255	Any	Any	Any	Any	Inbound
2	Permit	10.230.1.45	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
3	Permit	0.0.0.0	/ 0.0.0.0	10.225.49.15	/ 255.255.255.255	Any	Any	Any	Any	Inbound
4	Permit	10.225.49.15	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
5	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.61	/ 255.255.255.255	UDP	DHCP Client	DHCP Server	Any	Inbound
6	Permit	10.230.1.61	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	UDP	DHCP Server	DHCP Client	Any	Outbound
7	Deny	0.0.0.0	/ 0.0.0.0	10.0.0.0	/ 255.0.0.0	Any	Any	Any	Any	Inbound
8	Deny	10.0.0.0	/ 255.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
9	Deny	0.0.0.0	/ 0.0.0.0	172.16.0.0	/ 255.240.0.0	Any	Any	Any	Any	Inbound
10	Deny	172.16.0.0	/ 255.240.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
11	Deny	0.0.0.0	/ 0.0.0.0	192.168.0.0	/ 255.255.0.0	Any	Any	Any	Any	Inbound
12	Deny	192.168.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Outbound
13	Permit	0.0.0.0	/ 0.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any	Any	Any

The access list specifies the following access:

- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the DHCP server (10.230.1.61).
- Deny IP access to and from internal network address space (10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16).
- Allow access to and from all other subnets (Internet access).

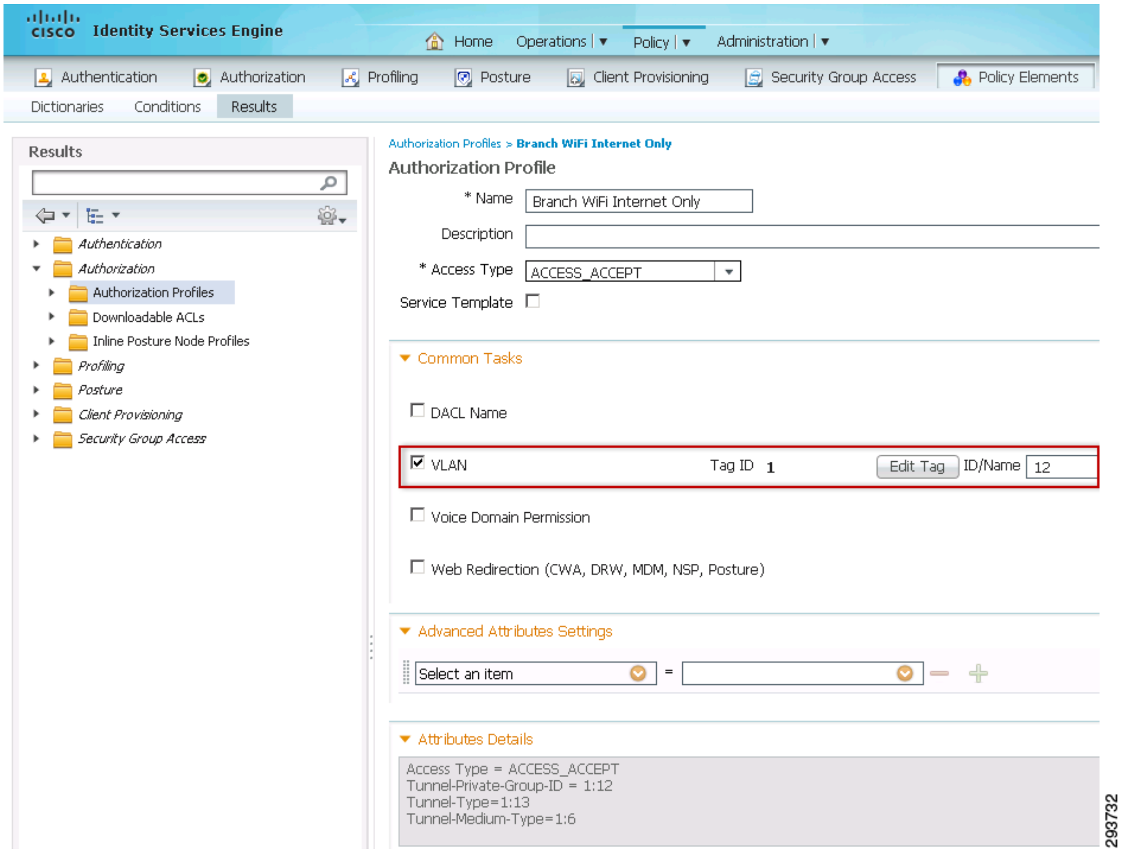
Once again, the access list is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

Branches with FlexConnect

For devices connecting from a branch location which implements a FlexConnect wireless design, the Branch WiFi Internet Only authorization profile dynamically assigns the device to VLAN12, which is dedicated for devices obtaining Internet_Only access.

Figure 15-39 shows this authorization profile.

Figure 15-39 Branch WiFi Internet Only



Authorization Profiles > **Branch WiFi Internet Only**

Authorization Profile

* Name: Branch WiFi Internet Only

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

□ DACL Name

☑ VLAN Tag ID 1 ID/Name 12

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

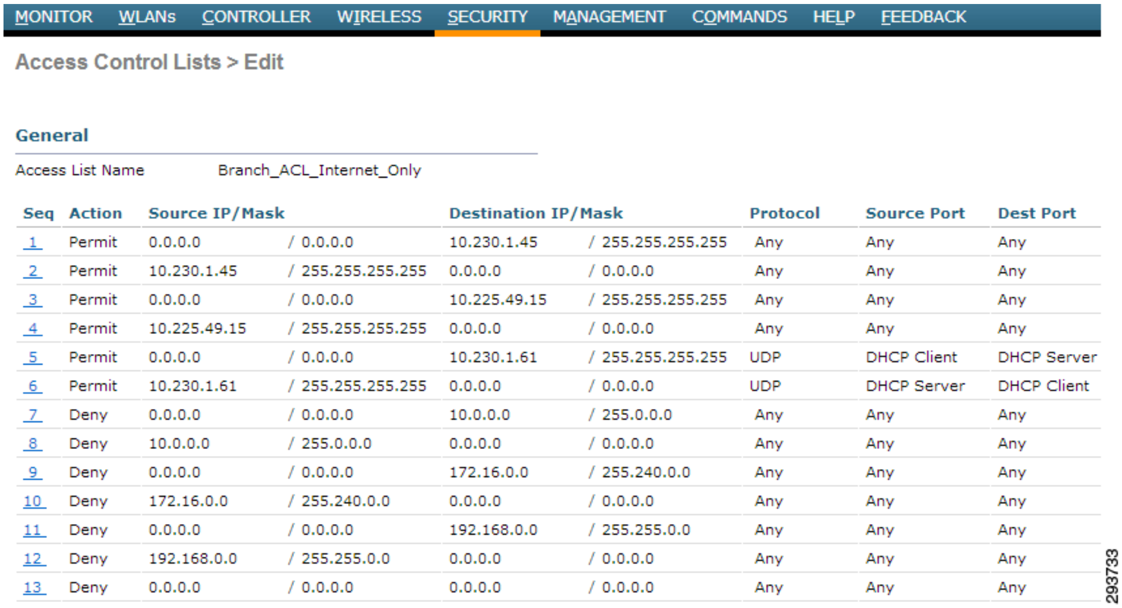
```
Access Type = ACCESS_ACCEPT
Tunnel-Private-Group-ID = 1:12
Tunnel-Type=1:13
Tunnel-Medium-Type=1:6
```

For branch locations which implement FlexConnect wireless designs, the Cisco 7500 Flex Wireless Controller relies on FlexConnect ACLs to enforce policy permissions. FlexConnect ACLs are created on the WLC and configured with the VLAN defined on the AP or the FlexConnect Group using the VLAN-ACL mapping for dynamic or AAA override VLANs. These FlexConnect ACLs are pushed to the APs when the authorization policy matches.

1. Create a FlexConnect ACL for each branch.
2. Apply the FlexConnect ACL on the FlexConnect group for each branch.
3. Define the VLAN-ACL mapping for each VLAN.

On the FlexConnect 7500 Controller, click **Security > Access Control Lists > FlexConnect ACLs** and define the ACL rules for Internet_Only access. Figure 15-40 shows an example of the Branch_ACL_Internet_Only ACL, which only allows access to the Internet. This ACL is the same for all branches.

Figure 15-40 Branch_ACL_Internet_Only



Access Control Lists > Edit

General

Access List Name Branch_ACL_Internet_Only

Seq	Action	Source IP/Mask	Destination IP/Mask	Protocol	Source Port	Dest Port
1	Permit	0.0.0.0 / 0.0.0.0	10.230.1.45 / 255.255.255.255	Any	Any	Any
2	Permit	10.230.1.45 / 255.255.255.255	0.0.0.0 / 0.0.0.0	Any	Any	Any
3	Permit	0.0.0.0 / 0.0.0.0	10.225.49.15 / 255.255.255.255	Any	Any	Any
4	Permit	10.225.49.15 / 255.255.255.255	0.0.0.0 / 0.0.0.0	Any	Any	Any
5	Permit	0.0.0.0 / 0.0.0.0	10.230.1.61 / 255.255.255.255	UDP	DHCP Client	DHCP Server
6	Permit	10.230.1.61 / 255.255.255.255	0.0.0.0 / 0.0.0.0	UDP	DHCP Server	DHCP Client
7	Deny	0.0.0.0 / 0.0.0.0	10.0.0.0 / 255.0.0.0	Any	Any	Any
8	Deny	10.0.0.0 / 255.0.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any
9	Deny	0.0.0.0 / 0.0.0.0	172.16.0.0 / 255.240.0.0	Any	Any	Any
10	Deny	172.16.0.0 / 255.240.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any
11	Deny	0.0.0.0 / 0.0.0.0	192.168.0.0 / 255.255.0.0	Any	Any	Any
12	Deny	192.168.0.0 / 255.255.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any
13	Deny	0.0.0.0 / 0.0.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any

The access list specifies the following access:

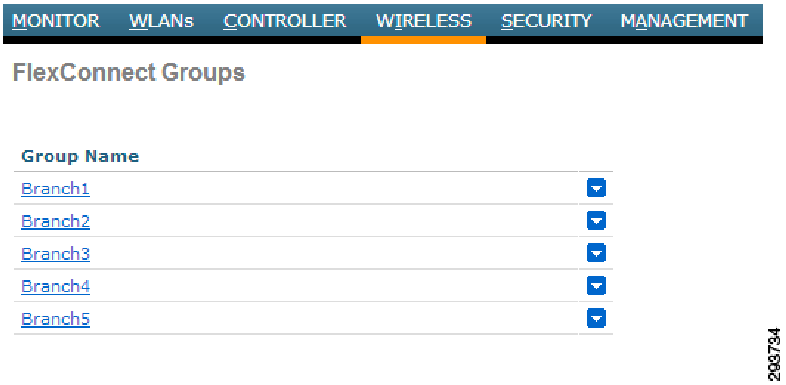
- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the DHCP server (10.230.1.61).
- Deny IP access to and from internal network address space (10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16).
- Allow access to and from all other subnets (Internet access).

The access list is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

For the purposes of this design guide, a FlexConnect group is defined for each branch, which allows for multiple FlexConnect access points in the branch to share configuration parameters.

On the FlexConnect 7500 controller, click **Wireless > FlexConnect Groups** and select the FlexConnect group for a particular branch location, as shown in Figure 15-41.

Figure 15-41 FlexConnect Groups

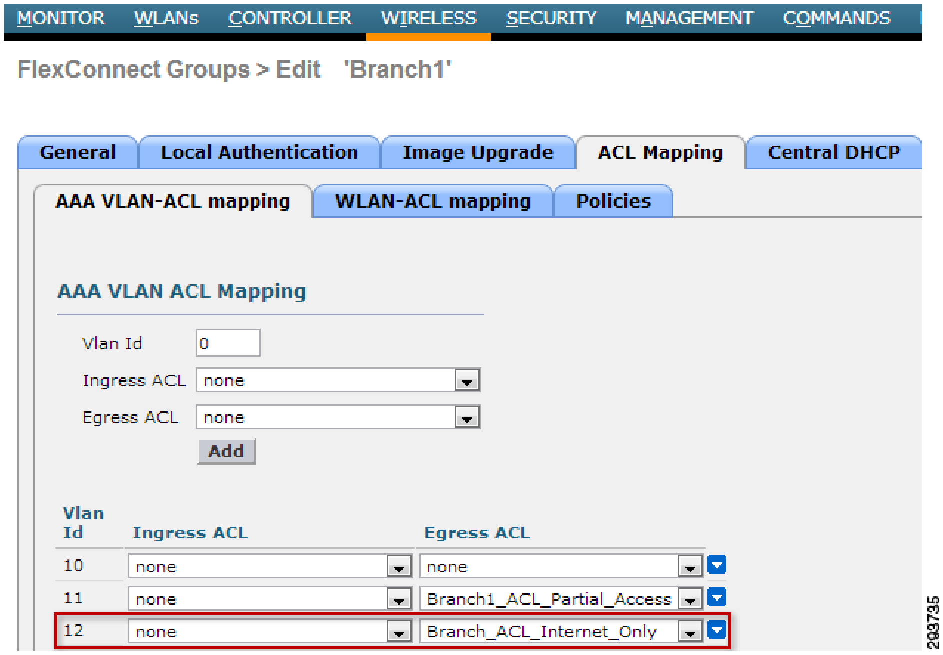


FlexConnect Groups

Group Name
Branch1
Branch2
Branch3
Branch4
Branch5

In Figure 15-42, the FlexConnect group for Branch1 is applying the Branch_ACL_Internet_Only ACL to endpoints connecting to VLAN 12.

Figure 15-42 FlexConnect Group for Branch1 Internet Only



FlexConnect Groups > Edit 'Branch1'

AAA VLAN ACL Mapping

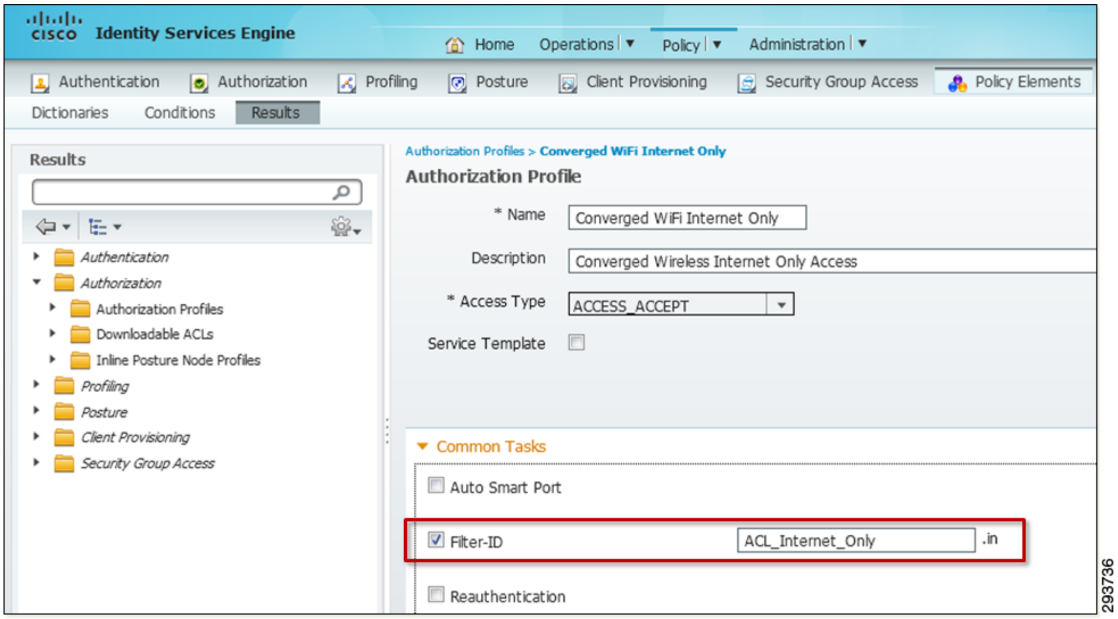
Vlan Id: 0
Ingress ACL: none
Egress ACL: none

Vlan Id	Ingress ACL	Egress ACL
10	none	none
11	none	Branch1_ACL_Partial_Access
12	none	Branch_ACL_Internet_Only

Converged Access Branch or Campus

For devices connecting from campus or branch locations which implement a Converged Access design, the Converged WiFi Internet Only authorization profile relies on the ACL_Internet_Only access list, enforced by the Catalyst 3850 Series switch. Figure 15-43 shows the authorization profile.

Figure 15-43 Converged WiFi Internet Only



* Name: Converged WiFi Internet Only

Description: Converged Wireless Internet Only Access

* Access Type: ACCESS_ACCEPT

Service Template: □

□ Auto Smart Port

☑ Filter-ID: ACL_Internet_Only .in

□ Reauthentication

Cisco Catalyst 3850 Series switches (and CT5760 wireless controllers) support both named ACLs and downloadable ACLs. For the Converged Access design a named ACL is implemented, meaning that the ACL must be configured on the Catalyst 3850 switch rather than being downloaded from ISE. Using the RADIUS Filter-ID attribute-value pair, ISE instructs the WLC to apply the ACL_Internet_Only ACL. The following configuration example shows the contents of this ACL, as defined in the Catalyst 3850 switch.

```
ip access-list extended ACL_Internet_Only
 permit udp any eq bootpc any eq bootps
 permit ip any host 10.230.1.45
 permit ip any host 10.225.49.15
 permit ip any host 10.225.100.10
 deny   ip any 10.0.0.0 0.255.255.255
 deny   ip any 172.16.0.0 0.15.255.255
 deny   ip any 192.168.0.0 0.0.255.255
 permit ip any any
!
```

The access-list shown in above is similar to the access list shown in Figure 15-38, but configured on a Catalyst switch instead of a wireless controller. Hence the structure of the access-list is slightly different. However the access-list specifies the following access:

- Allow DHCP access (bootpc and bootps).
- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE server (10.225.49.15).
- Deny IP access to and from the rest of the internal network IP address space (10.0.0.0 /8, 172.16.0.0 /12, 192.168.0.0 /16).
- Allow access to all other addresses (Internet addresses).

Note The MDM above is shown with private RFC1918 address. In practice, the MDM must be reachable from the public Internet and may not require a specific line entry in the ACL.

Again, the access list shown in this example is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

Personal Wired Devices—Full Access

To provide full access to personal wired devices, the Cisco ISE verifies the following:

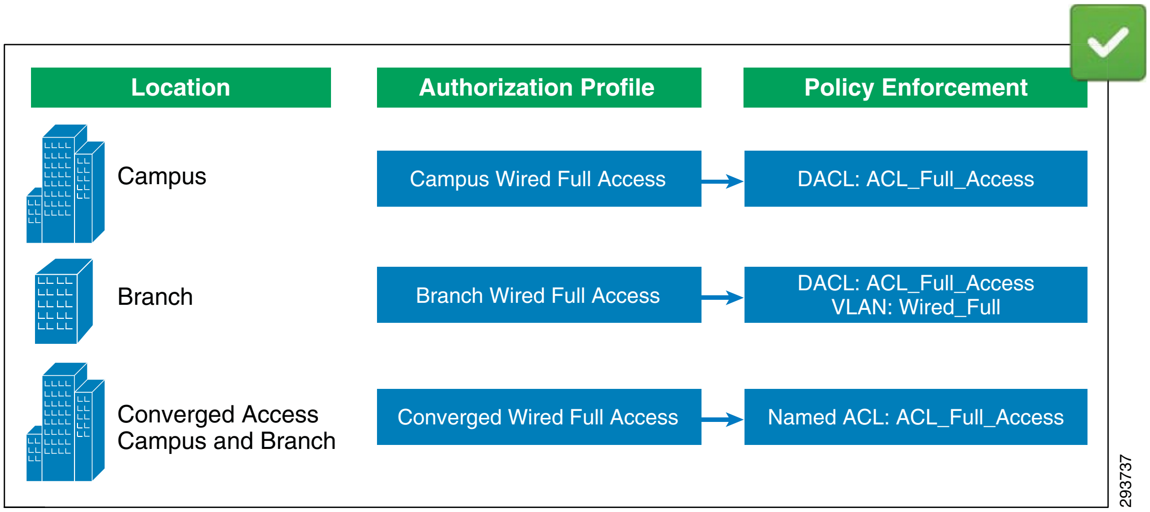
- The employee has completed the on-boarding process through the Guest Registration portal.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate, in this case, the MAC address of the endpoint.
- The connection originated using EAP-TLS authentication.
- The user is a member of the BYOD_Full_Access Active Directory group.

Since the wired designs presented in this design guide rely on slightly different access control mechanisms for Converged Access campuses and branches, for campuses and branches which do not implement Converged Access infrastructures, unique authorization rules are created for connections originating from each design.

Note For the purpose of clarity within this design guide, Converged Access branches refer to designs in which Catalyst 3850 Series switches are deployed at the access-layer of the branch network. From a wired perspective, branches which do not implement Converged Access infrastructures are branches which deploy other Catalyst access-layer switches, such as the Catalyst 3750X Series. Unless otherwise specified, these will be referred to simply as “branches” within the design guide. Similarly, Converged Access campuses refer to designs in which Catalyst 3850 Series switches are deployed at the access-layer of building distribution modules within the campus. From a wired perspective, campuses which do not implement Converged Access infrastructures are campuses which deploy other Catalyst access-layer switches, such as the Catalyst 3750X Series. Unless otherwise specified, these will be referred to simply as “campuses” within this design guide. This is in order to minimize the use of verbose phrases such as “branches which do not implement Converged Access infrastructure” and “campuses which do not implement Converged Access infrastructure”.

At a high level, Figure 15-44 shows how different authorization profiles are selected for connections originating from different locations with different infrastructure designs. Each authorization profile in turn enforces a unique permission using VLANs, dynamic ACLs (either named or downloadable [DACL]), etc.

Figure 15-44 Full Access Wired Enforcement



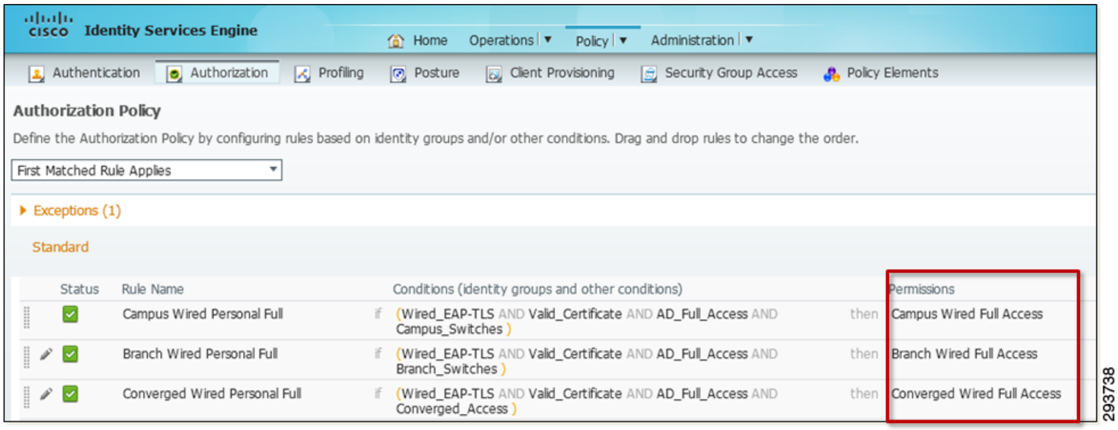
Location	Authorization Profile	Policy Enforcement
Campus	Campus Wired Full Access	DACL: ACL_Full_Access
Branch	Branch Wired Full Access	DACL: ACL_Full_Access VLAN: Wired_Full
Converged Access Campus and Branch	Converged Wired Full Access	Named ACL: ACL_Full_Access

Note Wired assignment of Security Group Tags (SGTs) is not discussed within this version of the design guide. Hence, there is no wired policy enforcement via SGTs in Figure 15-44. Future versions of this design guide may address wired SGT assignment.

To differentiate these connections, the ISE relies on Network Device Groups to group Catalyst switches based on their location or device type. This allows a single ISE to enforce policies across different groups of devices. Each Catalyst switch needs to be added to the proper device group by clicking **Administration > Network Resources > Network Devices** and specifying the proper location or device type from the pull-down menu.

Figure 15-45 shows the details of authorization profile configured in ISE for wired devices.

Figure 15-45 Authorization Policies for Wired Full Access



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.

First Matched Rule Applies ▼

▸ Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
✓	Campus Wired Personal Full	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Campus_Switches)	then	Campus Wired Full Access
✓	Branch Wired Personal Full	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Branch_Switches)	then	Branch Wired Full Access
✓	Converged Wired Personal Full	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then	Converged Wired Full Access

Looking at the rules in more detail, ISE evaluates the following conditions:

- Wired_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name. (defined as a simple condition).

- The user belongs to a specific Active Directory group (defined as a simple condition).
- The RADIUS authentication originated from a Catalyst switch which was a member of one of the following device groups—Campus_Switches, Branch_Switches, or Converged_Access (defined as a simple condition).

Wired Simple and Compound Conditions

To improve the readability of the authorization policy, simple and compound authorization conditions were defined to group different conditions. These conditions may be reused and modified without changing every authorization rule.

Table 15-8 shows the conditions used in the authorization rules.

Table 15-8 Simple and Compound Conditions

Wired EAP-TLS (Compound)	
Wired_EAP-TLS	Radius:Service-Type Equals Framed Radius:NAS-Port-Type Equals Ethernet Network Access:EapAuthentication Equals EAP-TLS
Check for Valid Certificate (Simple)	
Valid_Certificate	Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name
Active Directory Group (Simple)	
AD_ Full_Access	AD1:ExternalGroups EQUALS sdulab.com/Users/BYOD_Full_Access
AD_ Partial_Access	AD1:ExternalGroups EQUALS sdulab.com/Users/BYOD_Partial_Access
AD_Domain_users	AD1:ExternalGroups EQUALS sdulab.com/Users/Domain User
WLC Location or Device Type (Simple)	
Campus_Switches	DEVICE:Location EQUALS All Locations#Campus_Switches
Branch_Switches	DEVICE:Location EQUALS All Locations#Branch_Switches
Converged_Access	DEVICE:Device Type EQUALS All Device Types#Converged

Permission

When all conditions in the authorization policy rule match, the rule invokes the proper permission. The permissions can be of different forms such as an authorization profile or a standard result. In this design guide, for wired access the authorization policy is used as permission to the policy rules match. Table 15-9 explains the permissions used for the full access for wired users.

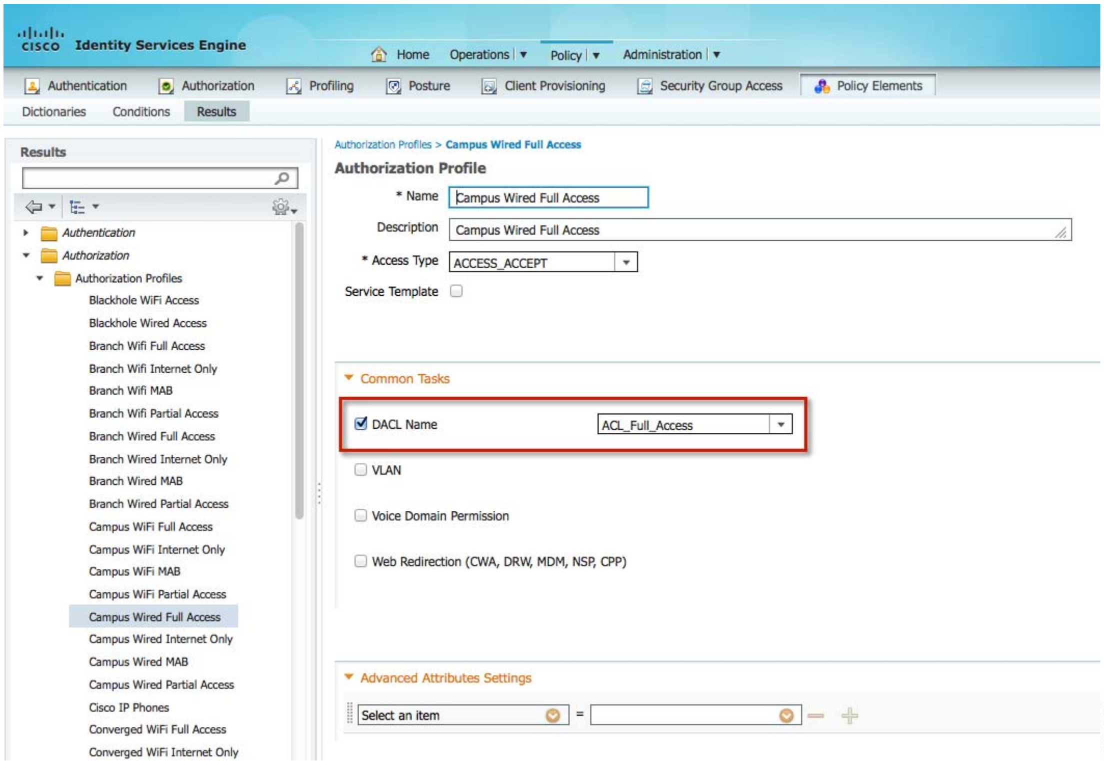
Table 15-9 Permissions Used for Wired Full Access

Permission name	Permission type	Purpose
Campus Wired Full Access	Authorization profile	Provides Full Access for 802.1X wired devices connecting from campus location.
Branch Wired Full Access	Authorization profile	To push a VLAN for 802.1X wired devices connecting from a branch location.
Converged Wired Full Access	Authorization profile	To push a named ACL for 802.1X wired devices connecting from either a campus or branch location with Converged Access.

Campus Wired

Figure 15-46 shows how the Campus Wired Full Access authorization profile is defined in ISE.

Figure 15-46 Campus Wired Full Access Authorization Profile



Authorization Profile

* Name: Campus Wired Full Access

Description: Campus Wired Full Access

* Access Type: ACCESS_ACCEPT

Service Template ☐

☑ DACL Name: ACL_Full_Access

☐ VLAN

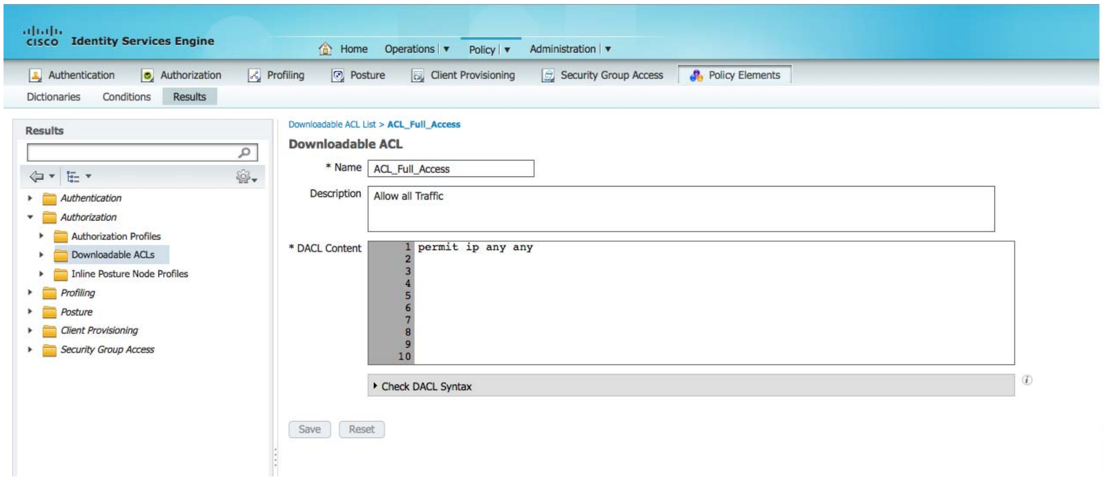
☐ Voice Domain Permission

☐ Web Redirection (CWA, DRW, MDM, NSP, CPP)

Note Cisco Catalyst switches support both downloadable ACLs (DACLs) and named ACLs. This design guide shows the use of downloadable ACLs for access control of wired devices when implementing a non-Converged Access infrastructure and the use of named ACLs for access control of wired devices when implementing a Converged Access infrastructure. This is done to show the range of capabilities for access control available on Cisco IOS-based platforms. The same wired policy enforcement for Converged Access and non-Converged Access infrastructure can be achieved if the customer desires, simply by using either downloadable ACLs (DACLs) or named ACLs for both designs. Both downloadable and named ACLs have advantages and disadvantages, depending upon where they are deployed within the network.

The downloadable ACL (DACL), which allows all IP traffic, overrides the default-ACL configured on the switch port. The default-ACL is used as an additional preventative measure in case the downloadable ACL is not applied to the switch port for some reason. Figure 15-47 shows the DACL definition which must be configured in ISE:

Figure 15-47 DACL Definition in ISE that Grants Full Access to the Users



* Name: ACL_Full_Access

Description: Allow all Traffic

* DACL Content:

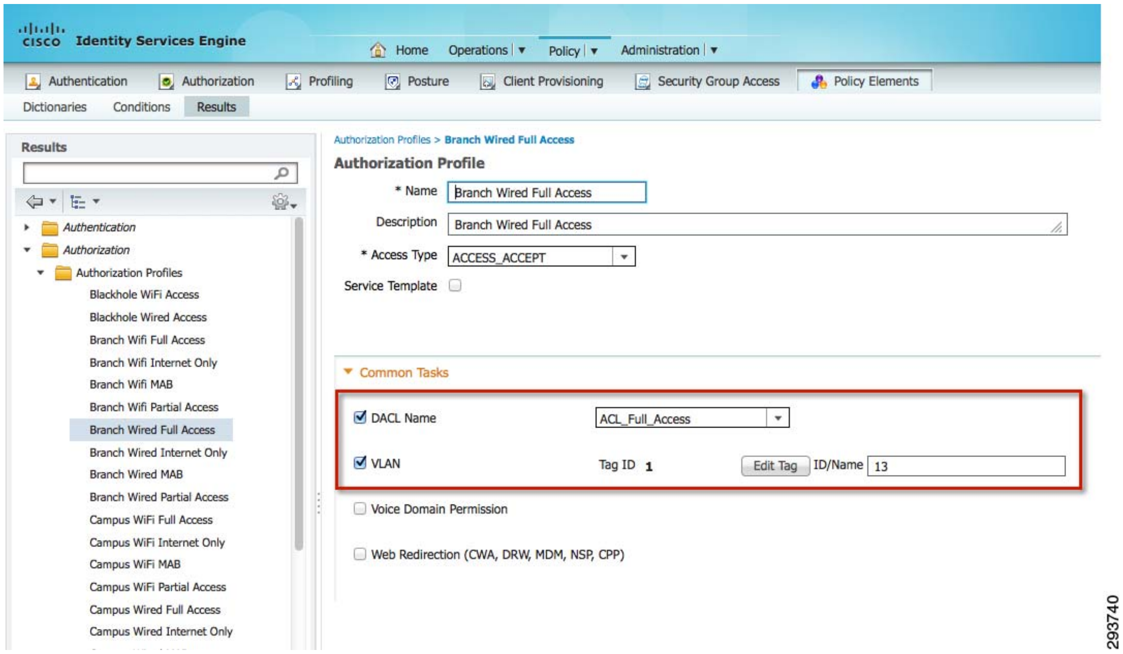
```
permit ip any any
```

Note ISE 1.2 has the ability to check the DACL syntax. This feature should be utilized in order to minimize the possibility that the DACL is not applied due to a syntax error.

Branch Wired

Figure 15-48 shows how a similar authorization profile is constructed for devices connected at a branch which does not have a Converged Access infrastructure. The authorization profile pushes VLAN information—in this case the VLAN name—along with the ACL information.

Figure 15-48 Branch Wired Full Access Authorization Profile



Authorization Profile

* Name: Branch Wired Full Access

Description: Branch Wired Full Access

* Access Type: ACCESS_ACCEPT

Service Template ☐

☑ DACL Name: ACL_Full_Access

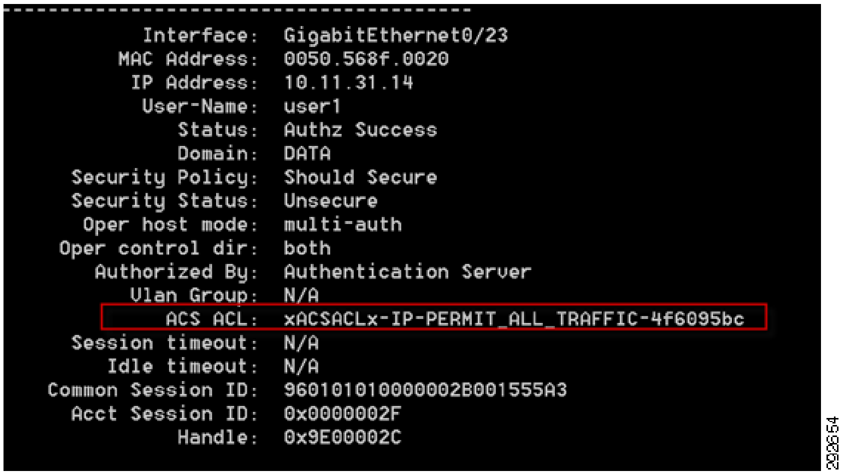
☑ VLAN Tag ID 1 ID/Name 13

☐ Voice Domain Permission

☐ Web Redirection (CWA, DRW, MDM, NSP, CPP)

Once this profile is downloaded to the Catalyst switch, the endpoint gets full access to the network. Figure 15-49 shows an example of the state of the port when this profile is downloaded by using the switch command **show authentication session interface Gi0/23**.

Figure 15-49 Catalyst Switch Port

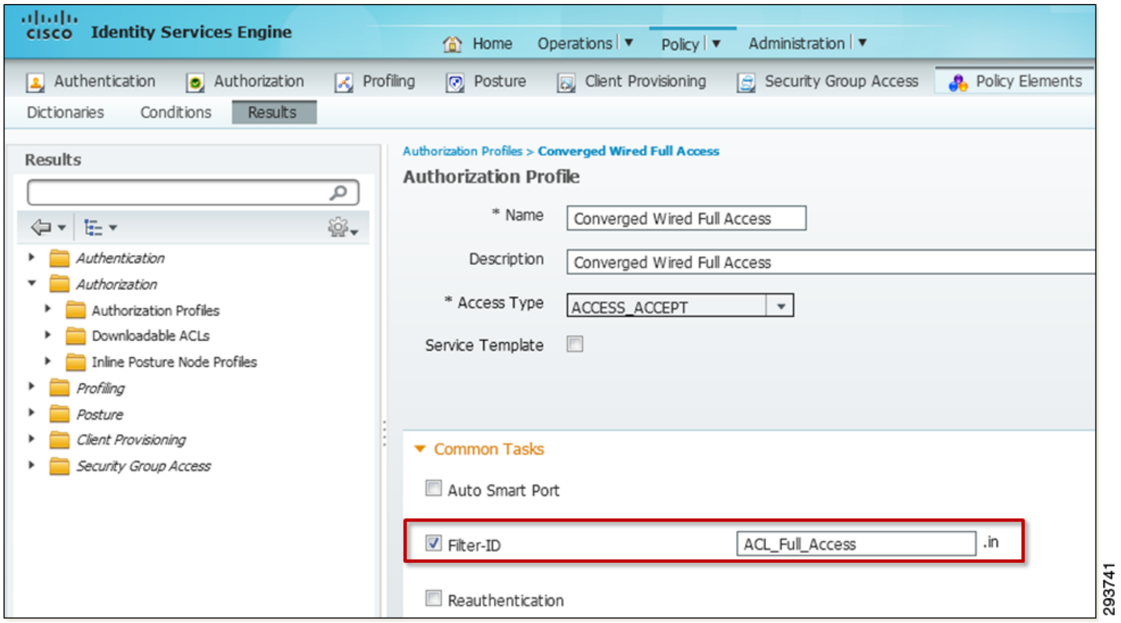


```
----------------------------------------
            Interface:  GigabitEthernet0/23
          MAC Address:  0050.568f.0020
           IP Address:  10.11.31.14
            User-Name:  user1
               Status:  Authz Success
               Domain:  DATA
      Security Policy:  Should Secure
      Security Status:  Unsecure
       Oper host mode:  multi-auth
     Oper control dir:  both
        Authorized By:  Authentication Server
           Vlan Group:  N/A
              ACS ACL:  xACSACLx-IP-PERMIT_ALL_TRAFFIC-4f6095bc
      Session timeout:  N/A
         Idle timeout:  N/A
    Common Session ID:  9601010100000002B001555A3
      Acct Session ID:  0x0000002F
               Handle:  0x9E00002C
```

Converged Access Branch or Campus

Figure 15-50 shows how the Converged Wired Full Access authorization profile is defined in ISE.

Figure 15-50 Converged Wired Full Access Authorization Profile



* Name: Converged Wired Full Access
Description: Converged Wired Full Access
* Access Type: ACCESS_ACCEPT
Service Template: □
□ Auto Smart Port
☑ Filter-ID: ACL_Full_Access .in
□ Reauthentication

For the Converged Access design a named ACL is implemented, meaning that the ACL must be configured on the Catalyst 3850 switch rather than being downloaded from ISE. Using the RADIUS Filter-ID attribute-value pair, ISE instructs the converged access switch to apply the ACL_Full_Access ACL. The following configuration example shows the contents of this ACL, as defined in the Catalyst 3850 switch.

```
!
ip access-list extended ACL_Full_Access
 permit ip any any
!
```

This ACL is used to override the default-ACL configured on the switch port. The default-ACL is used as an additional preventative measure in case ACL_Full_Access is not configured on the switch.

Personal Wired Devices—Partial Access

Partial Access grants access to corporate resources, in addition to Internet access. As mentioned in Personal Wireless Devices—Partial Access, once a device authenticates to ISE, an authorization profile is applied. For wired devices, the authorization profile is applied to the access layer switch.

To provide partial access to personal wired devices, the Cisco ISE verifies the following:

- The employee has completed the on-boarding process through the Guest Registration portal.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate, in this case, the MAC address of the endpoint.
- The connection originated using EAP-TLS authentication.
- The user is a member of the AD_Partial_Access Active Directory group.

At a high level, Figure 15-51 shows how different authorization profiles are selected for devices coming from different locations with different wired infrastructure designs. Each authorization profile in turn enforces a unique permission using VLANs, dynamic ACLs (either named or downloadable [DACL]), etc.

Figure 15-51 Wired Partial Access Enforcement

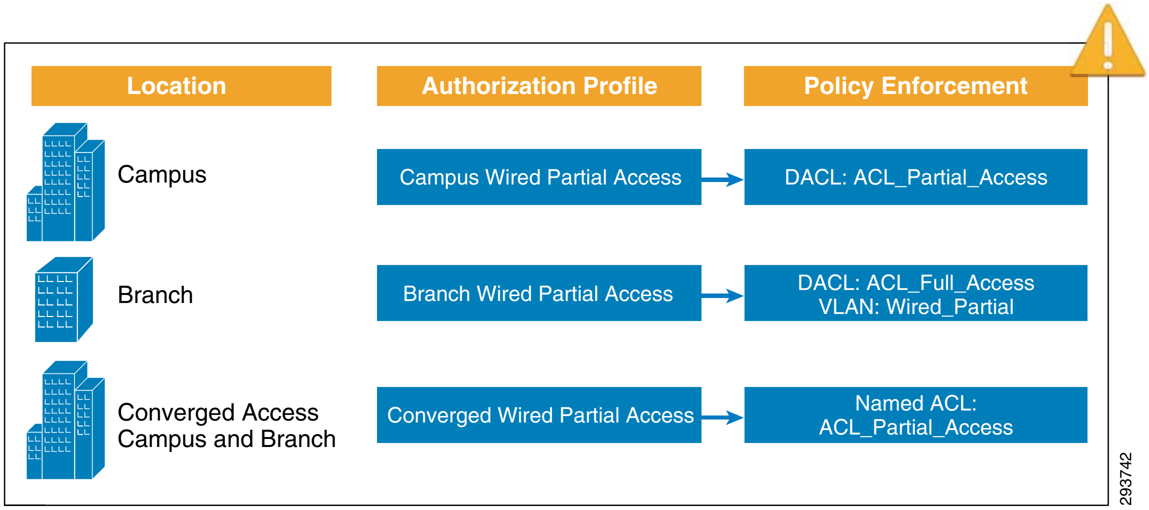
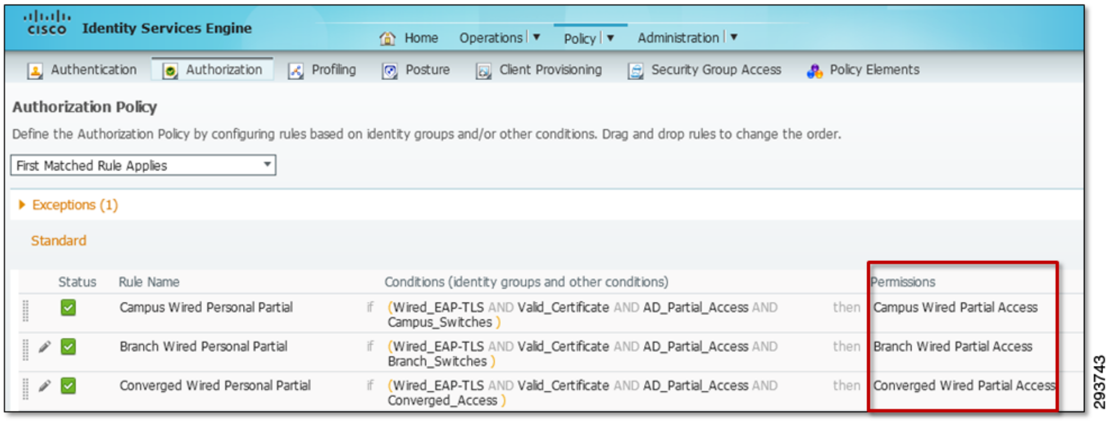


Figure 15-52 shows the details of authorization profile configured in ISE for wired devices.

Figure 15-52 Authorization Policies for Wired Partial Access



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.

First Matched Rule Applies

Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	Campus Wired Personal Partial	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Switches)	then	Campus Wired Partial Access
☑	Branch Wired Personal Partial	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Switches)	then	Branch Wired Partial Access
☑	Converged Wired Personal Partial	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then	Converged Wired Partial Access

Looking at the rules in more detail, ISE evaluates the following conditions:

- Wired_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name. (defined as a simple condition).
- The user belongs to a specific Active Directory group (defined as a simple condition).
- The RADIUS authentication originated from a Catalyst switch which was a member of one of the following device groups—Campus_Switches, Branch_Switches, or Converged_Access (defined as a simple condition).

Wired Simple and Compound Conditions explains the different conditions used in the rules.

Permissions

When all conditions in the authorization policy rule match, the rule invokes the proper permission. The permissions can be of different forms such as an authorization profile or a standard result. In this design guide, for wired access the authorization policy is used as permission to the policy rules match. Table 15-10 explains the permissions used for the partial access for wired users.

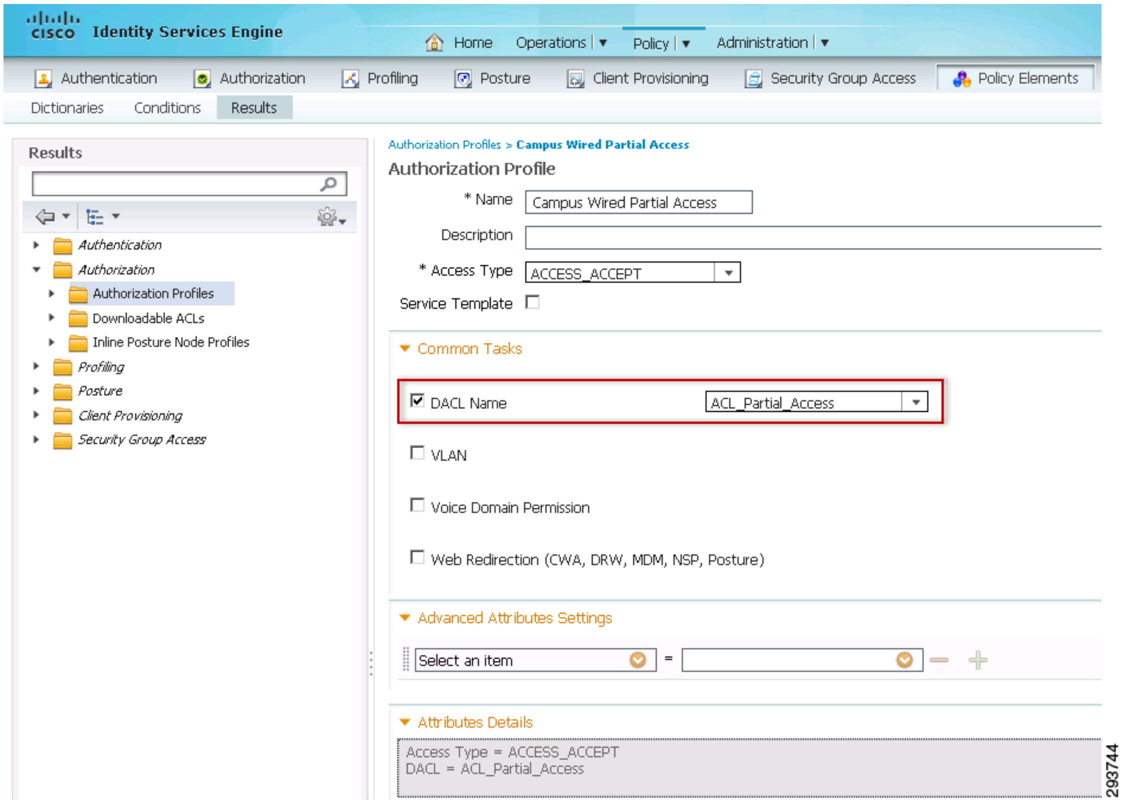
Table 15-10 Permissions Used for Wired Partial Access

Permission name	Permission type	Purpose
Campus Wired Partial Access	Authorization profile	To push a DACL for 802.1X wired devices connecting from campus location.
Branch Wired Partial Access	Authorization profile	To push a VLAN for 802.1X wired devices connecting from a branch location.
Converged Wired Partial Access	Authorization profile	To push a named ACL for 802.1X wired devices connecting from either a campus or branch location with Converged Access.

Campus Wired

For devices connecting from a campus location, the Campus Wired Partial Access authorization uses a DACL named ACL_Partial_Access enforced by the access layer switch, as shown in Figure 15-53.

Figure 15-53 Campus Wired Partial Access



Authorization Profiles > Campus Wired Partial Access

Authorization Profile

* Name: Campus Wired Partial Access

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

Common Tasks

☑ DACL Name: ACL_Partial_Access

□ VLAN

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

Advanced Attributes Settings

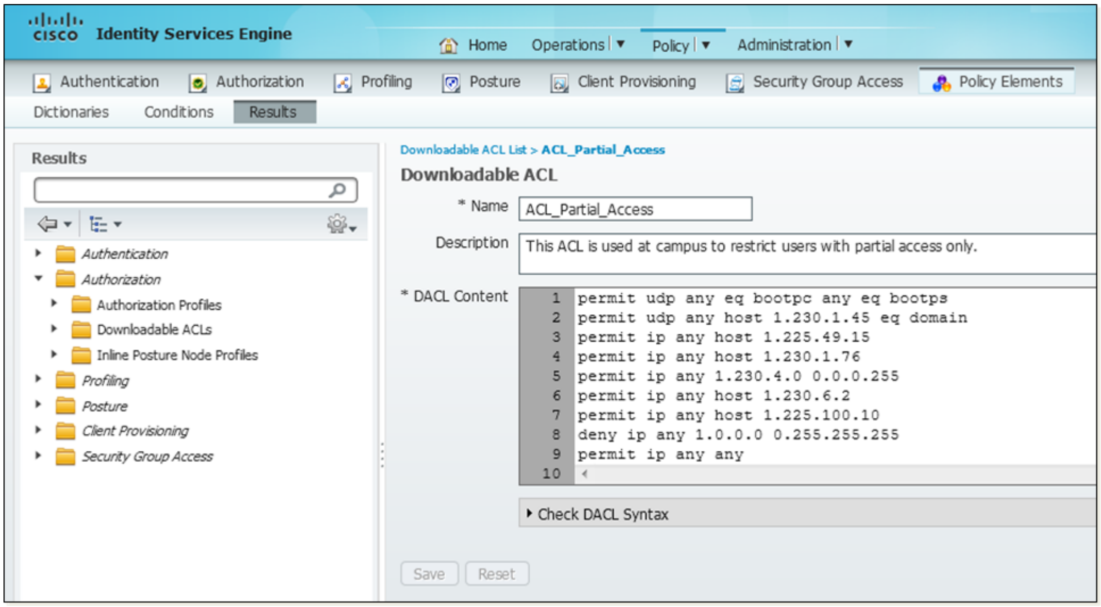
Select an item =

Attributes Details

Access Type = ACCESS_ACCEPT
DACL = ACL_Partial_Access

The DACL overrides the default-ACL configured on the switch. Figure 15-54 shows an example of this ACL, which is configured within ISE.

Figure 15-54 ACL_Partial_Access within ISE



Downloadable ACL

* Name: ACL_Partial_Access

Description: This ACL is used at campus to restrict users with partial access only.

* DACL Content:

```
permit udp any eq bootpc any eq bootps
permit udp any host 1.230.1.45 eq domain
permit ip any host 1.225.49.15
permit ip any host 1.230.1.76
permit ip any 1.230.4.0 0.0.0.255
permit ip any host 1.230.6.2
permit ip any host 1.225.100.10
deny ip any 1.0.0.0 0.255.255.255
permit ip any any
```

The above ACL specifies the following access:

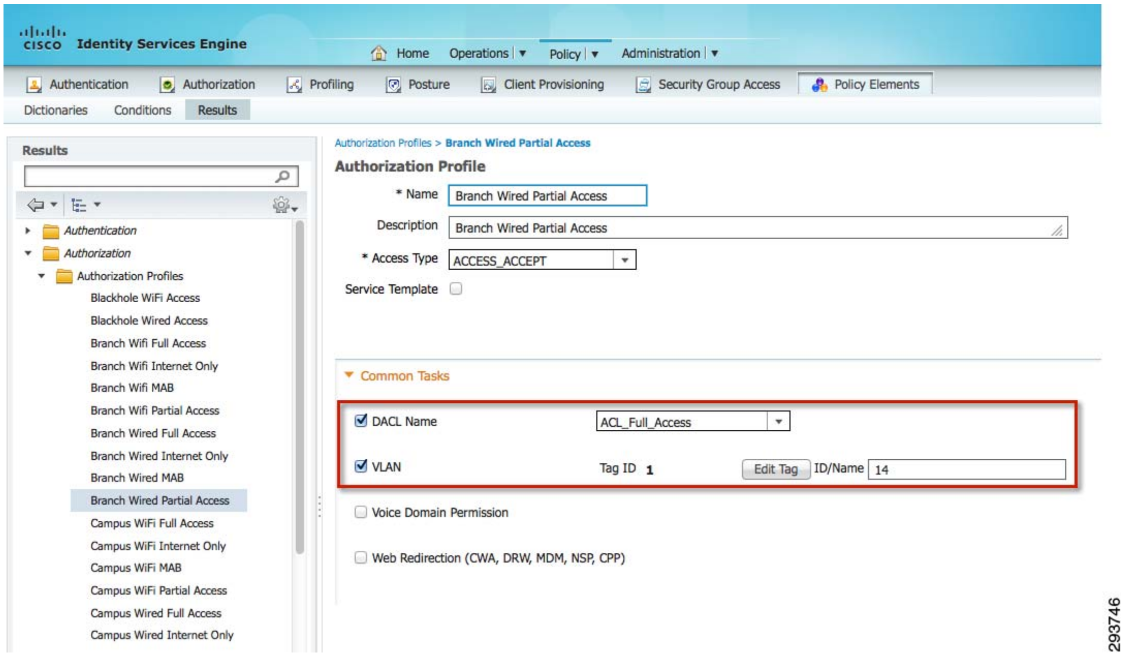
- Allow DHCP access (bootpc and bootps).
- Allow DNS access to the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from specific subnet (10.230.4.0 /24).
- Allow IP access to and from specific servers (10.230.6.2 and 10.225.100.10).
- Deny IP access to and from internal network address space (10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16).
- Allow access to and from all other subnets (Internet access).

Branch Wired

For devices connecting from a branch location, the Branch Wired Partial Access authorization pushes a VLAN assignment along with a downloadable ACL.

Figure 15-55 shows the details of the authorization profile configured in ISE.

Figure 15-55 Branch Wired Partial Access Authorization Profile



Authorization Profile

* Name: Branch Wired Partial Access

Description: Branch Wired Partial Access

* Access Type: ACCESS_ACCEPT

Service Template □

▾ Common Tasks

☑ DACL Name: ACL_Full_Access

☑ VLAN Tag ID 1 ID/Name 14

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, CPP)

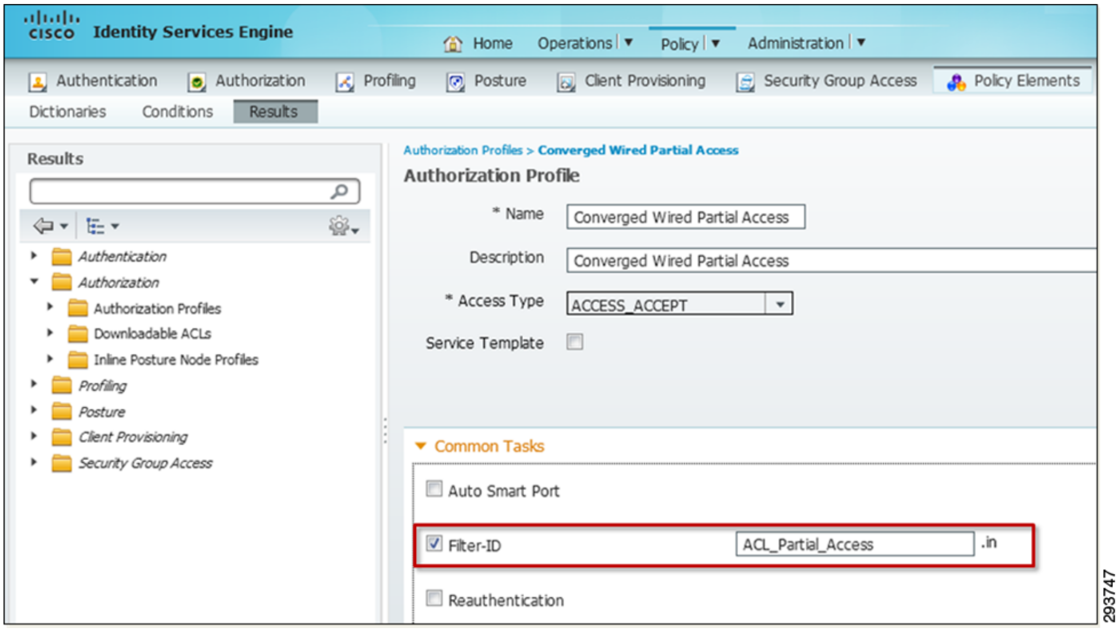
The DACL allows all IP traffic, so that the traffic initiated by the host reaches the branch router where the router-ACL is applied.

See VLAN Design at Branch Locations in Chapter 11, “BYOD Wired Infrastructure Design” for details regarding how this assignment of VLAN 14 is given full access for a branch which does not implement a Converged Access infrastructure.

Converged Access Branch and Campus

Figure 15-56 shows how the Converge Wired Partial Access authorization profile is defined in ISE.

Figure 15-56 Converged Wired Partial Access Authorization Profile



Authorization Profile

* Name: Converged Wired Partial Access

Description: Converged Wired Partial Access

* Access Type: ACCESS_ACCEPT

Service Template □

□ Auto Smart Port

☑ Filter-ID ACL_Partial_Access .in

□ Reauthentication

For the Converged Access design a named ACL is implemented. Using the RADIUS Filter-ID attribute-value pair, ISE instructs the converged access switch to apply the ACL_Partial_Access ACL. This is the same ACL discussed for converged access infrastructure in Personal Wireless Devices—Partial Access. For wired devices, the ACL is used to override the default-ACL configured on the switch port. The default-ACL is used as an additional preventative measure in case ACL_Partial_Access is not configured on the switch.

Personal Wired Devices—Internet Only Access

To provide Internet Only access to personal devices, the Cisco ISE verifies the following:

- The employee has completed the on-boarding process through the Guest Registration portal.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate, in this case, the MAC address of the endpoint.
- The connection originated using EAP-TLS authentication.
- The user is a member of the Domain Users Active Directory group.

At a high level, Figure 15-57 shows how different authorization profiles are selected for devices coming from different locations with different wired infrastructure designs. Each authorization profile in turn enforces a unique permission using VLANs, dynamic ACLs (either named or downloadable [DACL]), etc.

Figure 15-57 Wired Internet Only Access Enforcement

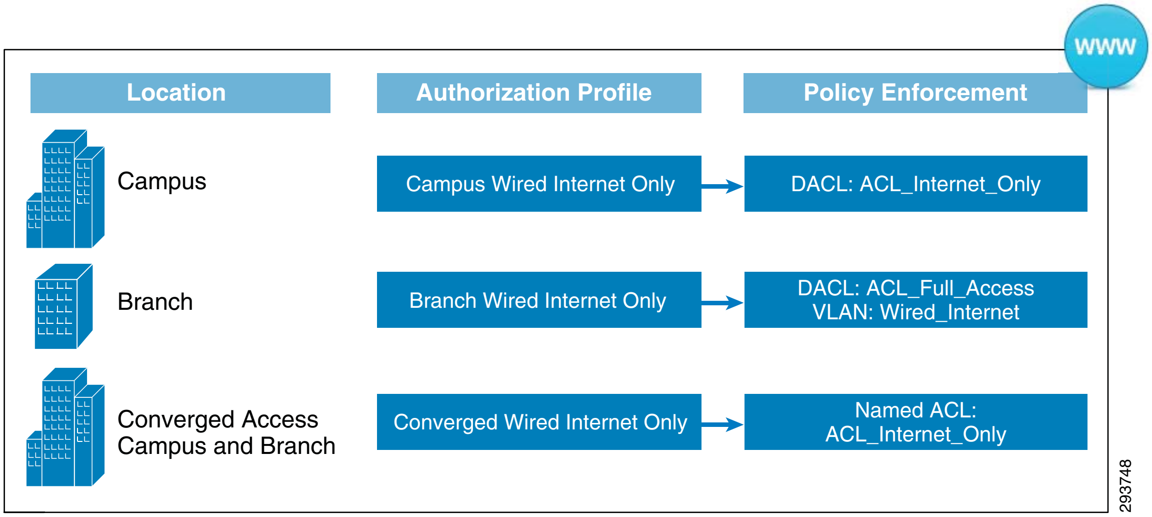
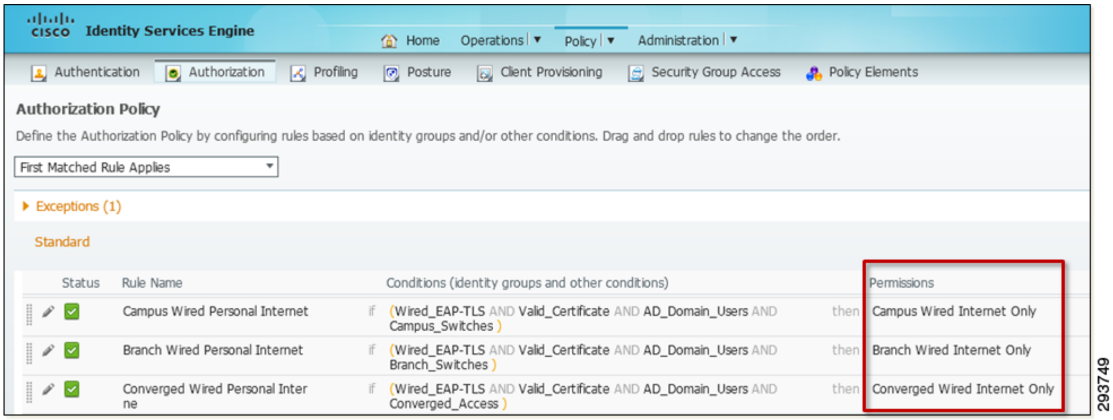


Figure 15-58 highlights the authorization policy to grant Internet Only access to personal wired devices.

Figure 15-58 Authorization Policies for Wired Internet Only Access



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.

First Matched Rule Applies

Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
✓	Campus Wired Personal Internet	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Switches)	then	Campus Wired Internet Only
✓	Branch Wired Personal Internet	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Switches)	then	Branch Wired Internet Only
✓	Converged Wired Personal Inter ne	if	(Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then	Converged Wired Internet Only

Looking at the rules in more detail, ISE evaluates the following conditions:

- Wired_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name. (defined as a simple condition).
- The user belongs to a specific Active Directory group (defined as a simple condition).
- The RADIUS authentication originated from a Catalyst switch which was a member of one of the following device groups—Campus_Switches, Branch_Switches, or Converged_Access (defined as a simple condition).

Wired Simple and Compound Conditions explains the different conditions used in the rules.

Permissions

When all conditions in the authorization policy rule match, the rule invokes the proper permission. The permissions can be of different forms such as an authorization profile or a standard result. In this design guide, for wired access the authorization policy is used as permission to the policy rules match. Table 15-11 explains the permissions used for Internet access.

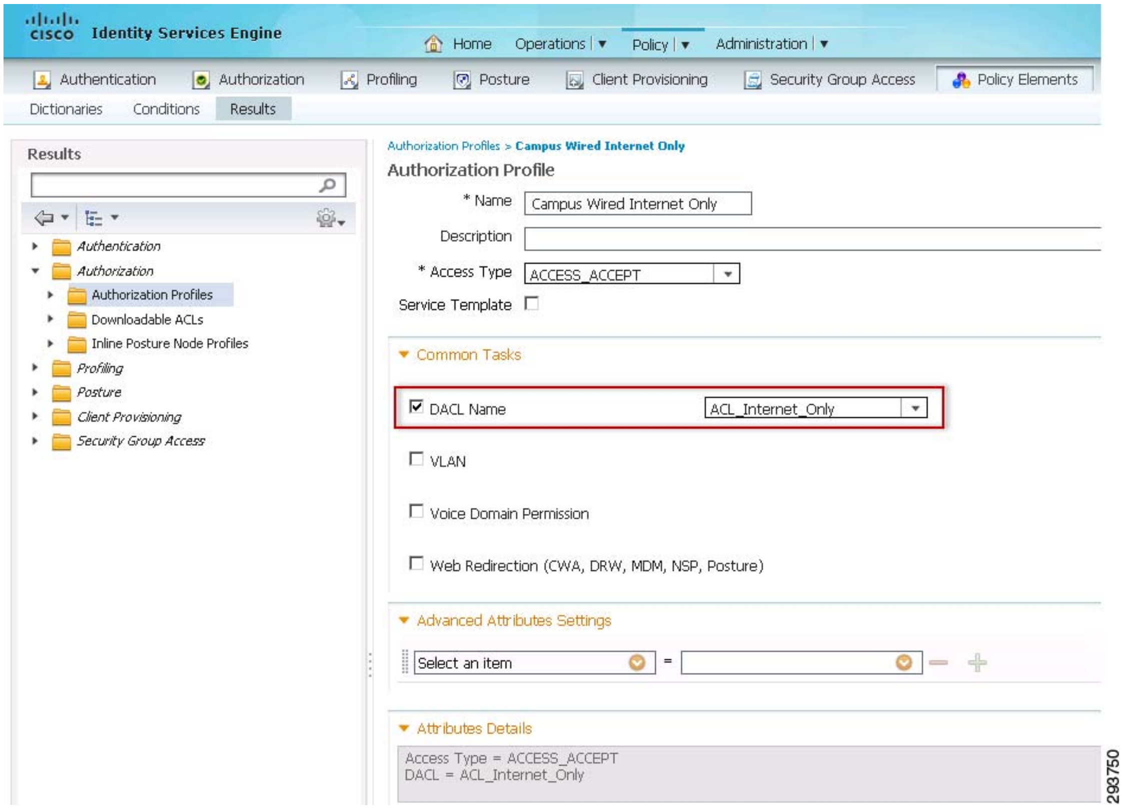
Table 15-11 Permissions Used for Wired Internet Access

Permission name	Permission type	Purpose
Campus Wired Internet Only	Authorization profile	To push a DACL for 802.1X wired devices connecting from a campus location.
Branch Wired Internet Only	Authorization profile	To push a VLAN for 802.1X wired devices connecting from a branch location.
Converged Wired Internet Only	Authorization profile	To push a named ACL for 802.1X wired devices connecting from either a campus or branch location with Converged Access

Wired Campus

For devices connecting from a campus location, the Campus Wired Internet Only authorization profile uses the DACL named ACL_Internet_Only, which is pushed to the access layer switch port. Figure 15-59 shows the Authorization profile.

Figure 15-59 Campus Wired Internet Only Authorization Profile



Authorization Profiles > Campus Wired Internet Only

Authorization Profile

* Name: Campus Wired Internet Only

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

▾ Common Tasks

☑ DACL Name: ACL_Internet_Only

□ VLAN

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

▾ Advanced Attributes Settings

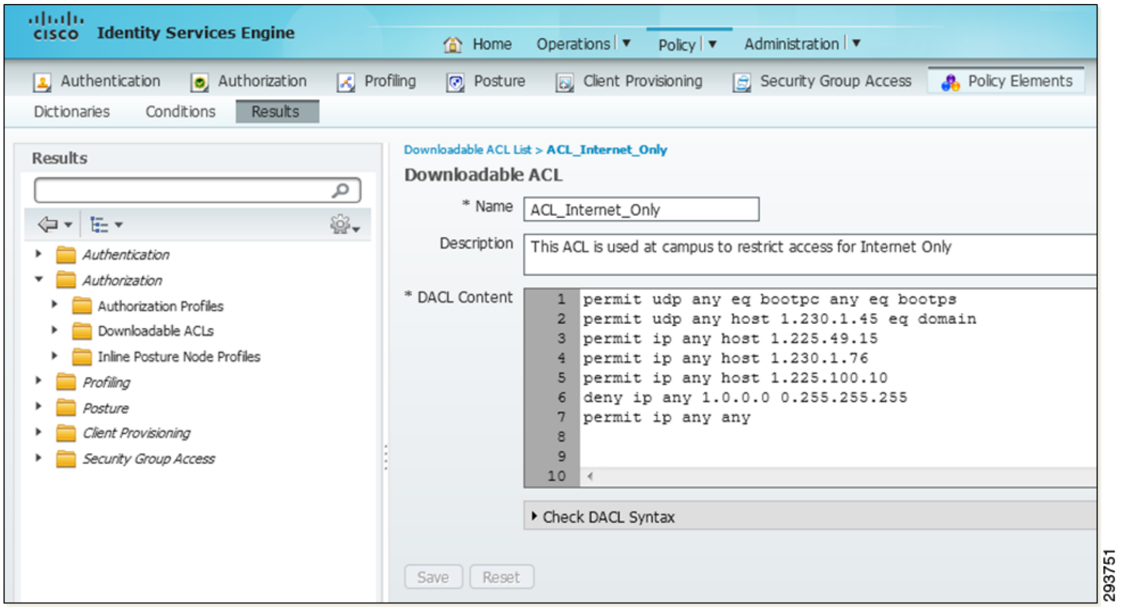
Select an item =

▾ Attributes Details

Access Type = ACCESS_ACCEPT
DACL = ACL_Internet_Only

The DACL overrides the default-ACL configured on the switch. Figure 15-60 shows an example of this ACL, which is configured within ISE.

Figure 15-60 ACL_Internet_Only DACL



Downloadable ACL List > ACL_Internet_Only

Downloadable ACL

* Name: ACL_Internet_Only

Description: This ACL is used at campus to restrict access for Internet Only

* DACL Content:

```
permit udp any eq bootpc any eq bootps
permit udp any host 1.230.1.45 eq domain
permit ip any host 1.225.49.15
permit ip any host 1.230.1.76
permit ip any host 1.225.100.10
deny ip any 1.0.0.0 0.255.255.255
permit ip any any
```

The access list specifies the following access:

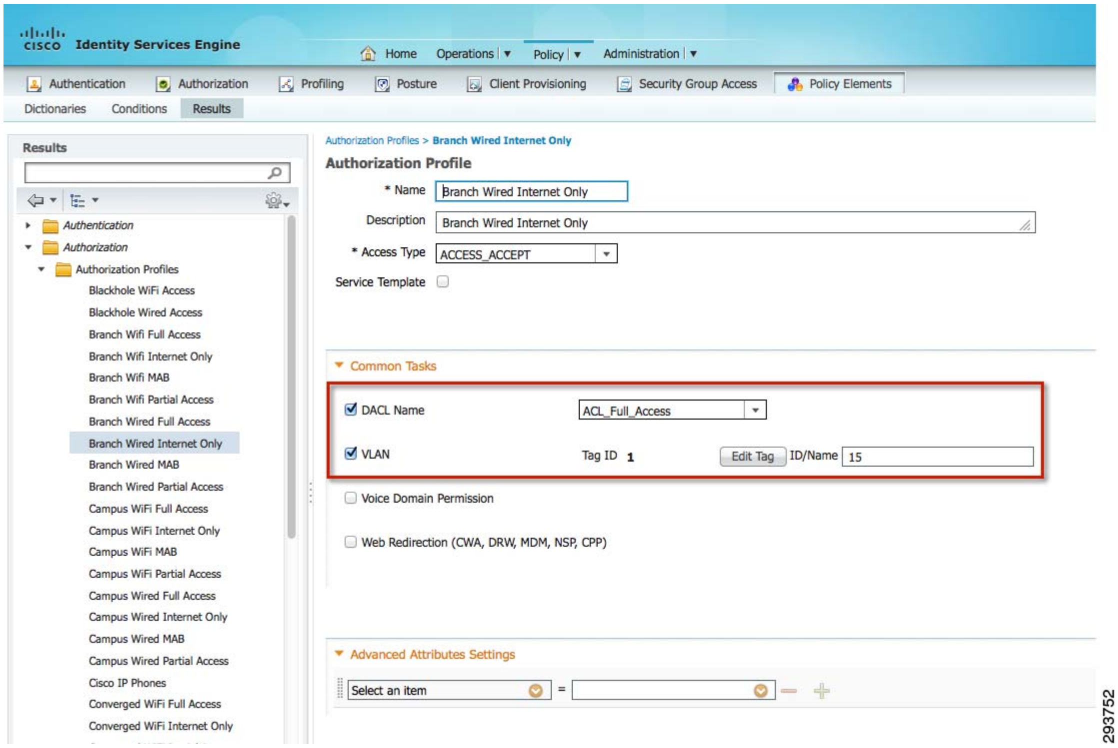
- Allow DHCP access (bootpc and bootps).
- Allow DNS access to the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Deny IP access to and from internal network address space (10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16).
- Allow access to and from all other subnets (Internet access).

This access list is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

Branch Wired

For devices connecting from a branch location, the Branch Wired Internet Only authorization pushes a VLAN assignment along with a downloadable ACL. Figure 15-61 illustrates the Branch Wired Internet_Only authorization profile, used to grant Internet_Only access to personal devices connecting from the branch.

Figure 15-61 Branch Wired Internet Only Authorization Profile



Authorization Profiles > Branch Wired Internet Only

Authorization Profile

* Name: Branch Wired Internet Only

Description: Branch Wired Internet Only

* Access Type: ACCESS_ACCEPT

Service Template □

☑ DACL Name: ACL_Full_Access

☑ VLAN Tag ID 1 ID/Name 15

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, CPP)

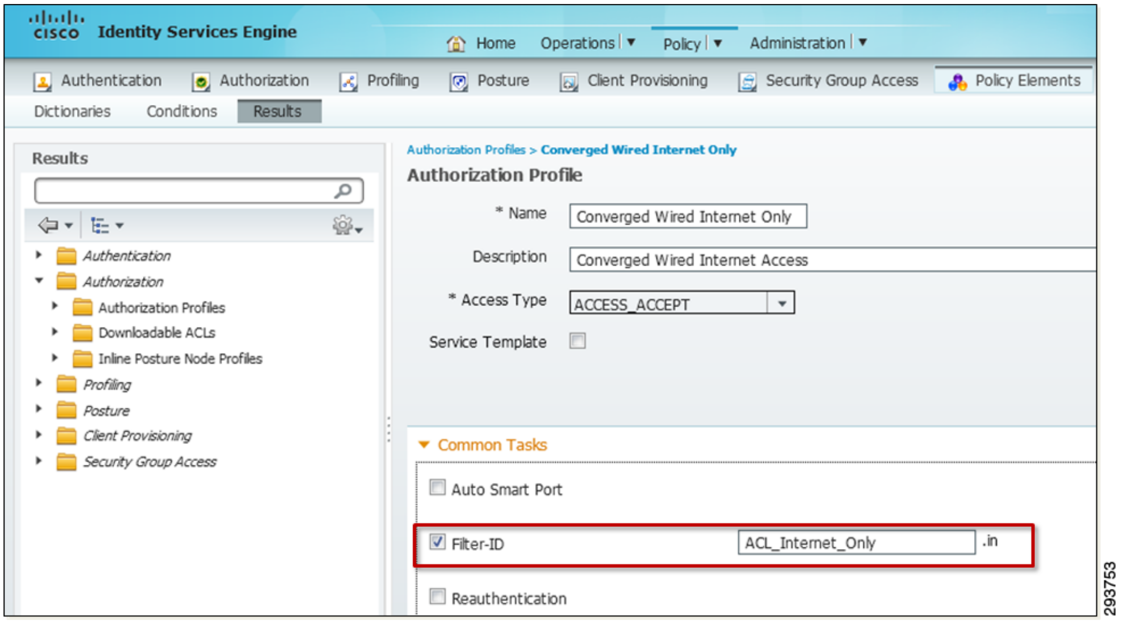
The ACL_Full_Access DACL is pushed to the access-layer switch to override the default-ACL on the port and allow all IP traffic to flow up to the branch router.

See VLAN Design at Branch Locations in Chapter 11, "BYOD Wired Infrastructure Design" for details regarding how this assignment of VLAN 15 is given full access for a branch which does not implement a Converged Access infrastructure.

Converged Access Branch and Campus

Figure 15-62 shows how the Converge Wired Internet Only authorization profile is defined in ISE.

Figure 15-62 Converged Wired Internet Only Authorization Profile



Authorization Profiles > Converged Wired Internet Only

Authorization Profile

* Name: Converged Wired Internet Only

Description: Converged Wired Internet Access

* Access Type: ACCESS_ACCEPT

Service Template □

▾ Common Tasks

□ Auto Smart Port

☑ Filter-ID: ACL_Internet_Only .in

□ Reauthentication

For the Converged Access design a named ACL is implemented. Using the RADIUS Filter-ID attribute-value pair, ISE instructs the converged access switch to apply the ACL_Internet_Only ACL. This is the same ACL discussed for converged access infrastructure in Personal Wireless Devices—Internet Only Access. For wired devices, the ACL is used to override the default-ACL configured on the switch port. The default-ACL is used as an additional preventative measure in case ACL_Internet_Only is not configured on the switch.

Android Devices—Deny Access

Rather than allowing differentiated access to the network which was depicted in the previous use cases, this use case discusses on how to deny access permission for some BYOD devices from connecting to the network. For example, some organizations may decide to have a more restrictive BYOD environment and grant access only to a specific type of device (e.g., Android, Apple iOS, etc.).

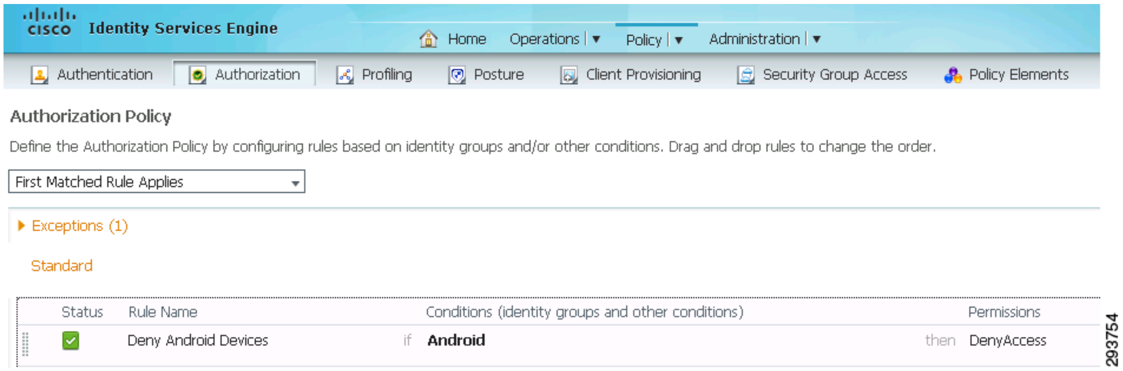
This example focuses on denying access to Android devices, relying on the profiling capabilities of ISE.

To deny access to Android devices, the Cisco ISE verifies the following:

- The employee attempts to connect to the network.
- The ISE profiler identifies the device type.
- If the device type is Android, deny access.

To configure the authorization rules in ISE, click **Policy > Authorization**. Figure 15-63 highlights the authorization policy to deny access to Android devices.

Figure 15-63 Deny Android Devices



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.

First Matched Rule Applies

▸ Exceptions (1)

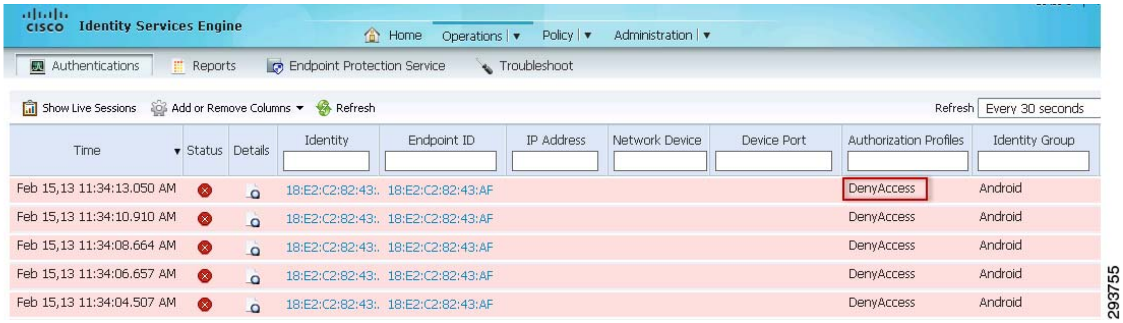
Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
✓	Deny Android Devices	if	Android	then	DenyAccess

The DenyAccess authorization profile is used to enforce the permissions and deny access to Android devices. The DenyAccess profile is a standard ISE profile and cannot be edited. This reserved profile cannot be edited but may be found under **Policy > Results> Authorization Profiles**.

Figure 15-64 shows an entry from ISE's log, highlighting the fact that the device has been profiled as an Android device and the DenyAccess authorization rule has been enforced.

Figure 15-64 DenyAccess



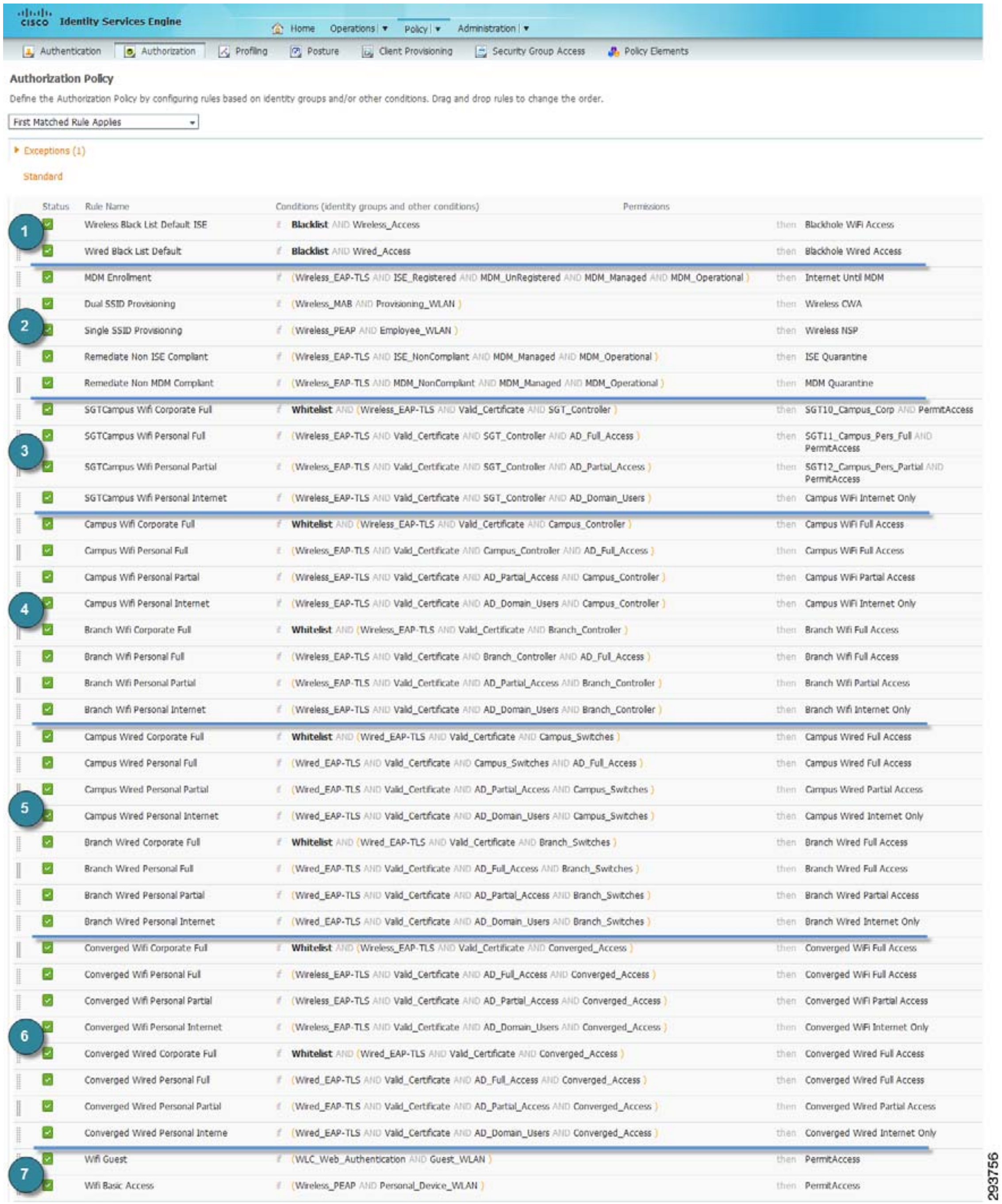
Time	Status	Details	Identity	Endpoint ID	IP Address	Network Device	Device Port	Authorization Profiles	Identity Group
Feb 15,13 11:34:13.050 AM	☒		18:E2:C2:82:43:.	18:E2:C2:82:43:AF				DenyAccess	Android
Feb 15,13 11:34:10.910 AM	☒		18:E2:C2:82:43:.	18:E2:C2:82:43:AF				DenyAccess	Android
Feb 15,13 11:34:08.664 AM	☒		18:E2:C2:82:43:.	18:E2:C2:82:43:AF				DenyAccess	Android
Feb 15,13 11:34:06.657 AM	☒		18:E2:C2:82:43:.	18:E2:C2:82:43:AF				DenyAccess	Android
Feb 15,13 11:34:04.507 AM	☒		18:E2:C2:82:43:.	18:E2:C2:82:43:AF				DenyAccess	Android

ISE Authorization Policy

For reference purposes, the complete authorization policy used during validation is shown in Figure 15-65. The figure highlights the following sections:

1. Used for blacklisting lost or stolen devices.
2. On-boarding and MDM registration/remediation (required for the advanced use case).
3. Wireless devices connecting from an access point in a SGT_Enabled location.
4. Wireless devices connecting from an access point in the campus or branch locations.
5. Wired devices connecting from a campus or branch locations.
6. Wired and Wireless devices connecting from a converged location.
7. Guest and Basic Access.

Figure 15-65 Complete Authorization Policy



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.

First Matched Rule Applies ▾

▸ Exceptions (1)

Standard

Status	Rule Name	Conditions (identity groups and other conditions)	Permissions
☑	Wireless Black List Default ISE	if **Blacklist** AND Wireless_Access	then Blackhole WiFi Access
☑	Wired Black List Default	if **Blacklist** AND Wired_Access	then Blackhole Wired Access
☑	MDM Enrollment	if (Wireless_EAP-TLS AND ISE_Registered AND MDM_UnRegistered AND MDM_Managed AND MDM_Operational)	then Internet Until MDM
☑	Dual SSID Provisioning	if (Wireless_MAB AND Provisioning_WLAN)	then Wireless CWA
☑	Single SSID Provisioning	if (Wireless_PEAP AND Employee_WLAN)	then Wireless NSP
☑	Remediate Non ISE Compliant	if (Wireless_EAP-TLS AND ISE_NonCompliant AND MDM_Managed AND MDM_Operational)	then ISE Quarantine
☑	Remediate Non MDM Compliant	if (Wireless_EAP-TLS AND MDM_NonCompliant AND MDM_Managed AND MDM_Operational)	then MDM Quarantine
☑	SGTCampus Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller)	then SGT10_Campus_Corp AND PermitAccess
☑	SGTCampus Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Full_Access)	then SGT11_Campus_Pers_Full AND PermitAccess
☑	SGTCampus Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Partial_Access)	then SGT12_Campus_Pers_Partial AND PermitAccess
☑	SGTCampus Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Domain_Users)	then Campus WiFi Internet Only
☑	Campus Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller)	then Campus WiFi Full Access
☑	Campus Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller AND AD_Full_Access)	then Campus WiFi Full Access
☑	Campus Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Controller)	then Campus WiFi Partial Access
☑	Campus Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Controller)	then Campus WiFi Internet Only
☑	Branch Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller)	then Branch Wifi Full Access
☑	Branch Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller AND AD_Full_Access)	then Branch Wifi Full Access
☑	Branch Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Controller)	then Branch Wifi Partial Access
☑	Branch Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Controller)	then Branch Wifi Internet Only
☑	Campus Wired Corporate Full	if **Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches)	then Campus Wired Full Access
☑	Campus Wired Personal Full	if (Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches AND AD_Full_Access)	then Campus Wired Full Access
☑	Campus Wired Personal Partial	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Switches)	then Campus Wired Partial Access
☑	Campus Wired Personal Internet	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Switches)	then Campus Wired Internet Only
☑	Branch Wired Corporate Full	if **Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Branch_Switches)	then Branch Wired Full Access
☑	Branch Wired Personal Full	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Branch_Switches)	then Branch Wired Full Access
☑	Branch Wired Personal Partial	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Switches)	then Branch Wired Partial Access
☑	Branch Wired Personal Internet	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Switches)	then Branch Wired Internet Only
☑	Converged Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Converged_Access)	then Converged WiFi Full Access
☑	Converged Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then Converged WiFi Full Access
☑	Converged Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then Converged WiFi Partial Access
☑	Converged Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then Converged WiFi Internet Only
☑	Converged Wired Corporate Full	if **Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Converged_Access)	then Converged Wired Full Access
☑	Converged Wired Personal Full	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then Converged Wired Full Access
☑	Converged Wired Personal Partial	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then Converged Wired Partial Access
☑	Converged Wired Personal Interne	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then Converged Wired Internet Only
☑	Wifi Guest	if (WLC_Web_Authentication AND Guest_WLAN)	then PermitAccess
☑	Wifi Basic Access	if (Wireless_PEAP AND Personal_Device_WLAN)	then PermitAccess

CHAPTER 16

BYOD Limited Use Case—Corporate Devices

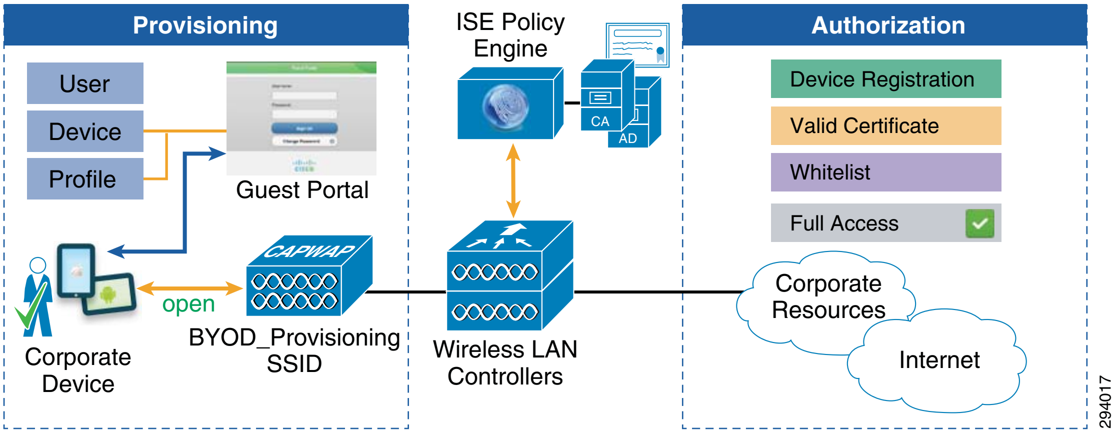
Revised: August 7, 2013

This chapter discusses design considerations and the construction of policy rules for providing network access to corporate devices, as well as the security policies enforced by the Cisco ISE. A corporate device is a corporate asset that is provided by the organization and has the approved configuration profiles and digital certificate to access the network. ISE allows the employee to on-board their corporate devices in a similar way personal devices are on-boarded, as discussed in Chapter 15, “BYOD Enhanced Use Case—Personal and Corporate Devices.”

Cisco ISE provides many ways to enforce security policies and determines what network resources each device is allowed to access. This chapter focuses on allowing full access to corporate devices. The ISE feature set is extremely flexible to meet diverse business requirements. The goal of this chapter is to highlight this flexibility of ISE and explain the steps to restrict access for corporate devices.

Figure 16-1 shows the different authorization rules used by ISE to grant full access to corporate devices. Different network components play a role in this process, including the wireless infrastructure, Active Directory, a CA server, etc.

Figure 16-1 Provisioning Corporate Devices



Whitelist Identity Group

An identity group is a logical list used to group endpoints according to their profiles and is an efficient way for ISE to enforce different permissions to different types of devices.

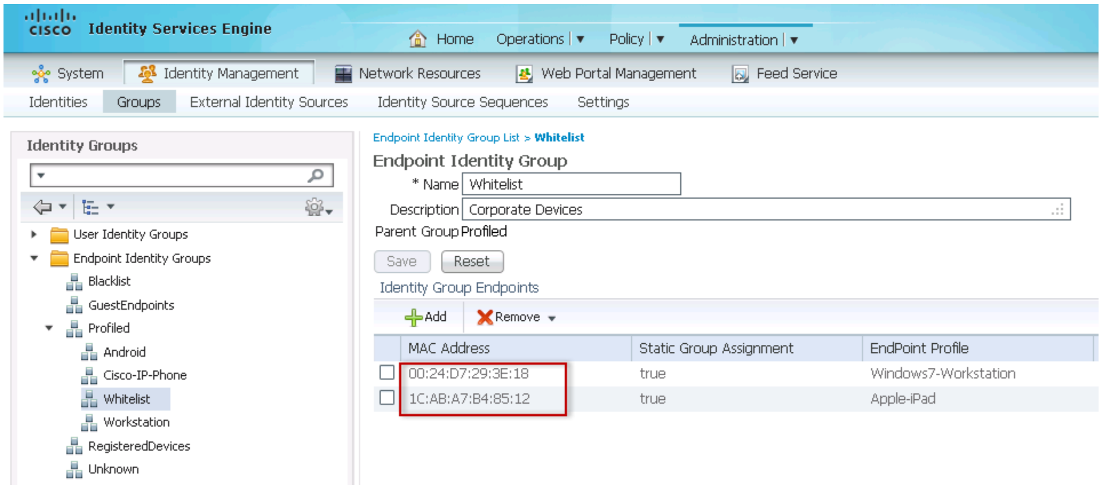
For this design guide, the Whitelist identity group was created for the purpose of uniquely identifying corporate devices. This identity group maintains a list of devices owned by the corporation. The Whitelist is manually updated by the IT administrator and contains the MAC addresses of devices that are granted full access. The assumption is that IT has added the devices to the Whitelist in advance.

The identity group provides an additional check when enforcing authorization rules. Endpoints may be moved to other identity groups, such as the Whitelist identity group or the Blacklist identity group, used when a device is lost or stolen. Chapter 22, "Managing a Lost or Stolen Device" has more details on the Blacklist identity group.

Note Endpoints can only be members of one identity group at a time.

To update an endpoint's identity group, click **Administration** > **Groups** > **Endpoint Identity Groups**. Figure 16-2 shows endpoints as members of the Whitelist identity group.

Figure 16-2 Whitelist Identity Group



Endpoint Identity Group List > **Whitelist**

Endpoint Identity Group

* Name Whitelist

Description Corporate Devices

Parent Group Profiled

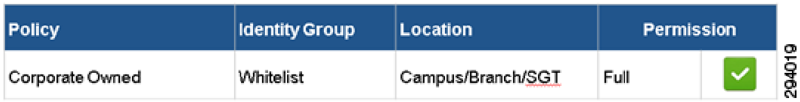
Identity Group Endpoints

	MAC Address	Static Group Assignment	EndPoint Profile
□	00:24:D7:29:3E:18	true	Windows7-Workstation
□	1C:AB:A7:B4:85:12	true	Apple-iPad

An Active Directory group could be used as an additional check, but for the purpose of this design guide the Whitelist identity group identifies a device as a corporate device. This model could easily be expanded to include AD groups to enforce additional policy requirements.

Figure 16-3 highlights the policy tested in this chapter, along with the different requirements and permissions. This policies, along with detailed configurations, is explained in this chapter.

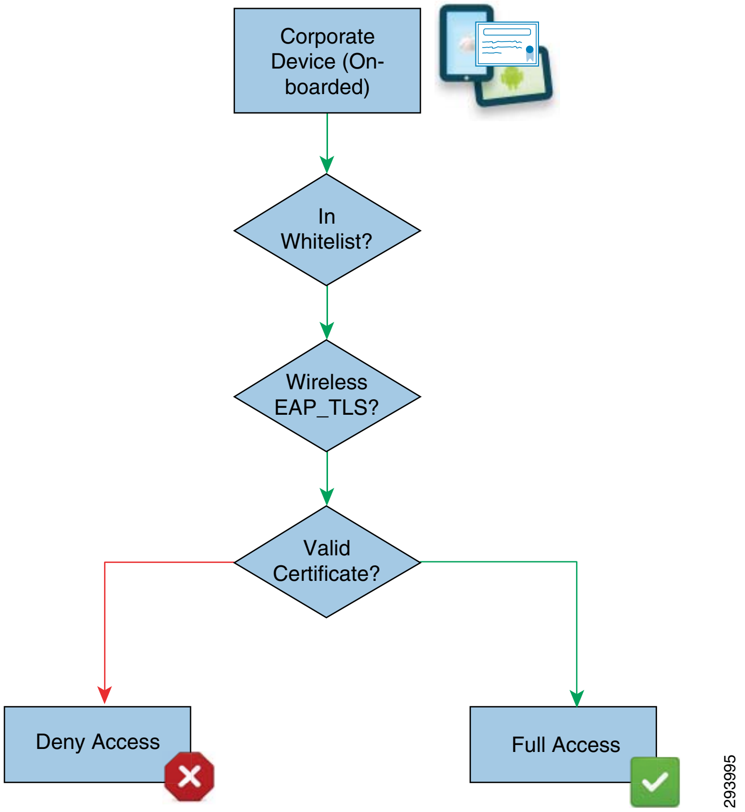
Figure 16-3 Access Policies and Permissions



Policy	Identity Group	Location	Permission	
Corporate Owned	Whitelist	Campus/Branch/SGT	Full	✓

This chapter assumes that after employees have on-boarded their devices, they'll connect to the BYOD_Employee. Figure 16-4 highlights the connectivity flow granting full access to corporate devices. If the device has been on-boarded, it belongs to the Whitelist identity group and has a digital certificate, the device is granted full access.

Figure 16-4 Corporate Device BYOD Access



Policy Enforcement for Security Group Access

A new addition to this CVD is the use of Security Group Tags in creating role-based policies in addition to ACLs to enforce policies for campus wireless users. Enforcing policies for SGA in BYOD architecture consist of three main components:

- Defining tags for the endpoints and the destination servers.
- Defining and implementing the Security Group ACL in the switching infrastructure.
- Defining firewall policies based on Security Group Tags if Security Group Firewall is implemented.

Depending on the SGA deployment scenario followed, the Security Group Egress Policy can be defined at the ISE and dynamically pushed to Catalyst 6500 infrastructure switches and the Nexus Data Center switches as Security Group ACLs (SGACL) or configured at the ASA Firewall as a SGT-based policy. These two choices are discussed in Chapter 23, "BYOD Policy Enforcement Using Security Group Access" as two different deployment scenarios.

Security Group Access Tags

The basic idea of Security Group Access is to define the tags for source and destination traffic flows and specify what source tags are able to reach other destination tags. For example, are devices tagged with an SGT 10 allowed to communicate with a server tagged with an SGT 40? This flow is either allowed or blocked at the enforcement point.

Using this tagging concept, unique tags have been defined for different types of source traffic generated by the endpoints. As explained in Chapter 12, "Security Group Access for BYOD," unique permissions are established for personal and corporate devices and unique tags have been defined for each use case.

Table 16-1 illustrates how tags are assigned to different devices.

Table 16-1 Source Tags

Device Type	Tag
Corporate device with Full Access	SGT 10
Personal device with Full Access	SGT 11
Personal device with Partial Access	SGT 12

Similarly, the destination servers also need to be associated with a particular tag. Table 16-2 illustrates how, based on their role, servers are assigned with a different tag.

Table 16-2 Destination Tags

Destination Server	Tag
Open Access	SGT 40
Corporate Server	SGT 50

Security Group ACL

After defining the source and destination tags, the next logical step is to define the egress policy that establishes the permissions for traffic between those tags. Table 16-3 illustrates the egress policy as an enforcement matrix.

Table 16-3 Enforcement Matrix

	Device Type	SGT 40	SGT 50
SGT 10	Corporate device with Full Access	Yes	Yes
SGT 11	Personal device with Full Access	Yes	Yes
SGT 12	Personal device with Partial Access	Yes	No

As shown in Table 16-3, corporate or personal devices granted full access will be allowed to reach servers that have been tagged with SGT 40 or SGT 50. Similarly, a personal device with a partial access is only allowed to connect with a server tagged with SGT 40.

The implementation of the SGACL depends upon the type of the deployment scenario. For the deployment scenario where Nexus is the enforcement point, the SGACL is designed in ISE and pushed to the Nexus switch. When the deployment scenario is using ASA as the enforcement point, then an SGT-based access rule is configured manually on the ASA firewall.

Authorization Polices for SGT

Based on policy matches and authorization profiles, the ISE assigns an SGT to campus wireless devices. Centralized Campus—Policy Enforcement using TrustSec in Chapter 9, "BYOD Wireless Infrastructure Design" provides information about the criteria used to determine when, based on the network device type of the wireless controller defined in ISE, an ACL versus an SGT should be returned upon successful authorization.

For the destination server tags, the configuration is done manually at the data center switch and the actual enforcement happens based on the deployment scenario. For more information about configuring tags for servers and the ASA, see Chapter 23, "BYOD Policy Enforcement Using Security Group Access.".

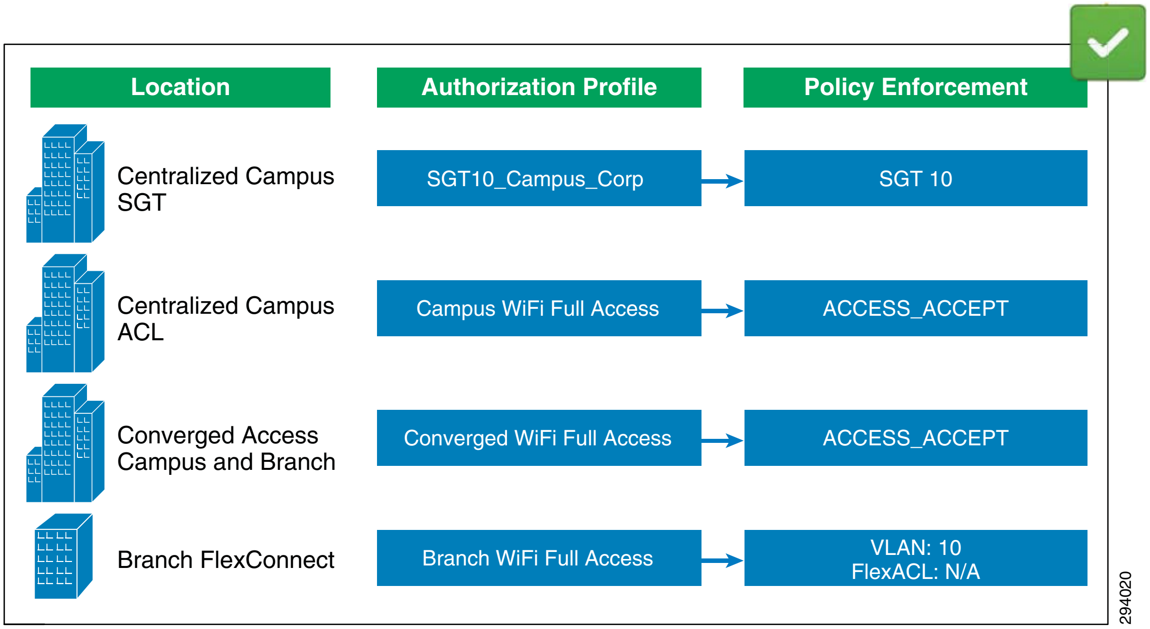
Corporate Devices—Full Access

To provide full access to corporate devices, the Cisco ISE verifies the following:

- The device has been on-boarded and has the right certificate and profile configurations.
- The device has been added to the Whitelist identity group.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate.
- The connection originated using EAP-TLS authentication.

Since the wireless designs presented in this design guide rely on different WLCs for FlexConnect branches, Centralized Controller campuses, and Converged Access campuses and branches, unique authorization rules are created for connections originating from each design. At a high level, Figure 16-5 shows how different authorization profiles are selected for connections originating from different locations with different wireless designs. Each authorization profile in turn enforces a unique permission using VLANs, SGTs, dynamic ACLs (either named or downloadable [DACL]), FlexConnect ACLs, etc.

Figure 16-5 Full Access Enforcement

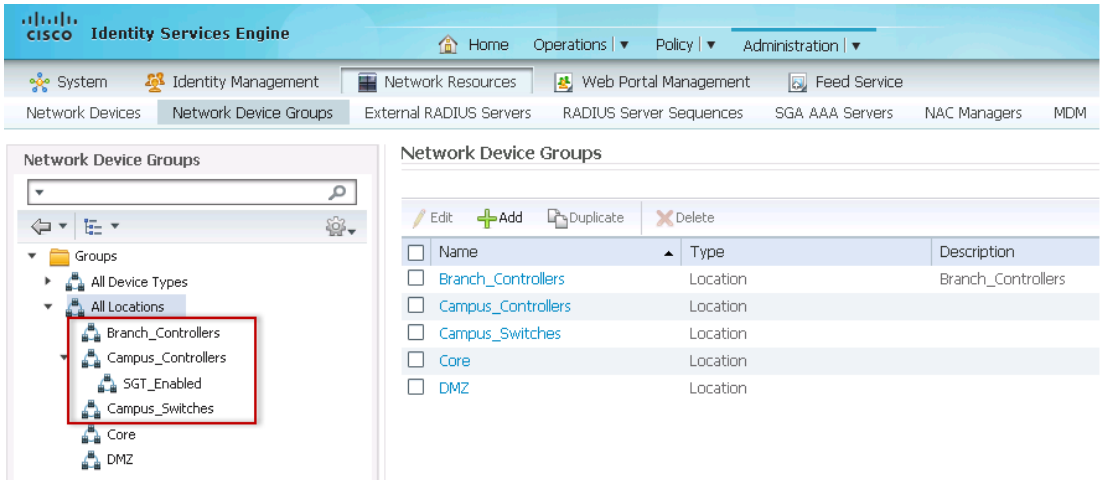


Location	Authorization Profile	Policy Enforcement
Centralized Campus SGT	SGT10_Campus_Corp	SGT 10
Centralized Campus ACL	Campus WiFi Full Access	ACCESS_ACCEPT
Converged Access Campus and Branch	Converged WiFi Full Access	ACCESS_ACCEPT
Branch FlexConnect	Branch WiFi Full Access	VLAN: 10 FlexACL: N/A

To differentiate these connections, the ISE relies on Network Device Groups to group WLCs based on their location or device type. This allows a single ISE to enforce policies across different groups of devices.

Figure 16-6 shows the different locations created for branch and campus devices.

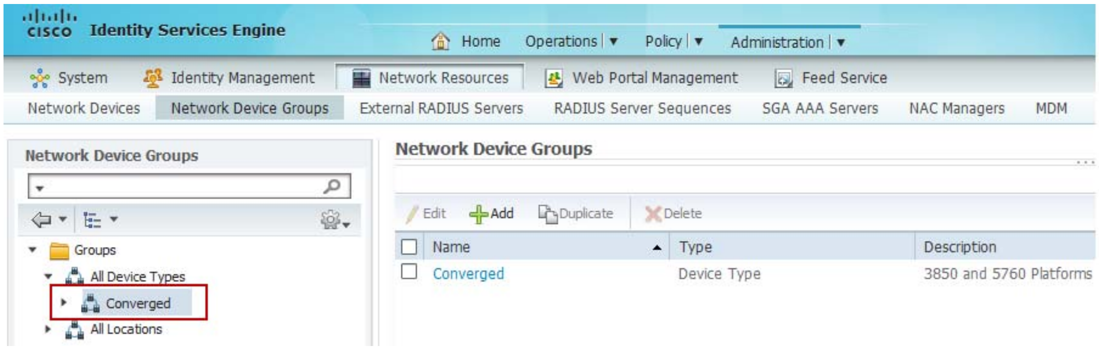
Figure 16-6 ISE Device Groups—Locations



□ Name	Type	Description
□ Branch_Controllers	Location	Branch_Controllers
□ Campus_Controllers	Location	
□ Campus_Switches	Location	
□ Core	Location	
□ DMZ	Location	

Similarly, Figure 16-7 shows a device type called Converged which can be created for Catalyst 3850 Series switches and CT5760 wireless controllers and used in the authorization policy.

Figure 16-7 ISE Device Groups—Device Types



Network Device Groups

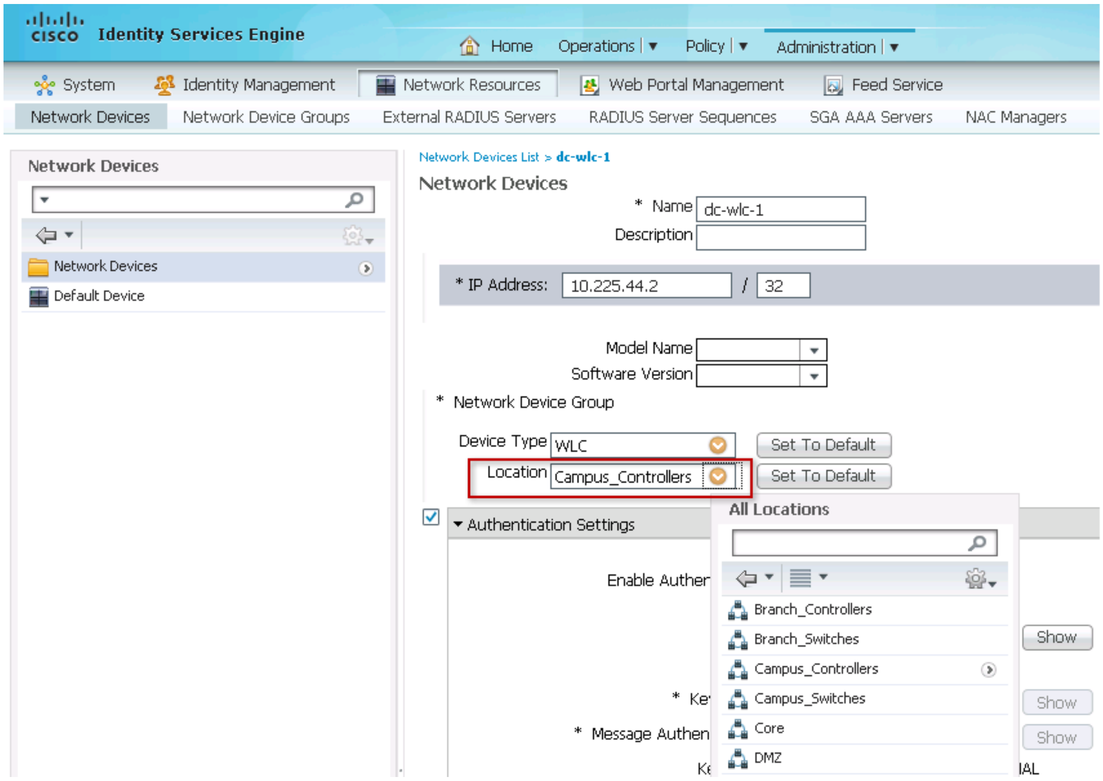
Name	Type	Description
Converged	Device Type	3850 and 5760 Platforms

Note One of the reasons a device type is used instead of a location for Converged Access designs is that the same authorization policy rules are used for Converged Access branch and campus designs within this design guide. Hence location—campus versus branch—is not particularly relevant from a Cisco ISE perspective to converged access designs presented in this design guide.

Each Wireless LAN Controller needs to be added to the proper device group by clicking **Administration > Network Resources > Network Devices** and specifying the proper location or device type from the pull-down menu.

Figure 16-8 shows how the dc-wlc-1 belongs to the Campus_Controllers location.

Figure 16-8 Campus Controller



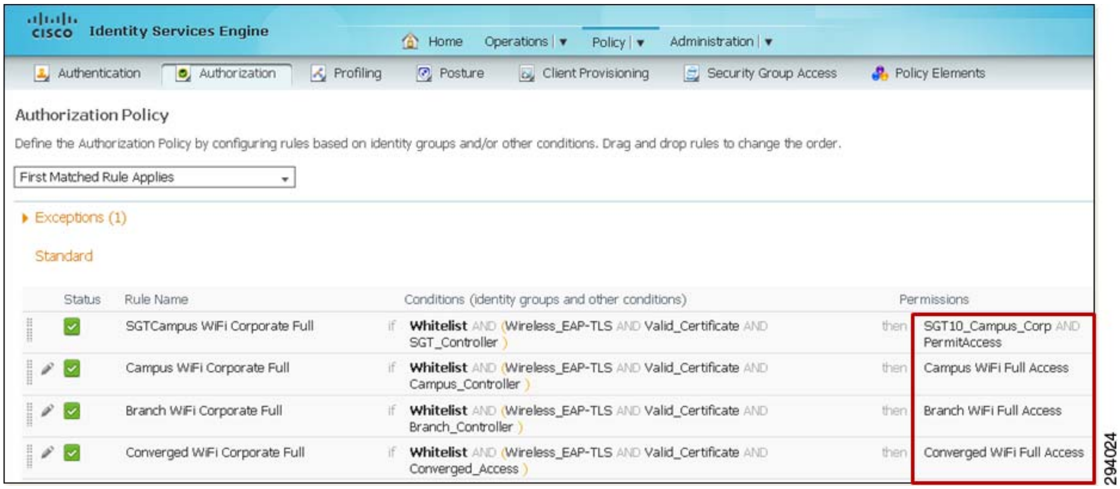
Network Devices

* Name: dc-wlc-1
Description:
* IP Address: 10.225.44.2 / 32
Model Name:
Software Version:
* Network Device Group
Device Type: WLC
Location: Campus_Controllers

Wireless LAN Controllers implementing a centralized (Local Mode) campus wireless design are assigned to the Campus_Controllers group.

To configure the authorization rules in ISE, click **Policy** > **Authorization**. Figure 16-9 highlights the authorization policy to grant full access to corporate devices.

Figure 16-9 Authorization Policies for Full Access



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.

First Matched Rule Applies

Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	SGTCampus WiFi Corporate Full	if	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller)	then	SGT10_Campus_Corp AND PermitAccess
☑	Campus WiFi Corporate Full	if	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller)	then	Campus WiFi Full Access
☑	Branch WiFi Corporate Full	if	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller)	then	Branch WiFi Full Access
☑	Converged WiFi Corporate Full	if	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Converged_Access)	then	Converged WiFi Full Access

Looking at the first rule in more detail, ISE evaluates these conditions:

- Whitelist—The endpoint has been added by an IT Administrator to the Whitelist identity group.
- Wireless_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate's Subject Alternative Name (defined as a simple condition).
- The RADIUS authentication originated from a wireless controller which was a member of one of the following device groups: Campus_Controller, SGT_Controller, Branch_Controller, or Converged_Access (defined as a simple condition).

Note A wireless controller which is a member of the Converged_Access device group could be either a standalone device, such as a Cisco CT5760 wireless controller, or a switch with integrated wireless controller functionality, such as the Catalyst 3850.

Simple and Compound Conditions

To improve the readability of the authorization policy, simple and compound authorization conditions were defined to group different conditions. These conditions may be reused and modified without changing every authorization rule.

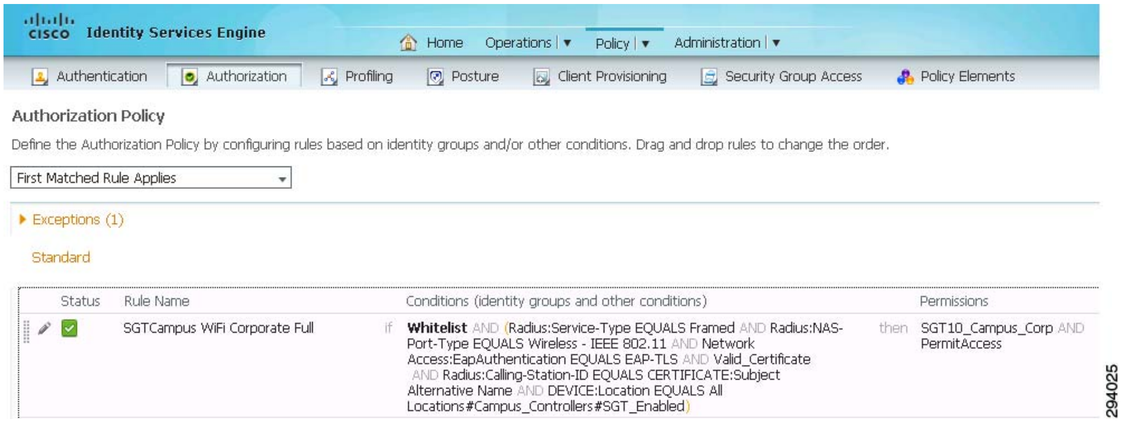
Table 16-4 shows the conditions used in the authorization rules.

Table 16-4 Wireless Simple and Compound Conditions

Wireless EAP-TLS (Compound)	
Wireless_EAP-TLS (See Figure 16-11)	Radius:Service-Type Equals Framed Radius:NAS-Port-Type Equals Wireless - IEEE 802.11 Network Access:EapAuthentication Equals EAP-TLS
Check for Valid Certificate (Simple)	
Valid_Certificate (See Figure 16-12)	Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name
WLC Location or Device Type (Simple)	
SGT_Controller	DEVICE:Location EQUALS All Locations#Campus_Controllers#SGT_Enabled
Campus_Controller	DEVICE:Location EQUALS All Locations#Campus_Controllers
Branch_Controller	DEVICE:Location EQUALS All Locations#Branch_Controllers
Converged_Access	DEVICE:Device Type EQUALS All Device Types#Converged

To illustrate the value of using simple/compound conditions, Figure 16-10 shows how much longer and harder to read a rule can be when simple/compound conditions are not implemented.

Figure 16-10 Authorization Rule without Conditions



Authorization Policy

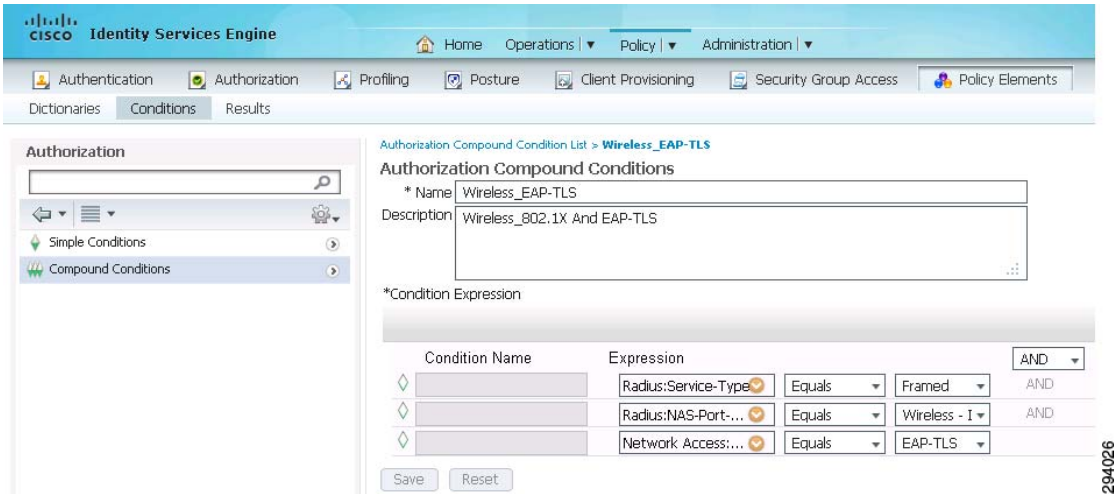
Define the Authorization Policy by configuring rules based on identity groups and/or other conditions. Drag and drop rules to change the order.

First Matched Rule Applies

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	SGTCampus WiFi Corporate Full	if	**Whitelist** AND (Radius:Service-Type EQUALS Framed AND Radius:NAS-Port-Type EQUALS Wireless - IEEE 802.11 AND Network Access:EapAuthentication EQUALS EAP-TLS AND Valid_Certificate AND Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name AND DEVICE:Location EQUALS All Locations#Campus_Controllers#SGT_Enabled)	then	SGT10_Campus_Corp AND PermitAccess

To define a new compound condition, click **Policy > Conditions > Authorization > Compound Conditions**. Figure 16-11 shows how the Wireless_EAP-TLS condition combines several conditions into one.

Figure 16-11 Wireless_EAP-TLS Condition



Authorization Compound Condition List > Wireless_EAP-TLS

Authorization Compound Conditions

* Name: Wireless_EAP-TLS

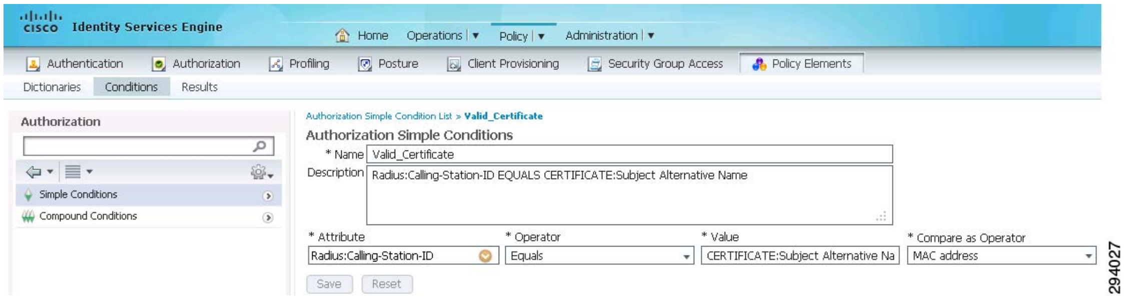
Description: Wireless_802.1X And EAP-TLS

*Condition Expression

Condition Name	Expression			AND
	Radius:Service-Type	Equals	Framed	AND
	Radius:NAS-Port-...	Equals	Wireless - I	AND
	Network Access:...	Equals	EAP-TLS	

Figure 16-12 shows the Valid_Certificate simple condition.

Figure 16-12 Valid_Certificate Condition



Authorization Simple Condition List > Valid_Certificate

Authorization Simple Conditions

* Name: Valid_Certificate

Description: Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name

* Attribute	* Operator	* Value	* Compare as Operator
Radius:Calling-Station-ID	Equals	CERTIFICATE:Subject Alternative Na	MAC address

The remaining conditions shown in Table 16-4 are defined in a similar way.

Permissions for Wireless Users

When all conditions in the authorization policy rule match, the rule invokes the proper permissions to provide Full Access, as shown in Table 16-5.

Table 16-5 Permissions for Full Access

Permission name	Permission type	Purpose
SGT10_Campus_Corp	Standard result	To assign a SGT for 802.1X wireless devices connecting from an SGT-enabled controller.
Campus WiFi Full Access	Authorization profile	Provides Full Access for 802.1X wireless devices connecting from a centralized campus controller.

Table 16-5 Permissions for Full Access

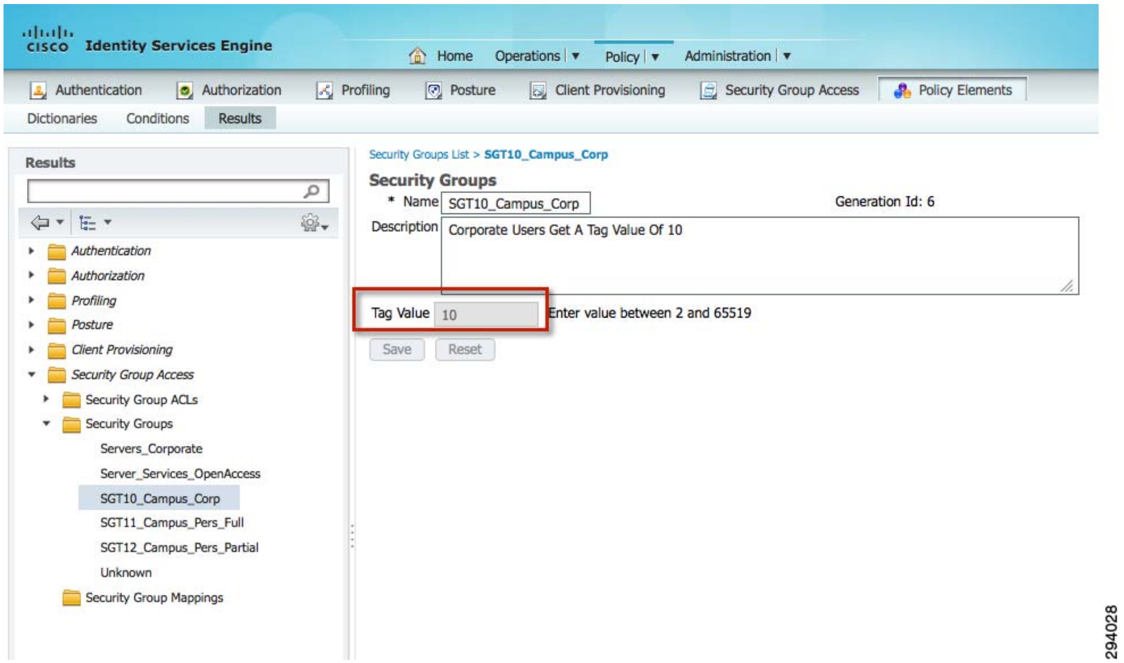
Permission name	Permission type	Purpose
Branch WiFi Full Access	Authorization profile	To push a VLAN for 802.1X wireless devices connecting from a FlexConnect branch controller.
Converged WiFi Full Access	Authorization profile	Provides Full Access for 802.1X wireless devices connecting from a Converged Access controller.

Note A Converged Access infrastructure refers to a branch or campus deployment with Catalyst 3850 Series switches and/or CT5760 wireless controllers within this design guide.

Centralized Campus with SGTs

Figure 16-13 shows how the SGT10_Campus_Corp authorization profile is pushing the Security Group Tag whose value is 10 for a user of a corporate device, who is allowed to obtain full access.

Figure 16-13 SGT10_Campus_Corp



Security Groups

* Name SGT10_Campus_Corp

Generation Id: 6

Description Corporate Users Get A Tag Value Of 10

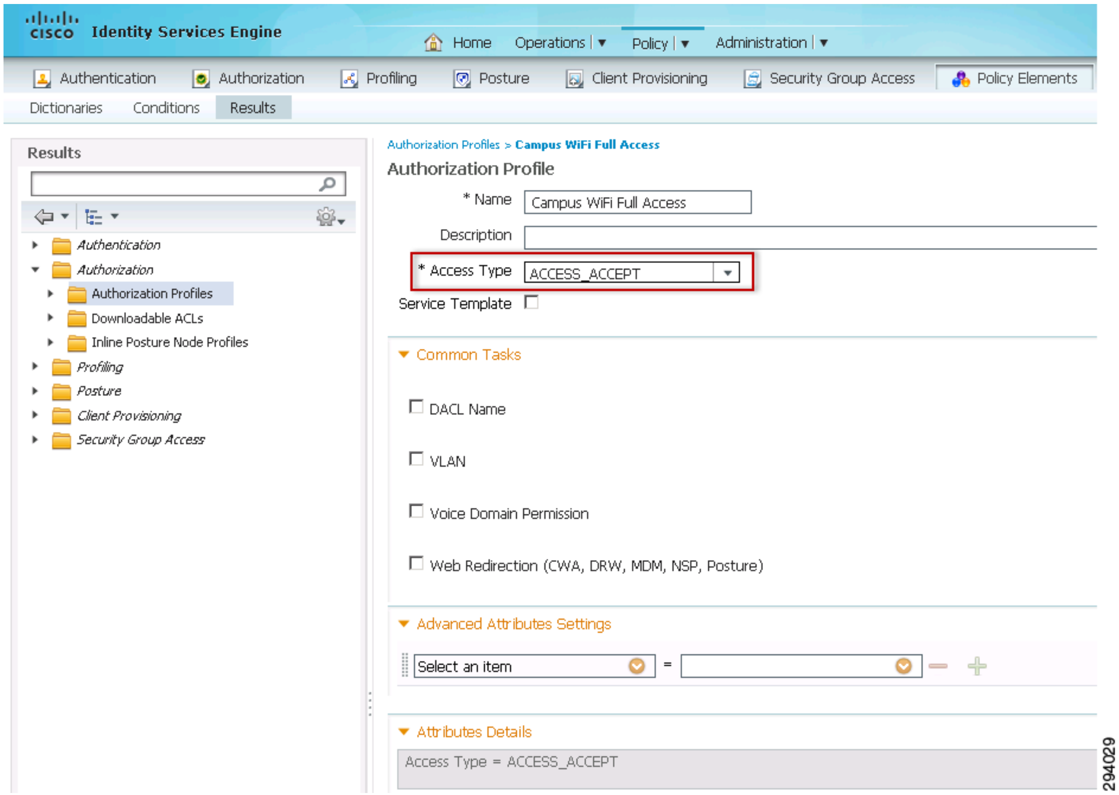
Tag Value 10 Enter value between 2 and 65519

See Chapter 23, "BYOD Policy Enforcement Using Security Group Access" for details regarding how SGT 10 is given full access for a campus which implements a centralized controller (Local Mode) design with SGTs.

Centralized Campus with ACLs

Figure 16-14 shows how the Campus WiFi Full Access authorization profile is using the ACCESS_ACCEPT Access Type to allow full access.

Figure 16-14 Campus WiFi Full Access



Authorization Profile

* Name: Campus WiFi Full Access

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

Common Tasks

□ DACL Name

□ VLAN

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

Attributes Details

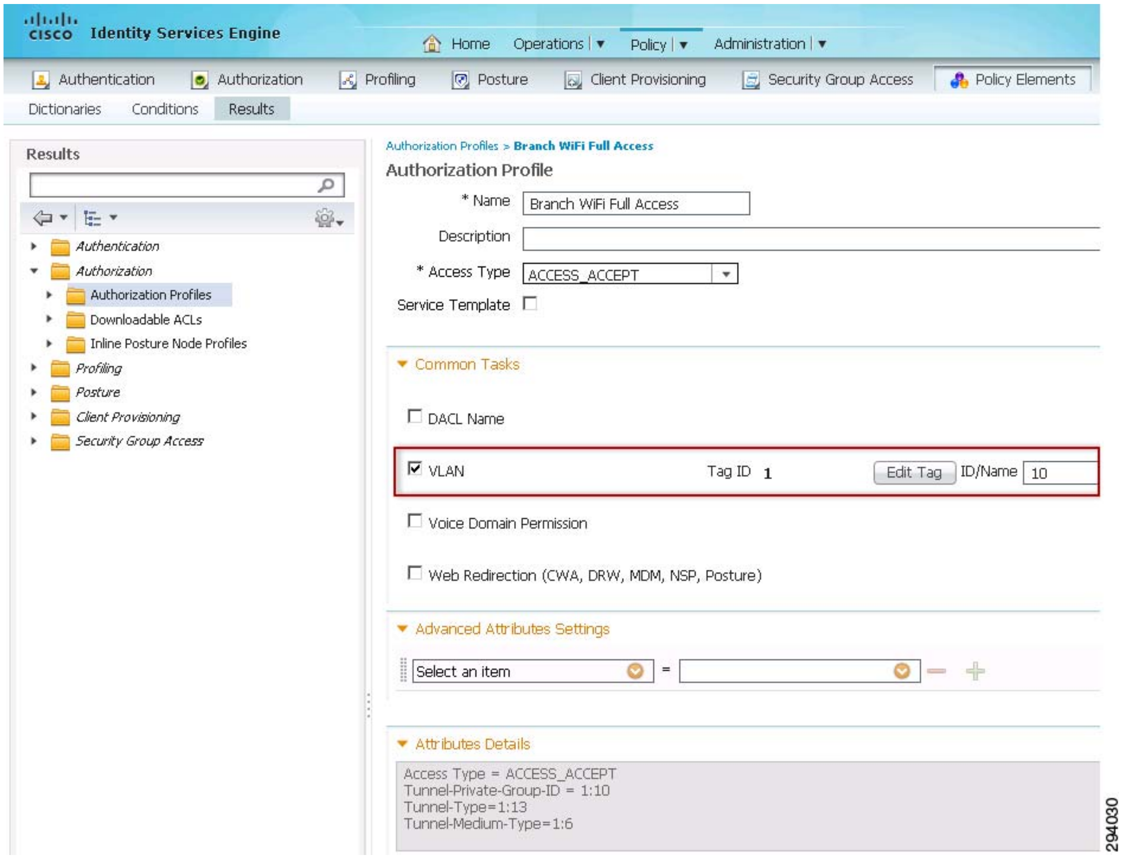
Access Type = ACCESS_ACCEPT

Since full access is allowed with this authorization profile, no Named ACL for access control needs to be specified by ISE.

Branch with FlexConnect

Endpoints connecting from a branch location dynamically get assigned to VLAN 10, which has been configured without an ACLs thus providing full access.

Figure 16-15 Branch WiFi Full Access



Authorization Profiles > Branch WiFi Full Access

Authorization Profile

* Name: Branch WiFi Full Access

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

Common Tasks

□ DACL Name

☑ VLAN Tag ID 1 ID/Name 10

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

Advanced Attributes Settings

Select an item =

Attributes Details

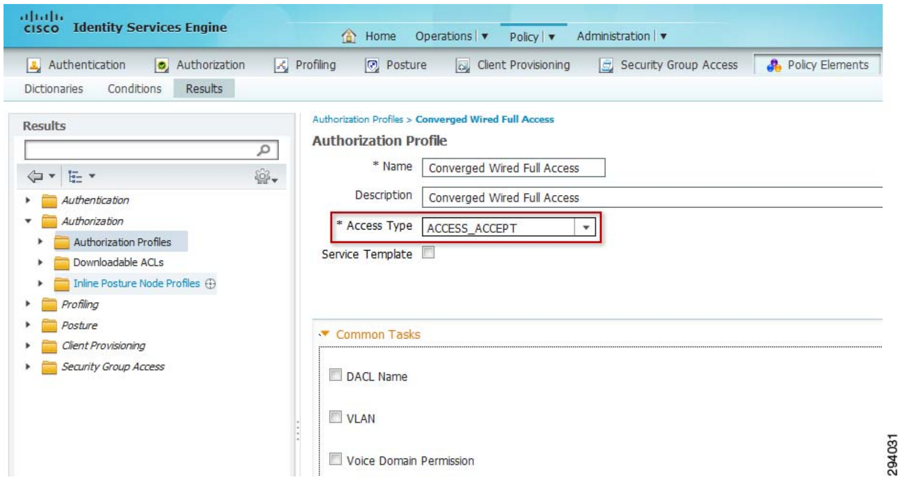
```
Access Type = ACCESS_ACCEPT
Tunnel-Private-Group-ID = 1:10
Tunnel-Type=1:13
Tunnel-Medium-Type=1:6
```

Converged Access Branch or Campus

Within this design guide, a Converged Access infrastructure refers to a branch or campus deployment with Catalyst 3850 Series switches and/or CT5760 wireless controllers.

Figure 16-16 shows how the Converged WiFi Full Access authorization profile is using the ACCESS_ACCEPT Access Type to allow full access.

Figure 16-16 Converged WiFi Full Access



Authorization Profiles > Converged Wired Full Access

Authorization Profile

* Name: Converged Wired Full Access

Description: Converged Wired Full Access

* Access Type: ACCESS_ACCEPT

Service Template ☐

Common Tasks

☐ DACL Name

☐ VLAN

☐ Voice Domain Permission

Again, since full access is allowed with this authorization profile, no Named ACL for access control needs to be specified by ISE.

Corporate Wired Devices—Full Access

The authorization policy rules for wired devices follow the same logic as wireless devices. Corporate approved wired devices are assumed to be pre-configured with the correct configuration profiles after being on-boarded.

To provide full access to corporate wired devices, the Cisco ISE verifies the following:

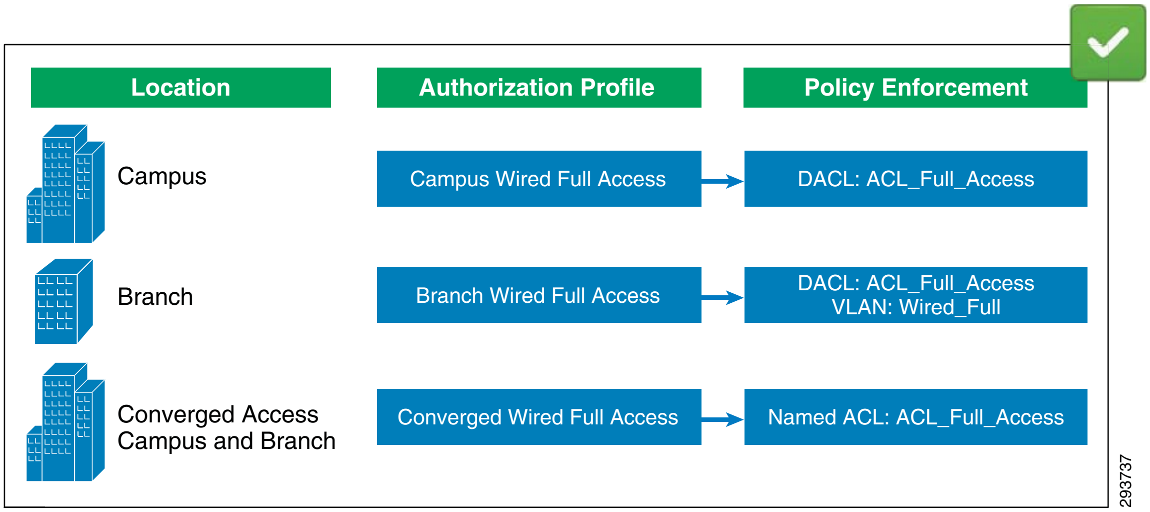
- The device has been on-boarded and has the right certificate and profile configurations.
- The device has been added to the Whitelist identity group.
- To uniquely identify the device and prevent spoofing, the Calling-Station-ID matches the Subject Alternative Name of the certificate, in this case, the MAC address of the endpoint.
- The connection originated using EAP-TLS authentication.

Since the wired designs presented in this design guide rely on slightly different access control mechanisms for converged access campuses and branches, for campuses and branches that do not implement converged access infrastructures unique authorization rules are created for connections originating from each design.

Note For the purpose of clarity within this design guide, converged access branches refer to designs in which Catalyst 3850 Series switches are deployed at the access-layer of the branch network. From a wired perspective, branches which do not implement converged access infrastructures are branches which deploy other Catalyst access-layer switches, such as the Catalyst 3750X Series. Unless otherwise specified, these are referred to simply as “branches” within the design guide. Similarly, converged access campuses refer to designs in which Catalyst 3850 Series switches are deployed at the access-layer of building distribution modules within the campus. From a wired perspective, campuses which do not implement converged access infrastructures are campuses which deploy other Catalyst access-layer switches, such as the Catalyst 3750X Series. Unless otherwise specified, these are referred to simply as "campuses" within this design guide. This is in order to reduce the use of verbose phrases such as "branches which do not implement converged access infrastructure" and "campuses which do not implement converged access infrastructure".

At a high level, Figure 16-17 shows how different authorization profiles are selected for connections originating from different locations with different infrastructure (converged access versus non-converged access) designs. Each authorization profile in turn enforces a unique permission using VLANs, dynamic ACLs (either named or downloadable [DACL]), etc.

Figure 16-17 Full Access Wired Enforcement

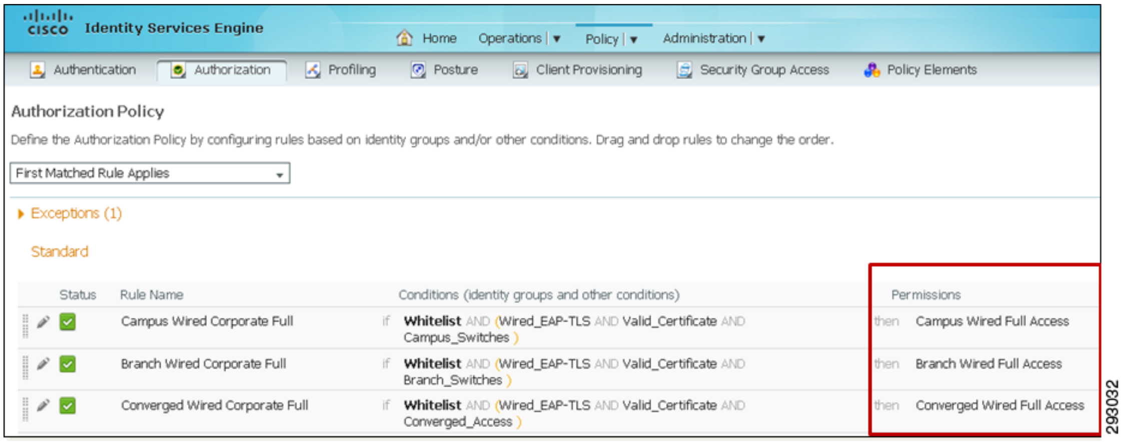


Note Wired assignment of Security Group Tags (SGTs) is not discussed within the design guide. Hence there is no wired policy enforcement via SGTs in Figure 16-17. Future versions of this design guide may address wired SGT assignment.

To differentiate these connections, the ISE relies on Network Device Groups to group Catalyst switches based on their location or device type. This allows a single ISE to enforce policies across different groups of devices. Each Catalyst switch needs to be added to the proper device group by clicking **Administration > Network Resources > Network Devices** and specifying the proper location or device type from the pull-down menu.

Figure 16-18 shows the details of authorization profile configured in ISE for wired devices.

Figure 16-18 Authorization Policies for Wired Full Access



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.

First Matched Rule Applies

Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	Campus Wired Corporate Full	if	**Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches)	then	Campus Wired Full Access
☑	Branch Wired Corporate Full	if	**Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Branch_Switches)	then	Branch Wired Full Access
☑	Converged Wired Corporate Full	if	**Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Converged_Access)	then	Converged Wired Full Access

Looking at the rules in more detail, ISE evaluates the following conditions:

- WhiteList—The endpoint has been added by an IT Administrator to the WhiteList identity group.
- Wired_EAP-TLS—The endpoint connected using EAP-TLS (defined as a compound condition).
- The endpoint has a valid certificate. The Calling-Station-ID matches the MAC address included in the certificate’s Subject Alternative Name (defined as a simple condition).
- The RADIUS authentication originated from a Catalyst switch which was a member of one of the following device groups: Campus_Switches, Branch_Switches, or Converged_Access (defined as a simple condition).

Wired Simple and Compound Conditions

To improve the readability of the authorization policy, simple and compound authorization conditions were defined to group different conditions. These conditions may be reused and modified without changing every authorization rule.

Table 16-6 shows the conditions used in the authorization rules.

Table 16-6 Wired Simple and Compound Conditions

Wired EAP-TLS (Compound)	
Wired_EAP-TLS	Radius:Service-Type Equals Framed Radius:NAS-Port-Type Equals Ethernet Network Access:EapAuthentication Equals EAP-TLS
Check for Valid Certificate (Simple)	
Valid_Certificate	Radius:Calling-Station-ID EQUALS CERTIFICATE:Subject Alternative Name
WLC Location or Device Type (Simple)	
Campus_Switches	DEVICE:Location EQUALS All Locations#Campus_Switches
Branch_Switches	DEVICE:Location EQUALS All Locations#Branch_Switches
Converged_Access	DEVICE:Device Type EQUALS All Device Types#Converged

Permissions for Wired Users

When all conditions in the authorization policy rule match, the rule invokes the proper permission. The permissions can be of different forms, such as an authorization profile or a standard result. In this design guide, for wired access the authorization policy is used as permission to the policy rules match. Table 16-7 explains the permissions used for the full access for wired users.

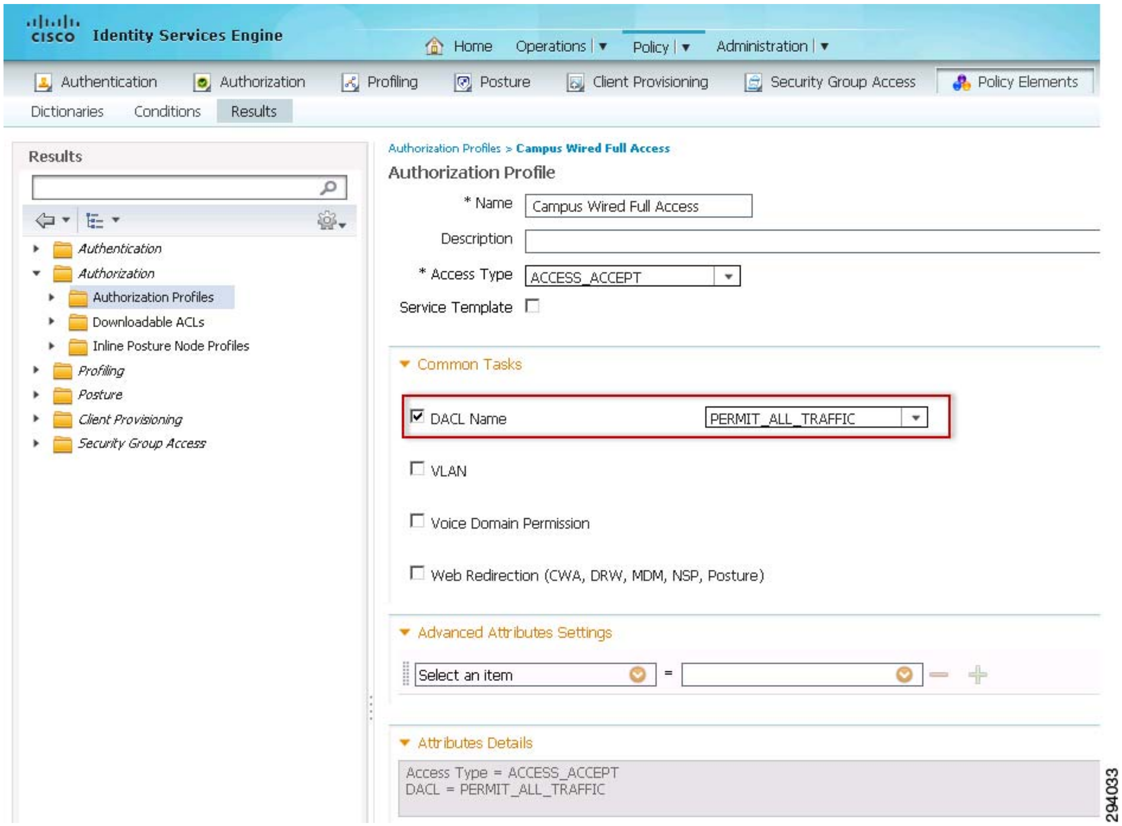
Table 16-7 Permissions Used for Wired Full Access

Permission Name	Permission Type	Purpose
Campus Wired Full Access	Authorization profile	Provides Full Access for 802.1X wired devices connecting from campus location.
Branch Wired Full Access	Authorization profile	To push a VLAN for 802.1X wired devices connecting from a branch location.
Converged Wired Full Access	Authorization profile	To push a named ACL for 802.1X wired devices connecting from either a campus or branch location with Converged Access.

Campus Wired

Figure 16-19 shows how the Campus Wired Full Access authorization profile is defined in ISE.

Figure 16-19 Campus Wired Full Access Authorization Profile



Authorization Profiles > Campus Wired Full Access

Authorization Profile

* Name: Campus Wired Full Access

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

Common Tasks

☑ DACL Name: PERMIT_ALL_TRAFFIC

□ VLAN

□ Voice Domain Permission

□ Web Redirection (CWA, DRW, MDM, NSP, Posture)

Advanced Attributes Settings

Select an item =

Attributes Details

```
Access Type = ACCESS_ACCEPT
DACL = PERMIT_ALL_TRAFFIC
```

Note Cisco Catalyst switches support both downloadable ACLs (DACLs) and named ACLs. This design guide shows and validates the use of downloadable ACLs for access control of wired devices when implementing a non-converged access infrastructure and the use of named ACLs for access control of wired devices when implementing a converged access infrastructure. This is done to show the depth and range of capabilities for access control available on Cisco IOS-based platforms. Note that the same wired policy enforcement for converged access and non-converged access designs can be achieved if the customer desires by simply using either downloadable ACLs (DACLs) or named ACLs for both designs. Both downloadable and named ACLs have advantages and disadvantages, depending upon where they are deployed within the network. ACL Complexity and Considerations in Chapter 5, "Campus and Branch Network Design for BYOD" discusses some of these advantages and disadvantages.

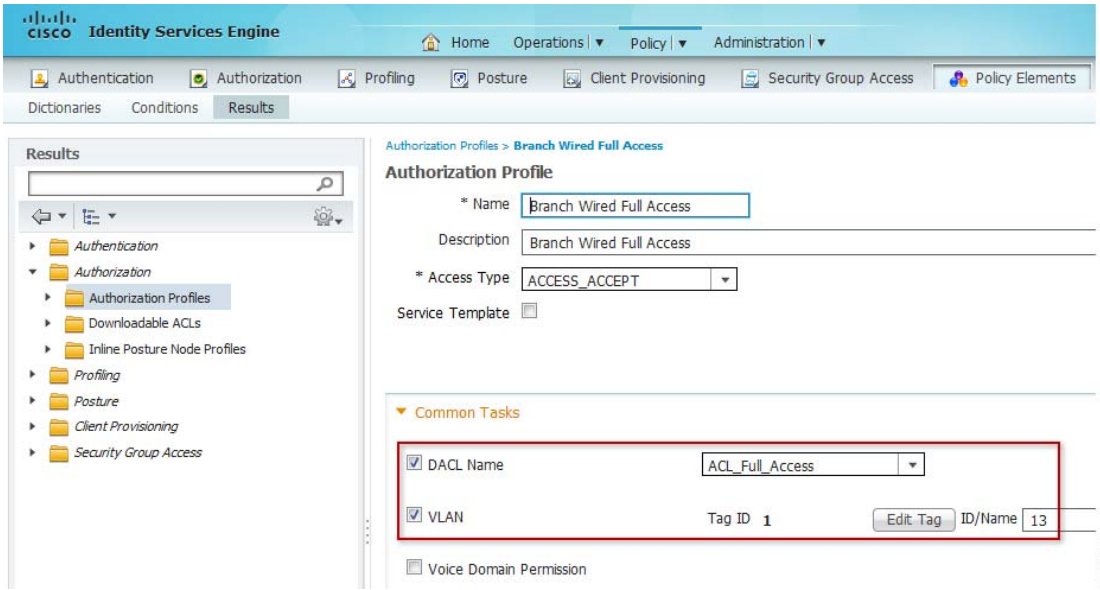
The downloadable ACL (DACL), which allows all IP traffic, overrides the default-ACL configured on the switch port. The default-ACL is used as an additional preventative measure in case the downloadable ACL is not applied to the switch port for some reason.

Note ISE 1.2 has the ability to check the DACL syntax. This feature should be utilized in order to minimize the possibility that the DACL is not applied due to a syntax error.

Branch Wired

Figure 16-20 shows how a similar authorization profile is constructed for devices connected at a branch which does not have a Converged Access infrastructure. The authorization profile pushes VLAN information along with the ACL information.

Figure 16-20 Branch Wired Full Access Authorization Profile



Authorization Profile

* Name: Branch Wired Full Access

Description: Branch Wired Full Access

* Access Type: ACCESS_ACCEPT

Service Template ☐

☑ DACL Name: ACL_Full_Access

☑ VLAN Tag ID 1 ID/Name 13

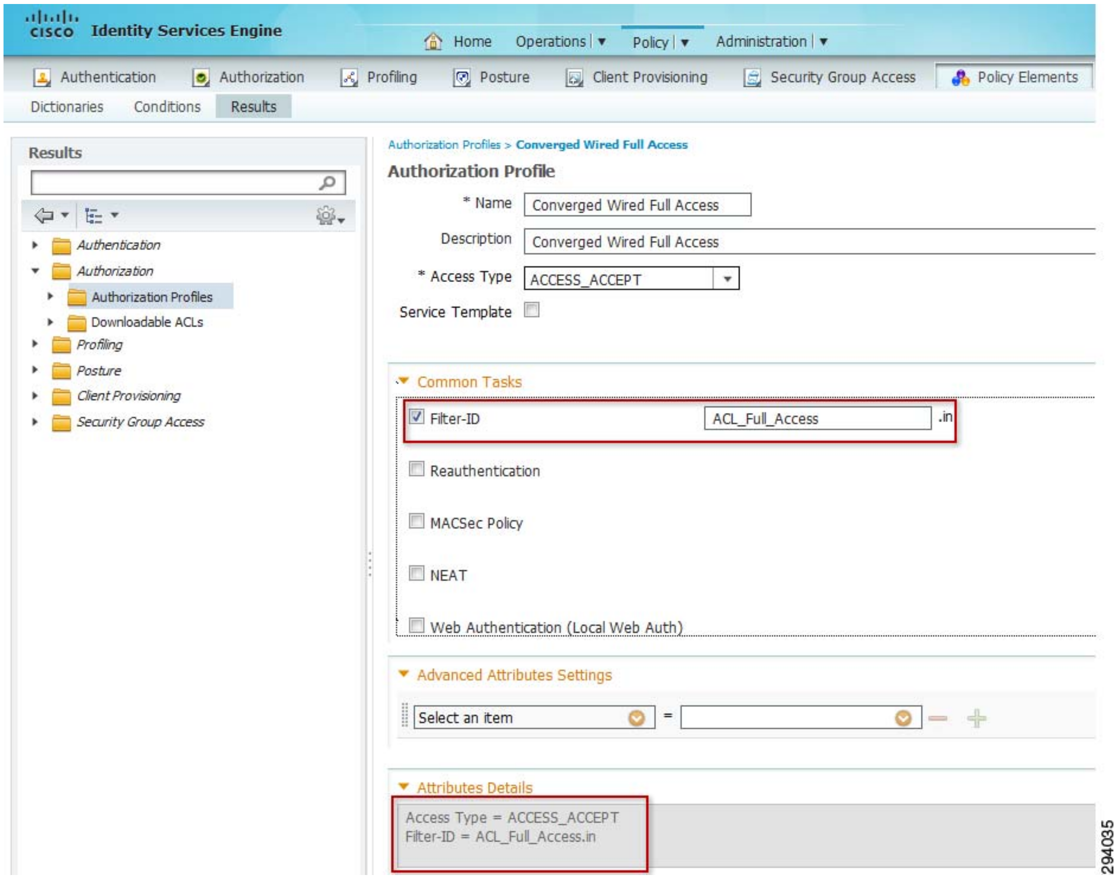
☐ Voice Domain Permission

Once this profile is downloaded to the Catalyst switch, the endpoint gets full access to the network.

Converged Access Branch or Campus

Figure 16-21 shows how the Converged Access Wired Full Access authorization profile is defined in ISE.

Figure 16-21 Converged Wired Full Access Authorization Profile



Authorization Profiles > Converged Wired Full Access

Authorization Profile

* Name: Converged Wired Full Access

Description: Converged Wired Full Access

* Access Type: ACCESS_ACCEPT

Service Template ☐

Common Tasks

☑ Filter-ID ACL_Full_Access .in

☐ Reauthentication

☐ MACSec Policy

☐ NEAT

☐ Web Authentication (Local Web Auth)

Advanced Attributes Settings

Select an item =

Attributes Details

Access Type = ACCESS_ACCEPT
Filter-ID = ACL_Full_Access.in

For the converged access design, a named ACL is implemented, meaning that the ACL must be configured on the Catalyst 3850 switch rather than being downloaded from ISE. Using the RADIUS Filter-ID attribute-value pair, ISE instructs the Catalyst 3850 to apply the ACL_Full_Access ACL. The following configuration example shows the contents of this ACL as defined in the Catalyst 3850 switch.

```
!
ip access-list extended ACL_Full_Access
 permit ip any any
!
```

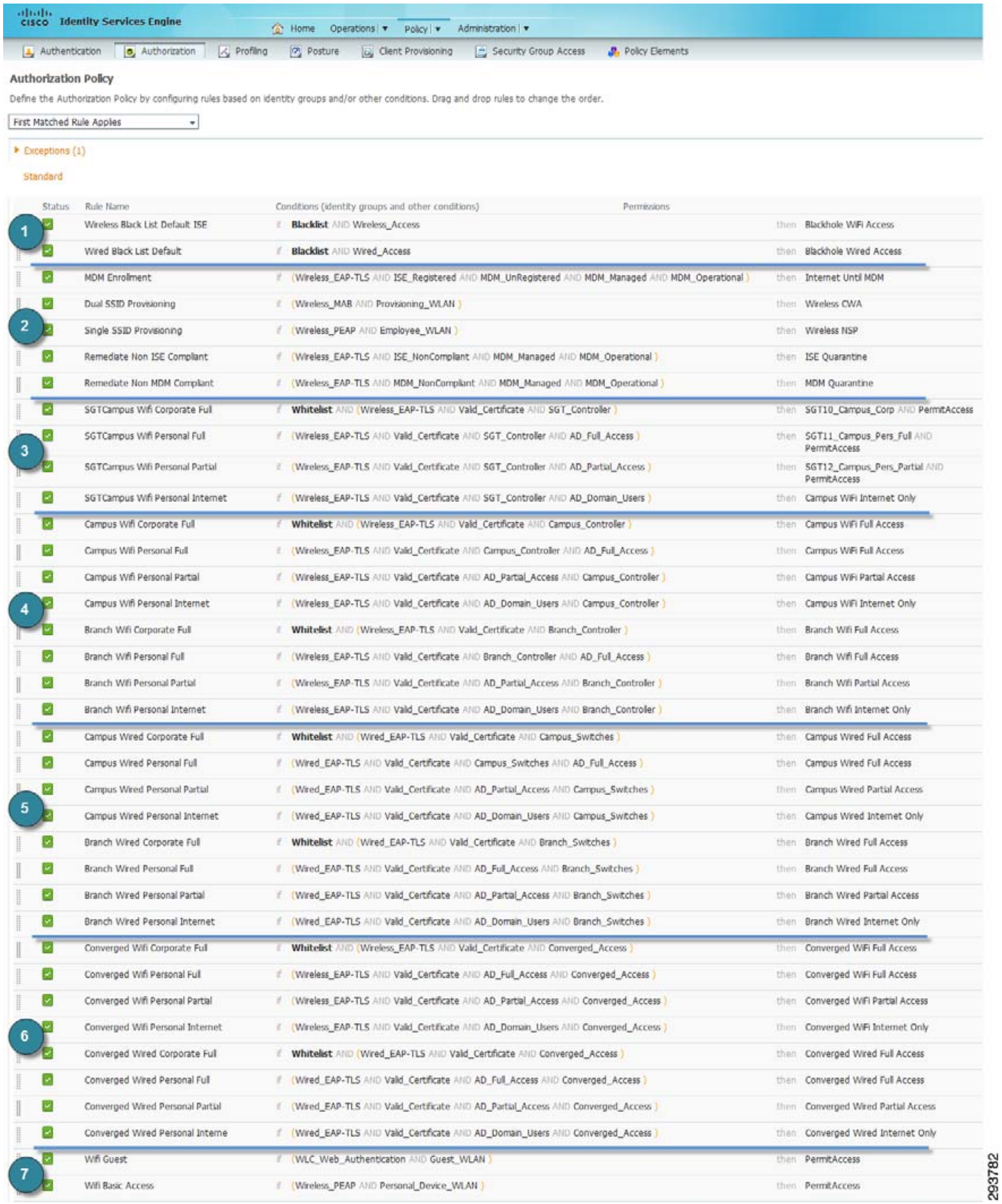
ISE Authorization Policy

For reference purposes, the complete authorization policy used during testing is shown in Figure 16-22. The figure highlights the following sections:

1. Used for blacklisting lost or stolen devices.
2. On-boarding and MDM registration/remediation.
3. Wireless devices connecting from an access point in a SGT_Enabled location.
4. Wireless devices connecting from an access point in the campus or branch locations.
5. Wired devices connecting from a campus or branch locations.

6. Wired and Wireless devices connecting from a converged location.
7. Guest and Basic Access.

Figure 16-22 Complete Authorization Policy



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.

First Matched Rule Applies ▾

▸ Exceptions (1)

Standard

Status	Rule Name	Conditions (identity groups and other conditions)	Permissions
☑	Wireless Black List Default ISE	if **Blacklist** AND Wireless_Access	then Blackhole WiFi Access
☑	Wired Black List Default	if **Blacklist** AND Wired_Access	then Blackhole Wired Access
☑	MDM Enrollment	if (Wireless_EAP-TLS AND ISE_Registered AND MDM_UnRegistered AND MDM_Managed AND MDM_Operational)	then Internet Until MDM
☑	Dual SSID Provisioning	if (Wireless_MAB AND Provisioning_WLAN)	then Wireless CWA
☑	Single SSID Provisioning	if (Wireless_PEAP AND Employee_WLAN)	then Wireless NSP
☑	Remediate Non ISE Compliant	if (Wireless_EAP-TLS AND ISE_NonCompliant AND MDM_Managed AND MDM_Operational)	then ISE Quarantine
☑	Remediate Non MDM Compliant	if (Wireless_EAP-TLS AND MDM_NonCompliant AND MDM_Managed AND MDM_Operational)	then MDM Quarantine
☑	SGTCampus Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller)	then SGT10_Campus_Corp AND PermitAccess
☑	SGTCampus Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Full_Access)	then SGT11_Campus_Pers_Full AND PermitAccess
☑	SGTCampus Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Partial_Access)	then SGT12_Campus_Pers_Partial AND PermitAccess
☑	SGTCampus Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Domain_Users)	then Campus WiFi Internet Only
☑	Campus Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller)	then Campus WiFi Full Access
☑	Campus Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller AND AD_Full_Access)	then Campus WiFi Full Access
☑	Campus Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Controller)	then Campus WiFi Partial Access
☑	Campus Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Controller)	then Campus WiFi Internet Only
☑	Branch Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller)	then Branch Wifi Full Access
☑	Branch Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller AND AD_Full_Access)	then Branch Wifi Full Access
☑	Branch Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Controller)	then Branch Wifi Partial Access
☑	Branch Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Controller)	then Branch Wifi Internet Only
☑	Campus Wired Corporate Full	if **Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches)	then Campus Wired Full Access
☑	Campus Wired Personal Full	if (Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches AND AD_Full_Access)	then Campus Wired Full Access
☑	Campus Wired Personal Partial	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Switches)	then Campus Wired Partial Access
☑	Campus Wired Personal Internet	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Switches)	then Campus Wired Internet Only
☑	Branch Wired Corporate Full	if **Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Branch_Switches)	then Branch Wired Full Access
☑	Branch Wired Personal Full	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Branch_Switches)	then Branch Wired Full Access
☑	Branch Wired Personal Partial	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Switches)	then Branch Wired Partial Access
☑	Branch Wired Personal Internet	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Switches)	then Branch Wired Internet Only
☑	Converged Wifi Corporate Full	if **Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Converged_Access)	then Converged WiFi Full Access
☑	Converged Wifi Personal Full	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then Converged WiFi Full Access
☑	Converged Wifi Personal Partial	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then Converged WiFi Partial Access
☑	Converged Wifi Personal Internet	if (Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then Converged WiFi Internet Only
☑	Converged Wired Corporate Full	if **Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Converged_Access)	then Converged Wired Full Access
☑	Converged Wired Personal Full	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then Converged Wired Full Access
☑	Converged Wired Personal Partial	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then Converged Wired Partial Access
☑	Converged Wired Personal Interne	if (Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then Converged Wired Internet Only
☑	Wifi Guest	if (WLC_Web_Authentication AND Guest_WLAN)	then PermitAccess
☑	Wifi Basic Access	if (Wireless_PEAP AND Personal_Device_WLAN)	then PermitAccess

CHAPTER 17

BYOD Advanced Use Case—Mobile Device Manager Integration

Revised: August 7, 2013

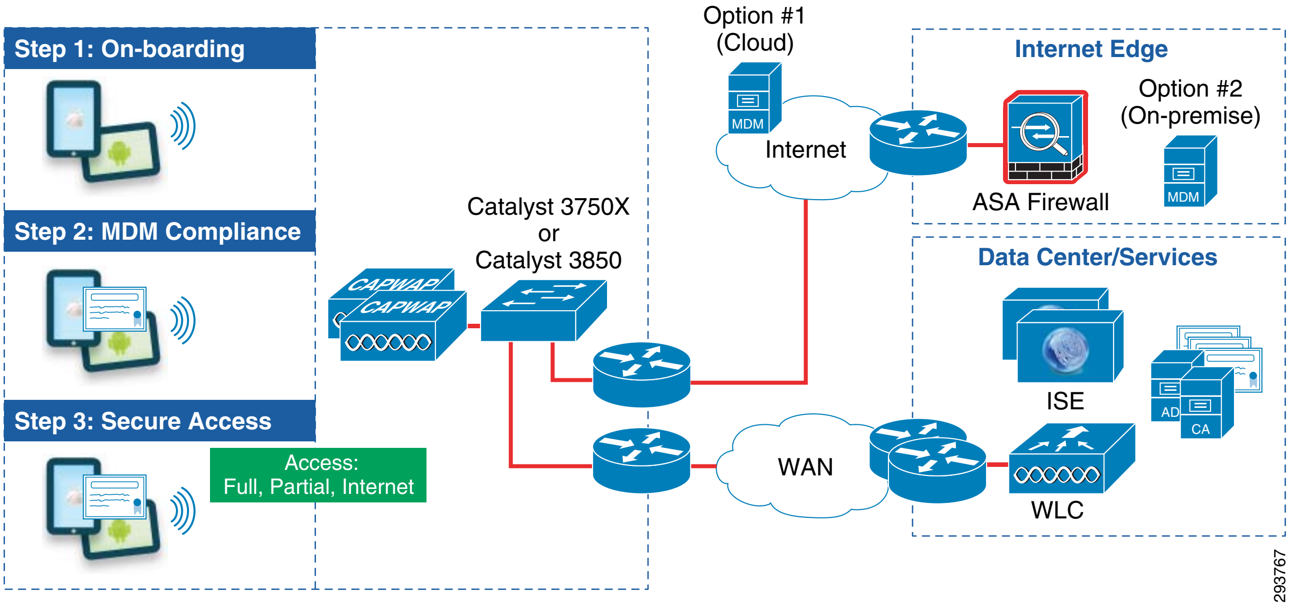
This chapter focuses on getting additional posture information from the integration with third-party Mobile Device Managers (MDMs). While previous chapters focused on on-boarding corporate and personal devices and providing differentiated access, this chapter makes use of more detailed endpoint information to enforce authorization policies.

MDM servers secure, monitor, manage, and support mobile devices to secure and control the use of mobile applications. The network is the only entity that can provide granular access to endpoints based on VLAN assignment, ACLs (named or downloadable [DACL]), SGTs, FlexConnect ACLs, etc. By integrating with third-party MDM servers, the Cisco ISE receives the necessary device attributes to enforce a more granular network access to those endpoints.

Figure 17-1 shows the interoperability between MDMs and the Cisco ISE. Once a device has been on-boarded with ISE, ISE queries the MDM for additional endpoint information. If the endpoint is registered and compliant with MDM policies, the device is granted access, based on other attributes, as described in the previous sections.

Notice that the MDM server can be deployed on-premise or in the cloud.

Figure 17-1 MDM Interoperability



The following steps take place when checking for device compliance:

1. The user connects to an on-boarding SSID and is guided through the registration and on-boarding process with ISE.
2. Once the user has been on-boarded with the proper certificate/profiles, the user connects to the secure Employee SSID.
3. ISE makes an API call to the MDM server. If the device is not registered with the MDM, the user is presented with the appropriate page to proceed to their MDM enrollment page.
4. Once the user completes the enrollment with the MDM server, they return to an enrollment redirect page that includes a continue button. When the user selects the continue option from the page, ISE will issue a Change of Authorization (CoA), forcing the user to re-authenticate. The API should now indicate the user has enrolled with the MDM. The MDM API results are cached by ISE for the duration of the authorization flow.
5. ISE uses the cached MDM information for the specific MAC address to verify the device's posture including its MDM compliance status. If the device is not in compliance with the MDM policies, the user is once again informed and is asked to become compliant.
6. Once the device becomes compliant, the user is authorized to access the network based on the assigned permissions (Full, Partial Access, or Internet Access).
7. ISE can poll the MDM server periodically to get compliance information.

Chapter 13, "Mobile Device Manager Integration for BYOD" provides more details on how to configure the integration between ISE and the MDM.

Supported MDM Functions

Cisco ISE relies on REST API calls to query the external MDM server for additional endpoint information. The communication between ISE and the MDM is mostly unidirectional, where ISE sends different commands to the MDM. Some commands query for device information (model, compliance status, serial number, etc.) while others can invoke an action on the device (Corporate Wipe, Full Wipe, PIN lock, etc.).

The following are some of the functions that ISE performs in conjunction with an MDM server:

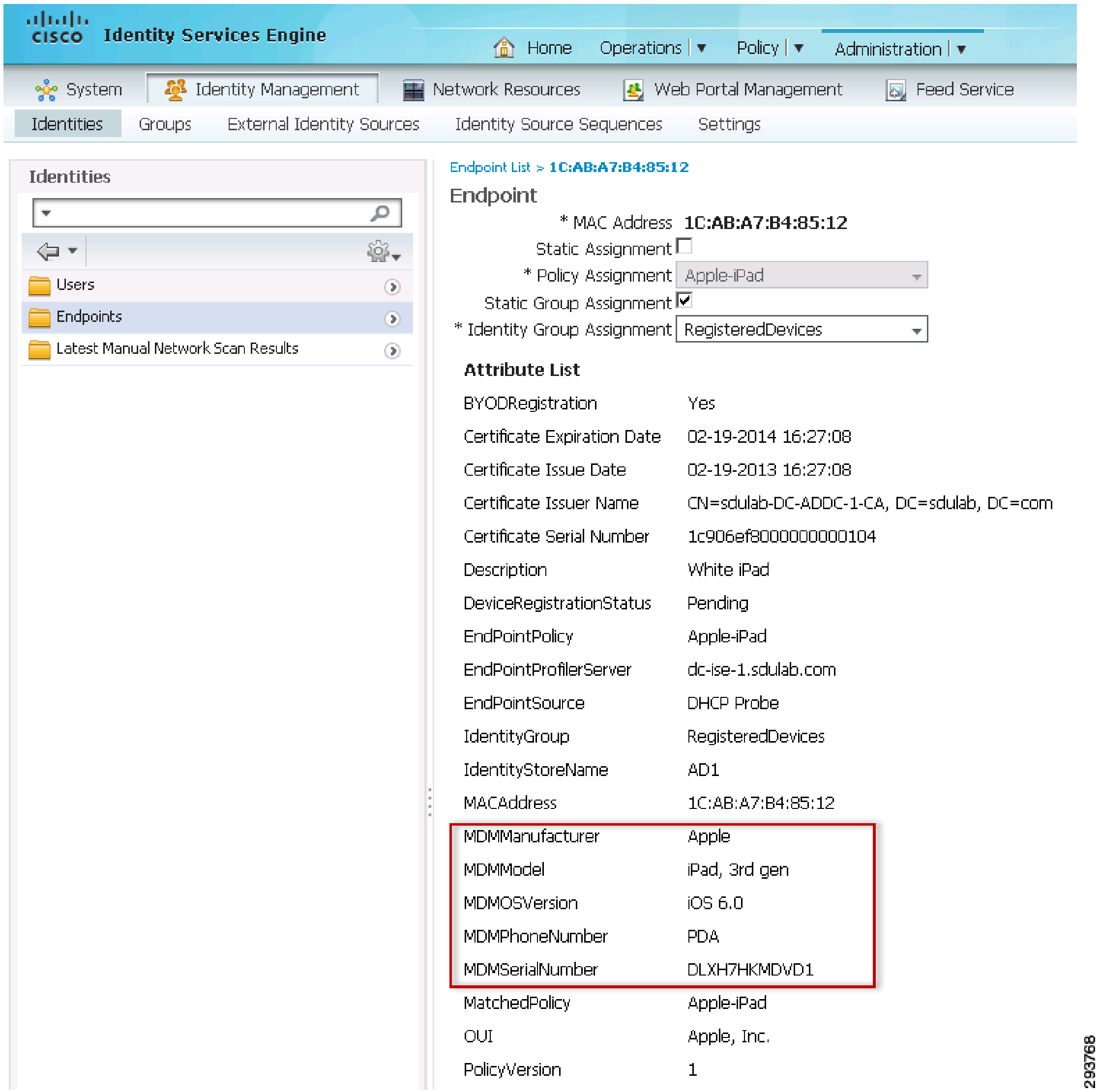
- Device registration—Unregistered endpoints connecting to the network are redirected to a web page hosted on the MDM server to initiate the MDM enrollment process.
- Device remediation—Cisco ISE imposes a captive portal on noncompliant endpoints. The user is redirected to a web page hosted by ISE but populated with device posture information obtained via the MDM API. The page informs the user and what actions to take to become compliant.
- Periodic compliance checks—Cisco ISE polls the MDM server periodically for a list of non-MDM compliant devices. ISE will determine if any device on the list is currently associated with the network and will issue a CoA against those devices.
- Device instructions through the MDM server—Remote actions can be issued for users' devices through the MDM server.

The endpoint database is updated with additional information from the MDM server that cannot be collected using the Cisco ISE Profiler. The following device attributes can be obtained from the MDM:

- MDMManufacturer
- MDMModel
- MDMOSVersion
- MDMPhoneNumber
- MDMSerialNumber
- MDMIMEI

These attributes can be viewed by clicking **Administration > Identity Management > Identities > Endpoints**, as shown in Figure 17-2.

Figure 17-2 MDM Attributes



Endpoint

* MAC Address 1C:AB:A7:B4:85:12

Static Assignment □

* Policy Assignment Apple-iPad

Static Group Assignment ☑

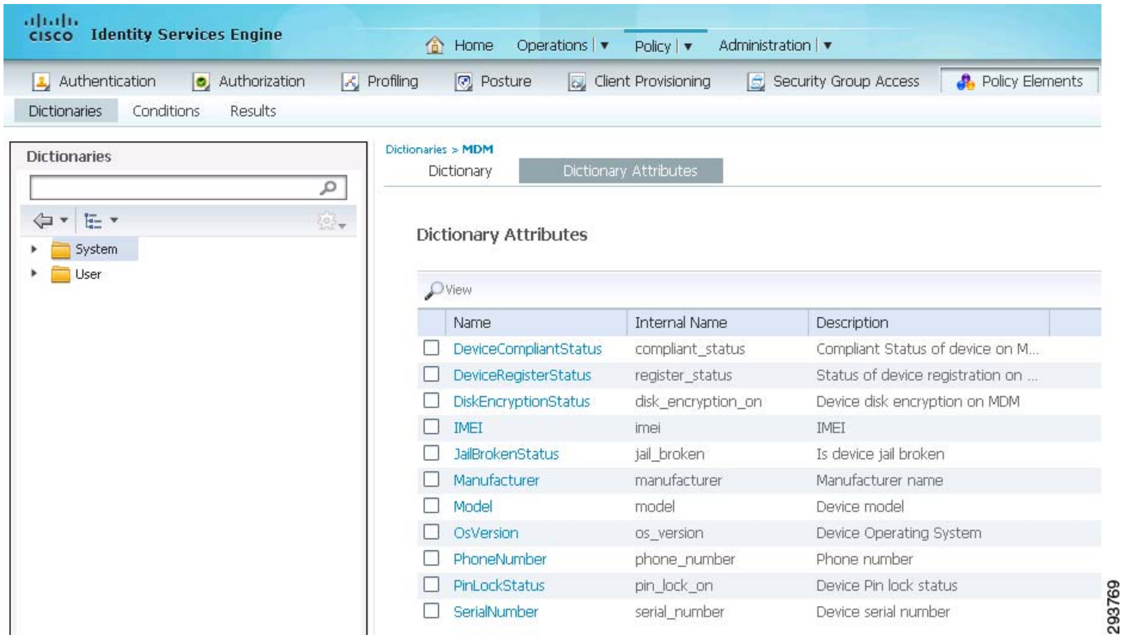
* Identity Group Assignment RegisteredDevices

Attribute List

BYODRegistration	Yes
Certificate Expiration Date	02-19-2014 16:27:08
Certificate Issue Date	02-19-2013 16:27:08
Certificate Issuer Name	CN=sdulab-DC-ADDC-1-CA, DC=sdulab, DC=com
Certificate Serial Number	1c906ef8000000000104
Description	White iPad
DeviceRegistrationStatus	Pending
EndPointPolicy	Apple-iPad
EndPointProfilerServer	dc-ise-1.sdulab.com
EndPointSource	DHCP Probe
IdentityGroup	RegisteredDevices
IdentityStoreName	AD1
MACAddress	1C:AB:A7:B4:85:12
MDMManufacturer	Apple
MDMModel	iPad, 3rd gen
MDMOSVersion	iOS 6.0
MDMPhoneNumber	PDA
MDMSerialNumber	DLXH7HKMDVD1
MatchedPolicy	Apple-iPad
OUI	Apple, Inc.
PolicyVersion	1

The integration with an MDM server allows the Cisco ISE to configure policies based on additional MDM attributes. The dictionary attributes can be found under **Policy > Dictionaries > MDM > Dictionary Attributes**, as shown in Figure 17-3.

Figure 17-3 Dictionary Attributes



Dictionary Attributes

	Name	Internal Name	Description
□	DeviceCompliantStatus	compliant_status	Compliant Status of device on M...
□	DeviceRegisterStatus	register_status	Status of device registration on ...
□	DiskEncryptionStatus	disk_encryption_on	Device disk encryption on MDM
□	IMEI	imei	IMEI
□	JailBrokenStatus	jail_broken	Is device jail broken
□	Manufacturer	manufacturer	Manufacturer name
□	Model	model	Device model
□	OsVersion	os_version	Device Operating System
□	PhoneNumber	phone_number	Phone number
□	PinLockStatus	pin_lock_on	Device Pin lock status
□	SerialNumber	serial_number	Device serial number

Some of these attributes are used in several authorization rules in this design guide.

Integration Process Flow

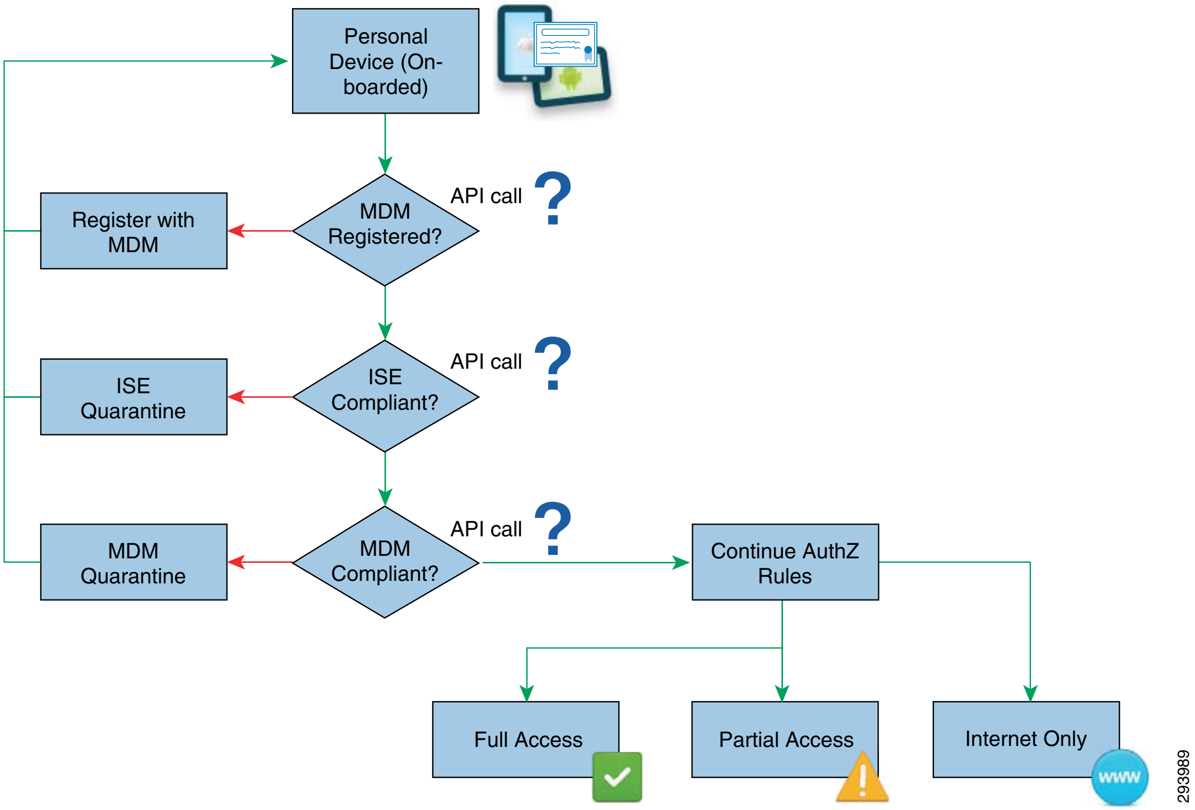
Figure 17-4 shows the integration process between ISE and the MDM:

1. The device has been on-boarded and the user connects to the BYOD_Employee SSID.
2. Cisco ISE makes an API call to the MDM server to verify that the device has been registered with the MDM.
3. If the device is not registered and is required to be registered, the user is asked to enroll with the MDM. This may include installing the appropriate application from the Apple App Store or Google Play.
4. ISE enforces some device attributes before allowing network access. If the device is not ISE Compliant, quarantine the device (explained below).
5. If the device is not compliant with the MDM policies, quarantine the device.

If the user has been on-boarded and is compliant with ISE and MDM policies, allow the proper permissions based on different rules.

Note The previous chapters explained how to grant Full Access, Partial Access and Internet Only access to personal and corporate devices.

Figure 17-4 MDM Compliance Checks



ISE Compliance Check

Once the device has been registered with the MDM, the ISE checks for certain device attributes before allowing access to the network. This can serve as an additional check and the first opportunity to verify some device attributes.

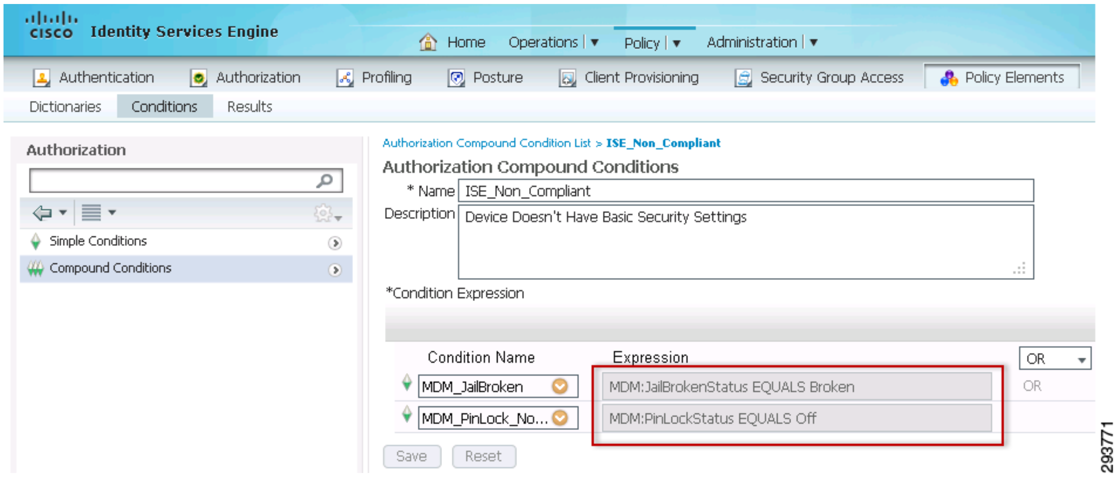
In this design guide, two device attributes were considered as the minimum for devices to obtain access to the network:

- Jailbroken or rooted devices—Not allowed into the network.
- PIN lock enforcement—Devices without a device PIN lock are denied access.

ISE makes the *JailBrokenStatus* and *PinLockStatus* API calls to the MDM to verify these attributes.

A compound condition was defined in the ISE to check for these two attributes. To define this compound condition click **Policy > Policy Elements > Conditions > Compound Conditions**, as shown in Figure 17-5.

Figure 17-5 ISE_Non_Compliant



Authorization Compound Condition List > **ISE_Non_Compliant**

Authorization Compound Conditions

* Name: ISE_Non_Compliant

Description: Device Doesn't Have Basic Security Settings

*Condition Expression

Condition Name	Expression	OR
MDM_JailBroken	MDM:JailBrokenStatus EQUALS Broken	OR
MDM_PinLock_No...	MDM:PinLockStatus EQUALS Off	

Additional dictionary attributes could be added to accommodate the security policies of each organization.

MDM Compliance Check

For devices that have been on-boarded and have met the ISE compliance check, an additional API call is made to the MDM to make sure the device has met all the compliance requirements established by the MDM.

If the device is not fully compliant with the MDM, ISE grants access to the Internet and denies access to all internal resources. When the user tries to access an internal resource, ISE redirects the session to a portal, highlighting the steps required to be completed to meet the MDM compliance rules.

ISE makes the DeviceCompliantStatus API call to the MDM to verify compliance. The MDM establishes what conditions result in a device being non-compliant.

ISE Configuration

Several ISE features play a role in verifying for ISE and MDM compliance before permissions can be applied. Some of them include Logical Profiles, authorization rules, ACLs, and API calls to the MDM to receive endpoint attributes.

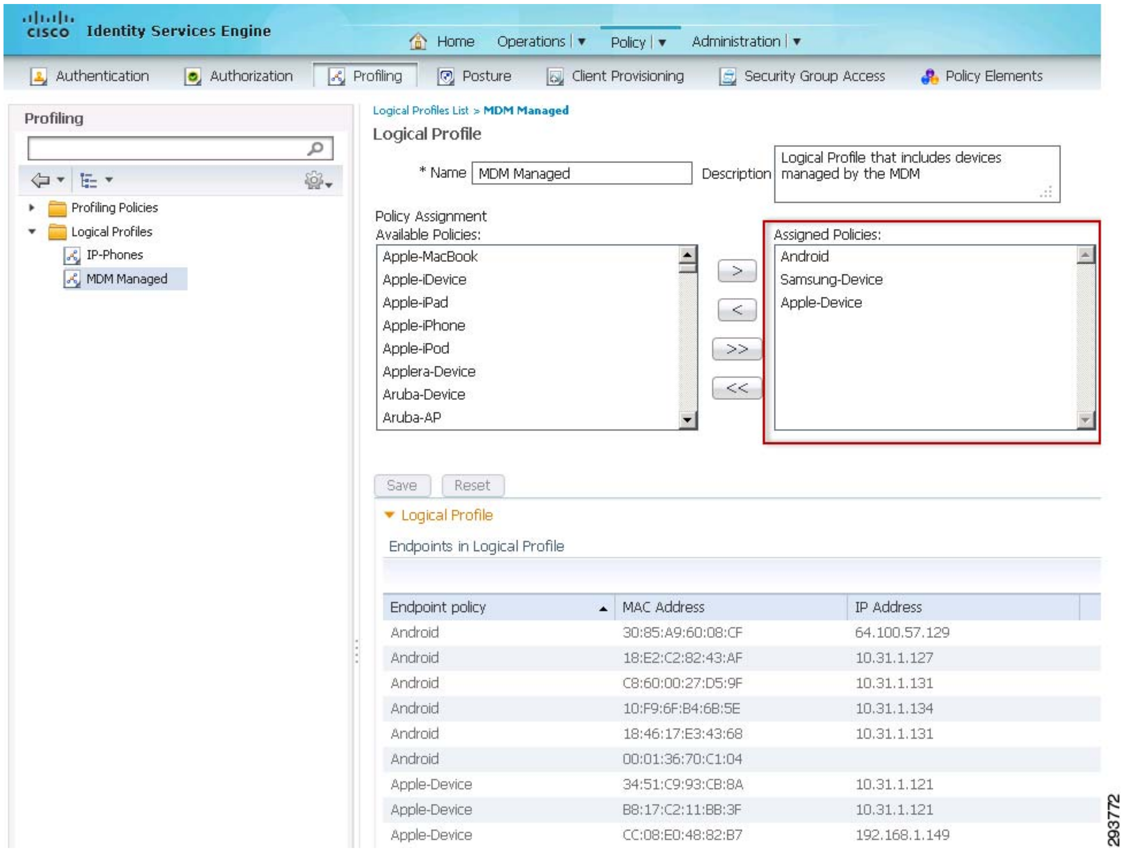
Logical Profile

The profiling service in the Cisco ISE is able to identify devices connecting to the network to grant the appropriate access to endpoints based on their device type. By collecting attributes of endpoints and grouping them according to their profiles, unique policies may be enforced for specific type of devices.

A logical profile is a virtual container of objects that share a common attribute. One example of a logical profile is a set of devices that includes all tablets or all smartphones. A second example is a set of all Android or Apple devices. For the purposes of this design guide, a logical profile was created to include the devices that are managed by the MDM. This allows the administrator to dynamically add or remove devices managed by the MDM.

Figure 17-6 shows the MDM Managed logical profile used to group devices allowed and managed or licensed by the MDM. This logical profile is used when defining the ISE authorization policy and includes devices profiled as Android, Samsung-Device, and Apple-Device. To configure this logical profile on the ISE, click **Policy > Profiling > Logical Profiles**.

Figure 17-6 MDM Managed Logical Profile



Logical Profile

* Name: MDM Managed

Description: Logical Profile that includes devices managed by the MDM

Policy Assignment

Available Policies:
Apple-MacBook
Apple-iDevice
Apple-iPad
Apple-iPhone
Apple-iPod
Applera-Device
Aruba-Device
Aruba-AP

Assigned Policies:
Android
Samsung-Device
Apple-Device

Logical Profile

Endpoints in Logical Profile

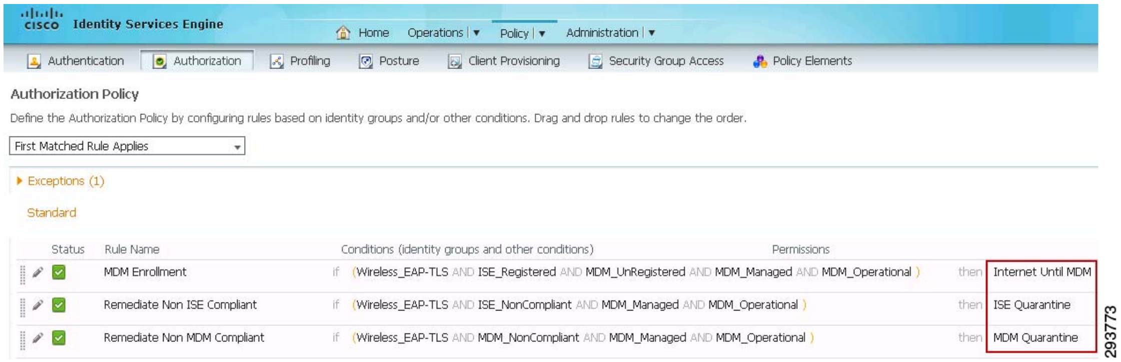
Endpoint policy	MAC Address	IP Address
Android	30:85:A9:60:08:CF	64.100.57.129
Android	18:E2:C2:82:43:AF	10.31.1.127
Android	C8:60:00:27:D5:9F	10.31.1.131
Android	10:F9:6F:B4:6B:5E	10.31.1.134
Android	18:46:17:E3:43:68	10.31.1.131
Android	00:01:36:70:C1:04	
Apple-Device	34:51:C9:93:CB:8A	10.31.1.121
Apple-Device	B8:17:C2:11:BB:3F	10.31.1.121
Apple-Device	CC:08:E0:48:82:B7	192.168.1.149

The logical profile could be easily expanded to include other devices supported and managed by the MDM without modifying the ISE authorization policy.

Authorization Policy

Figure 17-7 shows the ISE authorization rules used to enforce MDM and ISE compliance. These authorization rules are executed after the user has on-boarded the mobile device and before additional access (e.g., Full, Partial, Internet) to the network is granted.

Figure 17-7 MDM Compliance Authorization Rules



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.

First Matched Rule Applies

▸ Exceptions (1)

Standard

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	MDM Enrollment	if	(Wireless_EAP-TLS AND ISE_Registered AND MDM_UnRegistered AND MDM_Managed AND MDM_Operational)	then	Internet Until MDM
☑	Remediate Non ISE Compliant	if	(Wireless_EAP-TLS AND ISE_NonCompliant AND MDM_Managed AND MDM_Operational)	then	ISE Quarantine
☑	Remediate Non MDM Compliant	if	(Wireless_EAP-TLS AND MDM_NonCompliant AND MDM_Managed AND MDM_Operational)	then	MDM Quarantine

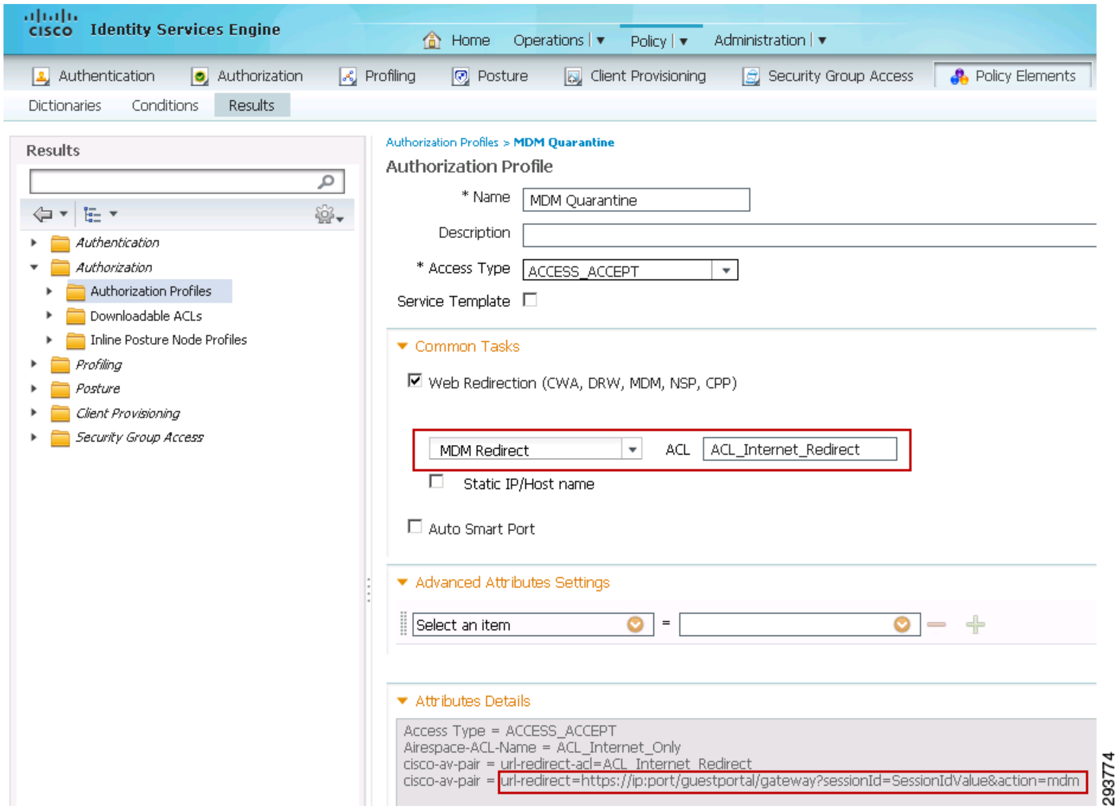
MDM Enrollment Rule

This rule matches when the following conditions are met:

- The endpoint connected via a wireless 802.1X SSID.
- Logical Profile equals MDM Managed—The device is managed and supported by the MDM.
- The device has gone through the on-boarding process and registered with ISE.
- The device has **not** registered with the MDM.

If these conditions match, the *Internet Until MDM* authorization profile is used. This profile is configured to redirect nonregistered devices to the redirect URL highlighted in Figure 17-8.

Figure 17-8 Internet Until MDM



* Name: MDM Quarantine

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

☑ Web Redirection (CWA, DRW, MDM, NSP, CPP)

MDM Redirect ACL ACL_Internet_Redirect

□ Static IP/Host name

□ Auto Smart Port

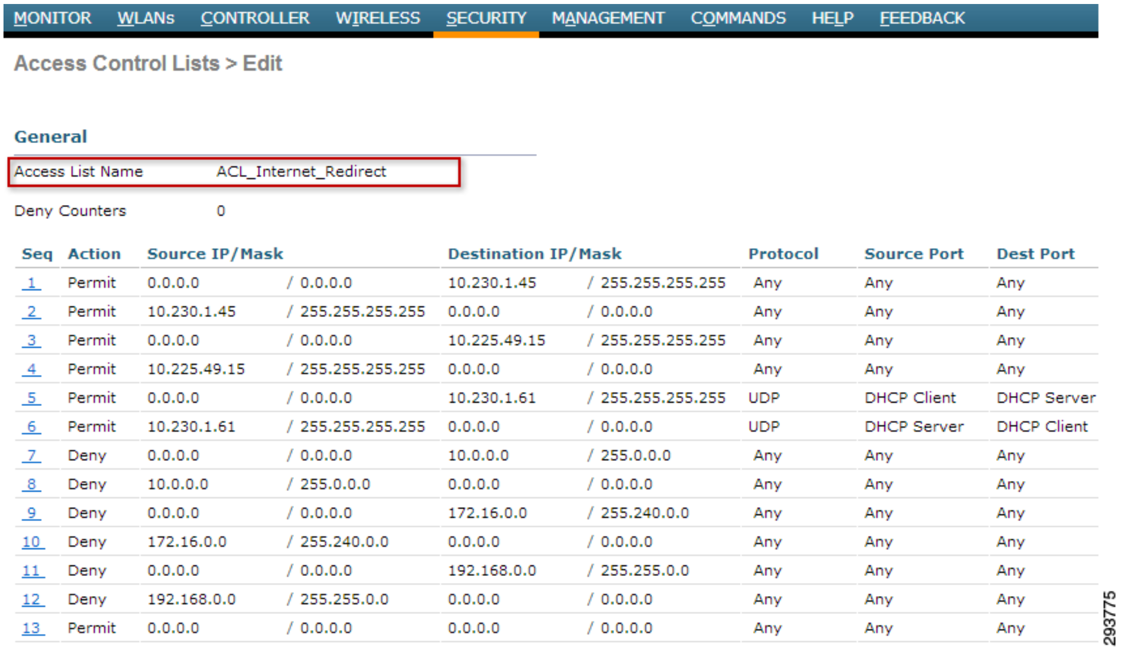
```
Access Type = ACCESS_ACCEPT
Airespace-ACL-Name = ACL_Internet_Only
cisco-av-pair = url-redirect-acl=ACL_Internet_Redirect
cisco-av-pair = url-redirect=https://ip:port/guestportal/gateway?sessionId=SessionIdValue&action=mdm
```

The authorization profile relies on two named ACLs previously defined in the Wireless LAN Controller: ACL_Internet_Redirect and ACL_Internet_Only. ACL_Internet_Redirect is shown as being applied to the MDM Redirect setting in the figure above. ACL_Internet_Only is shown as being sent to the wireless controller via the Radius:Airespace-ACL-Name attribute value (AV) pair in Figure 17-8. The behavior of the two ACLs is slightly different between CUWN wireless controllers, such as the CT5508 and Flex 7500, and IOS XE based controllers, such as the CT5760 and Catalyst 3850.

Note Within this document, wireless LAN Controller refers to either a standalone appliance such as the Cisco CT5508, Flex 7500, or CT5760 wireless controllers or to wireless controller functionality integrated within the Catalyst 3850 Series switch.

For CUWN wireless controllers, ACL_Internet_Redirect functions as both the ACL which controls web redirection, as well as the ACL which controls what the wireless client is allowed to access on the network. ACL_Internet_Only serves simply as a extra security configuration. CUWN wireless controllers do not make use of this ACL when URL redirection is specified. For CUWN wireless controllers the ACL_Internet_Redirect ACL shown in Figure 17-9 can be the same as the ACL_Internet_Only ACL discussed in the previous chapters.

Figure 17-9 ACL_Internet_Redirect



Access Control Lists > Edit

General

Access List Name ACL_Internet_Redirect

Deny Counters 0

Seq	Action	Source IP/Mask		Destination IP/Mask		Protocol	Source Port	Dest Port
1	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.45	/ 255.255.255.255	Any	Any	Any
2	Permit	10.230.1.45	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
3	Permit	0.0.0.0	/ 0.0.0.0	10.225.49.15	/ 255.255.255.255	Any	Any	Any
4	Permit	10.225.49.15	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
5	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.61	/ 255.255.255.255	UDP	DHCP Client	DHCP Server
6	Permit	10.230.1.61	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	UDP	DHCP Server	DHCP Client
7	Deny	0.0.0.0	/ 0.0.0.0	10.0.0.0	/ 255.0.0.0	Any	Any	Any
8	Deny	10.0.0.0	/ 255.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
9	Deny	0.0.0.0	/ 0.0.0.0	172.16.0.0	/ 255.240.0.0	Any	Any	Any
10	Deny	172.16.0.0	/ 255.240.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
11	Deny	0.0.0.0	/ 0.0.0.0	192.168.0.0	/ 255.255.0.0	Any	Any	Any
12	Deny	192.168.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
13	Permit	0.0.0.0	/ 0.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any

The ACL specifies the following access:

- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the DHCP server (10.230.1.61).
- Deny IP access to and from internal network address space (10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16).
- Allow access to and from all other subnets (Internet access).

.For Cisco IOS XE based wireless controllers, ACL_Internet_Redirect functions strictly as the ACL which controls web redirection. ACL_Internet_Only functions as the ACL which controls what the wireless client is allowed to access on the network. Hence IOS XE based wireless controllers make use of both ACLs when URL redirection is specified. An example of the ACL_Internet_Redirect ACL for Cisco IOS XE based wireless controllers is shown in Example 17-1.

Example 17-1 Internet Redirect ACL for IOS XE Based Controllers

```
!
ip access-list extended ACL_Internet_Redirect
 deny   udp any eq bootpc any eq bootps
 deny   ip any host 10.230.1.45
 deny   ip any host 10.225.49.15
 permit ip any 10.0.0.0 0.255.255.255
 permit ip any 172.16.0.0 0.15.255.255
 permit ip any 192.168.0.0 0.0.255.255
 deny   ip any any
!
```

The above ACL specifies the following access:

- Deny (do not redirect) DHCP access (bootpc and bootps).
- Deny (do not redirect) IP access to and from the DNS server (10.230.1.45).

- Deny (do not redirect) IP access to and from the ISE server (10.225.49.15).
- Allow (redirect) IP access to and from the rest of the internal network IP address space (10.0.0.0 /8, 172.16.0.0 /12, 192.168.0.0 /16).
- Deny (do not redirect) all other access to the Internet.

An example of the ACL_Internet_Only ACL for Cisco IOS XE based wireless controllers is shown in Example 17-2.

Example 17-2 Access ACL for IOS XE Based Controllers

```
!
ip access-list extended ACL_Internet_Only
 permit udp any eq bootpc any eq bootps
 permit ip any host 10.230.1.45
 permit ip any host 10.225.49.15
 deny   ip any 10.0.0.0 0.255.255.255
 deny   ip any 172.16.0.0 0.15.255.255
 deny   ip any 192.168.0.0 0.0.255.255
 permit ip any any
!
```

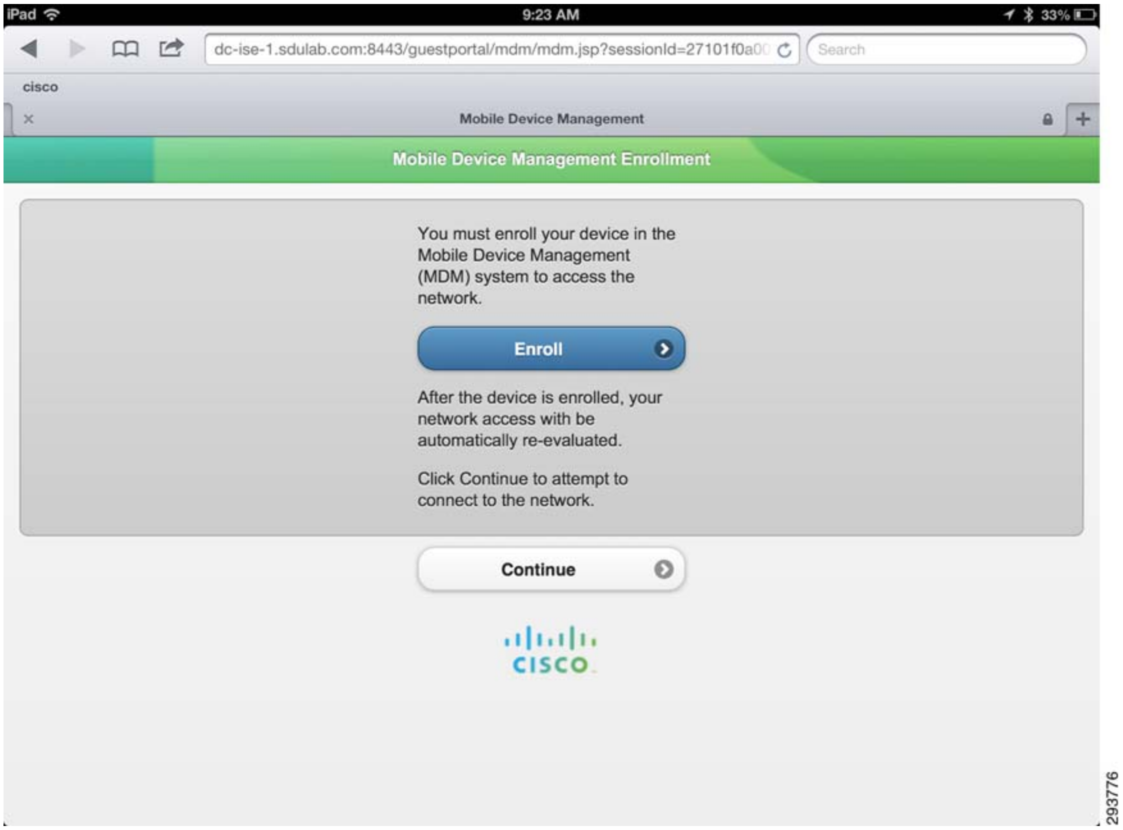
The above access-list specifies the following access:

- Allow DHCP access (bootpc and bootps).
- Allow IP access to and from the DNS server (1.230.1.45).
- Allow IP access to and from the ISE server (1.225.49.15).
- Deny IP access to and from the rest of the internal network IP address space (10.0.0.0 /8, 172.16.0.0 /12, 192.168.0.0 /16).
- Allow access to all other addresses (Internet addresses).

Note The access list shown in Example 17-2 is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

The first time the user tries to browse an internal resource, the session is redirected to a page similar to the one in Figure 17-10 providing a link to register with the appropriate MDM.

Figure 17-10 Register with MDM



iPad
9:23 AM
33%
dc-ise-1.sdulab.com:8443/guestportal/mdm/mdm.jsp?sessionId=27101f0a0
Search
cisco
Mobile Device Management
Mobile Device Management Enrollment

You must enroll your device in the Mobile Device Management (MDM) system to access the network.

After the device is enrolled, your network access with be automatically re-evaluated.

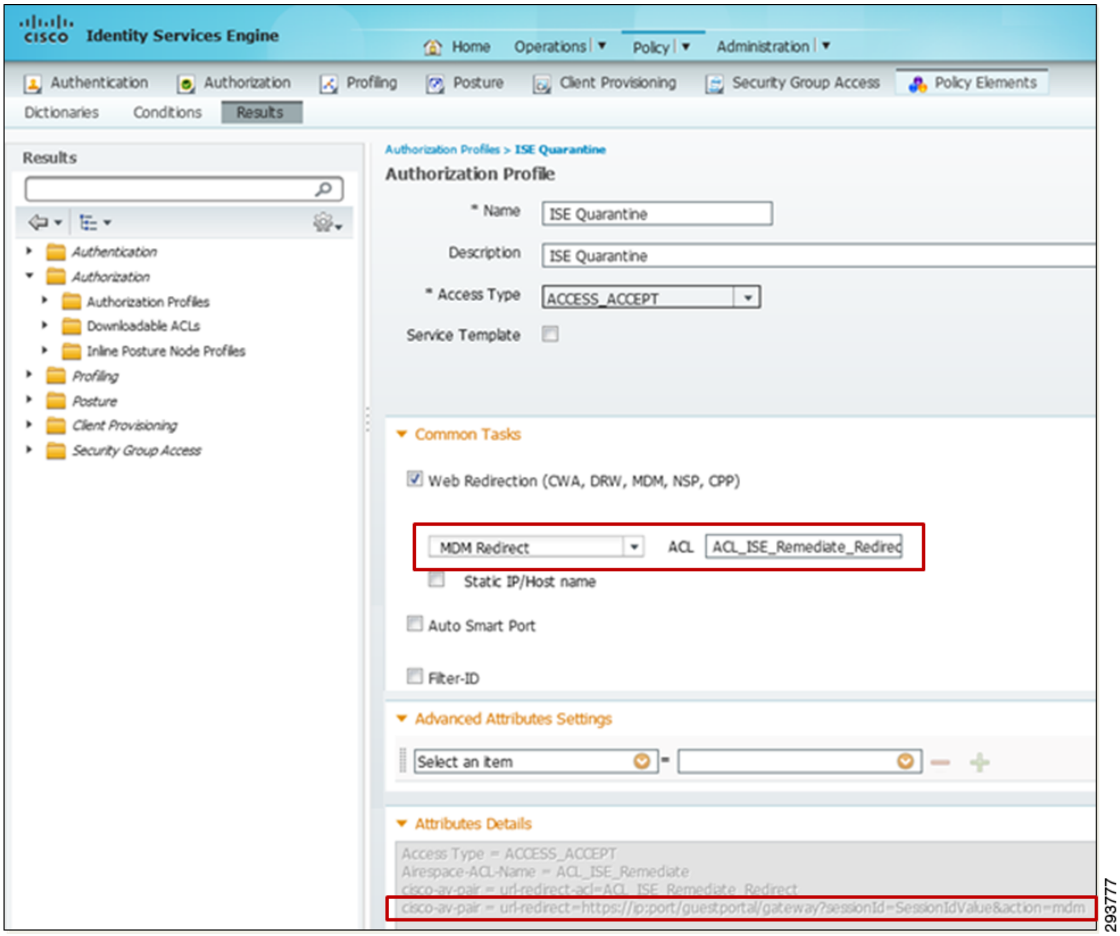
Click Continue to attempt to connect to the network.

Remediate Non-ISE Compliant Rule

This rule matches when the following conditions are met:

- The connection originated using EAP-TLS authentication (defined as a compound condition, see below).
- The device does not comply with ISE requirements. The ISE_Non_Compliant compound condition is highlighted in Figure 17-5.
- Logical Profile equals MDM Managed—The device is managed and supported by the MDM and is shown in Figure 17-6.
- If these conditions match, the ISE Quarantine authorization profile is used. This profile is configured to redirect nonregistered devices to the redirect URL highlighted in Figure 17-11.

Figure 17-11 ISE Quarantine Authorization Profile



* Name: ISE Quarantine

Description: ISE Quarantine

* Access Type: ACCESS_ACCEPT

Service Template □

☑ Web Redirection (CWA, DRW, MDM, NSP, CPP)

MDM Redirect ACL ACL_ISE_Remediate_Redirec

□ Static IP/Host name

□ Auto Smart Port

□ Filter-ID

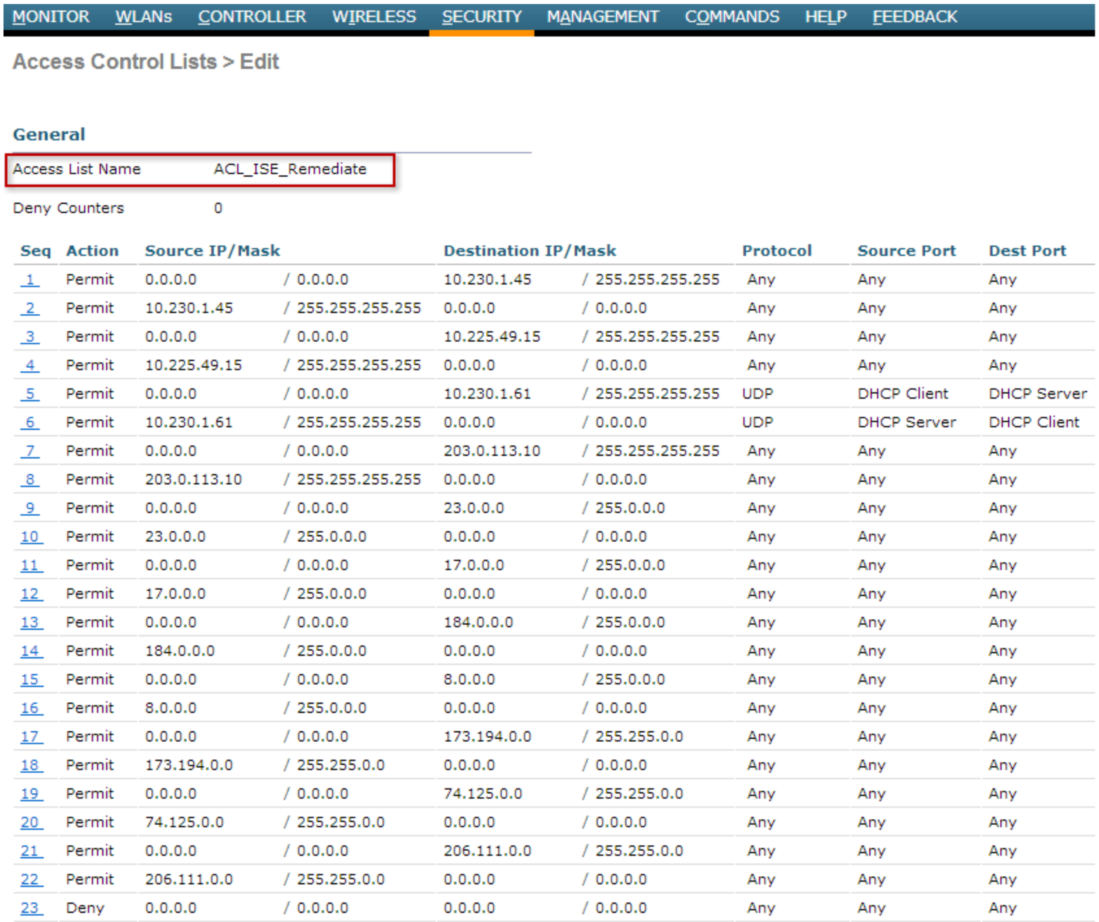
```
Access Type = ACCESS_ACCEPT
Airespace-ACL-Name = ACL_ISE_Remediate
cisco-av-pair = url-redirect-acl=ACL_ISE_Remediate_Redirect
cisco-av-pair = url-redirect=https://ip:port/guestportal/gateway?sessionId=SessionIdValue&action=mdm
```

The authorization profile relies on two named ACLs, previously defined in the Wireless LAN Controller: ACL_ISE_Remediate_Redirect and ACL_ISE_Remediate. ACL_ISE_Remediate_Redirect is shown as being applied to the MDM Redirect setting in Figure 17-11. ACL_ISE_Remediate is shown as being sent to the wireless controller via the Radius:Airespace-ACL-Name attribute value (AV) pair in Figure 17-11. The behavior of the two ACLs is slightly different between CUWN wireless controllers, such as the CT5508 and Flex 7500, and IOS XE based controllers such as the CT5760 and Catalyst 3850.

For CUWN wireless controllers, ACL_ISE_Remediate_Redirect functions as both the ACL which controls web redirection, as well as the ACL which controls what the wireless client is allowed to access on the network. ACL_ISE_Remediate serves simply as a extra security configuration. CUWN wireless controllers do not make use of this ACL when URL redirection is specified.

For CUWN wireless controllers the ACL_ISE_Remediate and ACL_ISE_Remediate_Redirect ACLs can be the same. An example of the ACL_ISE_Remediate ACL is shown in Figure 17-12.

Figure 17-12 ACL_ISE_Remediate



Access Control Lists > Edit

General

Access List Name ACL_ISE_Remediate

Deny Counters 0

Seq	Action	Source IP/Mask		Destination IP/Mask		Protocol	Source Port	Dest Port
1	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.45	/ 255.255.255.255	Any	Any	Any
2	Permit	10.230.1.45	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
3	Permit	0.0.0.0	/ 0.0.0.0	10.225.49.15	/ 255.255.255.255	Any	Any	Any
4	Permit	10.225.49.15	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
5	Permit	0.0.0.0	/ 0.0.0.0	10.230.1.61	/ 255.255.255.255	UDP	DHCP Client	DHCP Server
6	Permit	10.230.1.61	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	UDP	DHCP Server	DHCP Client
7	Permit	0.0.0.0	/ 0.0.0.0	203.0.113.10	/ 255.255.255.255	Any	Any	Any
8	Permit	203.0.113.10	/ 255.255.255.255	0.0.0.0	/ 0.0.0.0	Any	Any	Any
9	Permit	0.0.0.0	/ 0.0.0.0	23.0.0.0	/ 255.0.0.0	Any	Any	Any
10	Permit	23.0.0.0	/ 255.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
11	Permit	0.0.0.0	/ 0.0.0.0	17.0.0.0	/ 255.0.0.0	Any	Any	Any
12	Permit	17.0.0.0	/ 255.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
13	Permit	0.0.0.0	/ 0.0.0.0	184.0.0.0	/ 255.0.0.0	Any	Any	Any
14	Permit	184.0.0.0	/ 255.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
15	Permit	0.0.0.0	/ 0.0.0.0	8.0.0.0	/ 255.0.0.0	Any	Any	Any
16	Permit	8.0.0.0	/ 255.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
17	Permit	0.0.0.0	/ 0.0.0.0	173.194.0.0	/ 255.255.0.0	Any	Any	Any
18	Permit	173.194.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
19	Permit	0.0.0.0	/ 0.0.0.0	74.125.0.0	/ 255.255.0.0	Any	Any	Any
20	Permit	74.125.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
21	Permit	0.0.0.0	/ 0.0.0.0	206.111.0.0	/ 255.255.0.0	Any	Any	Any
22	Permit	206.111.0.0	/ 255.255.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any
23	Deny	0.0.0.0	/ 0.0.0.0	0.0.0.0	/ 0.0.0.0	Any	Any	Any

293778

The ACL specifies the following access:

- Allow IP access to and from the DNS server (10.230.1.45).
- Allow IP access to and from the ISE Server (10.225.49.15).
- Allow IP access to and from the DHCP server (10.230.1.61).
- Allow IP access to and from the MDM server (203.0.113.10).
- Allow IP access to Apple Push Notification Server (23.0.0.0 /8 and 17.0.0.0 /8).
- Allow IP access to Google Cloud Messaging (184.0.0.0 /8, 8.0.0.0 /8, 173.194.0.0 /16, 74.125.0.0 /16, 206.111.0.0 /16).
- Deny IP access (redirect) to all other IP addresses.

For Cisco IOS XE based wireless controllers, ACL_Internet_Redirect functions strictly as the ACL which controls web redirection. ACL_Internet_Only functions as the ACL which controls what the wireless client is allowed to access on the network. Hence IOS XE based wireless controllers make use of both ACLs when URL redirection is specified. An example of the ACL_Internet_Redirect ACL for Cisco IOS XE based wireless controllers is shown in Example 17-3.

Example 17-3 Remediate Redirect ACL for IOS XE Controllers

```
!
```

```
ip access-list extended ACL_ISE_Remediate_Redirect
 deny   udp any eq bootpc any eq bootps
 deny   ip any host 1.230.1.45
 deny   ip any host 1.225.49.15
 deny   ip any host 1.230.1.76
 deny   ip any 63.128.76.0 0.0.0.255
 deny   ip any 23.0.0.0 0.255.255.255
 deny   ip any 17.0.0.0 0.255.255.255
 deny   ip any 184.0.0.0 0.255.255.255
 deny   ip any 8.0.0.0 0.255.255.255
 deny   ip any 74.125.0.0 0.0.255.255
 deny   ip any 173.194.0.0 0.0.255.255
 deny   ip any 206.111.0.0 0.0.255.255
 deny   ip any host 1.225.100.10
 permit ip any any
!
```

The above ACL specifies the following access:

- Deny (do not redirect) DHCP traffic.
- Deny IP access (do not redirect) to and from the DNS server (1.230.1.45).
- Deny IP access (do not redirect) to and from the ISE server (1.225.42.15).
- Deny IP access (do not redirect) to and from MDM servers (host 1.230.1.76 and subnet 63.128.76.0 /24).
- Deny IP access (do not redirect) to Apple Push Notification Server (23.0.0.0 /8 and 17.0.0.0 /8).
- Deny IP access (do not redirect) to Google Cloud Messaging (184.0.0.0 /8, 8.0.0.0 /8, 74.125.0.0 /16, 173.194.0.0 /16, 206.111.0.0 /16).
- Permit IP access (redirect) traffic to all other IP addresses.

An example of the ACL_ISE_Remediate ACL for Cisco IOS XE based wireless controllers is shown in Example 17-4.

Example 17-4 Remediate Access ACL for Cisco IOS XE Controller

```
!
ip access-list extended ACL_ISE_Remediate
 permit udp any eq bootpc any eq bootps
 permit ip any host 1.230.1.45
 permit ip any host 1.225.49.15
 permit ip any host 1.230.1.76
 permit ip any 63.128.76.0 0.0.0.255
 permit ip any 23.0.0.0 0.255.255.255
 permit ip any 17.0.0.0 0.255.255.255
 permit ip any 184.0.0.0 0.255.255.255
 permit ip any 8.0.0.0 0.255.255.255
 permit ip any 74.125.0.0 0.0.255.255
 permit ip any 173.194.0.0 0.0.255.255
 permit ip any 206.111.0.0 0.0.255.255
 deny   ip any any
!
```

The above access-list specifies the following access:

- Allow DHCP traffic.
- Allow IP access to and from the DNS server (1.230.1.45).
- Allow IP access to and from the ISE server (1.225.42.15).
- Allow IP access to and from MDM servers (host 1.230.1.76 and subnet 63.128.76.0 /8).
- Allow IP access to Apple Push Notification Server (23.0.0.0 /8 and 17.0.0.0 /8).

- Allow IP access to Google Cloud Messaging (184.0.0.0 /8, 8.0.0.0 /8, 74.125.0.0 /16, 173.194.0.0 /16, 206.111.0.0 /16).
- Permit IP access to all other IP addresses.

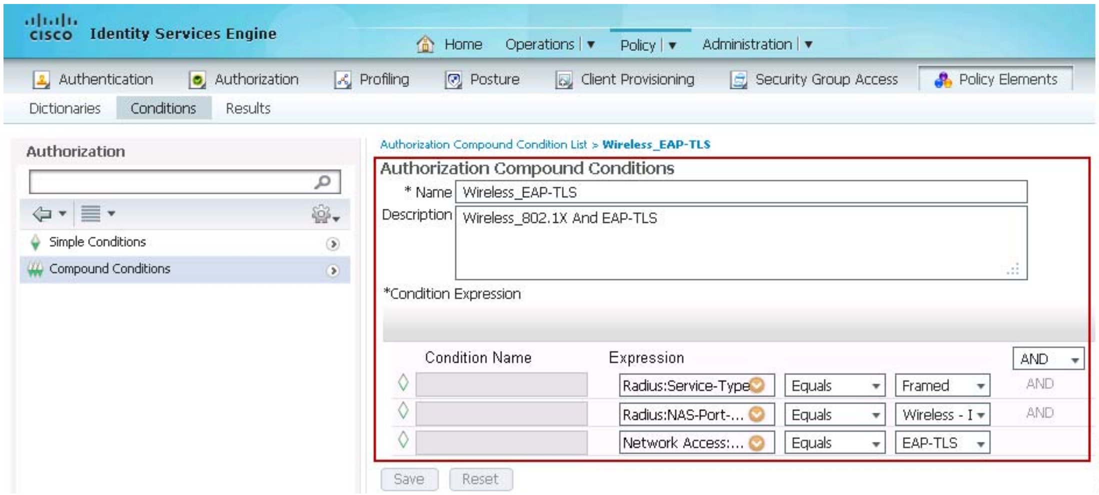
Note The access list shown in Example 17-4 is generic and not intended to work for every organization. An ACL should be more specific and only allow access to specific IP addresses and protocols in the required direction. A common practice is to make the ACLs as detailed as possible and to define every entry down to the port level.

The Wireless_EAP-TLS compound condition checks for the following conditions:

- Radius:Service-Type Equals Framed
- Radius:NAS-Port-Type Equals Wireless - IEEE 802.11
- Network Access:EapAuthentication Equals EAP-TLS

To define this compound condition, click **Policy > Conditions > Authorization > Compound Conditions**. Figure 17-13 shows how the Wireless_EAP-TLS condition combines several conditions into one.

Figure 17-13 Wireless_EAP-TLS Condition



Authorization Compound Conditions

* Name: Wireless_EAP-TLS

Description: Wireless_802.1X And EAP-TLS

*Condition Expression

Condition Name	Expression			AND
	Radius:Service-Type	Equals	Framed	AND
	Radius:NAS-Port-...	Equals	Wireless - I	AND
	Network Access:...	Equals	EAP-TLS	

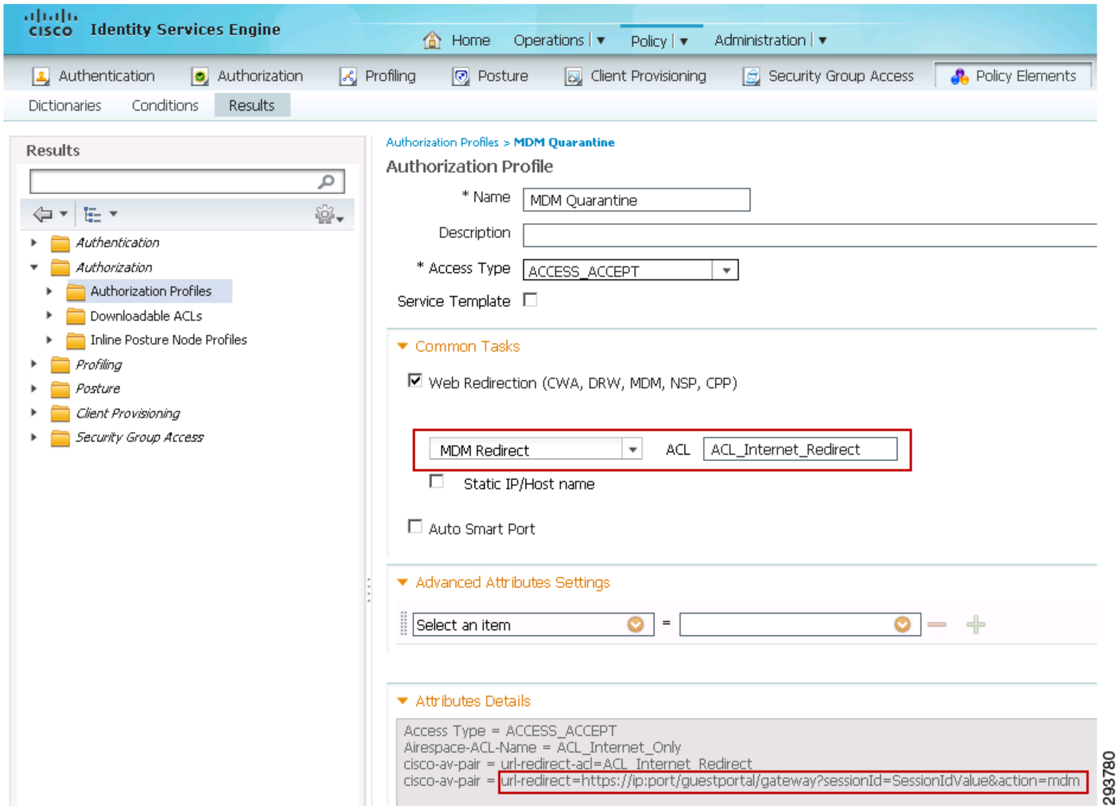
Remediate Non-MDM Compliant Rule

This rule matches when the following conditions are met:

- The connection originated using EAP-TLS authentication, as defined by the Wireless_EAP-TLS compound condition highlighted in Figure 17-13.
- The device does not comply with MDM policies. The ISE makes the DeviceCompliantStatus API call to the MDM to obtain this information.
- Logical Profile equals MDM Managed—The device is managed and supported by the MDM.

If these conditions match, the MDM Quarantine authorization profile is used. This profile is configured to redirect nonregistered devices to the redirect URL highlighted in Figure 17-14.

Figure 17-14 MDM Quarantine Authorization Profile



Authorization Profile

* Name: MDM Quarantine

Description:

* Access Type: ACCESS_ACCEPT

Service Template □

☑ Web Redirection (CWA, DRW, MDM, NSP, CPP)

MDM Redirect ACL ACL_Internet_Redirect

□ Static IP/Host name

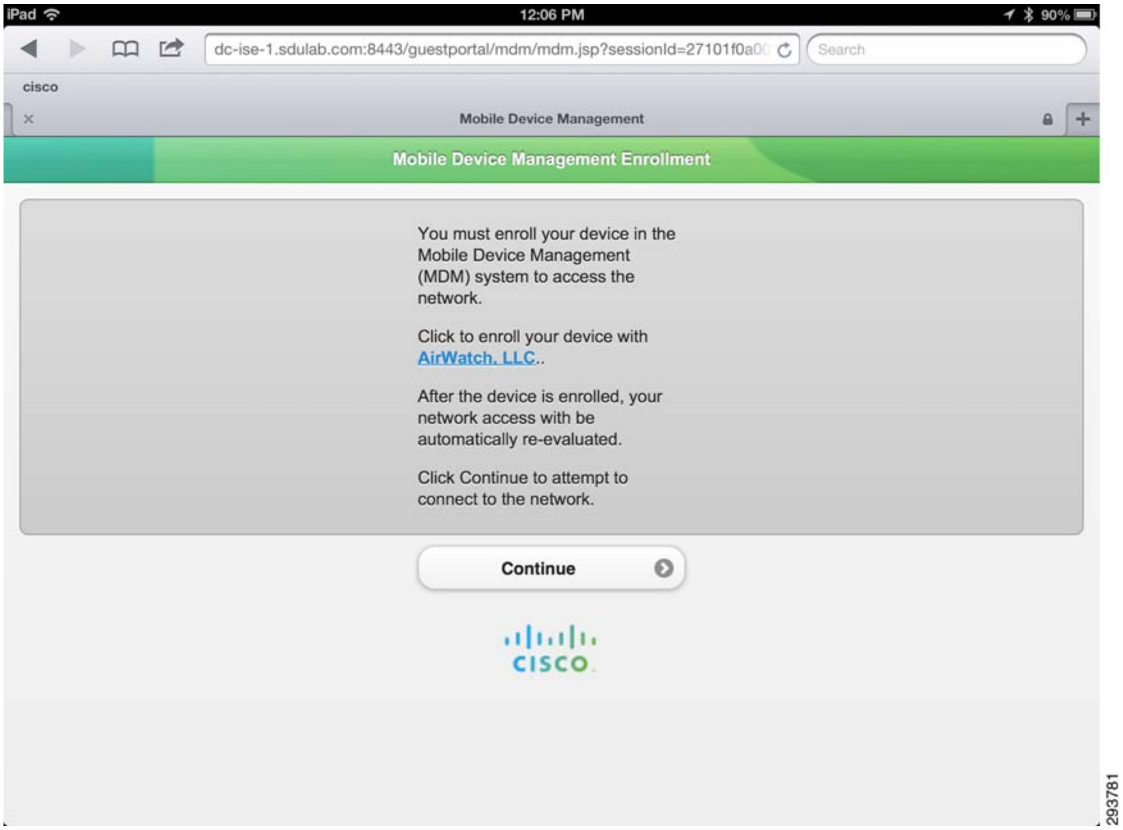
□ Auto Smart Port

```
Access Type = ACCESS_ACCEPT
Airespace-ACL-Name = ACL_Internet_Only
cisco-av-pair = url-redirect-acl=ACL_Internet_Redirect
cisco-av-pair = url-redirect=https://ip:port/guestportal/gateway?sessionId=SessionIdValue&action=mdm
```

The authorization profile relies on the same two named ACLs: ACL_Internet_Redirect and ACL_Internet_Only previously discussed in Remediate Non-ISE Compliant Rule.

When the user tries to browse an internal resource, the session is redirected to page similar to the one in Figure 17-15, indicating why the device is not compliant with the MDM policies.

Figure 17-15 MDM Quarantine


iPad
12:06 PM
90%
dc-ise-1.sdulab.com:8443/guestportal/mdm/mdm.jsp?sessionId=27101f0a0
Search
cisco
Mobile Device Management
Mobile Device Management Enrollment
Continue
cisco
293781

You must enroll your device in the Mobile Device Management (MDM) system to access the network.

Click to enroll your device with AirWatch, LLC..

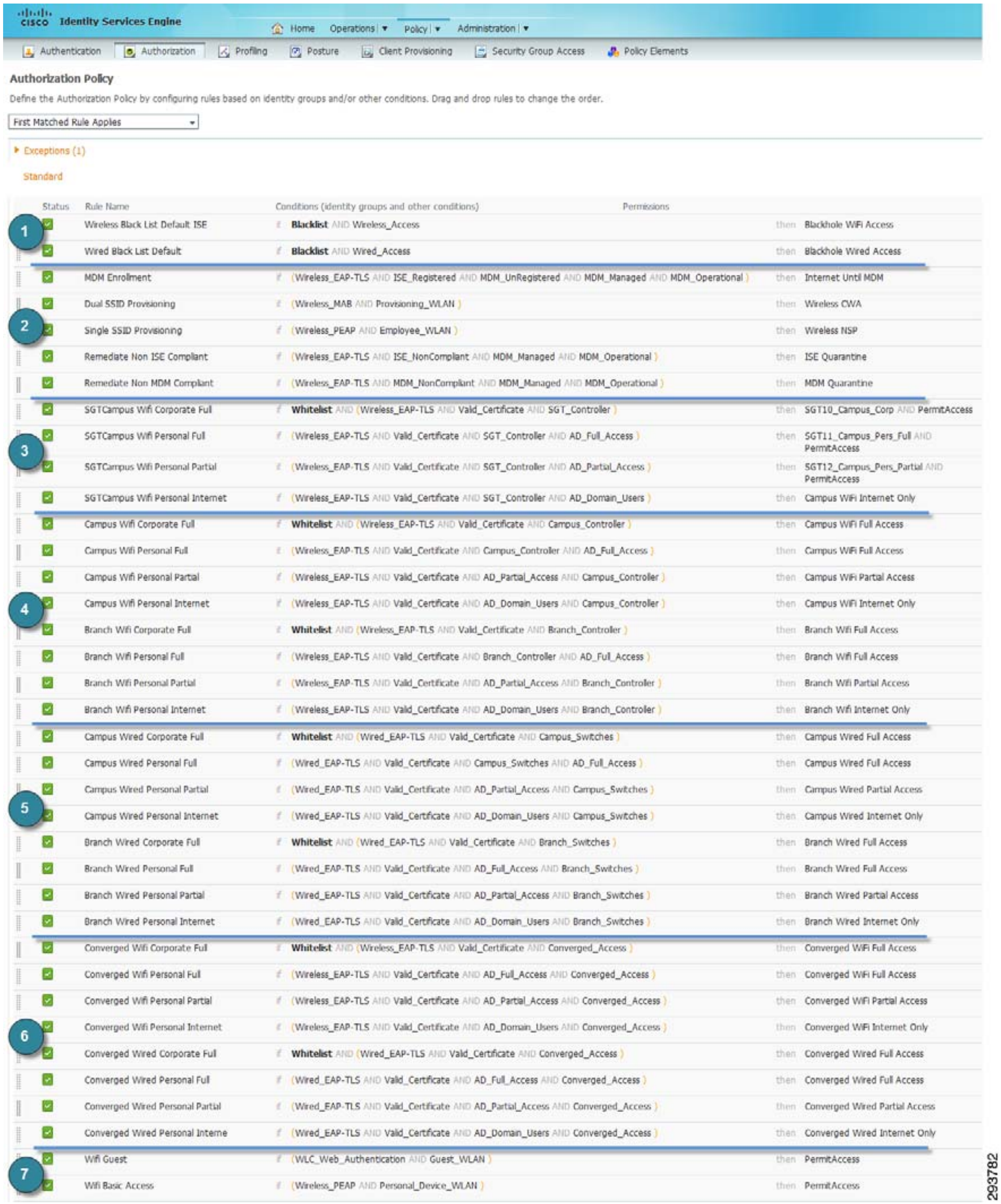
After the device is enrolled, your network access with be automatically re-evaluated.

Click Continue to attempt to connect to the network.

For reference purposes, the complete authorization policy used during testing is shown in Figure 17-16. The figure highlights the following sections:

1. Used for blacklisting lost or stolen devices.
2. On-boarding and MDM registration/remediation.
3. Wireless devices connecting from an access point in a SGT_Enabled location.
4. Wireless devices connecting from an access point in the campus or branch locations.
5. Wired devices connecting from a campus or branch locations.
6. Wired and Wireless devices connecting from a converged location.
7. Guest and Basic Access.

Figure 17-16 Complete Authorization Policy



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.

First Matched Rule Applies

▸ Exceptions (1)

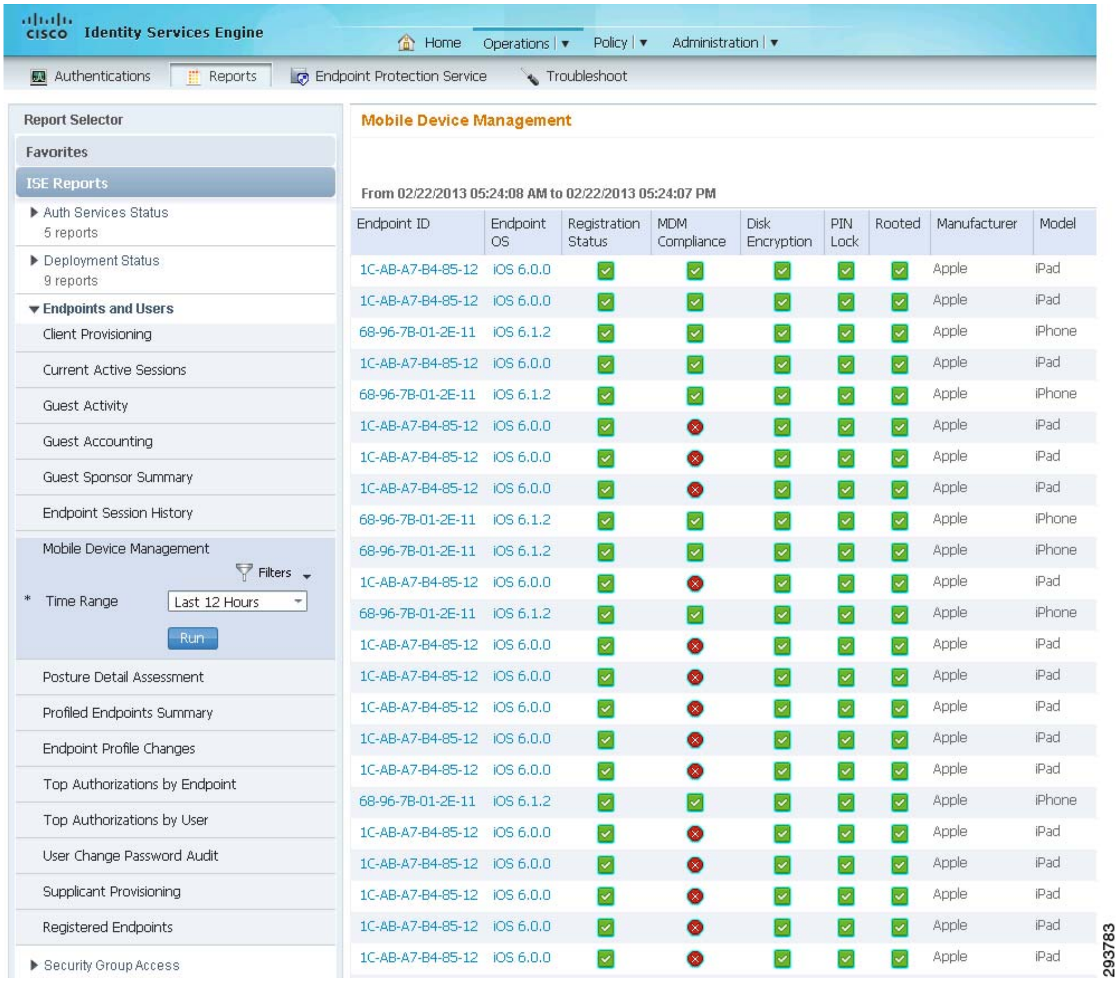
Standard

Status	Rule Name	Conditions (identity groups and other conditions)	Permissions
☑	Wireless Black List Default ISE	**Blacklist** AND Wireless_Access	then Blackhole WiFi Access
☑	Wired Black List Default	**Blacklist** AND Wired_Access	then Blackhole Wired Access
☑	MDM Enrollment	(Wireless_EAP-TLS AND ISE_Registered AND MDM_UnRegistered AND MDM_Managed AND MDM_Operational)	then Internet Until MDM
☑	Dual SSID Provisioning	(Wireless_MAB AND Provisioning_WLAN)	then Wireless CWA
☑	Single SSID Provisioning	(Wireless_PEAP AND Employee_WLAN)	then Wireless NSP
☑	Remediate Non ISE Compliant	(Wireless_EAP-TLS AND ISE_NonCompliant AND MDM_Managed AND MDM_Operational)	then ISE Quarantine
☑	Remediate Non MDM Compliant	(Wireless_EAP-TLS AND MDM_NonCompliant AND MDM_Managed AND MDM_Operational)	then MDM Quarantine
☑	SGTCampus Wifi Corporate Full	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller)	then SGT10_Campus_Corp AND PermitAccess
☑	SGTCampus Wifi Personal Full	(Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Full_Access)	then SGT11_Campus_Pers_Full AND PermitAccess
☑	SGTCampus Wifi Personal Partial	(Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Partial_Access)	then SGT12_Campus_Pers_Partial AND PermitAccess
☑	SGTCampus Wifi Personal Internet	(Wireless_EAP-TLS AND Valid_Certificate AND SGT_Controller AND AD_Domain_Users)	then Campus WiFi Internet Only
☑	Campus Wifi Corporate Full	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller)	then Campus WiFi Full Access
☑	Campus Wifi Personal Full	(Wireless_EAP-TLS AND Valid_Certificate AND Campus_Controller AND AD_Full_Access)	then Campus WiFi Full Access
☑	Campus Wifi Personal Partial	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Controller)	then Campus WiFi Partial Access
☑	Campus Wifi Personal Internet	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Controller)	then Campus WiFi Internet Only
☑	Branch Wifi Corporate Full	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller)	then Branch Wifi Full Access
☑	Branch Wifi Personal Full	(Wireless_EAP-TLS AND Valid_Certificate AND Branch_Controller AND AD_Full_Access)	then Branch Wifi Full Access
☑	Branch Wifi Personal Partial	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Controller)	then Branch Wifi Partial Access
☑	Branch Wifi Personal Internet	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Controller)	then Branch Wifi Internet Only
☑	Campus Wired Corporate Full	**Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches)	then Campus Wired Full Access
☑	Campus Wired Personal Full	(Wired_EAP-TLS AND Valid_Certificate AND Campus_Switches AND AD_Full_Access)	then Campus Wired Full Access
☑	Campus Wired Personal Partial	(Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Campus_Switches)	then Campus Wired Partial Access
☑	Campus Wired Personal Internet	(Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Campus_Switches)	then Campus Wired Internet Only
☑	Branch Wired Corporate Full	**Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Branch_Switches)	then Branch Wired Full Access
☑	Branch Wired Personal Full	(Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Branch_Switches)	then Branch Wired Full Access
☑	Branch Wired Personal Partial	(Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Branch_Switches)	then Branch Wired Partial Access
☑	Branch Wired Personal Internet	(Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Branch_Switches)	then Branch Wired Internet Only
☑	Converged Wifi Corporate Full	**Whitelist** AND (Wireless_EAP-TLS AND Valid_Certificate AND Converged_Access)	then Converged WiFi Full Access
☑	Converged Wifi Personal Full	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then Converged WiFi Full Access
☑	Converged Wifi Personal Partial	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then Converged WiFi Partial Access
☑	Converged Wifi Personal Internet	(Wireless_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then Converged WiFi Internet Only
☑	Converged Wired Corporate Full	**Whitelist** AND (Wired_EAP-TLS AND Valid_Certificate AND Converged_Access)	then Converged Wired Full Access
☑	Converged Wired Personal Full	(Wired_EAP-TLS AND Valid_Certificate AND AD_Full_Access AND Converged_Access)	then Converged Wired Full Access
☑	Converged Wired Personal Partial	(Wired_EAP-TLS AND Valid_Certificate AND AD_Partial_Access AND Converged_Access)	then Converged Wired Partial Access
☑	Converged Wired Personal Interne	(Wired_EAP-TLS AND Valid_Certificate AND AD_Domain_Users AND Converged_Access)	then Converged Wired Internet Only
☑	Wifi Guest	(WLC_Web_Authentication AND Guest_WLAN)	then PermitAccess
☑	Wifi Basic Access	(Wireless_PEAP AND Personal_Device_WLAN)	then PermitAccess

MDM Reports

Cisco ISE provides a logging mechanism that is used for auditing, fault management, and troubleshooting. Several reports provide information related to endpoints. In Figure 17-17, the Mobile Device Management report shows the endpoints connected to the ISE, and several attributes collected from the MDM. Other reports provide additional information that may be used for reporting and troubleshooting.

Figure 17-17 MDM Report



* Time Range: Last 12 Hours

Mobile Device Management

From 02/22/2013 05:24:08 AM to 02/22/2013 05:24:07 PM

Endpoint ID	Endpoint OS	Registration Status	MDM Compliance	Disk Encryption	PIN Lock	Rooted	Manufacturer	Model
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✓	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✓	✓	✓	✓	Apple	iPad
68-96-7B-01-2E-11	iOS 6.1.2	✓	✓	✓	✓	✓	Apple	iPhone
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✓	✓	✓	✓	Apple	iPad
68-96-7B-01-2E-11	iOS 6.1.2	✓	✓	✓	✓	✓	Apple	iPhone
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
68-96-7B-01-2E-11	iOS 6.1.2	✓	✓	✓	✓	✓	Apple	iPhone
68-96-7B-01-2E-11	iOS 6.1.2	✓	✓	✓	✓	✓	Apple	iPhone
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
68-96-7B-01-2E-11	iOS 6.1.2	✓	✓	✓	✓	✓	Apple	iPhone
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
68-96-7B-01-2E-11	iOS 6.1.2	✓	✓	✓	✓	✓	Apple	iPhone
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad
1C-AB-A7-B4-85-12	iOS 6.0.0	✓	✗	✓	✓	✓	Apple	iPad

CHAPTER 18

BYOD Basic Access Use Case

Revised: August 7, 2013

Previous chapters of this design guide have examined on-boarding employee personal devices to provide full, partial, or Internet only access. The use of digital certificates provides an additional level of authentication security by preventing the spoofing of device MAC addresses. Additionally, the use of the guest portal for self-registration and the My-Devices portal streamline the on-boarding and maintenance of employee personal devices, resulting in lower IT operating costs associated with providing BYOD services.

Despite these benefits, a subset of organizations may still decide on a business policy which does not on-board wireless employee personal devices, yet provides some access to corporate services and the Internet for such devices. This may be because of one or more of the following reasons:

- The organization does not have the desire or the ability to deploy digital certificates on employee personal devices.
- The employee may decide to opt-out of having the organization manage their personal device.
- The organization does not wish to administratively manage and maintain separate lists of registered corporate devices and BYOD devices which have full network access.
- The organization may wish to simply restrict employee personal devices to "outside" of the corporate firewall due to an unknown or un-trusted security posture of such devices.

Because of this, the following sections discuss design options for wireless employee personal devices which do not involve on-boarding such devices. The designs are based around extending traditional guest wireless access discussed in Chapter 21, "BYOD Guest Wireless Access" and providing similar guest-like wireless access for employee personal devices.

Note Throughout this chapter, it is assumed that corporate-owned devices will still be on-boarded as discussed in Chapter 16, "BYOD Limited Use Case—Corporate Devices." The use of a whitelist is still necessary to prevent employee personal devices from getting full access to the corporate network.

Extending Guest Wireless Access to Employee Personal Devices

The following sections discuss two methods for extending guest wireless access, discussed in Chapter 21, "BYOD Guest Wireless Access," to also allow employee personal devices access to the guest network:

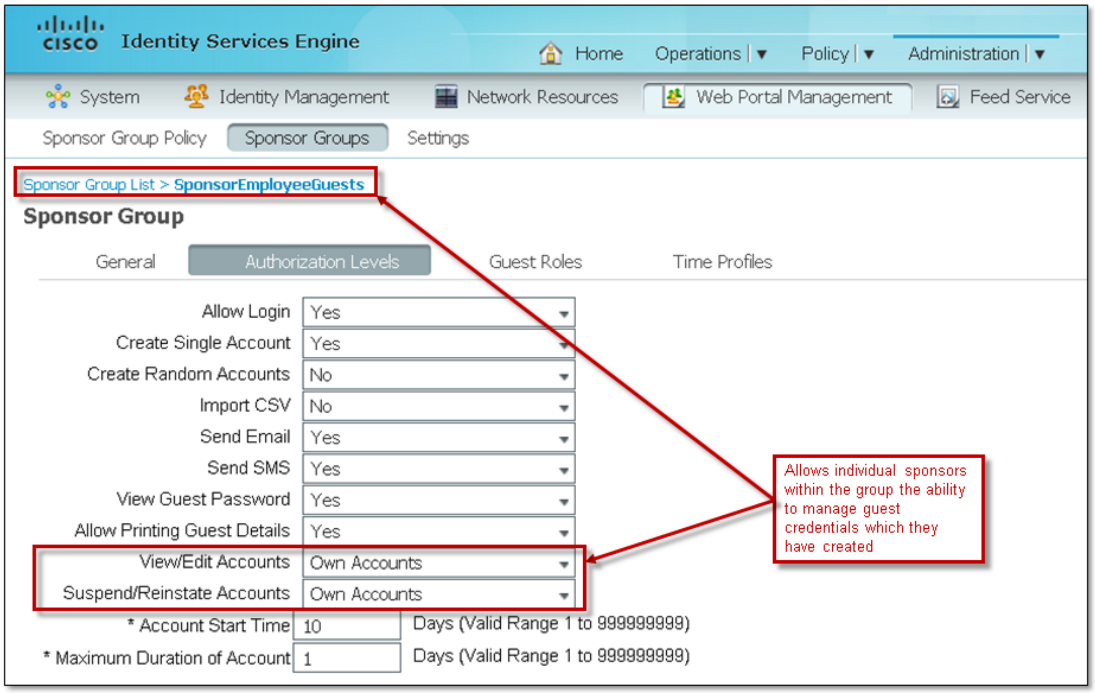
- Allowing employees to provision guest credentials for themselves.
- Extending guest web authentication (Web Auth) to also utilize the Microsoft Active Directory (AD) database when authenticating guests and employees using personal devices.

Allowing Employees to Provision Guest Credentials for Themselves

Chapter 21, "BYOD Guest Wireless Access" discusses provisioning guest credentials with the Cisco ISE sponsor portal. The most basic form of extending guest wireless access to employee personal devices is simply to allow employees to sponsor themselves as guests. Employees then manually connect to the open guest SSID to utilize personal devices on the wireless guest network.

With the Cisco ISE sponsor portal, the sponsor authentication policy can be based on membership within a particular Microsoft AD group. This was discussed in Configuring the Cisco ISE Sponsor Portal, which discussed the use of Microsoft AD groups within the ISE sponsor group policy as a means to limit sponsor access to the Cisco ISE server. This can equally be used to allow broader access to the ISE sponsor portal simply by adding additional employees to those Microsoft AD groups. Alternatively a new sponsor group can be created that allows individual employees to configure guest credentials yet restricts them to being able to only modify credentials that they provisioned. An example is shown in the figures below.

Figure 18-1 Example ISE Sponsor Group for Employees to Create Self Guest Credentials



Sponsor Group List > SponsorEmployeeGuests

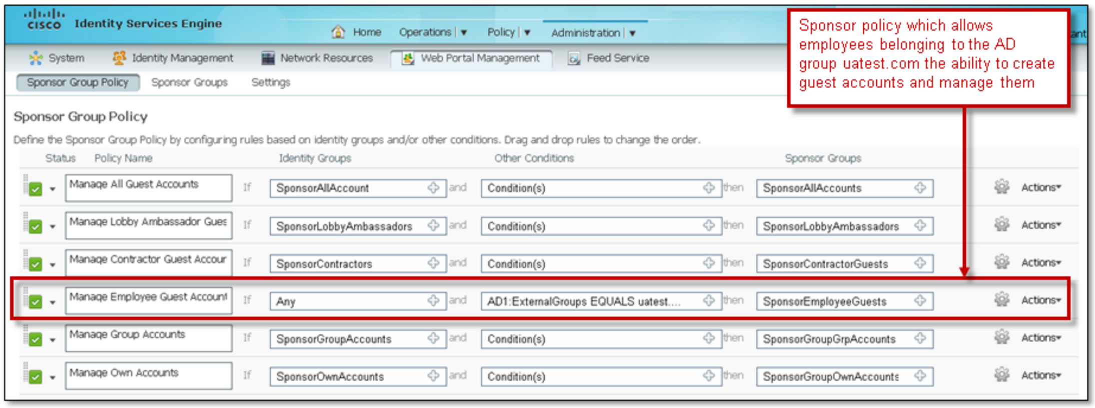
Sponsor Group

Allow Login: Yes
Create Single Account: Yes
Create Random Accounts: No
Import CSV: No
Send Email: Yes
Send SMS: Yes
View Guest Password: Yes
Allow Printing Guest Details: Yes
View/Edit Accounts: Own Accounts
Suspend/Reinstate Accounts: Own Accounts
* Account Start Time: 10 Days (Valid Range 1 to 999999999)
* Maximum Duration of Account: 1 Days (Valid Range 1 to 999999999)

Allows individual sponsors within the group the ability to manage guest credentials which they have created

Membership to this ISE sponsor group can then be restricted to a Microsoft AD group via the ISE sponsor group policy, as shown in Figure 18-2.

Figure 18-2 Example ISE Sponsor Group Policy for Employees to Create Self Guest Credentials



Sponsor Group Policy

Define the Sponsor Group Policy by configuring rules based on identity groups and/or other conditions. Drag and drop rules to change the order.

Status	Policy Name		Identity Groups		Other Conditions		Sponsor Groups	
☑	Manage All Guest Accounts	If	SponsorAllAccount	and	Condition(s)	then	SponsorAllAccounts	Actions
☑	Manage Lobby Ambassador Gues	If	SponsorLobbyAmbassadors	and	Condition(s)	then	SponsorLobbyAmbassadors	Actions
☑	Manage Contractor Guest Accour	If	SponsorContractors	and	Condition(s)	then	SponsorContractorGuests	Actions
☑	Manage Employee Guest Account	If	Any	and	AD1:ExternalGroups EQUALS uatest....	then	SponsorEmployeeGuests	Actions
☑	Manage Group Accounts	If	SponsorGroupAccounts	and	Condition(s)	then	SponsorGroupGrpAccounts	Actions
☑	Manage Own Accounts	If	SponsorOwnAccounts	and	Condition(s)	then	SponsorGroupOwnAccounts	Actions

Sponsor policy which allows employees belonging to the AD group uatest.com the ability to create guest accounts and manage them

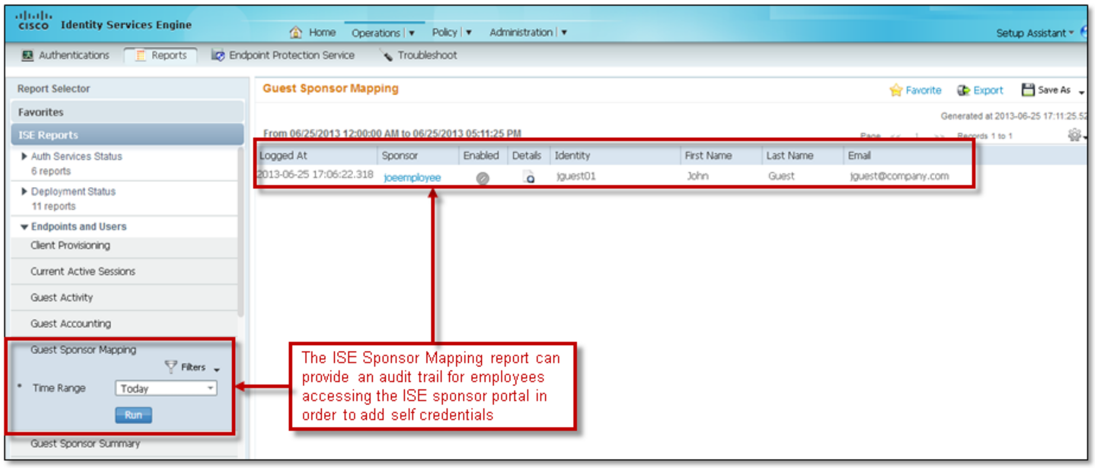
In this example, access to the sponsor group is limited to those members of the Microsoft Active Directory domain who are members of the group "Users/Domain Users". The exact condition for the example is of the form:

```
AD1:ExternalGroups EQUALS uatest.com/Users/Domain Users
```

The Microsoft Active Directory domain is "uatest.com" in this example. Note that the Microsoft Active Directory server must be configured as an external identity source to select this option. In this example it is known by the name "AD1".

One advantage of this design is that an audit trail exists through the ISE Reports for employees authenticating to the ISE sponsor portal. The ISE Sponsor Mapping report shows when the employee created a guest credential as well as the guest credential created. The ISE Sponsor Mapping report can be run over various time ranges from 30 minutes up to 30 days or a custom time range can be requested. This report can be used to gain a rough idea of which employees are accessing the ISE sponsor portal to create guest credentials and how often. An example is shown in Figure 18-3.

Figure 18-3 Example of the Audit Trail for an Employee Accessing the ISE Sponsor Portal



Time Range: Today

Guest Sponsor Mapping

Generated at 2013-06-25 17:11:25.52

From 06/25/2013 12:00:00 AM to 06/25/2013 05:11:25 PM

Records 1 to 1

Logged At	Sponsor	Enabled	Details	Identity	First Name	Last Name	Email
2013-06-25 17:06:22.318	joeemployee	⊘	🔍	jguest01	John	Guest	jguest@company.com

The ISE Sponsor Mapping report can provide an audit trail for employees accessing the ISE sponsor portal in order to add self credentials

Note that this method of allowing employees the ability to create guest credentials for themselves does not prevent them from creating credentials for true guests who are visiting the organization. Corporate business policy should dictate that true guest credentials only be added by authorized members of sponsor groups, as discussed in Chapter 21, "BYOD Guest Wireless Access." The next design option eliminates this issue by removing the ability for employees to create guest credentials for themselves altogether.

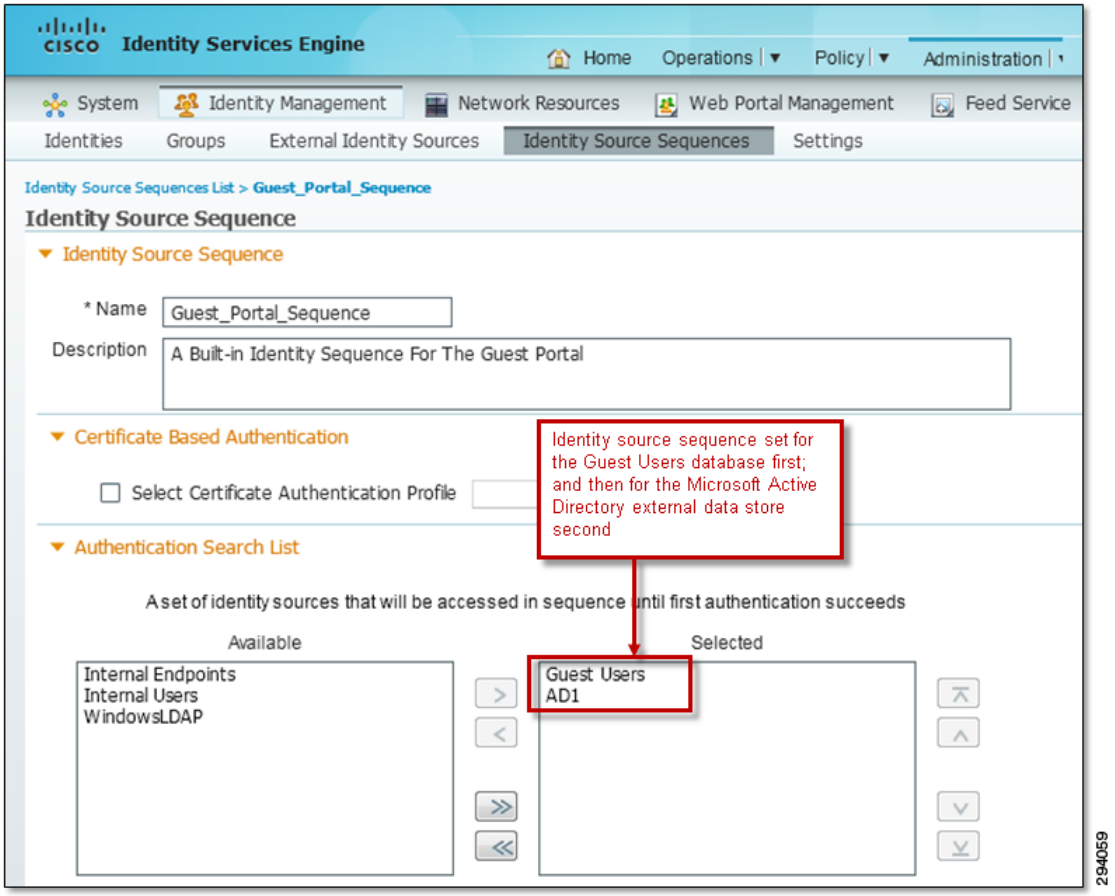
Extending Web Auth to Use Microsoft AD when Authenticating Employees with Personal Devices

The previous section discussed the most basic way of extending guest wireless access to allow employees with personal devices to access the guest network. That method simply allows employees to configure guest credentials for themselves via the Cisco ISE sponsor portal. Although this provides several advantages over methods such as utilizing a shared sponsor account on the guest wireless controller for adding credentials, it still has several shortcomings. Employees must still provision temporary guest credentials for themselves. Finally, there is nothing preventing the employee from sponsoring a true guest, other than corporate business policy.

An alternative means of providing access to the guest wireless network for employee personal devices is to simply allow the ISE server to check multiple identity sources for credentials when performing web authentication (Web Auth). For example, the ISE server could first check its internal identity groups (local database) for guest credentials. If the credentials are not found there, then check the Microsoft AD external identity store to see if the person accessing the guest network is an employee instead of a guest.

Cisco ISE Policy Configuration in Chapter 21, "BYOD Guest Wireless Access" discusses the use of a user-defined identity source sequence called Guest_Portal_Sequence for authenticating guest access via Web Auth. The Guest_Portal_Sequence uses the Internal Users identity source only. This can easily be extended by adding a Microsoft Active Directory (AD1) external identity source to the sequence, as shown in Figure 18-4.

Figure 18-4 Example of Guest_Portal_Access Identity Source Sequence Extended to Include AD



* Name: Guest_Portal_Sequence

Description: A Built-in Identity Sequence For The Guest Portal

□ Select Certificate Authentication Profile

A set of identity sources that will be accessed in sequence until first authentication succeeds

Available:
Internal Endpoints
Internal Users
WindowsLDAP

Selected:
Guest Users
AD1

Identity source sequence set for the Guest Users database first; and then for the Microsoft Active Directory external data store second

This configuration now allows employees who are in the Microsoft Active Directory database to access the guest wireless network from their personal devices once they have performed web authentication and accepted the Acceptable Use Policy (AUP) or End User Agreement (EUA).

Note This allows employees to access the guest wireless network from corporate-owned devices as well, since the authentication and authorization decision is based on Microsoft Active Directory userid and password only. The device itself is not considered within the authentication and authorization decision.

Deploying Guest-Like Wireless Access for Employee Personal Devices

The previous sections discussed options for extending access to the wireless guest network for employees with personal devices, either by allowing employees to configure guest credentials for themselves or by extending Web Auth to also check the Microsoft AD database where employee credentials are kept. With these options, employee personal devices share the same wireless SSID as guest devices. Employee personal devices also share the same IP subnet address space as guest devices, since they terminate on the same DMZ segment of the ASA firewall. Essentially the employee's personal device is treated as a guest on the network, which can bring up potential concerns.

Since IP subnet space is shared between guest devices and employee personal devices, there can be some concern that employee personal devices could deplete the IP addressing space, limiting the ability of guest devices to gain access to the guest network or vice-versa.

The ASA firewall guest DMZ interface ingress policy can be modified to allow certain application flows inbound from the guest network to a mirror of the company website server, dedicated for employee personal devices, sitting on other DMZ segments. This is discussed further in Accessing Corporate Resources. However, the ASA firewall policy would not be able to distinguish between guest devices and employee personal devices, since they share the same IP subnet address space. Therefore, application level access control at the mirror web server itself is necessary to prevent guests from accessing services on it. Likewise, the ASA firewall guest DMZ interface ingress policy could be modified to allow traffic from a virtual client—such as a Citrix or VMware client—inbound to internal Citrix or VMware servers. Again, the ASA firewall policy would not be able to distinguish between true guest devices and employee personal devices, since they share the same IP subnet address space. Application level access control at the Citrix or VMware server would be necessary to prevent guests from accessing these servers.

Since the guest SSID is typically open with no encryption, traffic from employee personal devices will be in the clear, unless the devices use either secure applications or some form of VPN tunneling, which encrypts the traffic. Although web traffic can be made secure simply by requiring the use of HTTPS, not all applications used by employee personal devices may be encrypted. This leaves some vulnerability which must be considered by security operations personnel, especially any site that authenticates using the employee's corporate login and password. If internal company data is being accessed from employee personal devices via the guest wireless network, then that information should be encrypted to prevent eavesdropping. Allowing employee devices to launch a VPN client to establish an IPsec VPN session-either directly to the ASA firewall or out to the Internet and back to another corporate VPN concentrator-may be one alternative. Another option is the establishment of an SSL VPN tunnel to the ASA firewall for employee devices. Both of these options may also require per-user authentication.

Note Cisco’s implementation of Web Auth uses HTTPS when redirecting the web session and requesting credentials.

Because of these concerns, security operations personnel may be hesitant to allow anything but Internet access for any device accessing the guest network, whether it is a true guest device or an employee personal device.

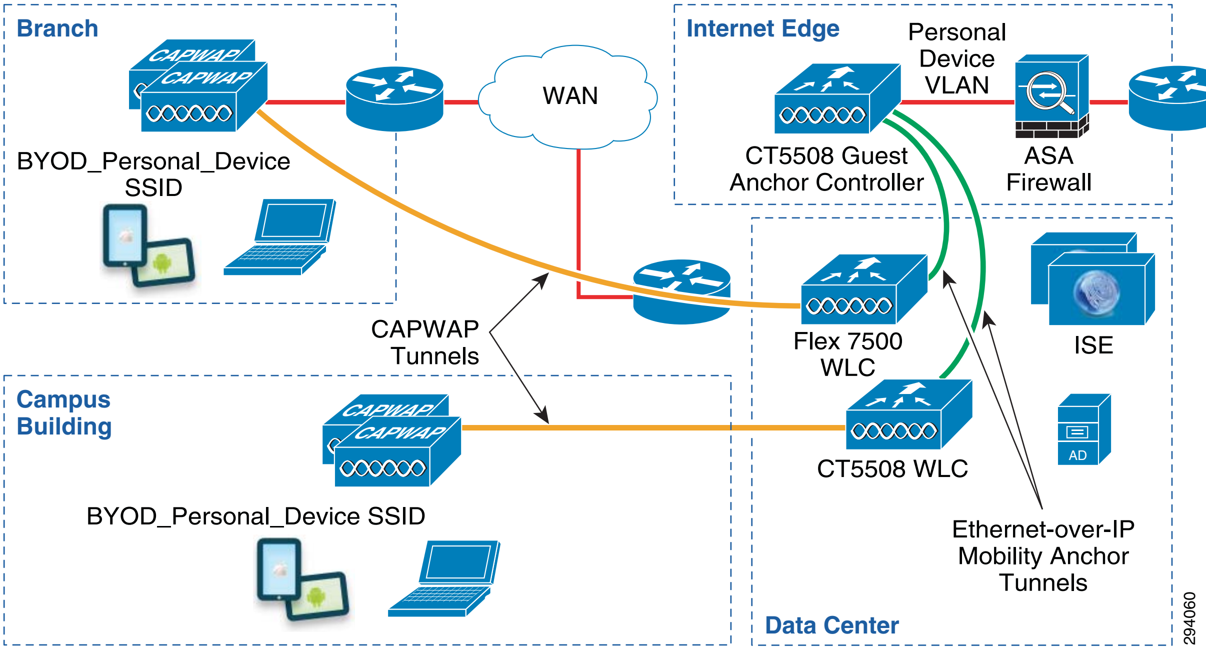
As in Chapter 21, “BYOD Guest Wireless Access,” two distinct terminologies are used in this chapter. The first pair of terminologies is guest controller and campus controller. The guest controller is a dedicated controller that is used for dealing with guest and employee personal device traffic. The campus controller is dedicated for handling internal traffic. Note that the term campus controller is used somewhat generically here. The campus controller discussed within this chapter may refer to a standalone wireless controller platform deployed within a campus location or wireless controller functionality integrated within Catalyst 3850 Series switches deployed within a branch location.

The second set of terminologies is foreign controller and anchor controller. These two terminologies are used when a user roams from one controller to another controller. The new controller to which the user associates is the foreign controller. This controller anchors all the traffic to the old controller, which becomes the anchor controller. These terminologies are used in this document.

Dedicated SSID for Employee Personal Devices

This section discusses another option in which a second guest-like wireless SSID is provisioned for employee personal devices. This SSID is auto-anchored to another DMZ segment off of the ASA firewall, in a similar fashion as the wireless guest SSID. An example of this design using CUWN infrastructure is shown in Figure 18-5.

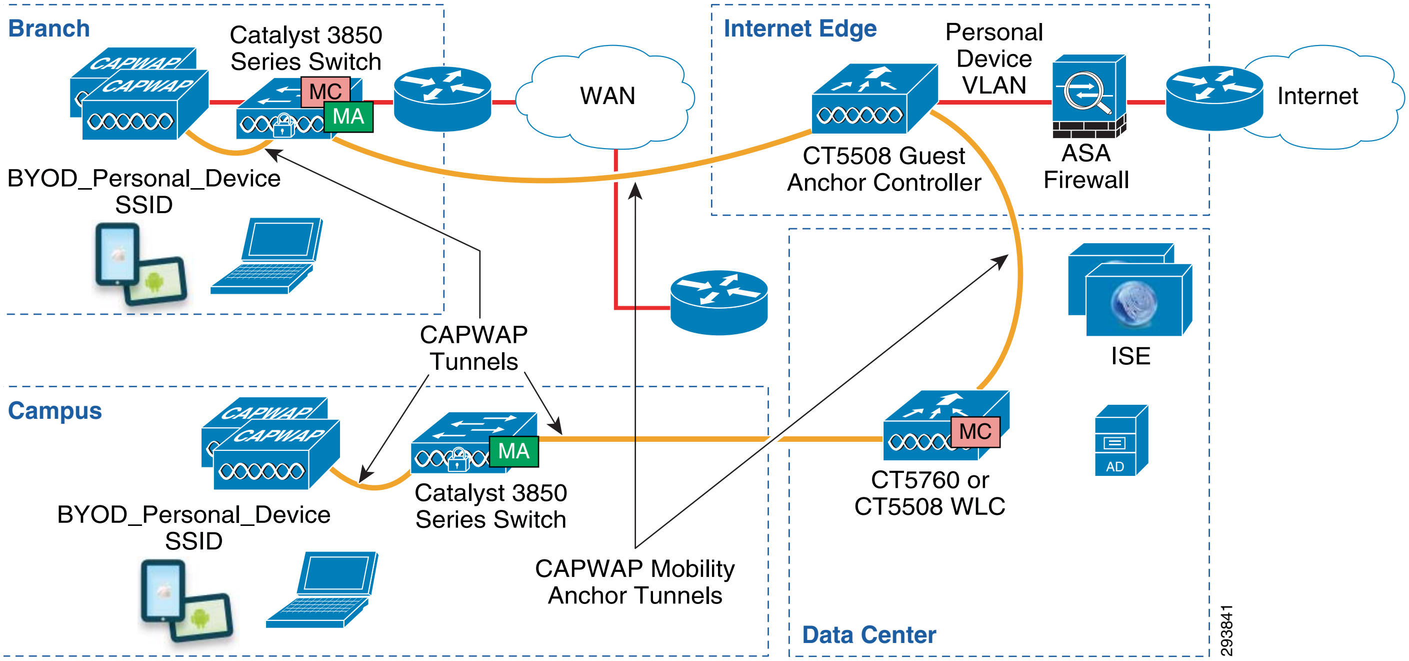
Figure 18-5 Guest-Like Wireless Access for Employee Personal Devices Using CUWN Infrastructure



With the auto-anchor mobility feature of Cisco wireless controllers, packets from the wireless client are encapsulated through a mobility tunnel between the internal wireless controller (known as the foreign controller) to the guest wireless controller (known as the anchor controller), where they are de-capsulated and delivered to the wired network.

A similar example of this design using a Converged Access wireless infrastructure is shown in Figure 18-6.

Figure 18-6 Guest-Like Wireless Access for Employee Personal Devices Using Converged Access Infrastructure


Branch
Catalyst 3850 Series Switch
CAPWAP
CAPWAP
MC
MA
WAN
BYOD_Personal_Device SSID
Internet Edge
Personal Device VLAN
Internet
CT5508 Guest Anchor Controller
ASA Firewall
ISE
CAPWAP Tunnels
Campus
CAPWAP
CAPWAP
MA
MC
Catalyst 3850 Series Switch
BYOD_Personal_Device SSID
CT5760 or CT5508 WLC
AD
CAPWAP Mobility Anchor Tunnels
Data Center
293841

The auto-anchor mobility feature also applies to the Converged Access Infrastructure. Note that with the Converged Access branch design shown in Figure 18-6, the Catalyst 3850 switch within the branch implements both the Mobility Agent (MA) and Mobility Controller (MC) function. With the Converged Access campus design, the Catalyst 3850 switch only implements the MA function. The MC function is implemented by a dedicated CT5760 wireless controller. Since the auto-anchor tunnel is initiated from the MC within a Converged Access design, traffic is first tunneled from the campus Catalyst 3850 switch to the CT5760 wireless controller, where it is then auto-anchored to the guest anchor controller within the DMZ. For additional discussion regarding the MA and MC functionality within Converged Access infrastructure, see Configuring the Infrastructure.

Note In this version of the design guide, it is assumed that employees with personal devices would need to manually associate with this SSID. Future versions may investigate other alternatives that make use of RADIUS change-of-authentication (CoA) functionality or device profiles.

An advantage of implementing a dedicated SSID for employee personal devices is that the SSID does not have to be configured with open access and can be encrypted, unlike the guest SSID discussed throughout this design guide. Instead, the employee personal device SSID can be secured via mechanisms such as 802.1X authentication and WPA-2/AES encryption to prevent eavesdropping of traffic from employee personal devices. Employees can be authenticated via the Cisco ISE server using the external Microsoft AD identity source as they associate with the SSID.

Another advantage of implementing a dedicated SSID for employee personal devices is that the devices can be isolated from guest devices by provisioning separate VLANs for each SSID. Separate DMZ segments-implemented as separate physical interfaces off of the ASA firewall or as separate VLAN sub-interfaces off a single physical interface of the ASA firewall-can be deployed. Each DMZ interface now has a separate IP subnet address space and a separate access-control policy. This expands the IP addressing space deployed for guest devices as well as employee personal devices and removes the issue of employee personal devices causing IP address starvation issues for guest devices and vice-versa. The guest DMZ can be configured to allow only Internet access for guest devices. The employee personal device DMZ can be configured to allow Internet access, as well as access to a mirror web server sitting on another DMZ segment. Additional access can be allowed by modifying the ASA firewall personal device DMZ interface ingress policy to allow traffic from a virtual client-such as a Citrix or VMware client-inbound to internal Citrix or VMware servers. Access can also be extended by allowing employee personal devices to launch a VPN client to establish an IPsec VPN session, either directly to the ASA firewall or out to the Internet and back to another corporate VPN concentrator. Another option is the establishment of an SSL VPN tunnel to the ASA firewall for employee personal devices.

Wireless Controller Configuration

To deploy this option in which a second guest-like wireless SSID is provisioned for employee personal devices, both the campus (foreign) wireless controllers and the guest (anchor) controller need to be configured with a new WLAN for employee personal devices. This WLAN has a unique SSID different from the corporate WLAN and the guest WLAN.

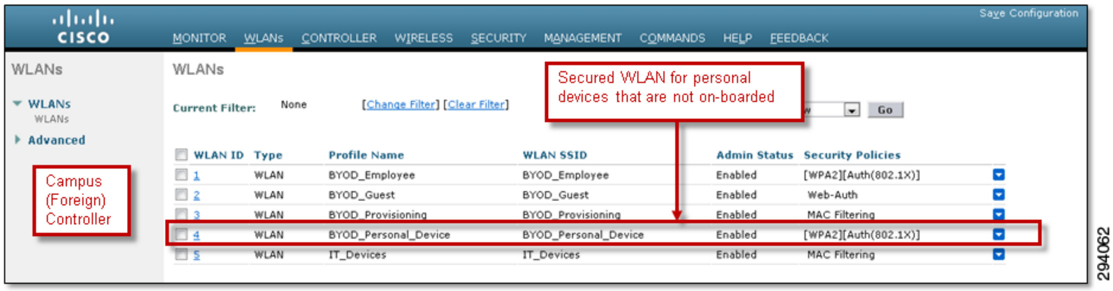
Campus Controller Configuration

This section discusses configurations when using either CUWN wireless controllers or Converged Access (IOS XE based) wireless controllers for the campus controller.

CUWN Wireless Controller Configuration

An example of a CUWN campus controller configuration is shown in Figure 18-7, in which the new WLAN is called the BYOD_Personal_Device WLAN.

Figure 18-7 Example Configuration of a CUWN Campus Wireless Controller for the Employee Personal Devices WLAN



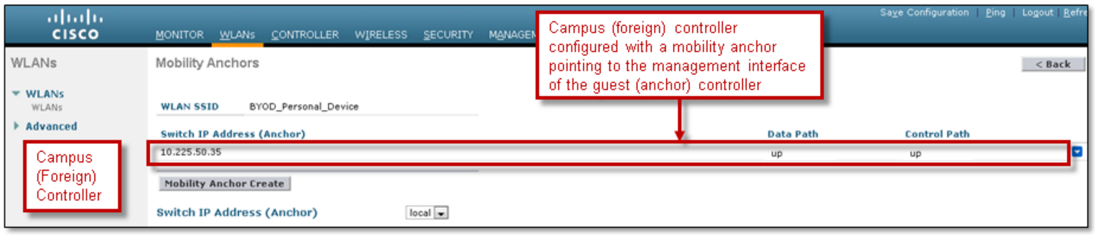
WLANs

Current Filter: None [Change Filter] [Clear Filter]

WLAN ID	Type	Profile Name	WLAN SSID	Admin Status	Security Policies
1	WLAN	BYOD_Employee	BYOD_Employee	Enabled	[WPA2][Auth(802.1X)]
2	WLAN	BYOD_Guest	BYOD_Guest	Enabled	Web-Auth
3	WLAN	BYOD_Provisioning	BYOD_Provisioning	Enabled	MAC Filtering
4	WLAN	BYOD_Personal_Device	BYOD_Personal_Device	Enabled	[WPA2][Auth(802.1X)]
5	WLAN	IT_Devices	IT_Devices	Enabled	MAC Filtering

The WLAN is configured for WPA2 security with AES as the cipher, along with 802.1X authenticated key management. Next, the WLAN on the campus (foreign) controller needs to be configured with a mobility anchor pointing at the management interface of the guest (anchor) controller. An example is shown in Figure 18-8. Note that in branch scenarios which utilize a FlexConnect wireless design, the controller servicing branch APs will be the foreign controller for the branch personal device WLAN.

Figure 18-8 Example Configuration of the Mobility Anchor on a Campus CUWN Wireless Controllers



Mobility Anchors

WLAN SSID BYOD_Personal_Device

Switch IP Address (Anchor)	Data Path	Control Path
10.225.50.35	up	up

Switch IP Address (Anchor) local

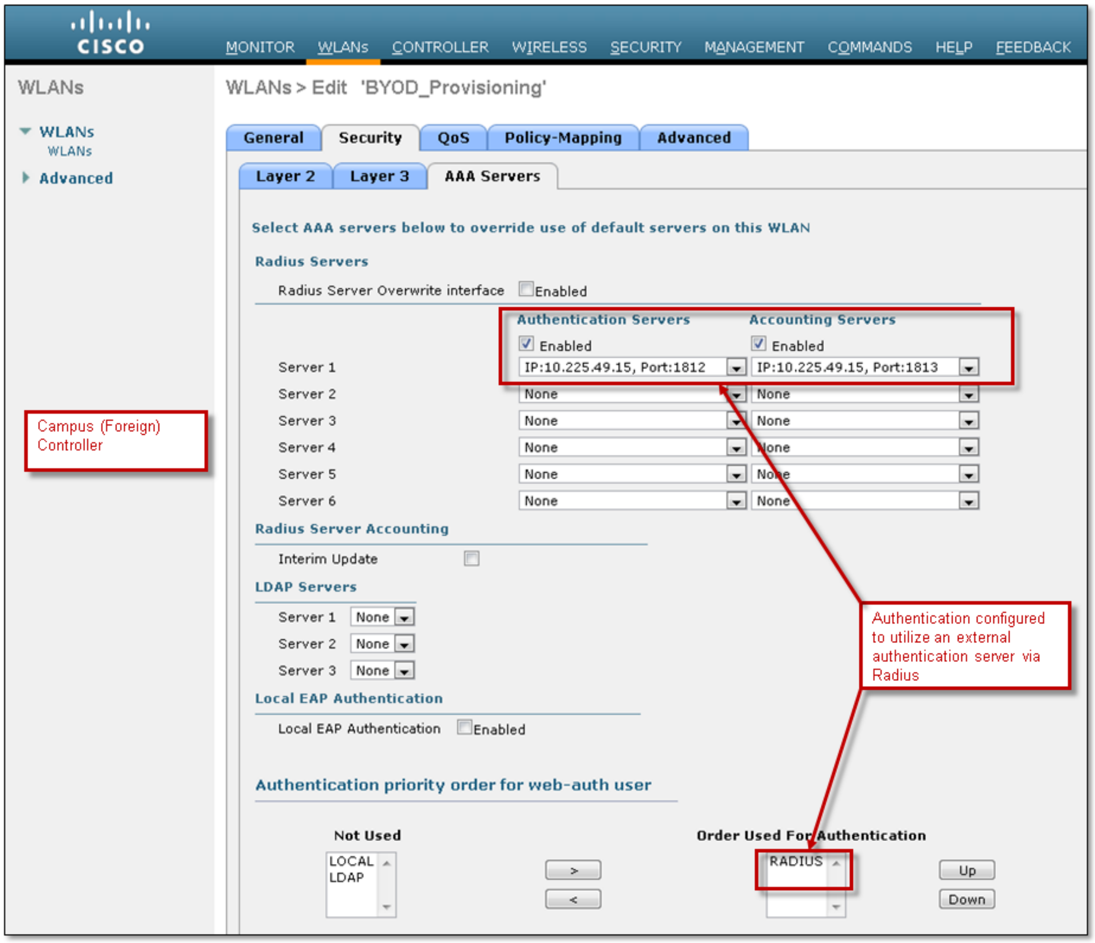
Campus (foreign) controller configured with a mobility anchor pointing to the management interface of the guest (anchor) controller

Campus (Foreign) Controller

Note that the campus controller and the guest controller must be part of the same mobility group before the mobility anchor can be configured. The mobility anchors establish the mobility tunnel through which packets from the wireless client are automatically encapsulated and sent from the campus controller to the guest controller where they are de-capsulated and delivered to the wired network.

The network administrator must also configure the employee personal devices WLAN to use RADIUS within the campus controller for authentication. This is shown in Figure 18-9.

Figure 18-9 Authentication via RADIUS for the Employee Personal Devices WLAN on the Campus Controller



WLANs > Edit 'BYOD_Provisioning'

Select AAA servers below to override use of default servers on this WLAN

Radius Servers

Radius Server Overwrite interface □ Enabled

	Authentication Servers	Accounting Servers
	☑ Enabled	☑ Enabled
Server 1	IP:10.225.49.15, Port:1812	IP:10.225.49.15, Port:1813
Server 2	None	None
Server 3	None	None
Server 4	None	None
Server 5	None	None
Server 6	None	None

Radius Server Accounting

Interim Update □

LDAP Servers

Server 1 None
Server 2 None
Server 3 None

Local EAP Authentication

Local EAP Authentication □ Enabled

Authentication priority order for web-auth user

Not Used	Order Used For Authentication
LOCAL LDAP	RADIUS

Campus (Foreign) Controller

Authentication configured to utilize an external authentication server via Radius

Since Web Auth is not involved with this option, there is no redirection of web sessions to a guest portal and hence no configuration required within the guest controller for Web Auth or any requirement for a pre-authentication ACL. When an employee personal device connects to the SSID, the RADIUS session is initiated by the campus controller management interface to the Cisco ISE server for authentication and authorization. Upon successful authentication, the employee's personal device is then anchored to the guest controller.

Converged Access (IOS XE Based) Wireless Controller Configuration

The following partial configuration shows an example of the employee personal devices WLAN along with part of the AAA server configuration on an IOS XE based wireless controller.

```
!
aaa new-model
!
aaa authentication login default enable
aaa authentication dot1x default group radius
aaa authorization network default group radius
aaa accounting dot1x default start-stop group radius
!
aaa server radius dynamic-author
 client 10.225.49.15 server-key 7 032A4802120A701E1D5D4C
!
aaa session-id common
!
dot1x system-auth-control
!
ip http server
!
radius-server attribute 6 on-for-login-auth
radius-server attribute 8 include-in-access-req
radius-server attribute 25 access-request include
radius-server attribute 31 send nas-port-detail
radius-server dead-criteria time 5 tries 3
radius-server host 10.225.49.15 auth-port 1812 acct-port 1813 key 7 1237161E060E5D56797F71
!                  /Radius server in the line above points to ISE
!
wlan BYOD_Personal_Device 4 BYOD_Personal_Device/Defines the personal devices WLAN and 
SSID
 client vlan Guest/Static assignment to non-routed (isolated) VLAN
 mobility anchor 10.225.50.35/Creates an anchor tunnel to the guest wireless controller
 session-timeout 1800
 no shutdown   /Enables the employee devices WLAN
!
```

By default WPA2 with AES as the cipher is enabled, along with 802.1X authenticated key management. Hence they do not show up in the configuration. The administrative-level **show wlan id <*wlan ID number*>** command can be used to display additional details regarding the configuration of the WLAN, including default values which do not appear within the configuration.

The employee devices WLAN must be configured on the device which functions as the Mobility Agent (MA) and on the device which functions as the Mobility Controller (MC). Therefore the configuration above is basically the same, regardless of whether a Catalyst 3850 Series switch is deployed as both the MA and MC within a branch deployment, a Catalyst 3850 Series switch is deployed as only an MA within a campus deployment, or a CT5760 wireless controller is deployed as an MA and MC within a campus deployment.

The Guest client VLAN in the configuration above is a VLAN which is isolated on the CT5760 wireless controller or Catalyst 3850 Series switch. It is not trunked to the adjacent Layer 3 device. This isolates any guest devices should the CAPWAP tunnel between the foreign and anchor controllers go down.

The following partial configuration example shows the configuration of the mobility group and mobility group members on an IOS XE based wireless controller.

```
!
wireless mobility group member ip 10.225.50.35 public-ip 10.225.50.35/Guest Controller
wireless mobility group name byod/Mobility group name
!
```

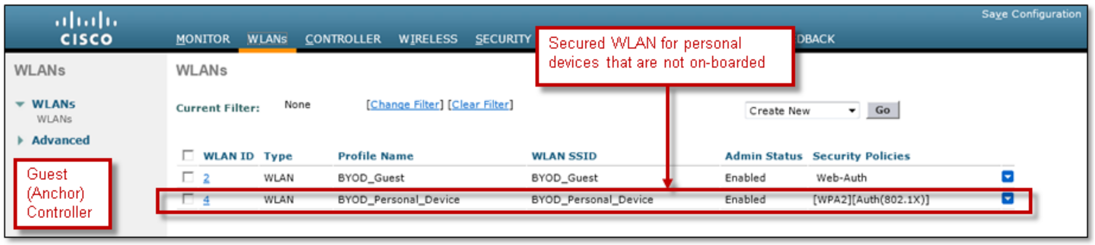
The mobility group name and mobility group peers must appear on the device which functions as the Mobility Controller (MC). Therefore, when a Catalyst 3850 Series switch is deployed as both the MA and MC within a branch deployment, the configuration must include the above two lines. A Catalyst 3850 Series switch deployed as only an MA within a campus deployment would not include the mobility group configuration. Instead the CT5760 wireless controller deployed as a MA and MC within a campus would contain the mobility group configuration. Note that since IOS XE based wireless controllers only support the new hierarchical mobility architecture; no configuration is required to enable it.

Note Cisco wireless controllers currently support two different mobility architectures. The old mobility architecture relies on Ethernet-over-IP tunnels between wireless controllers. The new mobility architecture, also called the hierarchical mobility architecture, relies on CAPWAP tunnels between wireless controllers. The two mobility architectures are not compatible with each other. If mobility (including the auto-anchoring function) is required between wireless controllers, all wireless controllers must be running either the new mobility or the old mobility architecture. The new mobility architecture is supported on Cisco 5508 and WiSM2 wireless controllers with software release 7.3.112 and on the Cisco 5508, WiSM2, and 2504 wireless controllers with software release 7.5. The new mobility architecture is supported on the Cisco 5760 wireless controller and the Catalyst 3850 Series switch with IOS XE software releases 3.2.0SE and 3.2.2SE. CUWN wireless controller release 7.4 and releases below 7.3.112 support only the old mobility architecture. The Cisco Flex 7500, 8500, and vWLC do not support the new mobility architecture. IOS XE based wireless controllers do not support the old mobility architecture. Hence if a network contains both Flex 7500 wireless controllers and Converged Access controllers, then separate sets of guest wireless controllers must be deployed with the DMZ to support both mobility architectures with the guest wireless design discussed in this design guide.

Guest Controller Configuration

The guest controller is the point where all the employee device traffic is terminated. For this version of the design guide, the discussion only includes a CT5508 CUWN wireless controller as the guest controller. An example of a guest controller configuration for the employee personal devices WLAN is shown in Figure 18-10.

Figure 18-10 Example Configuration of a Guest Wireless Controller for the Employee Personal Devices WLAN



WLANs

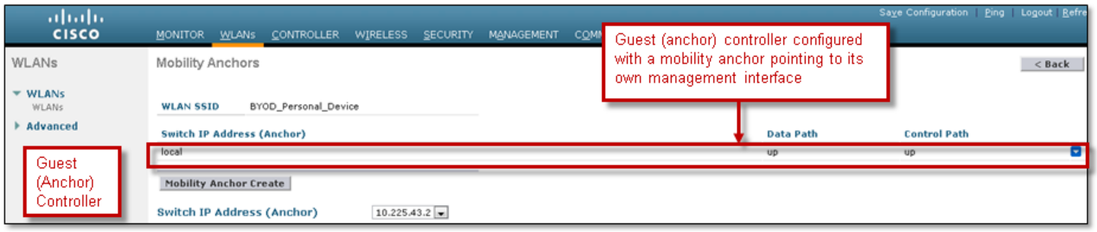
Current Filter: None [Change Filter] [Clear Filter]

□ WLAN ID	Type	Profile Name	WLAN SSID	Admin Status	Security Policies
□ 2	WLAN	BYOD_Guest	BYOD_Guest	Enabled	Web-Auth
□ 4	WLAN	BYOD_Personal_Device	BYOD_Personal_Device	Enabled	[WPA2][Auth(802.1X)]

As can be seen, the configuration of the WLAN on the guest controller must match the configuration of the WLAN on the campus controller.

The guest controller needs to be configured with a mobility anchor pointing at itself. An example is shown in Figure 18-11.

Figure 18-11 Example Configuration of the Mobility Anchor on a Guest CUWN Wireless Controller



Mobility Anchors

WLAN SSID BYOD_Personal_Device

Switch IP Address (Anchor)	Data Path	Control Path
local	up	up

Switch IP Address (Anchor) 10.225.43.2

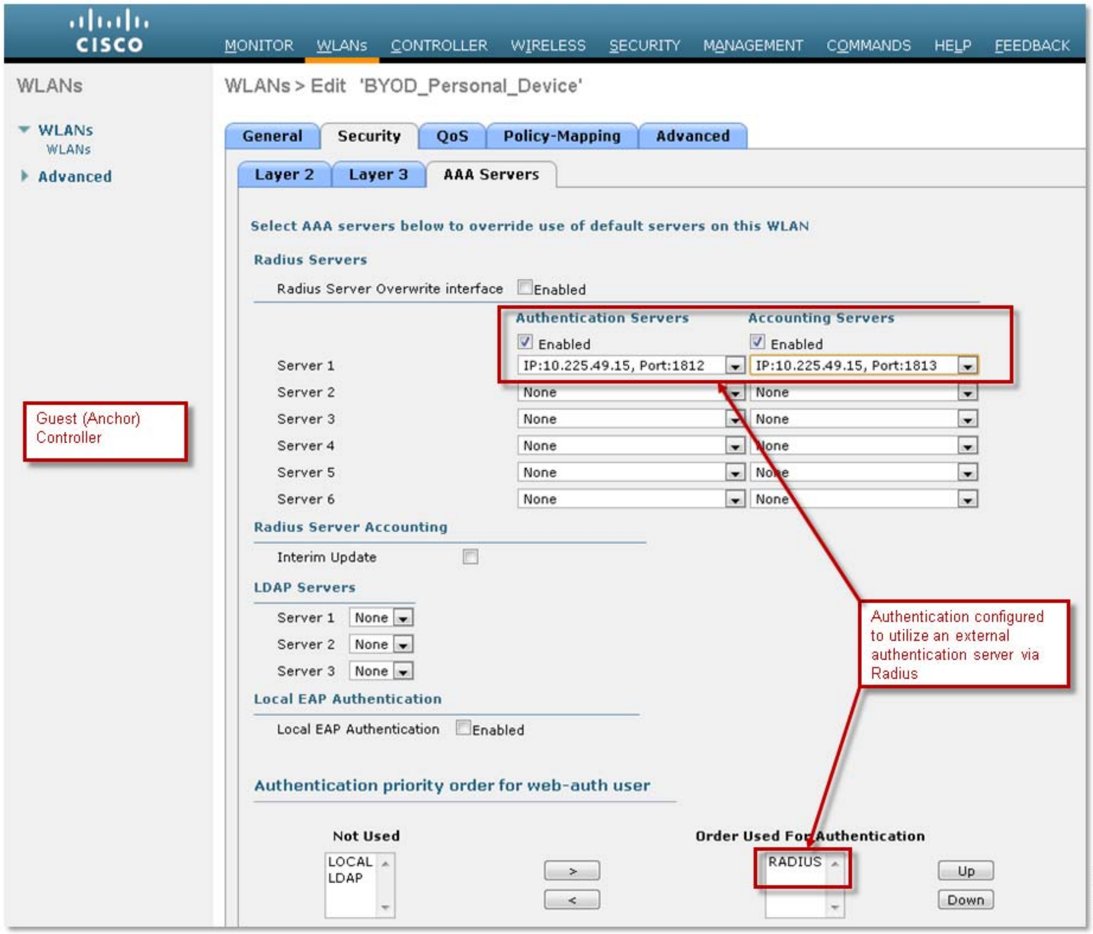
Guest (anchor) controller configured with a mobility anchor pointing to its own management interface

Guest (Anchor) Controller

Again, this assumes the campus controller and the guest controller are configured to be part of the same mobility group before the mobility anchor is configured.

The network administrator must also configure the employee personal devices WLAN to use RADIUS within the guest controller for authentication. This is shown in Figure 18-12.

Figure 18-12 Authentication via RADIUS for the Employee Personal Devices WLAN on the Guest Controller



WLANs > Edit 'BYOD_Personal_Device'

Select AAA servers below to override use of default servers on this WLAN

Radius Servers

Radius Server Overwrite interface □ Enabled

	Authentication Servers	Accounting Servers
	☑ Enabled	☑ Enabled
Server 1	IP:10.225.49.15, Port:1812	IP:10.225.49.15, Port:1813
Server 2	None	None
Server 3	None	None
Server 4	None	None
Server 5	None	None
Server 6	None	None

Radius Server Accounting

Interim Update □

LDAP Servers

Server 1 None
Server 2 None
Server 3 None

Local EAP Authentication

Local EAP Authentication □ Enabled

Authentication priority order for web-auth user

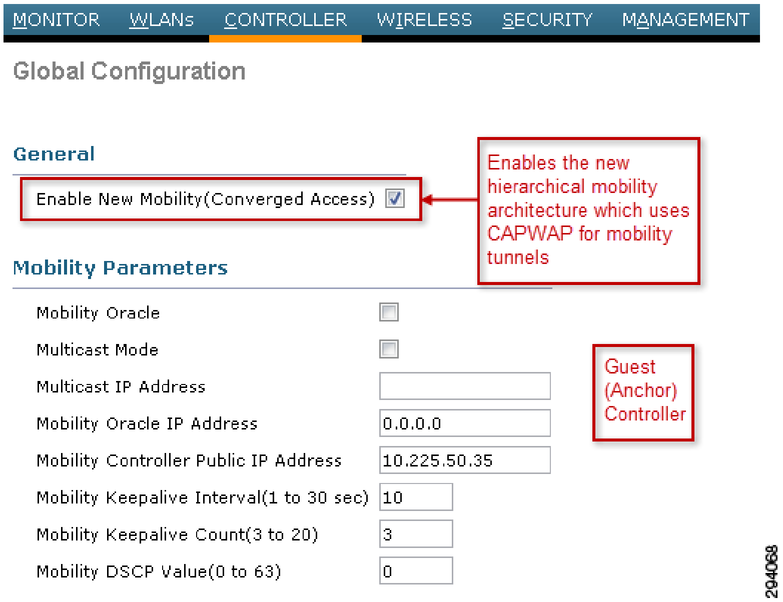
Not Used	Order Used For Authentication
LOCAL LDAP	RADIUS

Guest (Anchor) Controller

Authentication configured to utilize an external authentication server via Radius

Finally, in order to support the new mobility architecture (also referred to as the hierarchical mobility architecture), the network administrator must check the Enable Hierarchical Architecture option within the global mobility configuration of both the campus and guest controller. An example is shown in Figure 18-13.

Figure 18-13 Enabling the Hierarchical Mobility Architecture



Global Configuration

General

Enable New Mobility(Converged Access) ☑

Enables the new hierarchical mobility architecture which uses CAPWAP for mobility tunnels

Mobility Parameters

Mobility Oracle	□
Multicast Mode	□
Multicast IP Address	
Mobility Oracle IP Address	0.0.0.0
Mobility Controller Public IP Address	10.225.50.35
Mobility Keepalive Interval(1 to 30 sec)	10
Mobility Keepalive Count(3 to 20)	3
Mobility DSCP Value(0 to 63)	0

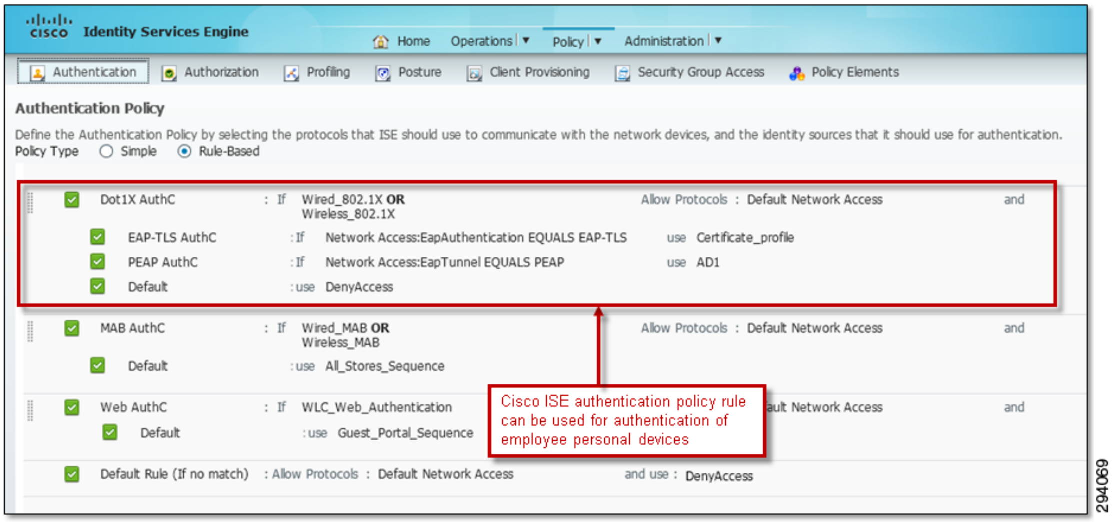
Guest (Anchor) Controller

Note Since the Flex 7500 wireless controller does not support the new mobility architecture, this step can be skipped in deployments involving a Flex 7500 as the branch wireless controller.

Cisco ISE Policy Configuration

From a Cisco ISE policy perspective, the existing authentication rule—which is used to support both the on-boarding of corporate-owned (IT-managed) devices and the authentication of on-boarded corporate-owned devices within the Limited Access use case—can also be used to support wireless employee personal devices for the Basic Access use case. An example of such a policy rule is shown in Figure 18-14.

Figure 18-14 Example of Cisco ISE Authentication Policy Allowing Wireless Employee Personal Device Access



Authentication Policy

Define the Authentication Policy by selecting the protocols that ISE should use to communicate with the network devices, and the identity sources that it should use for authentication.

Policy Type ○ Simple ● Rule-Based

☑ Dot1X AuthC : If Wired_802.1X **OR** Wireless_802.1X Allow Protocols : Default Network Access and
- ☑ EAP-TLS AuthC :If Network Access:EapAuthentication EQUALS EAP-TLS use Certificate_profile
- ☑ PEAP AuthC :If Network Access:EapTunnel EQUALS PEAP use AD1
- ☑ Default :use DenyAccess

☑ MAB AuthC : If Wired_MAB **OR** Wireless_MAB Allow Protocols : Default Network Access and
- ☑ Default :use All_Stores_Sequence

☑ Web AuthC : If WLC_Web_Authentication ...ult Network Access and
- ☑ Default :use Guest_Portal_Sequence

☑ Default Rule (If no match) : Allow Protocols : Default Network Access and use : DenyAccess

Cisco ISE authentication policy rule can be used for authentication of employee personal devices

The logical format of the authentication policy rule for this example is:

```
IF (Wired_802.1X OR Wireless_802.1X)
    THEN (Allow Default Network Access AND
        IF Network Access:EapAuthentication EQUALS EAP-TLS USE Certificate_Profile
        IF Network Access:EapTunnel EQUALS PEAP USE AD1
        ELSE Default EQUALS DenyAccess)
```

Wired_802.1X is a system-generated compound condition that is used here to match 802.1X-based authentication requests from switches. It matches the following two standard RADIUS dictionary attribute-value (AV) pairs:

```
Service-Type - [6] EQUALS Framed
NAS-Port-Type - [61] EQUALS Ethernet
```

Wireless_802.1X is a system-generated compound condition that is used here to match 802.1X-based authentication requests from Cisco wireless controllers. It matches the following two standard RADIUS dictionary attribute-value (AV) pairs:

```
Service-Type - [6] EQUALS Framed
NAS-Port-Type - [61] EQUALS Wireless - IEEE 802.11
```

Default Network Access is a system-generated authentication result, which allows various EAP protocols to be used for authentication.

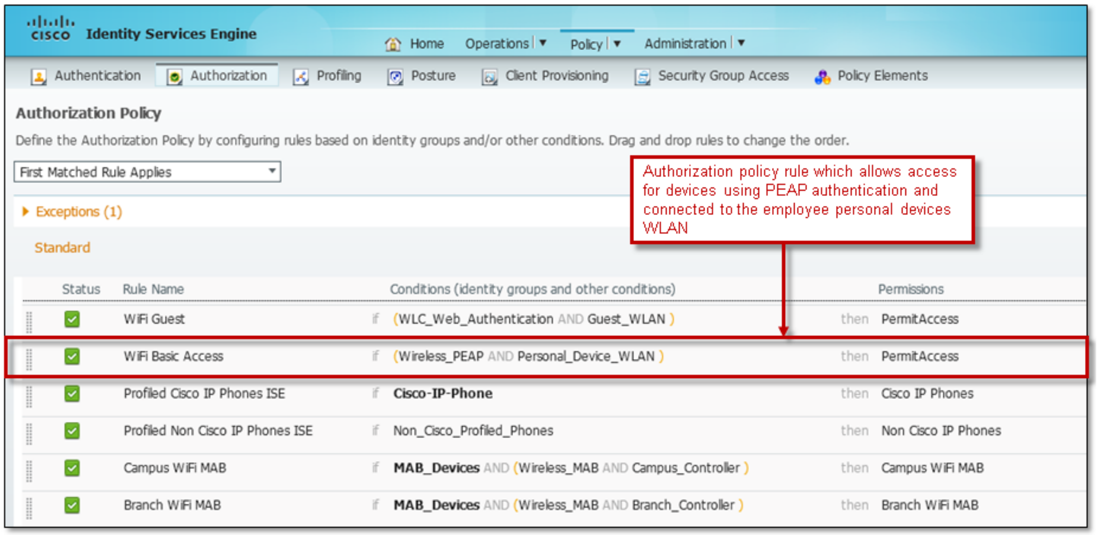
Certificate_Profile is a user-defined Certificate Authentication Profile configured under the External Identity Sources section of the Cisco ISE server.

AD1 corresponds to the Microsoft Active Directory identity store, where employee credentials are typically held within an organization.

For the Basic Access use case, wireless employee personal devices which use PEAP for authentication will match on the second condition—**IF Network Access:EapTunnel EQUALS PEAP USE AD1**—causing these devices to proceed to the authorization phase. Note that the example above works for employee personal devices which utilize PEAP authentication only. If the customer requires other authentication or EAP methods, additional conditions would need to be added to the above authentication policy rule. These conditions could also use the AD1 Microsoft Active Directory identity store to verify employee user credentials. Alternatively, the default condition could be changed from denying access to also using the AD1 identity store.

From a Cisco ISE policy perspective, an additional authorization rule needs to be added in order to support the Basic Access use case. This rule permits access for devices using PEAP authentication, which originate from the SSID corresponding to the employee personal devices WLAN. An example of the policy rule is shown in Figure 18-15.

Figure 18-15 Example of Cisco ISE Authorization Policy Allowing Wireless Employee Personal Device Access



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.

First Matched Rule Applies ▾

▸ Exceptions (1)

Standard

Authorization policy rule which allows access for devices using PEAP authentication and connected to the employee personal devices WLAN

Status	Rule Name		Conditions (identity groups and other conditions)		Permissions
☑	WiFi Guest	if	(WLC_Web_Authentication AND Guest_WLAN)	then	PermitAccess
☑	WiFi Basic Access	if	(Wireless_PEAP AND Personal_Device_WLAN)	then	PermitAccess
☑	Profiled Cisco IP Phones ISE	if	**Cisco-IP-Phone**	then	Cisco IP Phones
☑	Profiled Non Cisco IP Phones ISE	if	Non_Cisco_Profiled_Phones	then	Non Cisco IP Phones
☑	Campus WiFi MAB	if	**MAB_Devices** AND (Wireless_MAB AND Campus_Controller)	then	Campus WiFi MAB
☑	Branch WiFi MAB	if	**MAB_Devices** AND (Wireless_MAB AND Branch_Controller)	then	Branch WiFi MAB

The logical format of the authorization policy rule for this example is:

```
IF (Wireless_PEAP AND Personal_Device_WLAN)
    THEN PermitAccess
```

Wireless_PEAP is a user-defined compound authorization condition that is used here to match authentication requests from wireless PEAP devices. It matches the following two standard RADIUS dictionary attribute-value (AV) pairs, along with a Network Access condition which specifies the use of PEAP.

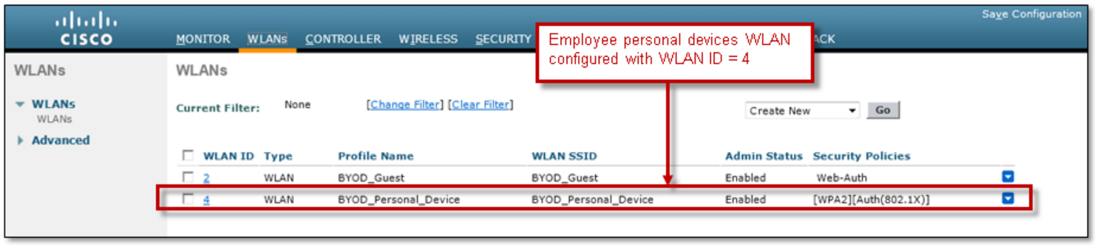
```
Service-Type - [6] EQUALS Framed
NAS-Port-Type - [61] EQUALS Wireless - IEEE 802.11
Network Access:EapTunnel EQUALS PEAP
```

Personal_Device_WLAN is a user-defined simple authorization condition for employee personal devices that access the network via the WLAN corresponding to the employee personal devices SSID. It matches the following RADIUS AV pair from the Airespace dictionary:

```
Airespace-Wlan-Id - [1] EQUALS 4
```

The Airespace-Wlan-Id is the identification number (WLAN ID) of the WLAN corresponding to the employee personal devices SSID. This is shown in Figure 18-16.

Figure 18-16 Example Wireless Controller WLAN IDs Showing Employee Personal Devices WLAN and SSID



Employee personal devices WLAN configured with WLAN ID = 4

WLANs

Current Filter: None [Change Filter] [Clear Filter]

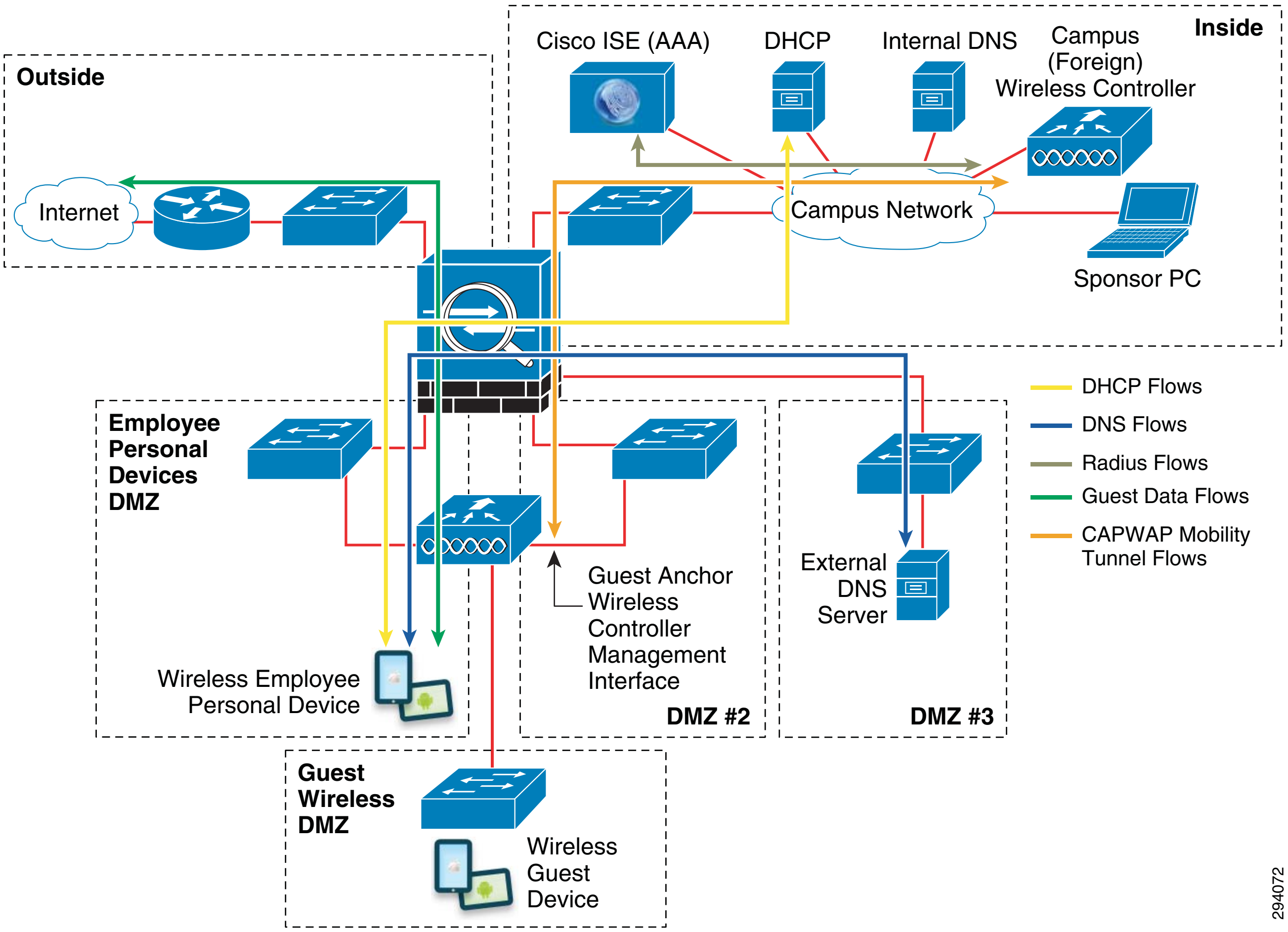
□ WLAN ID	Type	Profile Name	WLAN SSID	Admin Status	Security Policies
□ 2	WLAN	BYOD_Guest	BYOD_Guest	Enabled	Web-Auth
□ 4	WLAN	BYOD_Personal_Device	BYOD_Personal_Device	Enabled	[WPA2][Auth(802.1X)]

Note that this WLAN ID must be consistent across the entire BYOD deployment. This rule allows the ISE authorization policy to differentiate 802.1X authentication requests coming from the employee personal devices SSID and simply permit access. A WLAN ID cannot be changed on an existing WLAN. To change a WLAN ID, the WLAN must be removed and created again.

ASA Firewall Configuration

Figure 18-17 shows an example of the flows that need to pass through the Cisco ASA firewall to support this option.

Figure 18-17 Example of Flows that Need to Pass Through the Cisco ASA Firewall for Employee Personal Devices



The RADIUS session is initiated by the campus (foreign) wireless controller management interface to the Cisco ISE server for authentication and authorization. Therefore it does not need to be allowed through the ASA firewall for employees who are authenticating with personal devices. If using the newer hierarchical mobility architecture (as indicated in Figure 18-17), a CAPWAP auto-anchor mobility tunnel (UDP ports 5246 and 5247) between the management interfaces of the two wireless controllers must be allowed through the ASA firewall. If using the older mobility tunnel architecture, an Ethernet-over-IP (IP protocol 97) auto-anchor mobility tunnel, as well as the WLAN control port (UDP port 16666) between the management interfaces of the two wireless controllers, must be allowed through the ASA firewall.

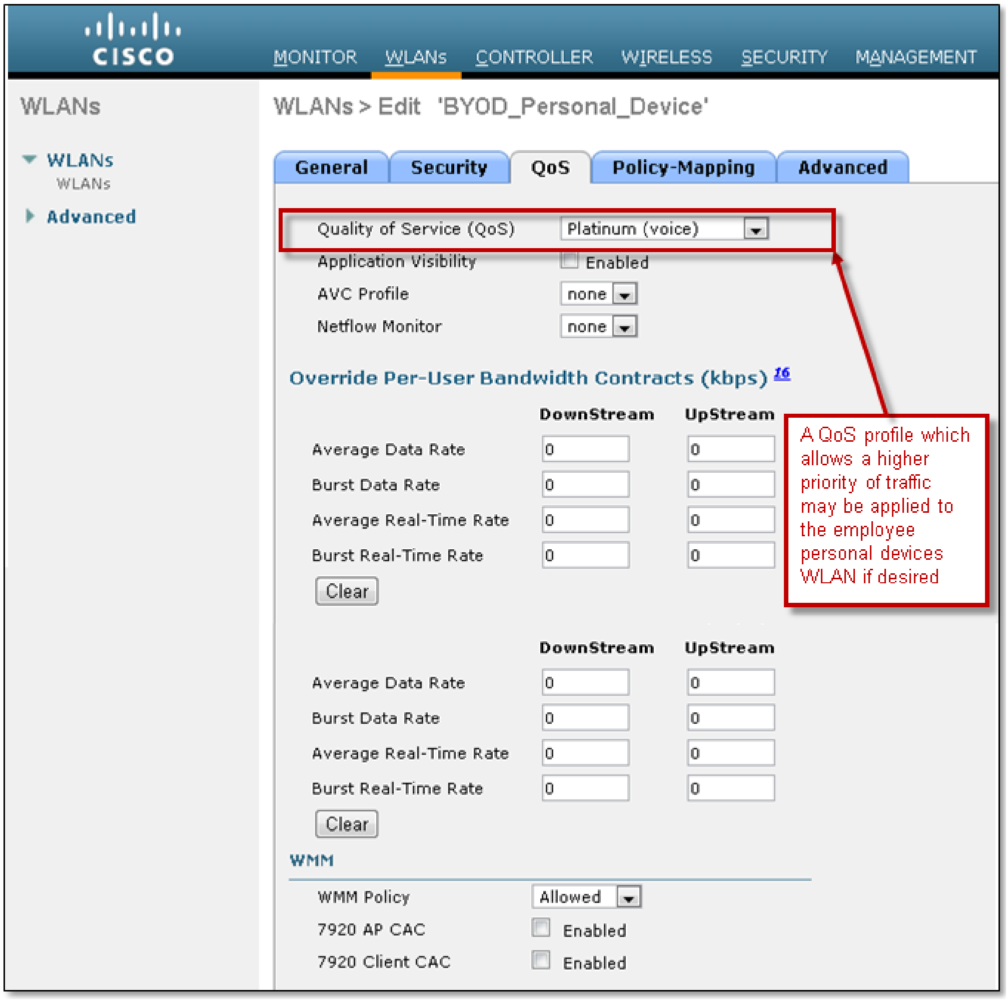
Besides allowing DNS and DHCP (assuming the deployment of an internal DHCP server), the ASA firewall should be configured to block all other traffic generated from employee personal devices onto the internal network. Additional ports can be opened to accommodate the access of corporate resources as discussed in the following section and summarized in Table 21-2.

Note Additional ASA firewall ports may need to be opened to accommodate guest wireless access, depending upon the deployment model discussed in Chapter 21, “BYOD Guest Wireless Access.”

Differentiated Quality of Service Treatment

With this deployment model, a separate QoS policy can be applied to employee personal devices, different from guest wireless devices. This is because wireless employee personal devices are terminated on a separate WLAN from wireless guest devices. For CUWN wireless controllers, as of software version 7.2, QoS is applied per WLAN by way of a profile, as shown in Figure 18-18.

Figure 18-18 Example of QoS Profile Applied to a WLAN



WLANs > Edit 'BYOD_Personal_Device'

Quality of Service (QoS)	Platinum (voice)
Application Visibility	☐ Enabled
AVC Profile	none
Netflow Monitor	none

Override Per-User Bandwidth Contracts (kbps) [16]

	DownStream	UpStream
Average Data Rate	0	0
Burst Data Rate	0	0
Average Real-Time Rate	0	0
Burst Real-Time Rate	0	0

	DownStream	UpStream
Average Data Rate	0	0
Burst Data Rate	0	0
Average Real-Time Rate	0	0
Burst Real-Time Rate	0	0

WMM

WMM Policy	Allowed
7920 AP CAC	☐ Enabled
7920 Client CAC	☐ Enabled

A QoS profile which allows a higher priority of traffic may be applied to the employee personal devices WLAN if desired

Note IOS XE based wireless controllers support much more extensive QoS capabilities. However they also have the ability to support similar QoS per WLAN based on the older profiles model of CUWN wireless controllers. This version of the design guide does not address QoS on IOS XE based wireless controllers. Future versions will discuss this topic more thoroughly.

This may be desirable if employee personal devices are going to be allowed to run virtual desktop client applications such as a Citrix client or VMware client or if employee personal devices run collaboration clients such as Cisco Jabber.

Note Chapter 21, "BYOD Guest Wireless Access" discusses rate limiting per-SSID and per-User. These features can be used for employee personal devices as they were for guest devices. Rate limiting is configured on the campus (foreign) controller and not the guest (anchor) controller.

Accessing Corporate Resources

Because employee devices are associated to the network from a DMZ interface, which is effectively outside of the corporate firewall, they do not have access to company resources located inside the firewall. This may be perfectly acceptable and desirable. Employee devices still have access to the public Internet. This enables them to connect to cloud-based resources such as Cisco WebEx or partner websites. The employee device is afforded some level of usability, making the device useful as a productivity tool.

Companies may want to offer access to additional resources but still maintain the security offered by restricting employee devices to the guest side of the firewall. There are various options available to accomplish this objective, including:

- Setting up a mirror of the company website
- Allowing VPN access
- Allowing virtual desktop client access

Securing Mirror Sites for Personal Devices

One approach to bringing services to employee personal devices accessing the guest network is to set up a mirror of the company website in another DMZ segment, referred to as an employee device security zone (EDSZ) within this section. If employee personal devices connect to the guest wireless network, the website will only be accessible after the user has completed the Web Auth process and accepted an Acceptable Use Policy (AUP) or End User Agreement (EUA). This website does not need to be an exact match of an internal website, but could contain relevant content that employees can use on their personal devices to make them more effective. In addition, the website could include content optimized for smaller mobile displays. Examples of applications that could be offered in the EDSZ include access to email, a team wiki page, or the company news site.

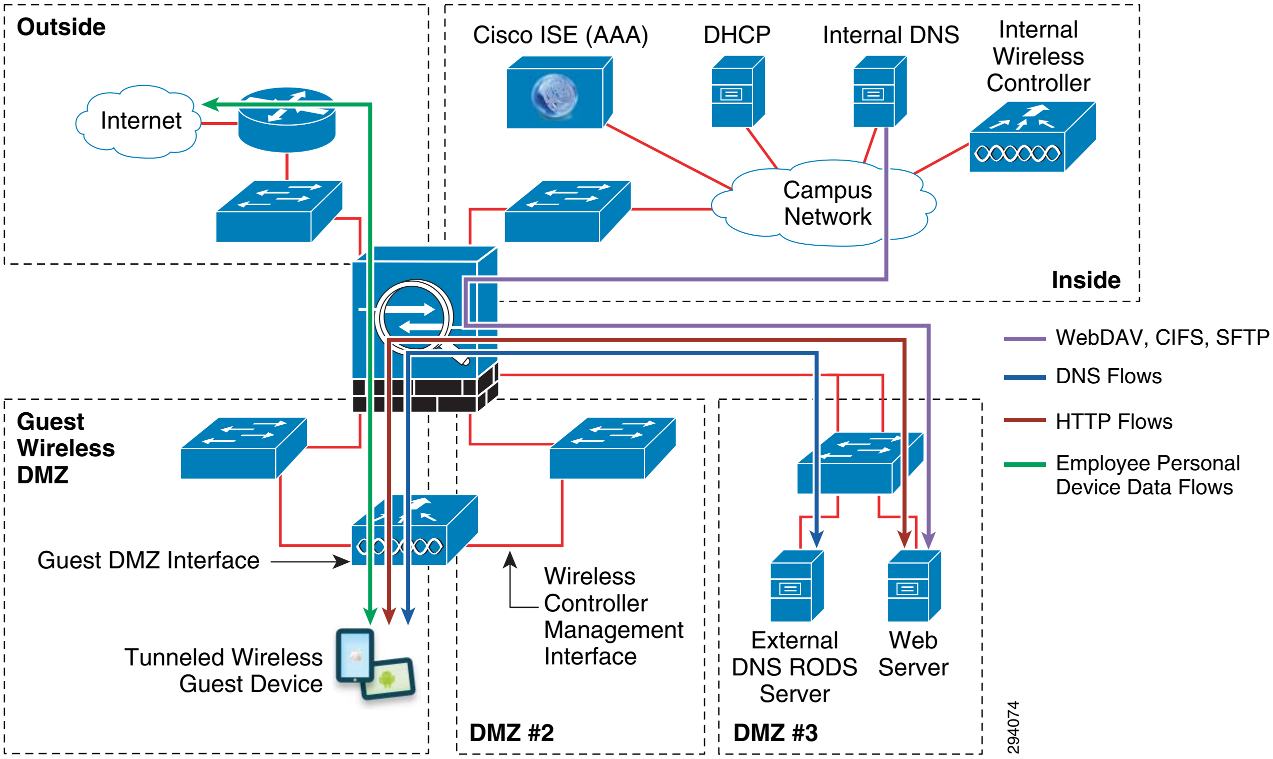
There are several methods available to setup a secure website. In general, the deployment is very similar to a typical DMZ web service, except that rather than residing in an Internet facing DMZ, the server is located on a subnet accessible by employee personal devices. The intent of this section is not to provide detailed guidance on the deployment of a presentation server, application server, and database server. Site administrators should be familiar with the approach that best fits their security environment. Some high level considerations when setting up the server include:

- Dual attachment—Usually this is considered to be more secure. The client-side NIC should implement firewall services that allow inbound connections on TCP port 80 or 443. Only session requests initiated by the client subnets should be allowed towards the server. Session requests initiated by the server should not be allowed towards the client subnets. If the employee device wireless network is encrypted, then some organizations may be comfortable allowing users to attach via HTTP.

- The back-end NIC should be used to move content between the server and the data store or application server. It may also be allowed for remote administration of the site. Single-attached servers are possible although usually a dedicated and secured gateway is setup for the server-to-server communications that is separate from the server-to-web client gateway.
- Content Delivery—Generally content is either static or dynamic. Static content can be pushed overnight or as needed to keep the website current. Dynamic content could allow the employee device to post information to the site. The website could use a local data store that is synchronized with an external data store or have a secured channel to an application server.
- User Authentication—Some method should be used to ensure only authorized and authenticated users are able to view site content. Utilizing Microsoft Active Directory or a local user database are two possible methods. Active Server pages (ASP.NET) can also be used to leverage the login controls used with Microsoft Internet Information Server (IIS) servers and provide a more sophisticated authentication model such as single sign-on (SSO). Local databases are easier to setup but require a high level of administrative overhead and are usually only appropriate in very small organizations.
- Secure Sockets—Websites in the employee device security zone (EDSZ) should implement secure socket layer (SSL) or transport layer security (TLS) if employees are sending sensitive information, such as their login credentials. This can be relaxed somewhat if the EDSZ has been implemented with wireless encryption. On the other hand, if employee devices reside in the traditional guest network where wireless packets are not typically protected with encryption and are co-mingled with actual guest traffic, then SSL/TLS websites are needed. This is particularly important if employees are passing their corporate credentials to a mirror website.
- Web Server software—There is a wide range of web server software available. Deciding which type of server to deploy impacts what security features are available. Common choices include Microsoft IIS, Apple, and Tomcat. Wikipedia has a comparison of web server software that can illustrate the choices available (http://en.wikipedia.org/wiki/Comparison_of_web_server_software). It is also possible to host sites on a secure cloud service. This service could be restricted to IP addresses or require client side certificates. With proper security precautions, a cloud-based site could also allow mobile employees access to some traditional corporate resources such as payroll or benefits that are increasingly finding their way to the cloud.

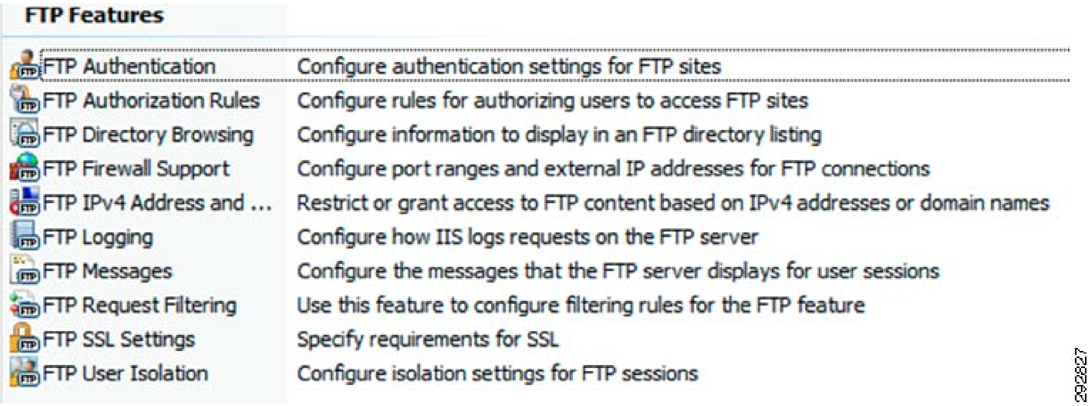
Figure 18-19 illustrates a simple scenario where static content is deployed in a DMZ dedicated for employees using personal devices. A Windows 2008 server is deployed with Microsoft IIS 7.0 as well as some other network services specific to the DMZ, such as DNS and Read-Only Directory Services (RODS). Users are authenticated against the corporate Microsoft Active Directory server. The RODS service requires DNS to be installed on the same server. The web server is typically a dedicated box. However, in some situations it may be desirable to run RODS and IIS on the same server to simplify basic authentication using Microsoft AD. It is more appropriate when supporting a small-to-modest number of employee devices.

Figure 18-19 Example of a Mirror Website for Employee Personal Devices



Moving content to the secured server can be done by various means. One approach is to use FTP, however because FTP is not secured, a better approach is to use either SFTP or FTP over SSL. By default, Microsoft IIS does not ship with a secure FTP server. Microsoft supports FTP over SSL rather than SFTP. Administrators must copy the installation package from Microsoft's website (http://learn.iis.net/page.aspx/310/what-is-new-for-microsoft-and-ftp-in-iis-7/) and install the feature on their server. If FTP is already running, the administrator needs to deselect the FTP feature from the services manager prior to installing the FTP over SSL server. The improved FTP over SSL server offers additional tools not available in the standard FTP package that are used to manage access to the FTP site, as shown in Figure 18-20.

Figure 18-20 Example of Tools Available with the FTP over SSL Server



FTP Features

FTP Authentication	Configure authentication settings for FTP sites
FTP Authorization Rules	Configure rules for authorizing users to access FTP sites
FTP Directory Browsing	Configure information to display in an FTP directory listing
FTP Firewall Support	Configure port ranges and external IP addresses for FTP connections
FTP IPv4 Address and ...	Restrict or grant access to FTP content based on IPv4 addresses or domain names
FTP Logging	Configure how IIS logs requests on the FTP server
FTP Messages	Configure the messages that the FTP server displays for user sessions
FTP Request Filtering	Use this feature to configure filtering rules for the FTP feature
FTP SSL Settings	Specify requirements for SSL
FTP User Isolation	Configure isolation settings for FTP sessions

Anonymous authentication should be disabled and at least basic authentication should be enabled. There are other options that may be appropriate from some organizations.

Instead of FTP over SSL, administrators can choose to use Web Distributed Authoring and Versioning (WebDAV). This method offers more flexibility than FTP because many operating systems allow the connection to be mounted to the file system. By providing a directory handle, web authoring applications as well as other applications can directly use the secured pipe. WebDAV is based on HTTP or HTTPS and provides the ability to authenticate and encrypt data. If employees are placed directly in the guest SSID, then WebDAV HTTPS should be used since passwords are sent. If employee devices are placed in an encrypted EDSZ, then WebDAV HTTPS could be used to provide an additional layer of encryption. The security considerations are detailed in section 20 of RFC4918.

Another option similar to WebDAV is CIFS. This protocol also allows local directory mounts of the remote site. It is commonly found in Microsoft environments, although Samba is available for non-Windows servers. Microsoft also supports SMB2 with Vista, Windows 7, and Windows 8, which is an update to CIFS. There are several other approaches that provide a secure path between either the web authoring site or the application server. A particular enterprise will likely leverage the same methods as the web servers located in the traditional DMZ.

DNS Support

The employee devices need access to a DNS server. If the EDSZ web server is using RODS, then DNS is already available on the Directory Server. It is installed by default when the RODS is setup unless the administrator explicitly chooses not to. Dynamic updates are secured and zone transfers are not enabled. If the web server is not using AD for employee authentication, then DNS will be a standalone service.

Outlook Web Access for Employee Devices

Email is a foundational service that can be offered to employee devices. This can be accomplished by deploying a web interface to the mail server such as Outlook Web Access (OWA) or ActiveSync for exchange environments. Some enterprises may already be offering this service for employees that need email while traveling. In this case, the employee devices can continue to use the current Internet facing OWA server.

Microsoft does not support the OWA server in a DMZ zone. Instead, the OWA server should be behind the firewall. Holes can be opened for port 443. Another option is to setup Apache in the EDSZ as a reverse proxy. The Microsoft recommended approach is to run OWA on the client access server (CAS) and publish the CAS with Microsoft's Internet security and acceleration (ISA) server into the EDSZ. This is a full blown deployment and may not be appropriate as a method to grant employee personal device access due to the complexity involved versus other methods, such as simply opening a hole in the EDSZ DMZ firewall for HTTPS to the enterprise CAS.

Another option is subscribing to Office365, which is Microsoft's cloud-based Exchange and Office environment. In this case, employees would use the public Internet service to gain access to their email or other cloud-based enterprise resources. At this time, there is not a native Office365 application for either Android or iOS devices and users would be restricted to HTTPS access unless they were using a Windows 8-based mobile device. This method would also allow Direct-To-Cloud over 3G/4G or off-premise accesses to the same resources. Microsoft is only one of many cloud based enterprise environments offering email services.

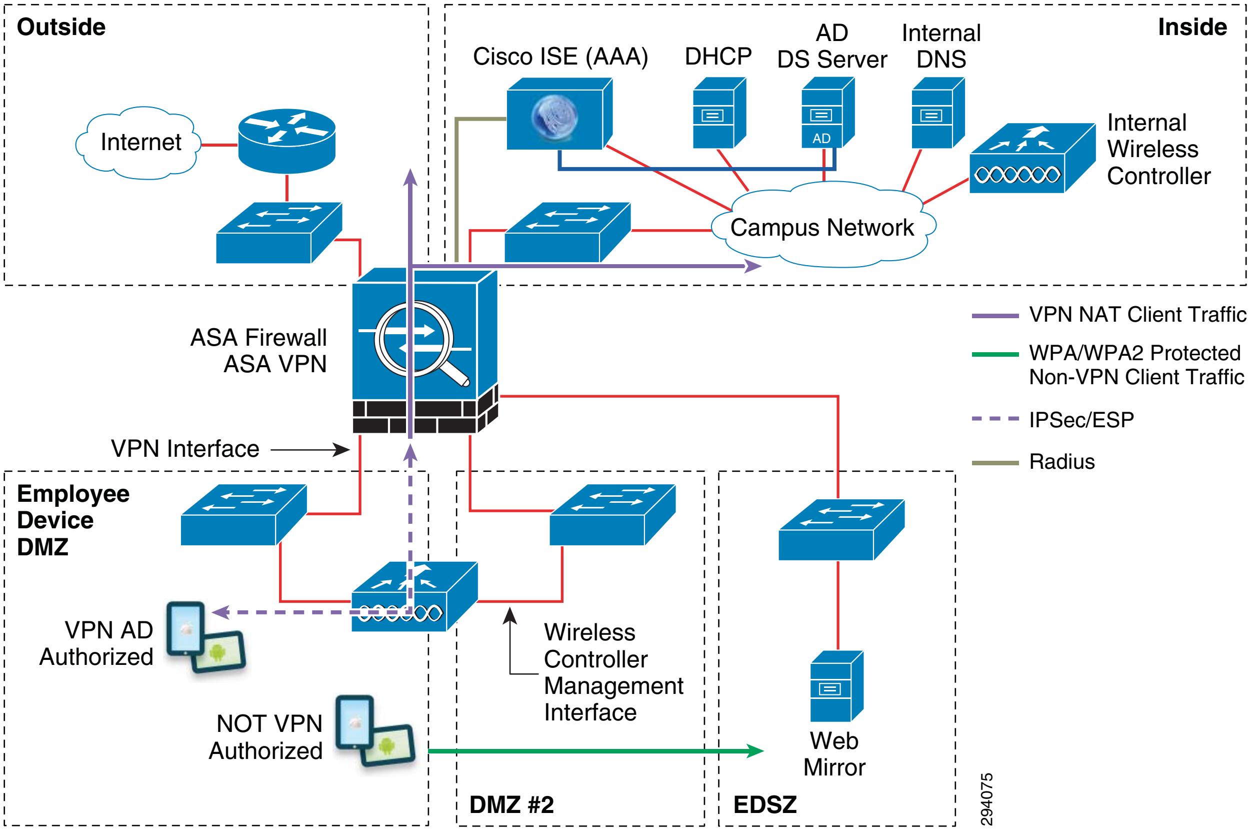
ActiveSync Support

Future versions of this document will discuss mobile device managers (MDM) that are used to manage the configuration profiles of mobile devices and provide additional security features needed for lost or stolen devices. Some of the MDM functionality is licensed from Microsoft, including remote-wipe, PIN lock enforcement, and others. ActiveSync is used to synchronize email, calendar events, and contacts between the Microsoft Exchange server and the mobile device's email application. Administrators may be interested in providing ActiveSync to devices in the employee device security zone (EDSZ). When properly configured and certified, ActiveSync can also provide the MDM security features mentioned previously. Providing this support is similar to OWA. The firewall policy in the EDSZ can be set to allow connections to ActiveSync on the CAS that may be published on an ISA server. ActiveSync is supported by WebDAV and should be used over HTTPS (TCP port 443).

VPN Client

Enterprises that restrict employee devices to a guest or dedicated EDSZ may want to allow a subset of these users the ability to launch the built-in VPN client to connect to the secured part of the network. There are two methods that can be employed. First, the device may already have access to the current Internet-facing VPN concentrator. In this case, the employee device would connect from the guest network out through the public Internet and then back in to the Internet DMZ where the VPN concentrator is located. If employee devices are co-mingled with actual guest traffic, then this may be the best approach. However, if a dedicated and secured SSID is deployed behind an ASA firewall specifically for employee personal devices, then this firewall could also provide VPN access for some privileged users. Alternatively, a dedicated VPN concentrator could be located in the EDSZ. After the device authenticates and joins the secured wireless domain, these users would connect to the VPN concentrator to gain additional secured access. Only employee devices in the dedicated security zone can reach the concentrator. The general layout of the network components are shown in Figure 18-21.

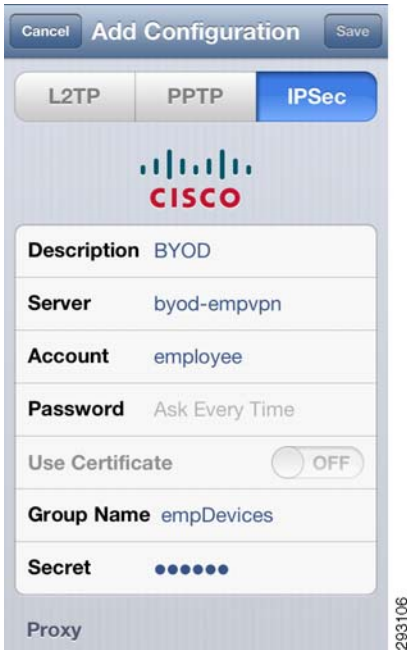
Figure 18-21 Employee Zone VPN Network Components



Apple iOS devices include a built-in Cisco IPSec client allowing ESP tunnel mode and XAUTH. Both Apple and Android devices offer L2TP with IPsec and pre-shared key (PSK). The ASA can be setup to accept both types of VPN clients. For this discussion, the focus is the Cisco VPN client found on Apple iOS devices.

The employee needs to know the name of the VPN concentrator, group, and group secret to configure the VPN client. Future version of this document will illustrate how the VPN configuration can be pushed to the employee device without user intervention. Certificates can also be pushed to the employee device to further secure access to the VPN concentrator. The use of certificates negates the need for a group and group secret.

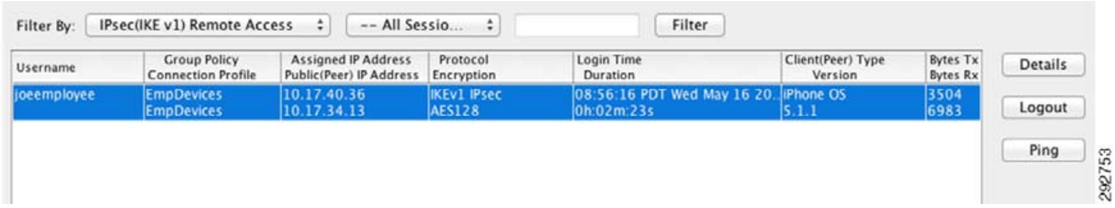
Figure 18-22 iOS VPN Client Configuration



Description	BYOD
Server	byod-empvpn
Account	employee
Password	Ask Every Time
Use Certificate	OFF
Group Name	empDevices
Secret	●●●●●●
Proxy	

When the user connects to the VPN concentrator, they are asked for their Microsoft AD credentials. This information is passed by the Cisco ASA to the Cisco ISE server, where a policy decision can be made. This decision can include attributes from Microsoft Active Directory or any of the other parameters Cisco ISE can use to determine policy. If the user is authenticated and authorized by Cisco ISE, the ASA completes the VPN connection. Once connected, the ASA can apply additional security and access restrictions to the tunnel, further controlling what resources the employee device can reach. The ASA can also be used to monitor who is using the VPN portal, as shown in Figure 18-23.

Figure 18-23 ASA Management for VPN Connections



Filter By: IPsec(IKE v1) Remote Access -- All Sessio... Filter

Username	Group Policy Connection Profile	Assigned IP Address Public(Peer) IP Address	Protocol Encryption	Login Time Duration	Client(Peer) Type Version	Bytes Tx Bytes Rx
joeemployee	EmpDevices EmpDevices	10.17.40.36 10.17.34.13	IKEv1 IPsec AES128	08:56:16 PDT Wed May 16 20.. 0h:02m:23s	iPhone OS 5.1.1	3504 6983

ASA provides additional information for managing VPN connections.

Virtual Desktop Client

Another available deployment model is to allow a virtual desktop to run on the employee device. The actual applications and associated data remain on the secured hosting server. Once the device disconnects from the network, the data is typically no longer available to the user. The enterprise can control which users are able to launch a virtual desktop and what applications are available on that desktop. The firewall between the EDSZ and the hosting server can be configured to allow specific connections.

There are a wide range of possibilities. In its simplest from, the employee could use VNC to connect back to their desktop or a dedicated server. A VNC client is available for both iOS and Android devices. This may be adequate for some small environments where availability and manageability are not a top priority. By default, the connection is not encrypted, which is a concern. Administrators may not have the necessary control over which applications are available on the hosting server. Employees may be tempted to attach to their desktop and send sensitive data to an external account via email or cloud file sharing services such as Dropbox and Google Drive. This temptation only arises as a means to bypass IT policy and should be considered before allowing remote desktops to attach to employee deployed VNC servers. The use case for employee devices with virtual VNC desktops needs careful review. The employee is likely sitting in front of the actual desktop, with a full keyboard and mouse and likely does not need a remote desktop. The best approach may be to block TCP port 5900 from traversing the firewall to unknown destinations.

Cisco offers the Cisco Virtual Workspace (VXI) Smart Solution and partners with several companies that offer a virtual desktop on mobile iOS and Android devices including VMware View, Citrix, and WYSE. Virtual desktops on employee devices are best suited in VXI environments where a centralized UCS server is securing and managing sessions. With VXI in place for corporate devices, extending access to employee devices may allow productivity gains. This can be done by opening the firewall to allow a connection to specific and well known servers. Beyond BYOD, virtual desktops are compelling because of the reduction in IT costs. Adding tablet support maximizes the benefit because the requirement for employee laptops is reduced. A small and lightweight VDI hardware appliance replaces the traditional desktop, and mobile device support un-tethers the employee from the cube. Tablets with virtual desktops can offer much of the same functionality as employee laptops, but at a reduced cost and with stronger tools to address lost and stolen devices plus centralized data security inherent in VXI.

Finally AnyConnect provides a centralized virtual desktop that integrates with the ASA firewall. This is a good approach because security is the foundation of the system. AnyConnect desktops attach to the ASA firewall via SSL. Virtual desktops are evolving in capabilities and will be covered in more detail the next release of this document.

Summary

These types of alternate solutions offer a wide range of options to provide employees compute resources without compromising corporate data. Leveraging the guest environment can serve as part of a migration path to a fully certificate-based BYOD solution. Guest type deployments can be set up fairly quickly without the need to touch a large number of third-party devices and yet still meet the basic requirement of allowing employees to use their personal devices to increase the organization’s productivity.

CHAPTER 19

User Experience—How To On-board a BYOD Device

Revised: September 27, 2013

The Cisco ISE allows employees to be in charge of on-boarding their own devices through a self-registration workflow and simplifies the automatic provisioning of supplicants as well as certificate enrollment for the most common BYOD devices. The workflow supports iOS, Android, Windows, and Mac OS devices and assists in transitioning these devices from an open environment to a secure network with the proper access based on device and user credentials.

The simple workflow provides a positive experience to employees provisioning their own device and allows IT to enforce the appropriate access policies.

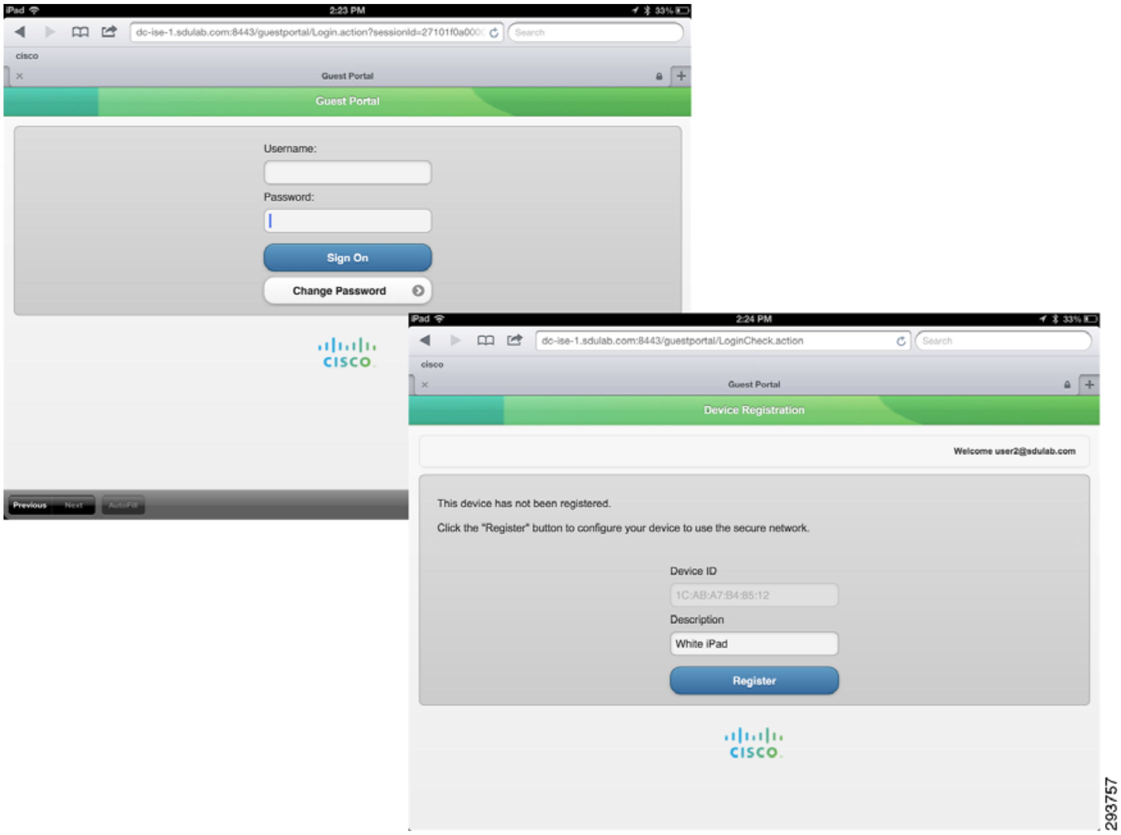
Apple iOS Devices

The employee connects to the provisioning SSID and is redirected to the Guest Registration portal for registration after opening a browser. The employee logs in using their Active Directory credentials.

If the device is not yet registered, the session is redirected to the self-registration portal, where the user is asked to enter a description for the new device. The employee is not allowed to change the Device ID (MAC address), which is automatically discovered by ISE.

Note Cisco has been made aware of potential incompatibilities introduced by Apple iOS 7. We are working to understand the limitations and design updates will be made to this publication.

Figure 19-1 Guest Portal and Self-Registration Portal



Username:

Password:

Welcome user2@sdulab.com

This device has not been registered.

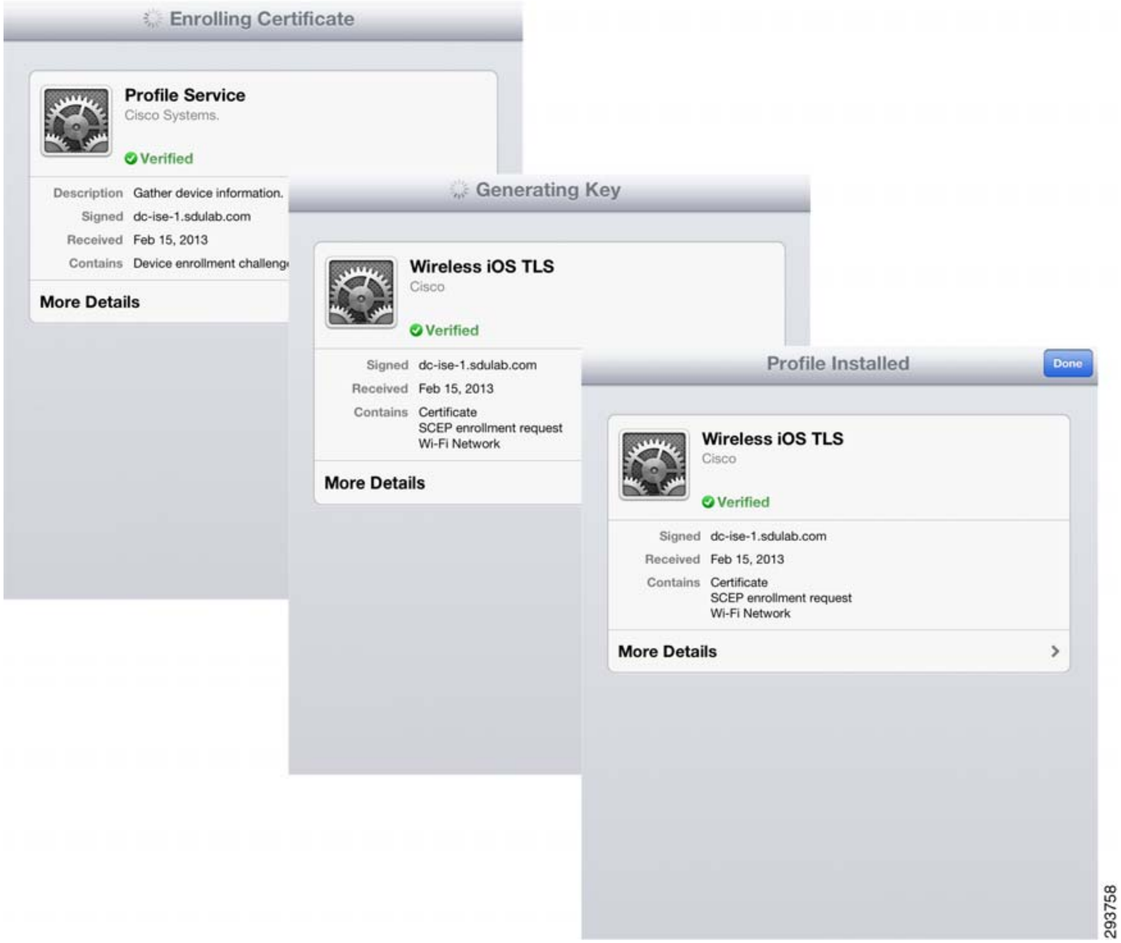
Click the "Register" button to configure your device to use the secure network.

Device ID: 1C:AB:A7:B4:85:12

Description: White iPad

- The supplicant profile is downloaded and installed on the endpoint.
- Keys are generated and the certificate is enrolled.
- The Wi-Fi profile required to connect to the BYOD_Employee is installed.

Figure 19-2 Enrollment and Profile Installation



Profile Service
Cisco Systems.
✓ Verified

Description Gather device information.
Signed dc-ise-1.sdulab.com
Received Feb 15, 2013
Contains Device enrollment challeng

Wireless iOS TLS
Cisco
✓ Verified

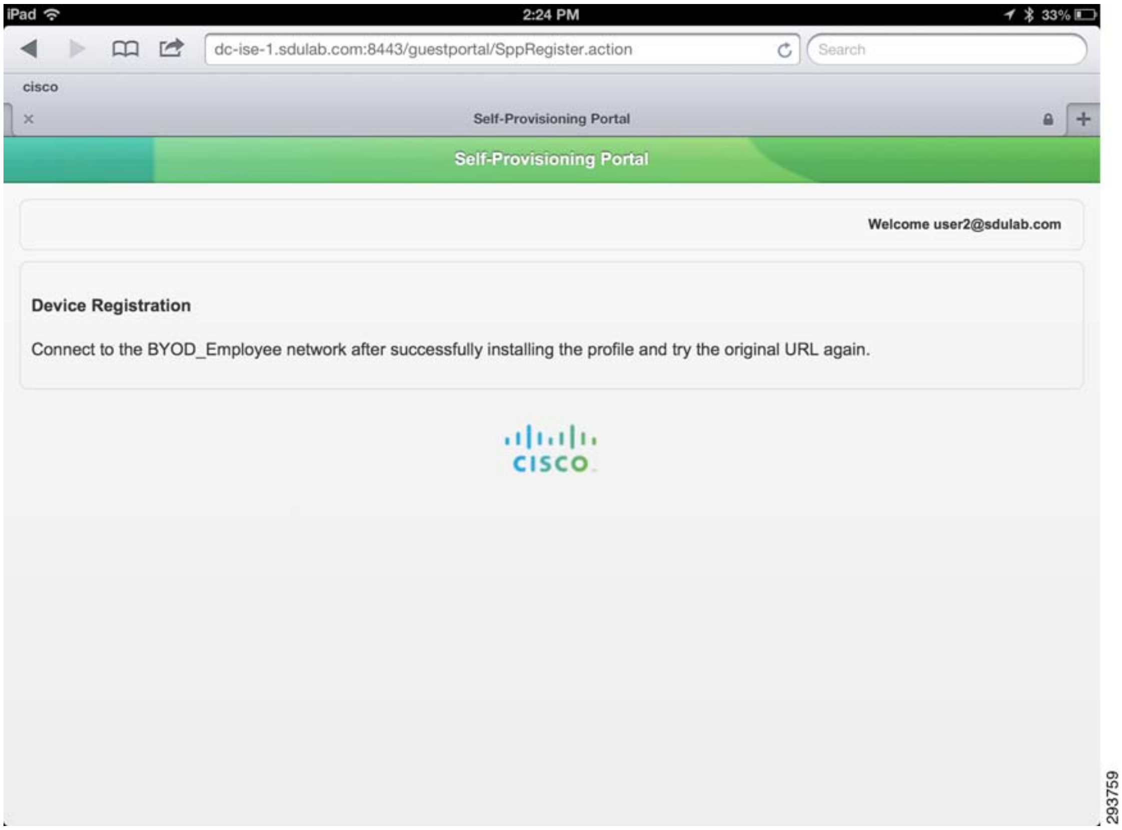
Signed dc-ise-1.sdulab.com
Received Feb 15, 2013
Contains Certificate
SCEP enrollment request
Wi-Fi Network

Wireless iOS TLS
Cisco
✓ Verified

Signed dc-ise-1.sdulab.com
Received Feb 15, 2013
Contains Certificate
SCEP enrollment request
Wi-Fi Network

The employee is notified that registration is complete and is reminded to manually connect to the BYOD_Employee SSID.

Figure 19-3 Device Registration Complete



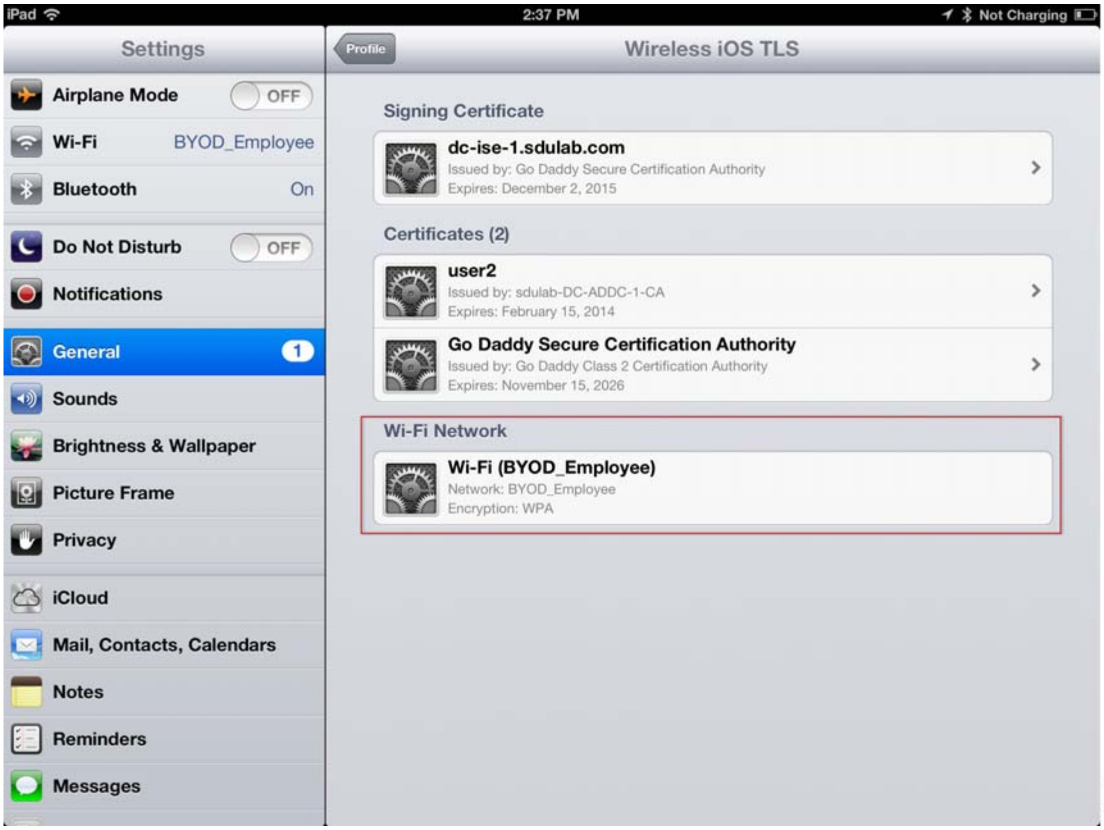
Device Registration

Connect to the BYOD_Employee network after successfully installing the profile and try the original URL again.

Note For iOS devices, the employee is required to connect manually to the BYOD_Employee SSID.

The certificates and profile can be viewed by clicking **Settings > General > Profiles** and selecting **Mobile Profile**. Figure 19-4 highlights the Wi-Fi profile to connect to the BYOD_Employee SSID.

Figure 19-4 *Mobile Profile Details*



Wireless iOS TLS

Signing Certificate

dc-ise-1.sdulab.com
Issued by: Go Daddy Secure Certification Authority
Expires: December 2, 2015

Certificates (2)

user2
Issued by: sdulab-DC-ADDC-1-CA
Expires: February 15, 2014

Go Daddy Secure Certification Authority
Issued by: Go Daddy Class 2 Certification Authority
Expires: November 15, 2026

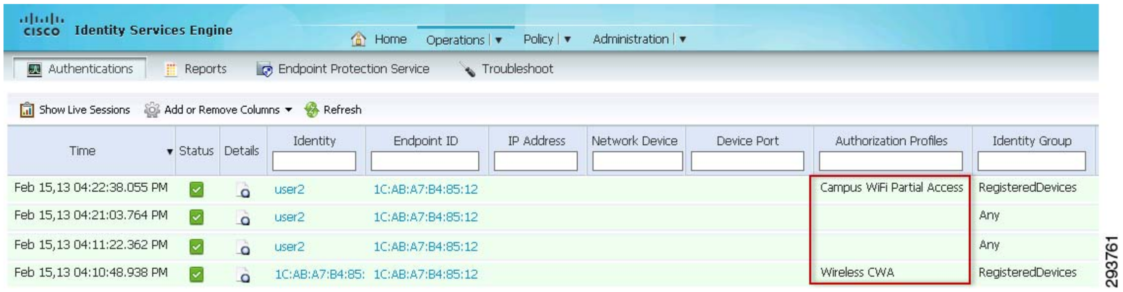
Wi-Fi Network

Wi-Fi (BYOD_Employee)
Network: BYOD_Employee
Encryption: WPA

As shown in Figure 19-5, the ISE maintains a detailed log of the authentications as they take place:

- The first log shows how the first time the device connects, the MAC address is used for authentication, and the Wireless CWA profile is used for authorization, enabling the redirection to the Guest Registration portal.
- Once the enrollment and provisioning take place, the user connects to the secure BYOD_Employee SSID. ISE grants Partial Access to the device.

Figure 19-5 *ISE Authentications Log*



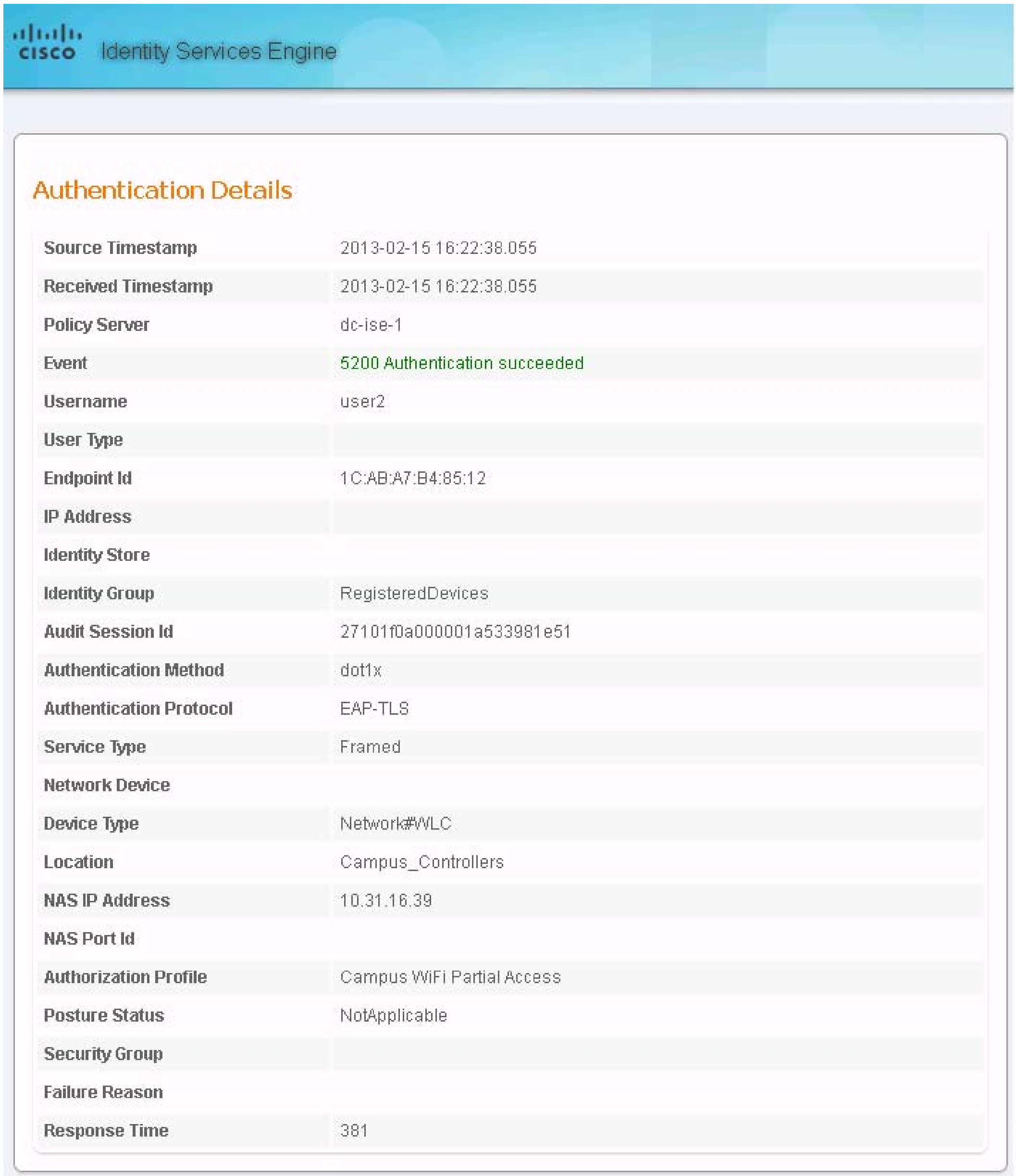
Time	Status	Details	Identity	Endpoint ID	IP Address	Network Device	Device Port	Authorization Profiles	Identity Group
Feb 15,13 04:22:38.055 PM	✓		user2	1C:AB:A7:B4:85:12				Campus WiFi Partial Access	RegisteredDevices
Feb 15,13 04:21:03.764 PM	✓		user2	1C:AB:A7:B4:85:12					Any
Feb 15,13 04:11:22.362 PM	✓		user2	1C:AB:A7:B4:85:12					Any
Feb 15,13 04:10:48.938 PM	✓		1C:AB:A7:B4:85:	1C:AB:A7:B4:85:12				Wireless CWA	RegisteredDevices

Figure 19-6 shows in more detail the steps that took place and how the rule was evaluated to grant Partial Access.

- Authentication is dot1x and EAP-TLS.
- Username is user2. The Active Directory (AD1) identity store was used.

- MAC Address is discovered.
- The Wireless_Dot1X_AuthC authentication rule was used.
- The Campus WiFi Partial Access authorization rule matched. This rule enforces the access list ACL_Partial_Access in the Wireless LAN Controller.

Figure 19-6 ISE Authentication Details



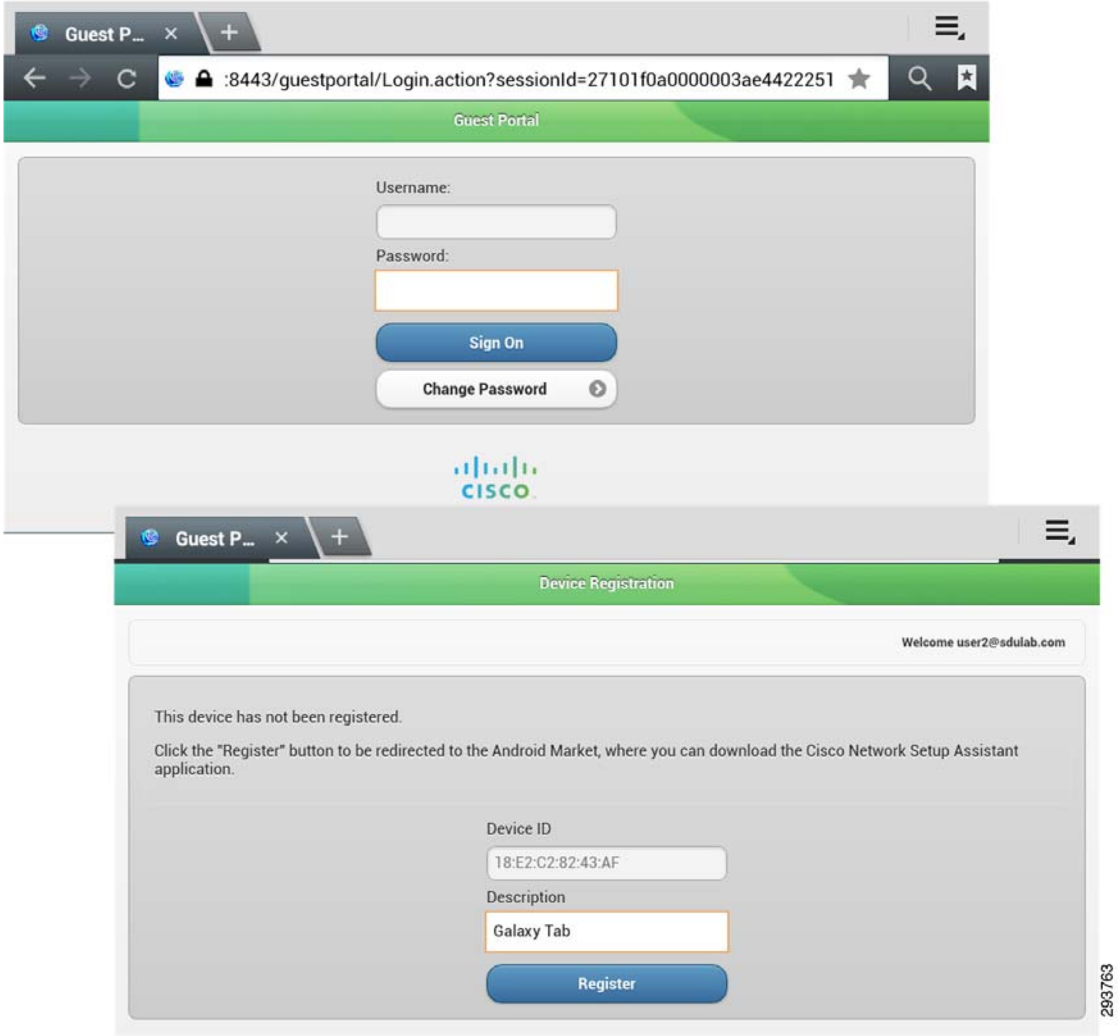
Authentication Details

Source Timestamp	2013-02-15 16:22:38.055
Received Timestamp	2013-02-15 16:22:38.055
Policy Server	dc-ise-1
Event	5200 Authentication succeeded
Username	user2
User Type	
Endpoint Id	1C:AB:A7:B4:85:12
IP Address	
Identity Store	
Identity Group	RegisteredDevices
Audit Session Id	27101f0a000001a533981e51
Authentication Method	dot1x
Authentication Protocol	EAP-TLS
Service Type	Framed
Network Device	
Device Type	Network#WLC
Location	Campus_Controllers
NAS IP Address	10.31.16.39
NAS Port Id	
Authorization Profile	Campus WiFi Partial Access
Posture Status	NotApplicable
Security Group	
Failure Reason	
Response Time	381

Android Devices

The user experience is very similar when provisioning Android devices. The employee is redirected to the Guest Registration portal and is allowed to enter a description for the new device.

Figure 19-7 Guest Portal and Self-Registration Portal



:8443/guestportal/Login.action?sessionId=27101f0a0000003ae4422251

Welcome user2@sdulab.com

This device has not been registered.

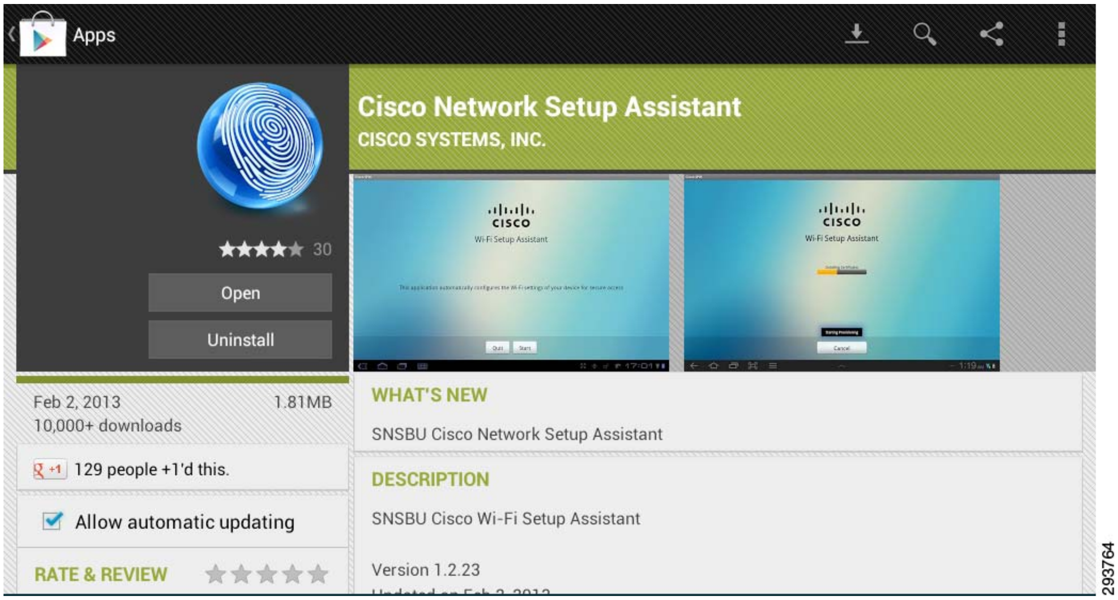
Click the "Register" button to be redirected to the Android Market, where you can download the Cisco Network Setup Assistant application.

Device ID: 18:E2:C2:82:43:AF

Description: Galaxy Tab

The employee is then redirected to Google Play where the Cisco SPW for Android may be downloaded.

Figure 19-8 Supplicant Provisioning Wizard from Google Play



Cisco Network Setup Assistant
CISCO SYSTEMS, INC.

Feb 2, 2013 1.81MB
10,000+ downloads

129 people +1'd this.

☑ Allow automatic updating

WHAT'S NEW

SNSBU Cisco Network Setup Assistant

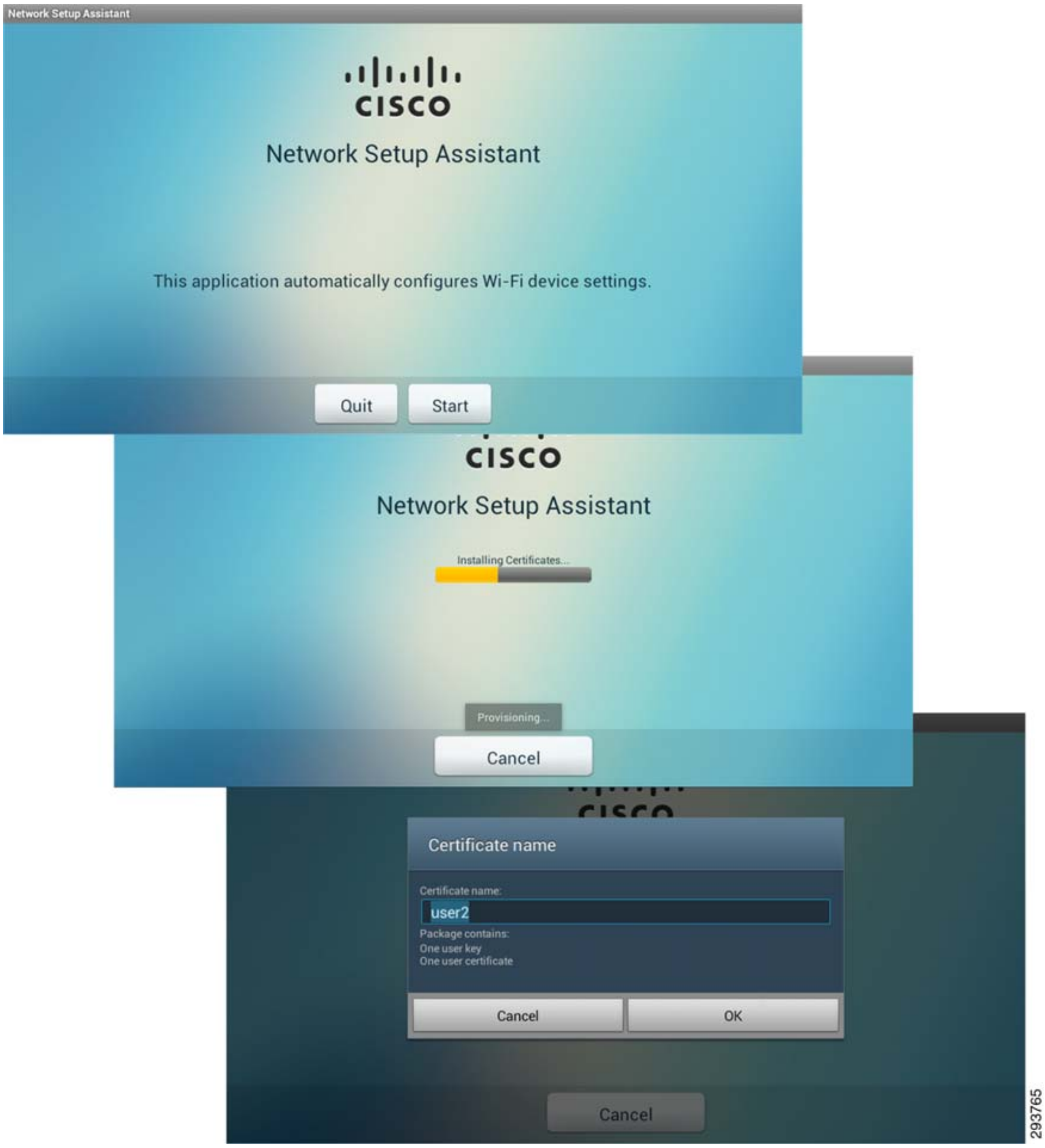
DESCRIPTION

SNSBU Cisco Wi-Fi Setup Assistant

Version 1.2.23

The SPW is launched and the provisioning process begins. The SPW discovers the ISE and begins downloading the profile and installing the certificates.

Figure 19-9 *Provisioning Process*



This application automatically configures Wi-Fi device settings.

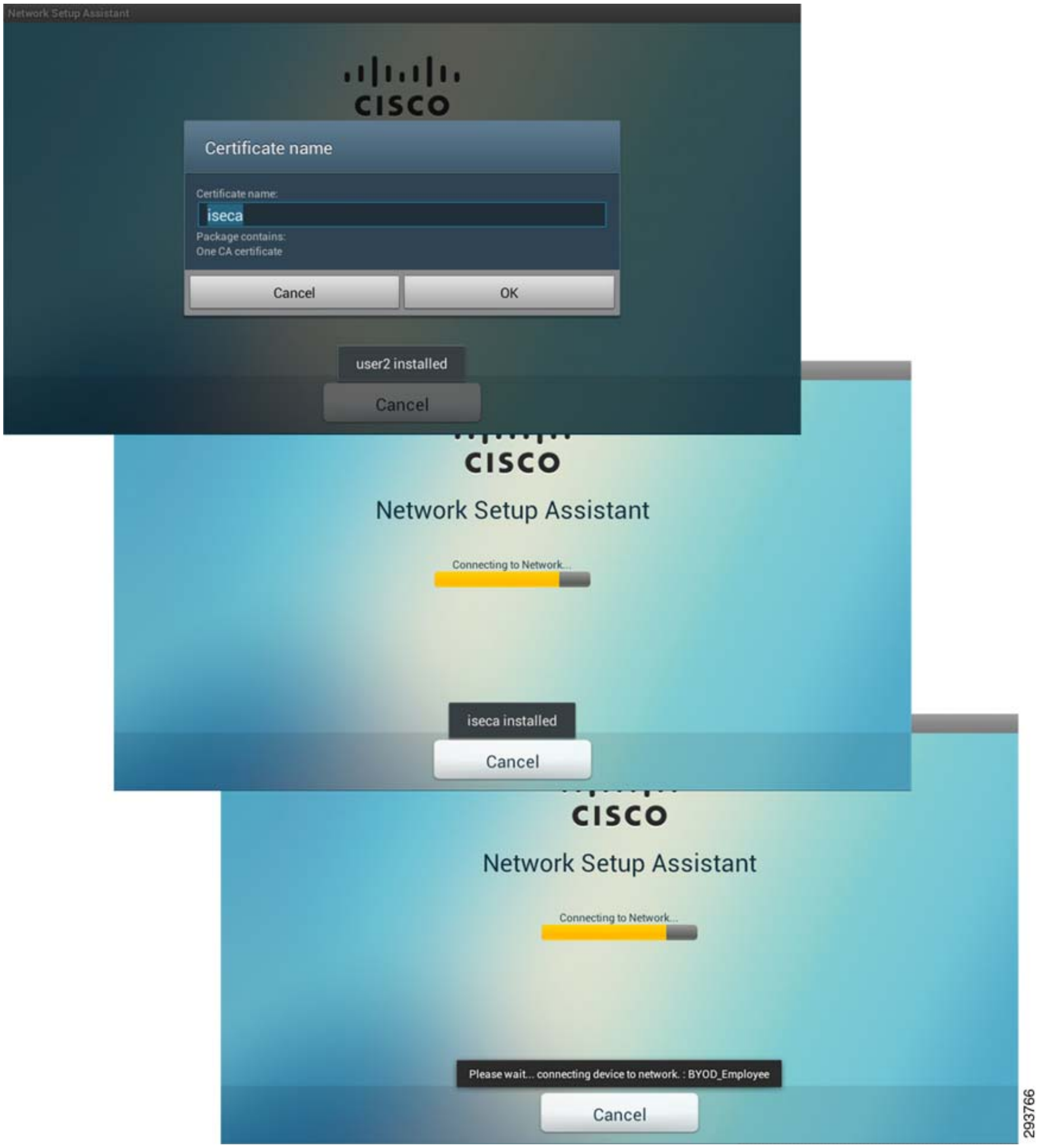
Installing Certificates...

Certificate name: user2

Package contains:
One user key
One user certificate

The employee is allowed to name the certificate and provides a password for the certificate storage for their device. The Wi-Fi profile to connect to BYOD_Employee is applied.

Figure 19-10 Certificate and Profile



Network Setup Assistant

Certificate name

Certificate name: iseca

Package contains:
One CA certificate

user2 installed

Network Setup Assistant

Connecting to Network...

iseca installed

Network Setup Assistant

Connecting to Network...

Please wait... connecting device to network. : BYOD_Employee

Without employee intervention, the provisioning process automatically connects the Android device to the BYOD_Employee SSID, as shown in Figure 19-11.

Figure 19-11 Automatic Connection to BYOD_Employee

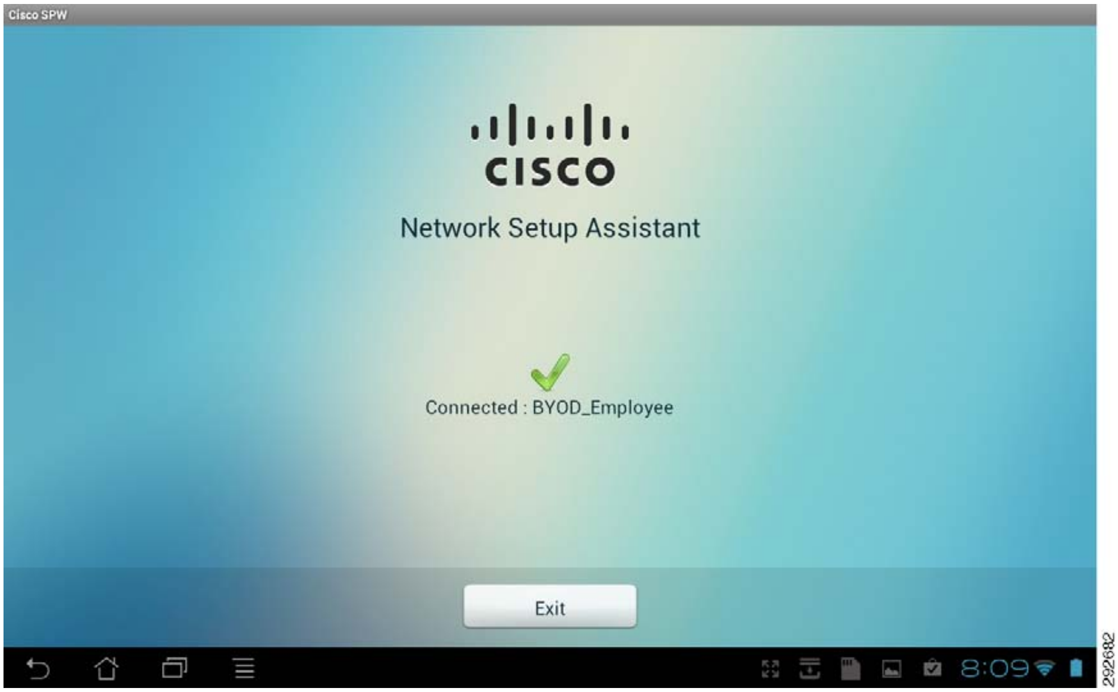
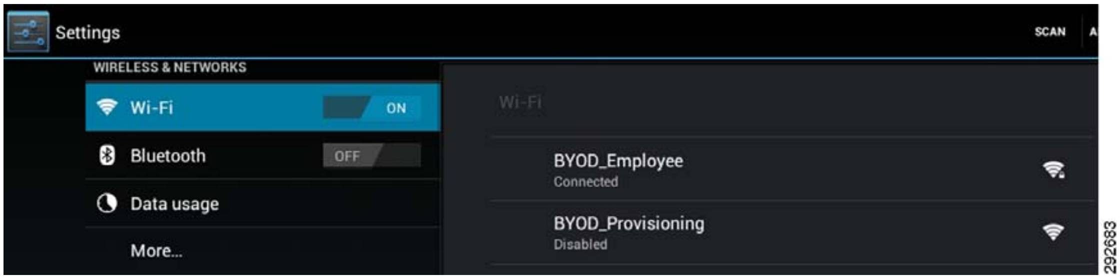


Figure 19-12 shows how the device is automatically connected to the secure BYOD_Employee SSID.

Figure 19-12 BYOD_Employee Secure SSID



Windows Devices

The user experience while provisioning a Windows device is very similar, redirecting the session to the Guest Registration portal and asking the employee for authentication.

Some Windows devices have multiple network adapters, for example, a laptop with both wired and wireless adapter. The network security policy checks that the device mac-address (sent using calling-station-id attribute) matches the SAN field of the device digital certificate before allowing access. This is done to prevent spoofing. Since each adapter has a unique mac-address, the anti-spoofing policy check can cause difficulties for devices with multiple adapters. If a device registers with a wired adapter, it will obtain a digital certificate with the mac-address of the wired adapter. If the same device attempts to later authenticate to the secure wireless network, most operating systems will attempt to the use the wired adapter certificate for authentication and will fail because the mac-address of the wireless adapter will not match the SAN field of the digital certificate. To avoid this problem, a device with multiple adapters must register both the wired and wireless adapter.

There are two methods for provisioning wireless devices:

- Dual SSID model, which supports MAB on the provisioning SSID and dot1X on the employee SSID.
- Single SSID model, which supports only the dot1X protocol.

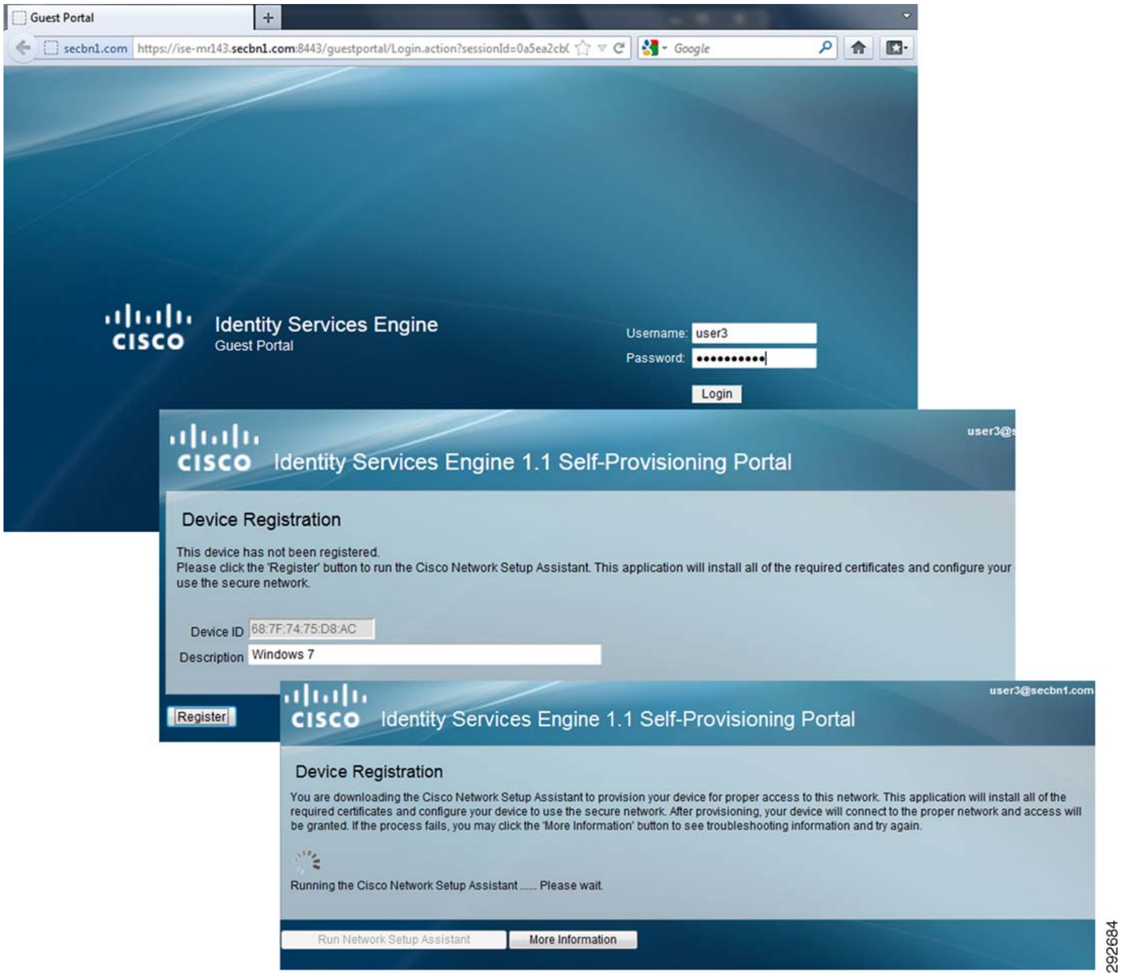
For the Dual SSID method, the wired and wireless adapters may be provisioned in any order. For example, if the device associates with the provisioning SSID (which supports MAB) and is successfully provisioned, then subsequently connects with the wired adapter, 802.1X will fail because of the anti-spoofing check in the policy and the user will be re-directed to complete the provisioning process. Thereafter, the device can access the network with either adapter.

For the Single SSID method, the order in which the wired and wireless adapters are provisioned matters. For example, if the device connects using the wired adapter first and is successfully provisioned, then subsequently connects using the wireless adapter, some operating systems attempt to establish a EAP-TLS connection using the wired digital certificate instead of undergoing the provisioning process. This connection attempt will fail because of the anti-spoofing check in the policy. To prevent this from happening, the user must provision the wireless adapter before connecting with the wired adapter for the single SSID method.

Windows Wireless Devices

After authenticating at the portal and entering a description for the new Windows device, the SPW is downloaded.

Figure 19-13 Guest Registration Portal


Guest Portal
secbn1.com https://ise-mr143.secbn1.com:8443/guestportal/Login.action?sessionId=0a5ea2cb(
Google
Login
Register
user3@s
user3@secbn1.com
Run Network Setup Assistant
More Information
292684

Identity Services Engine
Guest Portal

Username: user3
Password: ••••••••••

Identity Services Engine 1.1 Self-Provisioning Portal

Device Registration

This device has not been registered.
Please click the 'Register' button to run the Cisco Network Setup Assistant. This application will install all of the required certificates and configure your use the secure network.

Device ID 68:7F:74:75:D8:AC
Description Windows 7

Identity Services Engine 1.1 Self-Provisioning Portal

Device Registration

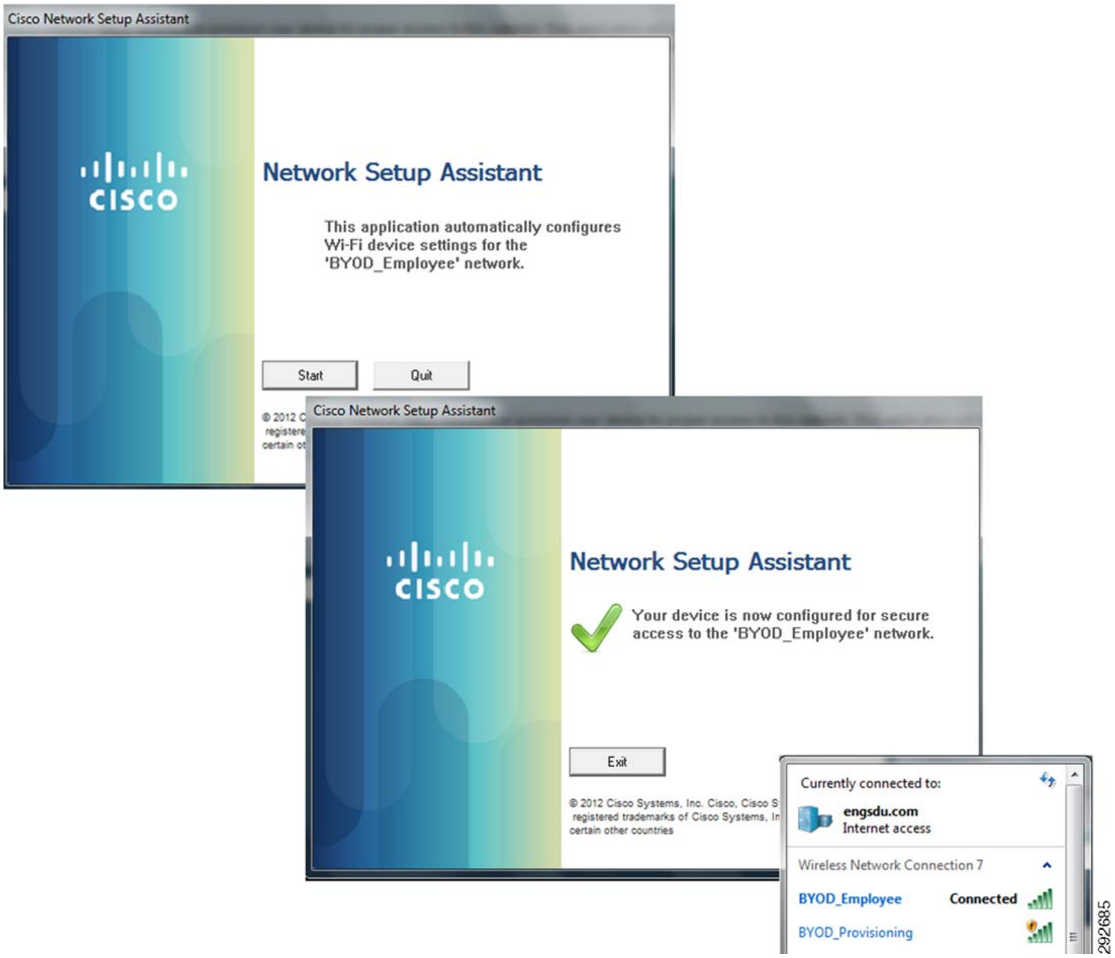
You are downloading the Cisco Network Setup Assistant to provision your device for proper access to this network. This application will install all of the required certificates and configure your device to use the secure network. After provisioning, your device will connect to the proper network and access will be granted. If the process fails, you may click the 'More Information' button to see troubleshooting information and try again.

Running the Cisco Network Setup Assistant ...... Please wait.

The SPW is launched to install the profile, the keys are generated, and the certificate enrollment takes place.

The SPW installs the BYOD_Employee configuration to connect to the secure SSID. The connection is switched automatically to the BYOD_Employee SSID.

Figure 19-14 SPW and Connection to Secure SSID



Cisco Network Setup Assistant

Network Setup Assistant

This application automatically configures Wi-Fi device settings for the 'BYOD_Employee' network.

Cisco Network Setup Assistant

Network Setup Assistant

Your device is now configured for secure access to the 'BYOD_Employee' network.

© 2012 Cisco Systems, Inc. Cisco, Cisco S registered trademarks of Cisco Systems, In certain other countries

Currently connected to:
engsdu.com
Internet access

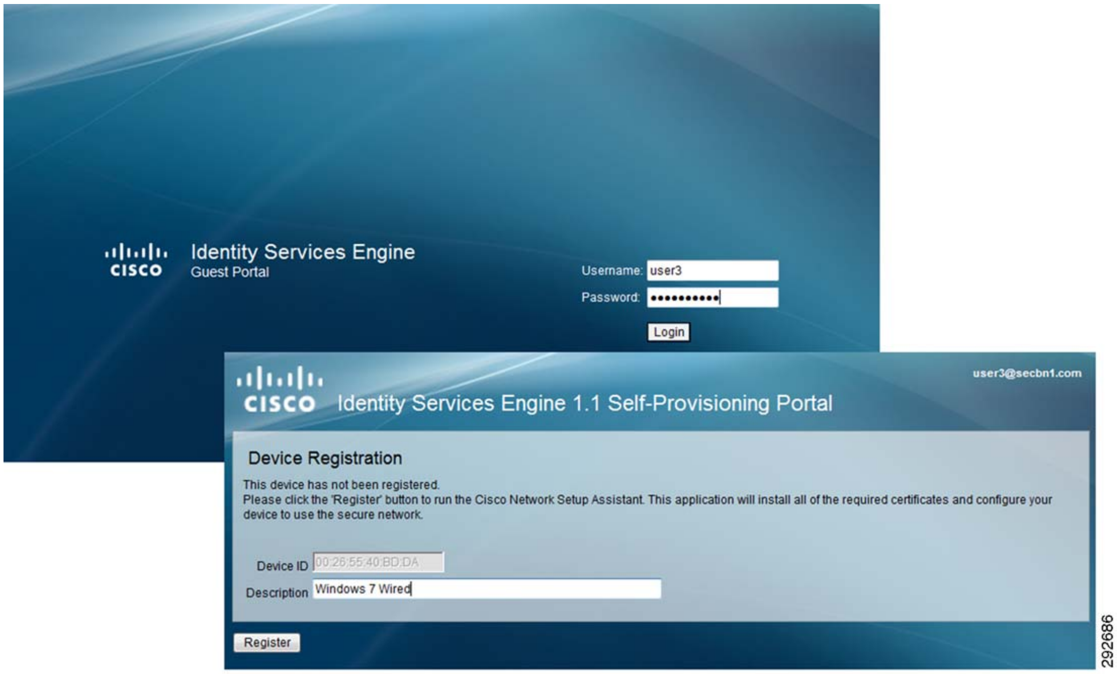
Wireless Network Connection 7

BYOD_Employee	Connected
BYOD_Provisioning	

Windows Wired Devices

The user experience is very similar, but instead of configuring access to a secure SSID, the SPW configures the devices to connect via a wired connection.

Figure 19-15 Guest Registration Portal



Username: user3

Password: ••••••••••

Device Registration

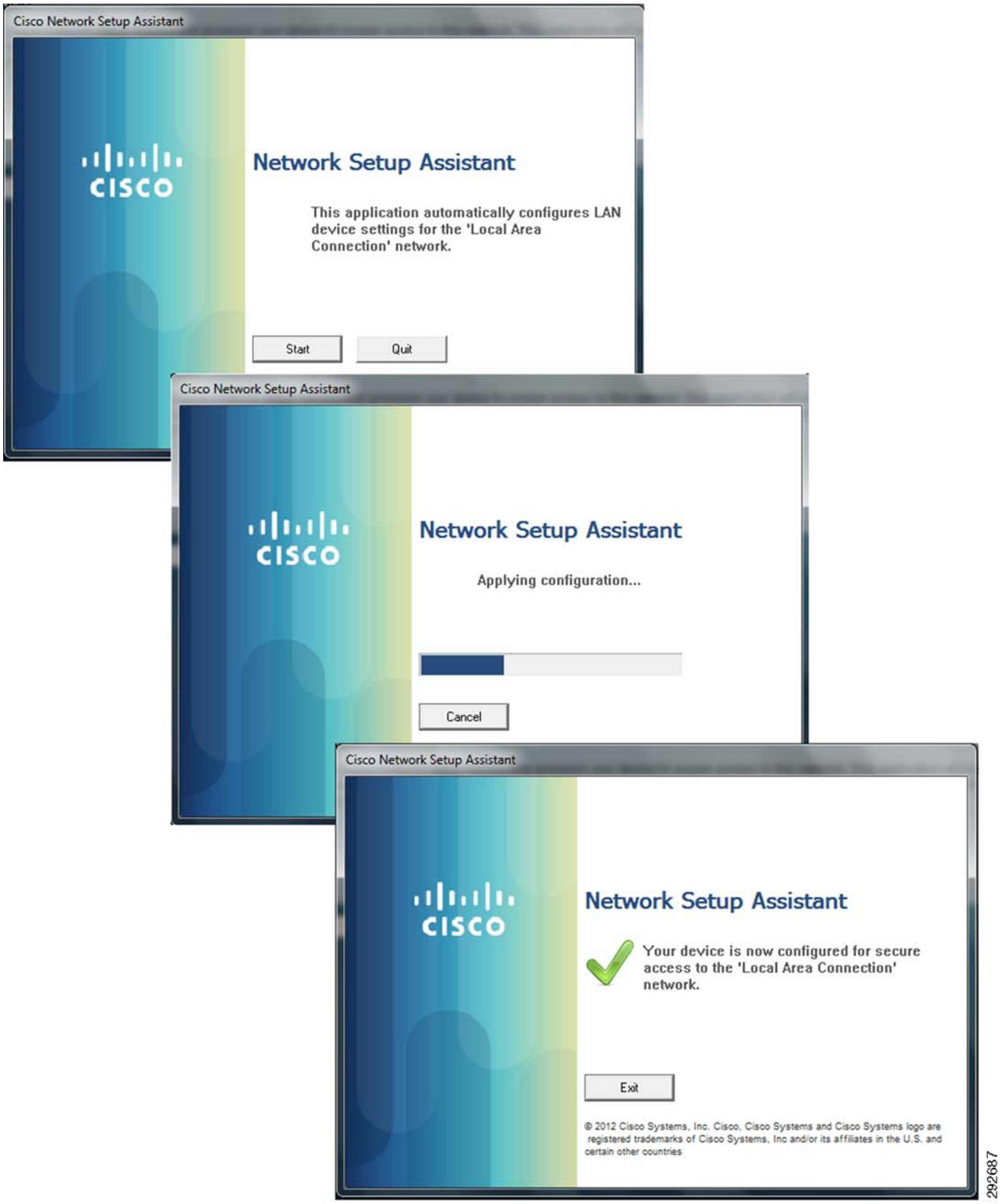
This device has not been registered.
Please click the 'Register' button to run the Cisco Network Setup Assistant. This application will install all of the required certificates and configure your device to use the secure network.

Device ID 00:26:55:40:BD:DA

Description Windows 7 Wired

The SPW is downloaded and the proper configurations are applied to the device.

Figure 19-16 SPW and Secure Access



Cisco Network Setup Assistant

Network Setup Assistant

This application automatically configures LAN device settings for the 'Local Area Connection' network.

Start Quit

Cisco Network Setup Assistant

Network Setup Assistant

Applying configuration...

Cancel

Cisco Network Setup Assistant

Network Setup Assistant

Your device is now configured for secure access to the 'Local Area Connection' network.

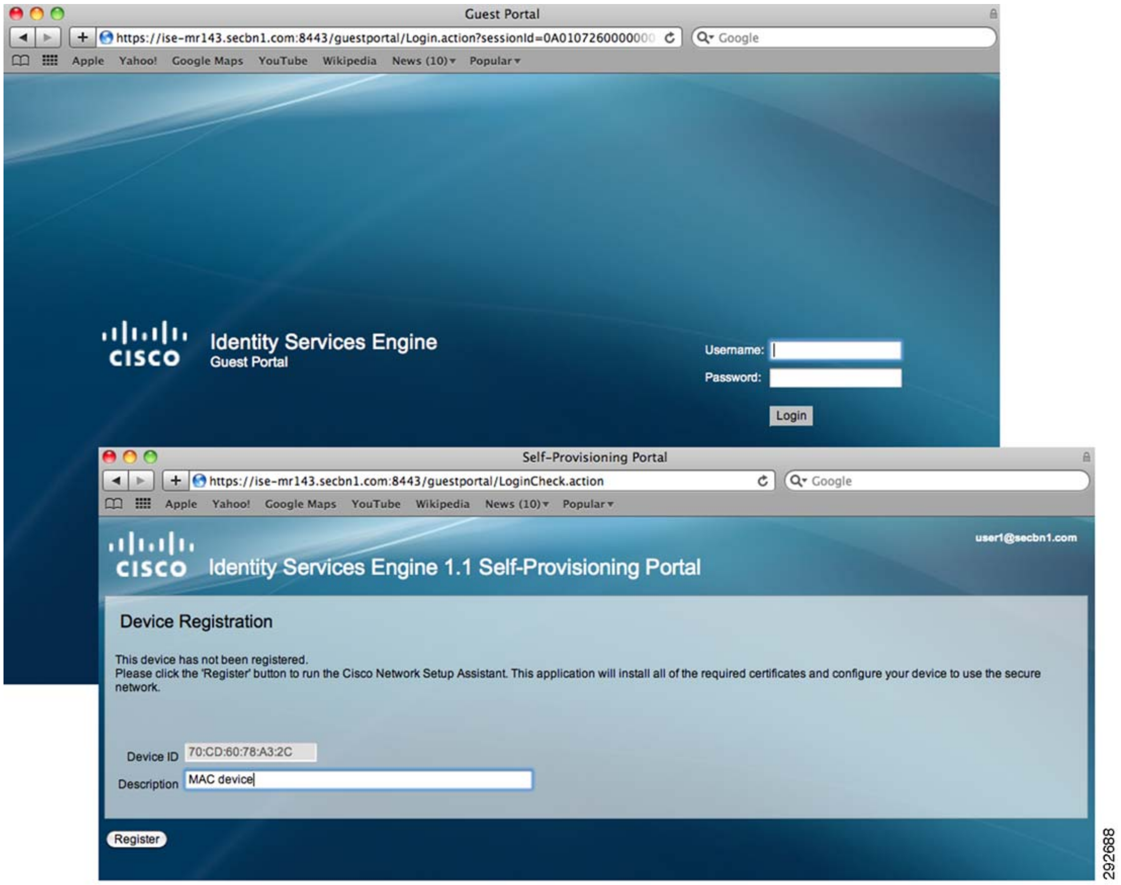
Exit

© 2012 Cisco Systems, Inc. Cisco, Cisco Systems and Cisco Systems logo are registered trademarks of Cisco Systems, Inc and/or its affiliates in the U.S. and certain other countries

Mac OS/X Devices

The user experience while provisioning a Mac OS X wired device is also very similar, redirecting the session to the Guest Registration portal and asking the employee for authentication.

Figure 19-17 Guest Registration and Self-Registration Portals


Guest Portal
https://ise-mr143.secbn1.com:8443/guestportal/Login.action?sessionId=0A0107260000000
Google
Apple Yahoo! Google Maps YouTube Wikipedia News (10) Popular
cisco
Identity Services Engine
Guest Portal
Username:
Password:
Login
Self-Provisioning Portal
https://ise-mr143.secbn1.com:8443/guestportal/LoginCheck.action
Google
Apple Yahoo! Google Maps YouTube Wikipedia News (10) Popular
cisco
Identity Services Engine 1.1 Self-Provisioning Portal
user1@secbn1.com
Register
292688

Device Registration

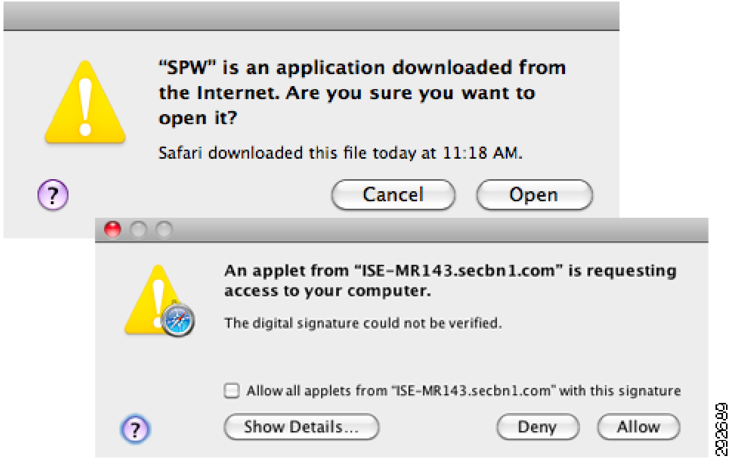
This device has not been registered.
Please click the 'Register' button to run the Cisco Network Setup Assistant. This application will install all of the required certificates and configure your device to use the secure network.

Device ID 70:CD:60:78:A3:2C

Description MAC device

The SPW is downloaded and installed.

Figure 19-18 SPW and Secure Access



"SPW" is an application downloaded from the Internet. Are you sure you want to open it?

Safari downloaded this file today at 11:18 AM.

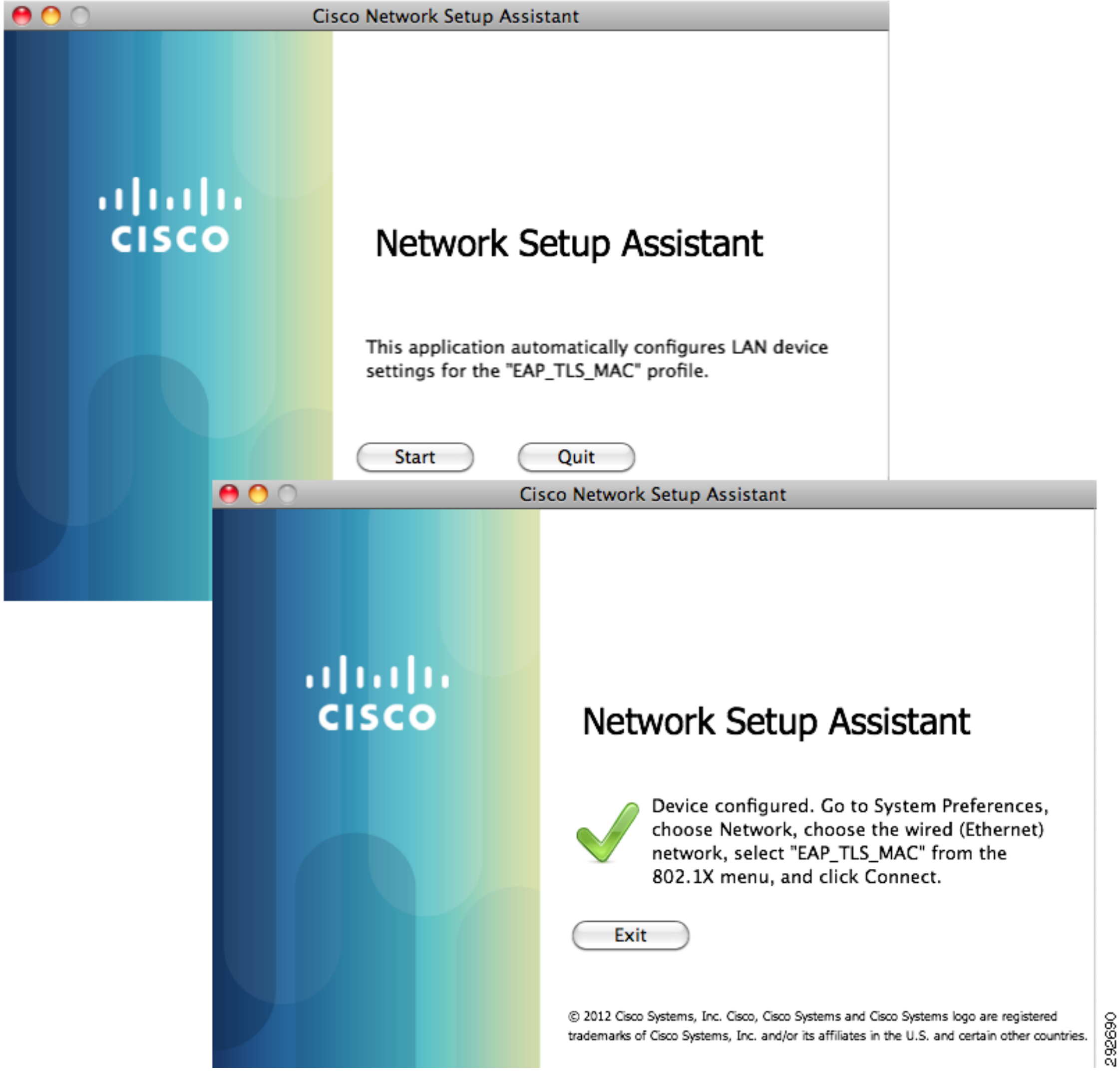
An applet from "ISE-MR143.secbn1.com" is requesting access to your computer.

The digital signature could not be verified.

□ Allow all applets from "ISE-MR143.secbn1.com" with this signature

The Network Setup Assistant configures the EAP-TLS_MAC profile for secure access.

Figure 19-19 Network Setup Assistant



Cisco Network Setup Assistant

Network Setup Assistant

This application automatically configures LAN device settings for the "EAP_TLS_MAC" profile.

Cisco Network Setup Assistant

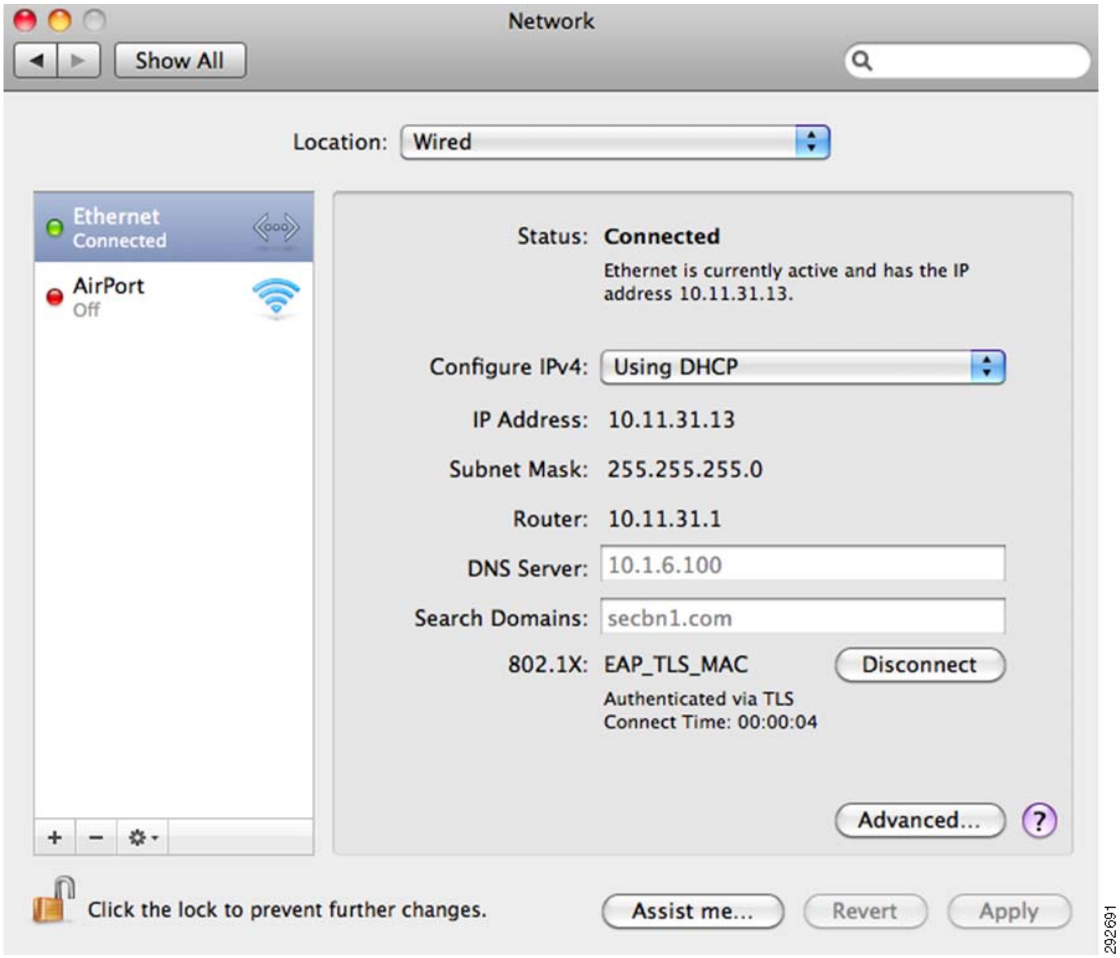
Network Setup Assistant

Device configured. Go to System Preferences, choose Network, choose the wired (Ethernet) network, select "EAP_TLS_MAC" from the 802.1X menu, and click Connect.

© 2012 Cisco Systems, Inc. Cisco, Cisco Systems and Cisco Systems logo are registered trademarks of Cisco Systems, Inc. and/or its affiliates in the U.S. and certain other countries.

The network settings in Figure 19-20 show the new EAP_TLS_MAC configuration.

Figure 19-20 Network Settings



Location: Wired

Status: Connected

Ethernet is currently active and has the IP address 10.11.31.13.

Configure IPv4: Using DHCP

IP Address: 10.11.31.13

Subnet Mask: 255.255.255.0

Router: 10.11.31.1

DNS Server: 10.1.6.100

Search Domains: secbn1.com

802.1X: EAP_TLS_MAC

Authenticated via TLS
Connect Time: 00:00:04

Click the lock to prevent further changes.