Configure Dynamic VLAN Assignment with WLCs Based on ISE to Active Directory Group Map

Contents

Introduction

This document describes the concept of dynamic VLAN assignment.

Prerequisites

The document describes how to configure the wireless LAN controller (WLC) and Identity Services Engine (ISE) server in order to assign wireless LAN (WLAN) clients into a specific VLAN dynamically.

Requirements

Cisco recommends that you have knowledge of these topics:

- Basic knowledge of Wireless LAN Controllers (WLCs) and Lightweight Access Points (LAPs)
- Functional knowledge of an Authentication, Authorization, and Accounting (AAA) server such as an ISE
- Thorough knowledge of wireless networks and wireless security issues
- Functional and configurable knowledge of dynamic VLAN assignment
- Basic understanding of Microsoft Windows AD services, as well as a domain controller and DNS concepts
- Have basic knowledge of Control And Provisioning of Access Point protocol (CAPWAP)

Components Used

The information in this document is based on these software and hardware versions:

- Cisco 5520 Series WLC that runs firmware release 8.8.111.0
- Cisco 4800 Series AP
- Native Windows supplicant and Anyconnect NAM
- Cisco Secure ISE version 2.3.0.298
- Microsoft Windows 2016 Server configured as a domain controller
- Cisco 3560-CX Series Switch that runs version 15.2(4)E1

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Conventions

Refer to Cisco Technical Tips Conventions for more information on document conventions.

Dynamic VLAN Assignment with RADIUS Server

In most WLAN systems, each WLAN has a static policy that applies to all clients associated with a Service Set Identifier (SSID), or WLAN in the controller terminology. Although powerful, this method has limitations because it requires clients to associate with different SSIDs in order to inherit different QoS and security policies.

Cisco WLAN solution addresses that limitation by the support of identity networking. This allows the network to advertise a single SSID but allows specific users to inherit different QoS, VLAN attributes, and/or security policies based on the user credential.

Dynamic VLAN assignment is one such feature that places a wireless user into a specific VLAN based on the credentials supplied by the user. This task to assign users to a specific VLAN is handled by a RADIUS authentication server, such as Cisco ISE. This can be used, for example, in order to allow the wireless host to remain on the same VLAN as it moves within a campus network.

The Cisco ISE server authenticates wireless users against one of several possible databases, which includes its internal database. For example:

- Internal DB
- Active Directory
- Generic Lightweight Directory Access Protocol (LDAP)
- Open Database Connectivity (ODBC)-compliant relational databases
- Rivest, Shamir, and Adelman (RSA) SecurID token servers
- RADIUS-compliant token servers

Cisco ISE Authentication Protocols and Supported External Identity Sources list the various authentication protocols supported by ISE internal and external databases.

This document focuses on authenticating wireless users that use Windows Active Directory external database.

After successful authentication, ISE retrieves the group information of that user from the Windows database and associates the user to the respective authorization profile.

When a client attempts to associate with a LAP registered with a controller, the LAP passes the credentials of the user to the WLC with the help of the respective EAP method.

WLC sends those credentials to ISE with the use of RADIUS protocol (encapsulating the EAP) and ISE passes the credentials of users to AD for validation with the help of the KERBEROS protocol.

AD validates the user credentials and upon successful authentication, informs the ISE.

Once the authentication is successful, the ISE server passes certain Internet Engineering Task Force (IETF) attributes to WLC. These RADIUS attributes decide the VLAN ID that must be assigned to the wireless client. The SSID (WLAN, in terms of WLC) of the client does not matter because the user is always assigned to this predetermined VLAN ID.

The RADIUS user attributes used for the VLAN ID assignment are:

- IETF 64 (Tunnel Type)â€”Set this to VLAN
- IETF 65 (Tunnel Medium Type)â€”Set this to 802
- IETF 81 (Tunnel Private Group ID)â€”Set this to VLAN ID

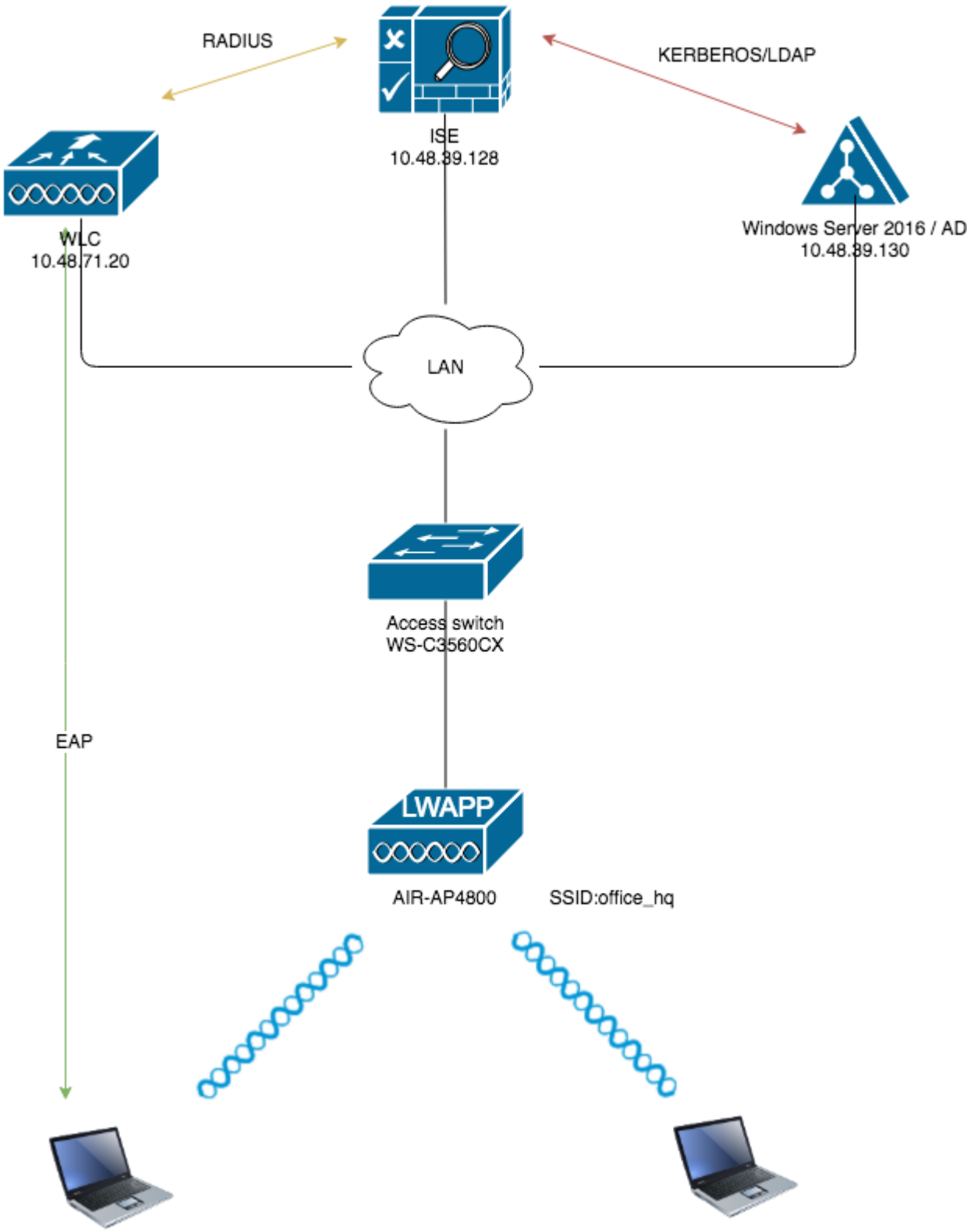
The VLAN ID is 12 bits and takes a value between 1 and 4094, inclusive. Because the Tunnel-Private-Group-ID is of type string, as defined in RFC2868 for use with IEEE 802.1X, the VLAN ID integer value is encoded as a string. When these tunnel attributes are sent, it is necessary to fill in the Tag field.

As noted in RFC 2868, section 3.1: the Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same tunnel. Valid values for this field are 0x01 through 0x1F, inclusive. If the Tag field is unused, it must be zero (0x00). Refer to **RFC 2868** for more information on all RADIUS attributes.

Configure

This section provides the information needed to configure the described features in the document.

Network Diagram



Configurations

These are the configuration details of the components used in this diagram:

- The IP address of the ISE (RADIUS) server is 10.48.39.128.
- The Management and AP-manager Interface address of the WLC is 10.48.71.20.
- DHCP server resides in the LAN network and is configured for respective client pools; it is not shown

in the diagram.

- VLAN1477 and VLAN1478 are used throughout this configuration. Users from the **Marketing** department are configured in order to be placed into the VLAN1477 and users from the **HR** department are configured in order to be placed into VLAN1478 by the RADIUS server when both users connect to the same SSID â€• **office_hq**.

  VLAN1477: 192.168.77.0/24. Gateway: 192.168.77.1 VLAN1478: 192.168.78.0/24. Gateway: 192.168.78.1

- This document uses 802.1x with PEAP-mschapv2 as the security mechanism.

Note: Cisco recommends that you use advanced authentication methods, such as EAP-FAST and EAP-TLS authentication, in order to secure the WLAN.

These assumptions are made before you perform this configuration:

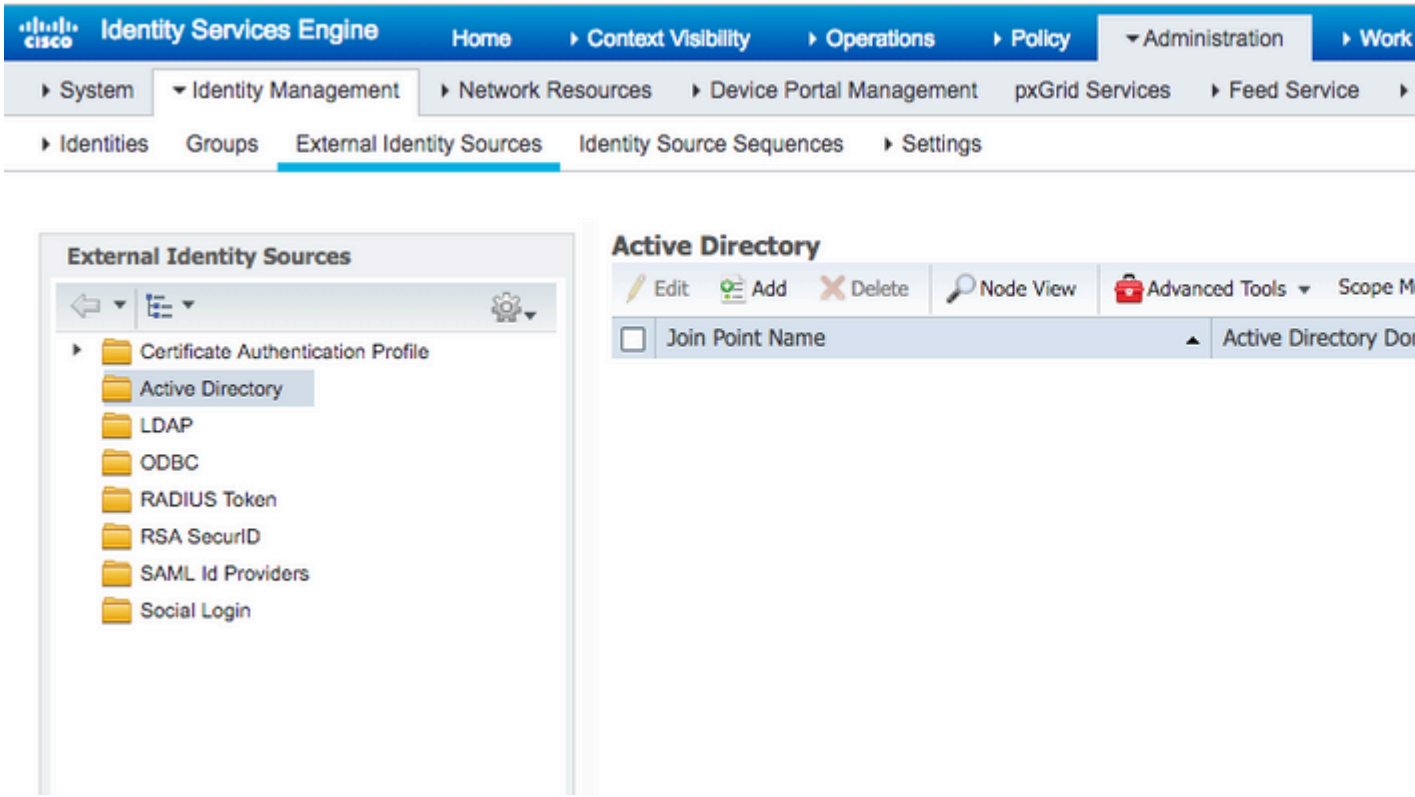
- The LAP is already registered with the WLC
- The DHCP server is assigned a DHCP scope
- Layer 3 connectivity exists between all devices in the network
- The document discusses the configuration required on the wireless side and assumes that the wired network is in place
- Respective users and groups are configured on AD

In order to accomplish dynamic VLAN assignment with WLCs based on ISE to AD group mapping, these steps must be performed:

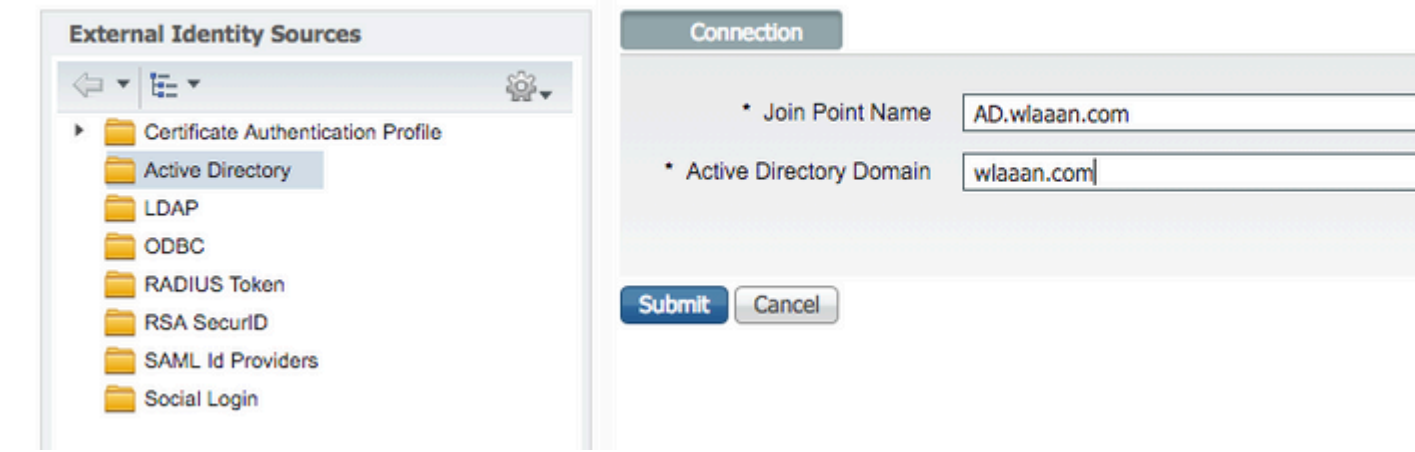
1. ISE to AD integration and configuration of authentication and authorization policies for users on ISE.
2. WLC configuration in order to support dot1x authentication and AAA override for SSID 'office_hq'.
3. End client supplicant configuration.

ISE to AD Integration and Configuration of Authentication and Authorization Policies for Users on ISE

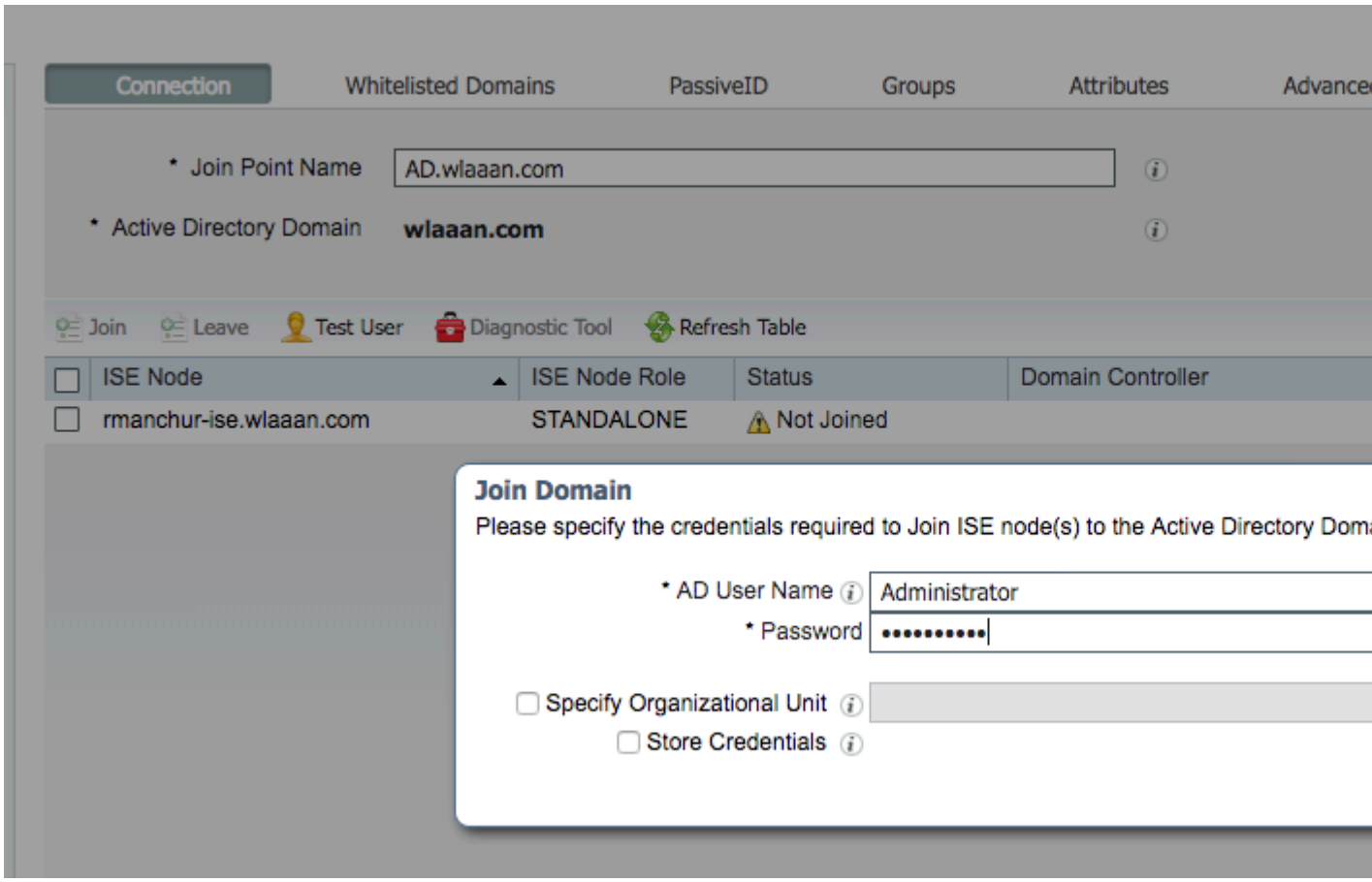
1. Login to the ISE Web UI interface using an **admin** account.
2. Navigate to Administration > Identity management > External Identity Sources > Active directory.



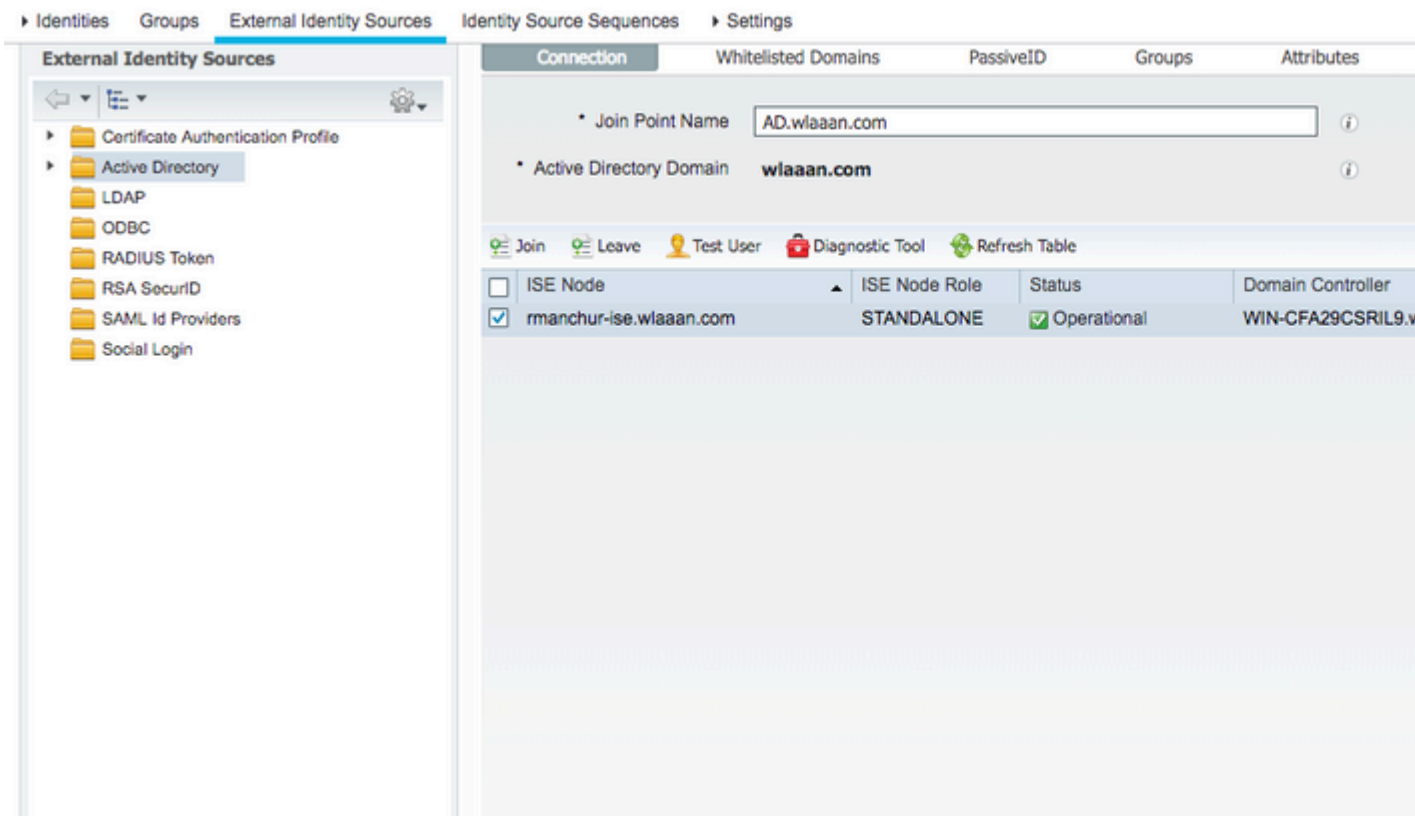
3. Click **Add** and enter the domain name and identity store name from the Active Directory Join Point Name settings. In the example, ISE is registered to the domain wlaaan.com and joinpoint is specified as AD.wlaaan.com - locally significant name to ISE.



4. A pop-up window opens after Submit button is pressed that asks you if you want to join ISE to AD immediately. Press Yes and provide Active Directory user credentials with admin rights to add a new host to the domain.



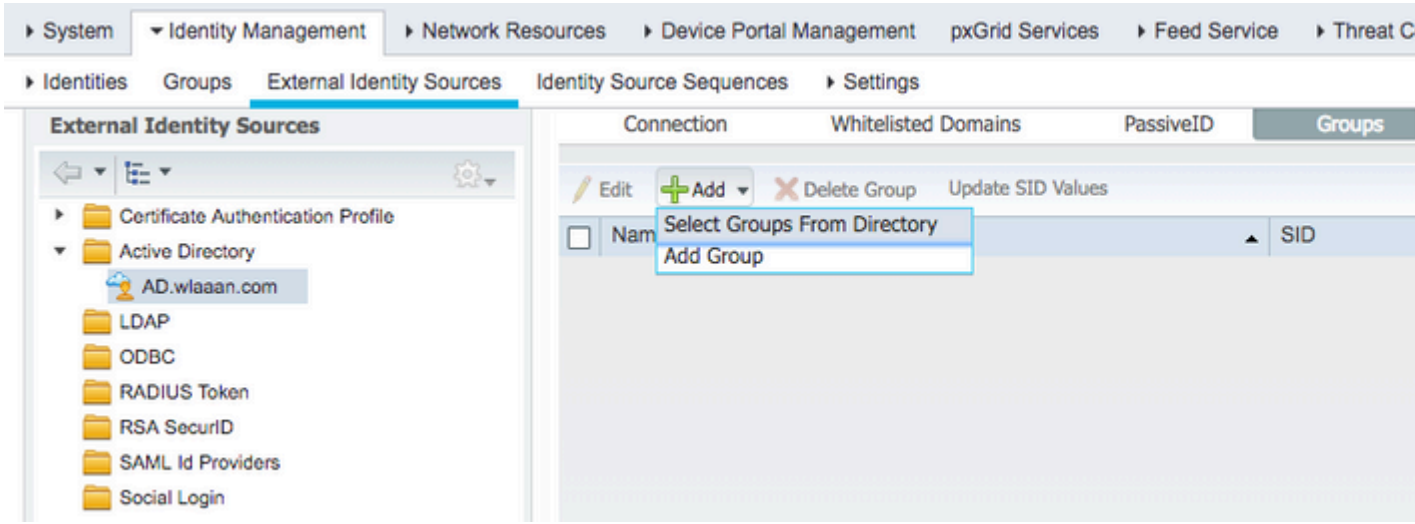
5. After this point, you must have ISE successfully registered to AD.



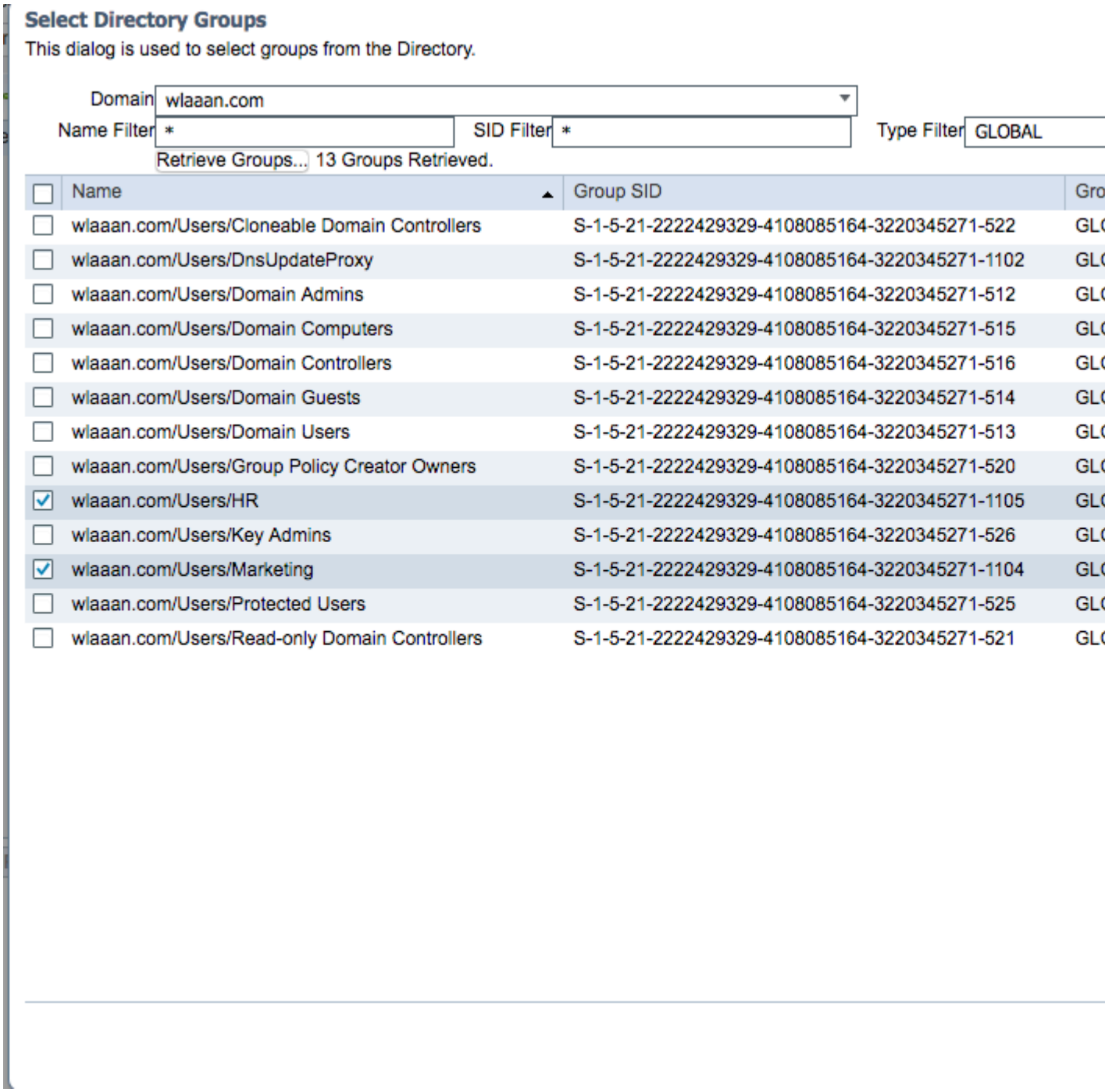
In case you have any issues with the registration process, you can use the Diagnostic Tool in order to run the tests required for AD connectivity.

6. You must retrieve groups for the active Directories that are used in order to assign respective

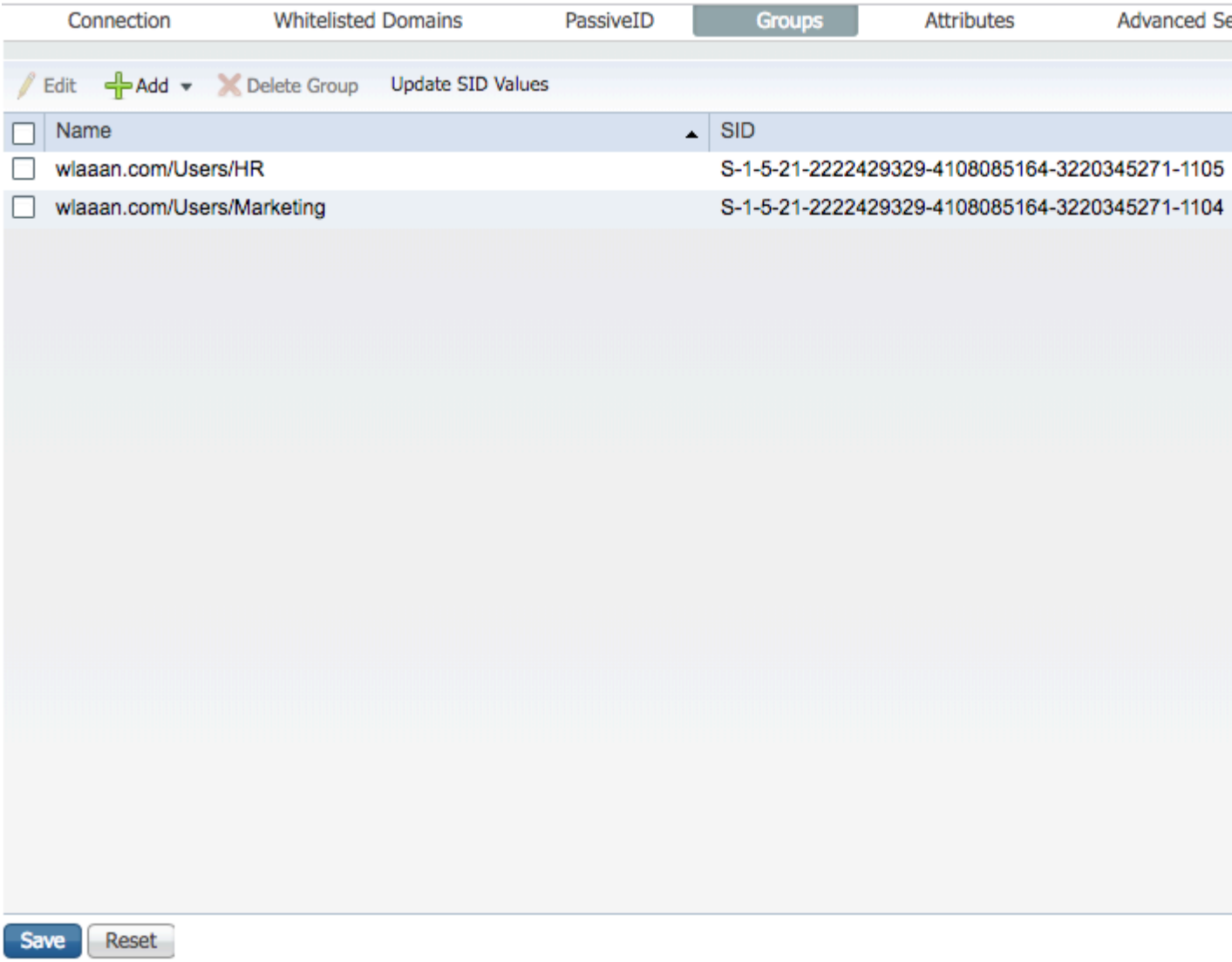
authorization profiles. Navigate to Administration > Identity management > External Identity Sources > Active directory > <Your AD> > Groups, then click Add and choose Select Groups from Active Directory.



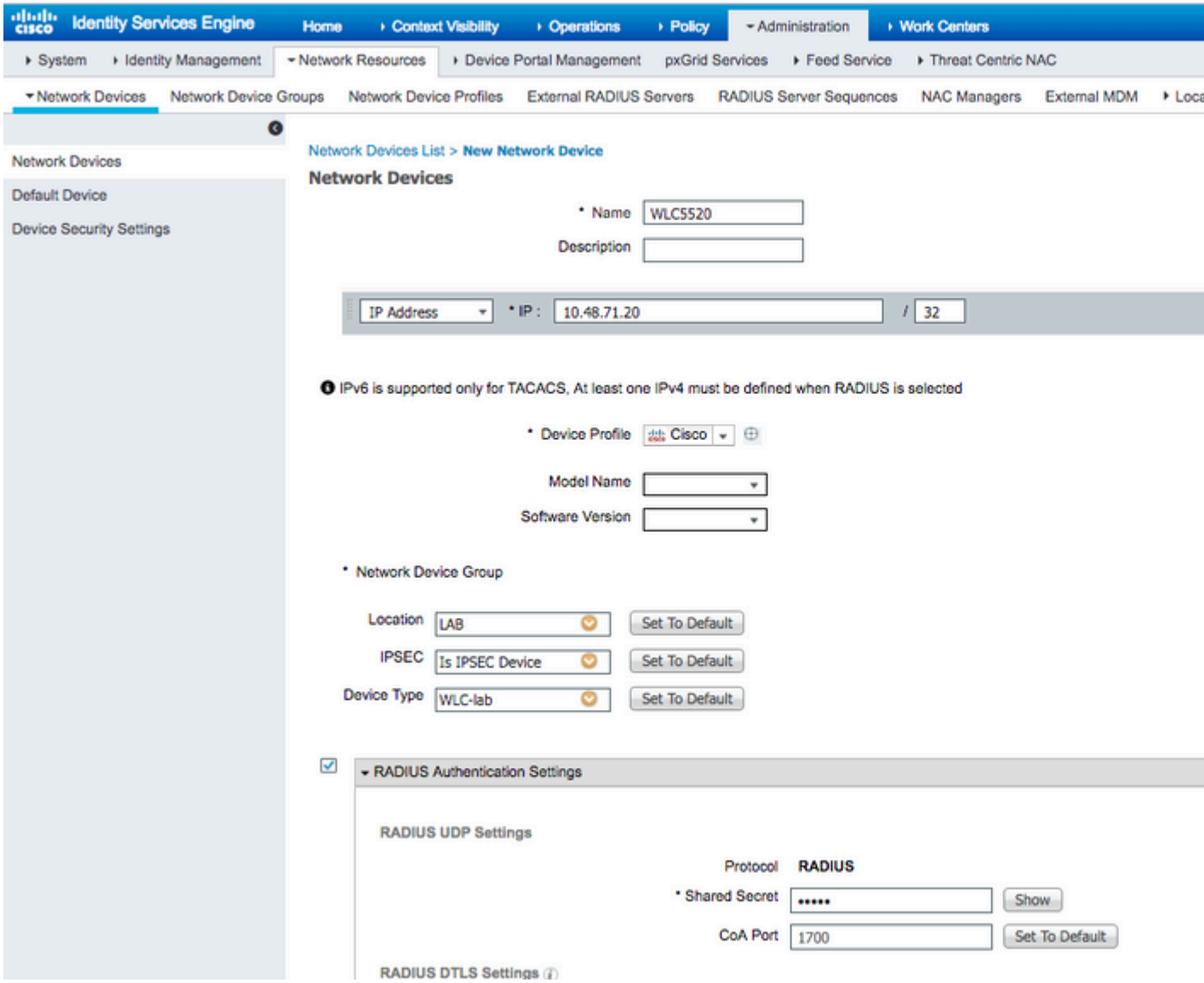
7. A new pop-up window opens where you can either specify a filter in order to retrieve specific group(s) or retrieve all groups from AD.
   Choose the respective groups from the AD group list and press OK.



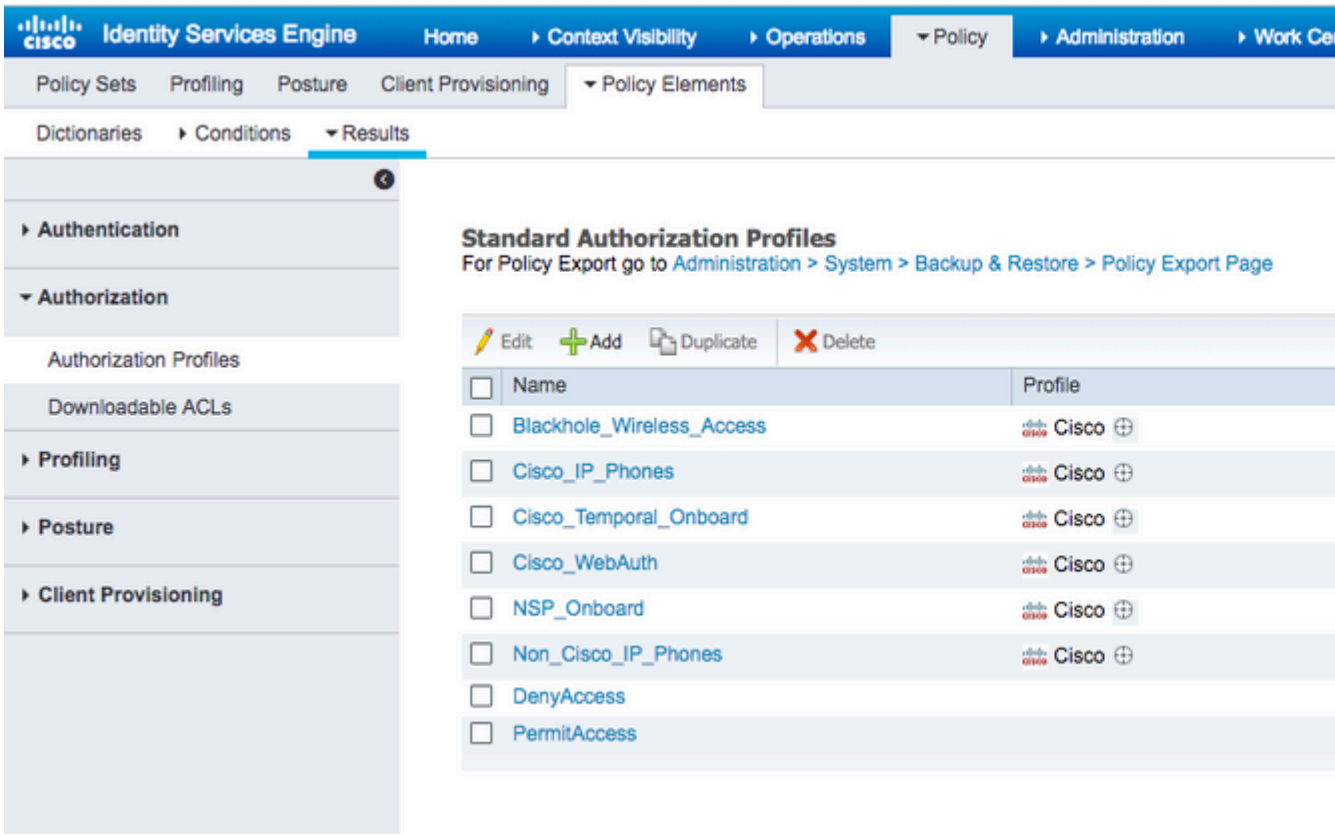
8. Respective Groups are added to ISE and can be saved. Press Save.



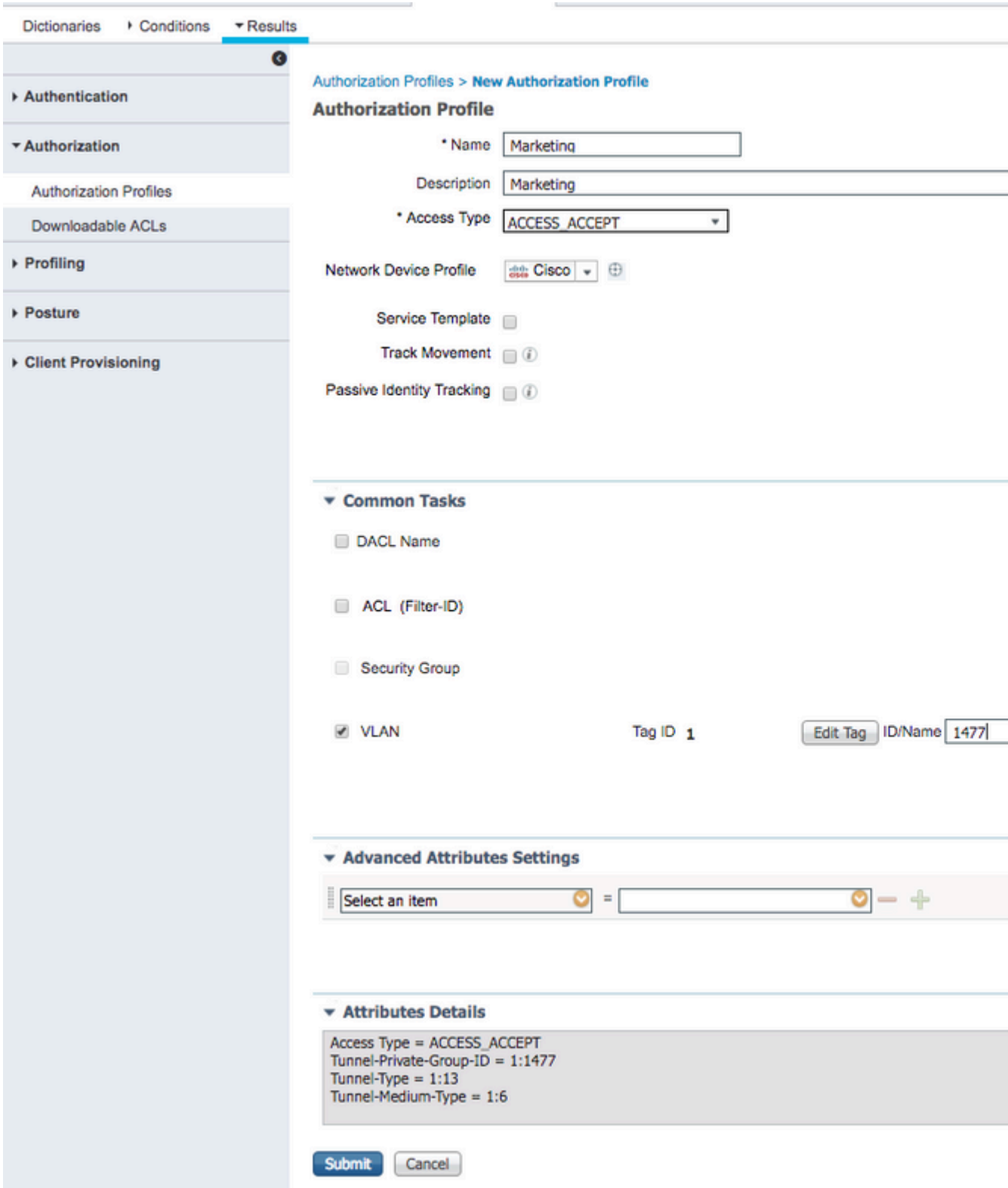
9. Add WLC to the ISE Network device list - navigate to Administration > Network Resources > Network Devices and press Add.
   Complete configuration, by providing WLC management IP address and RADIUS shared secret between WLC and ISE.



10. Now after you joined ISE to AD and added the WLC to the device list, you can start the configuration of authentication and authorization policies for users.
    - Create an authorization profile in order to assign users from **Marketing** to **VLAN1477** and from the **HR** group to **VLAN1478**.
      Navigate to Policy > Policy Elements > Results > Authorization > Authorization profiles and click the Add button in order to create a new profile.

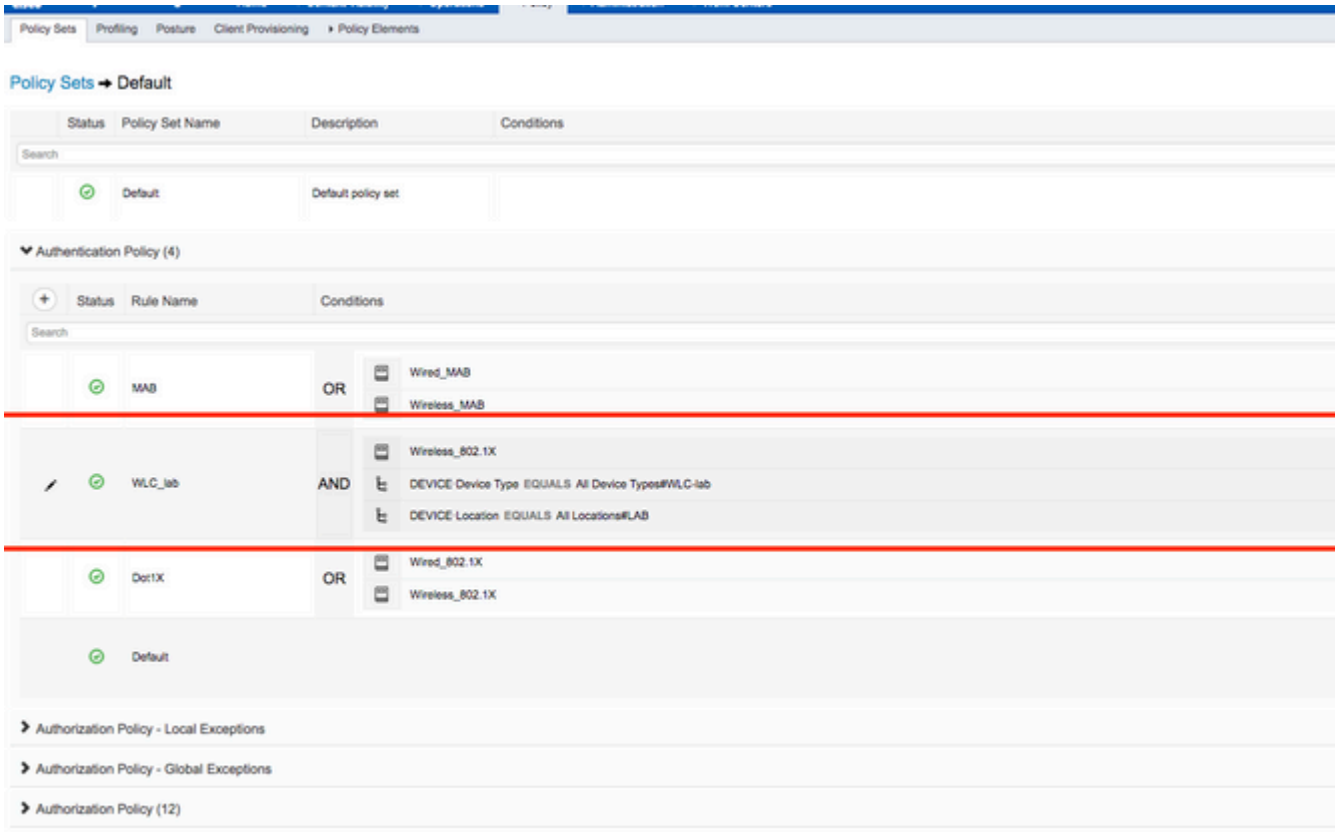


- Complete the authorization profile configuration with VLAN information for the respective group; the example shows Marketing group configuration settings.

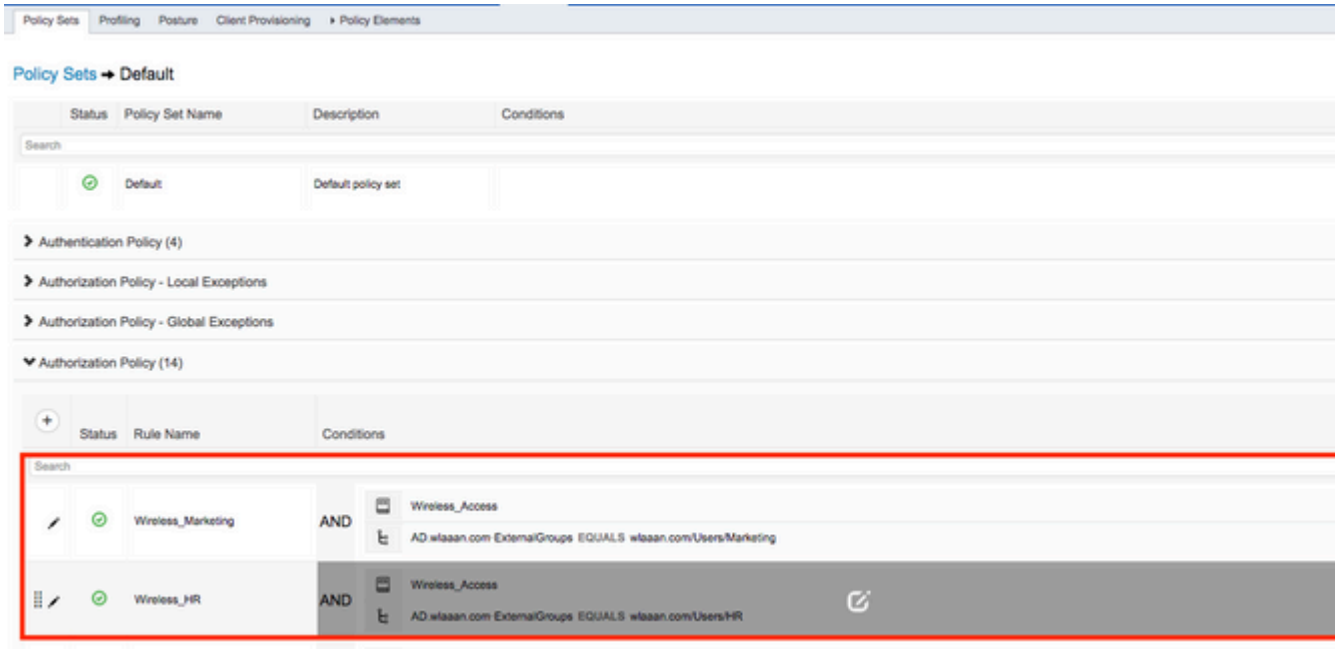


Similar configuration must be done for other groups and respective VLAN tag attributes must be configured.

- After authorization profiles are configured, you can define authentication policies for wireless users. This can be done either by configuring Custom or modifying the Default Policy set. In this example, the Default policy set is modified. Navigate to Policy > Policy Sets > Default. By default for dot1x authentication type, ISE is going to use All_User_ID_Stores, although it works even with current default settings since **AD** is part of the identity source list of All_User_ID_Stores, this example uses a more specific rule WLC_lab for that respective LAB controller and uses **AD** as the only source for authentication.



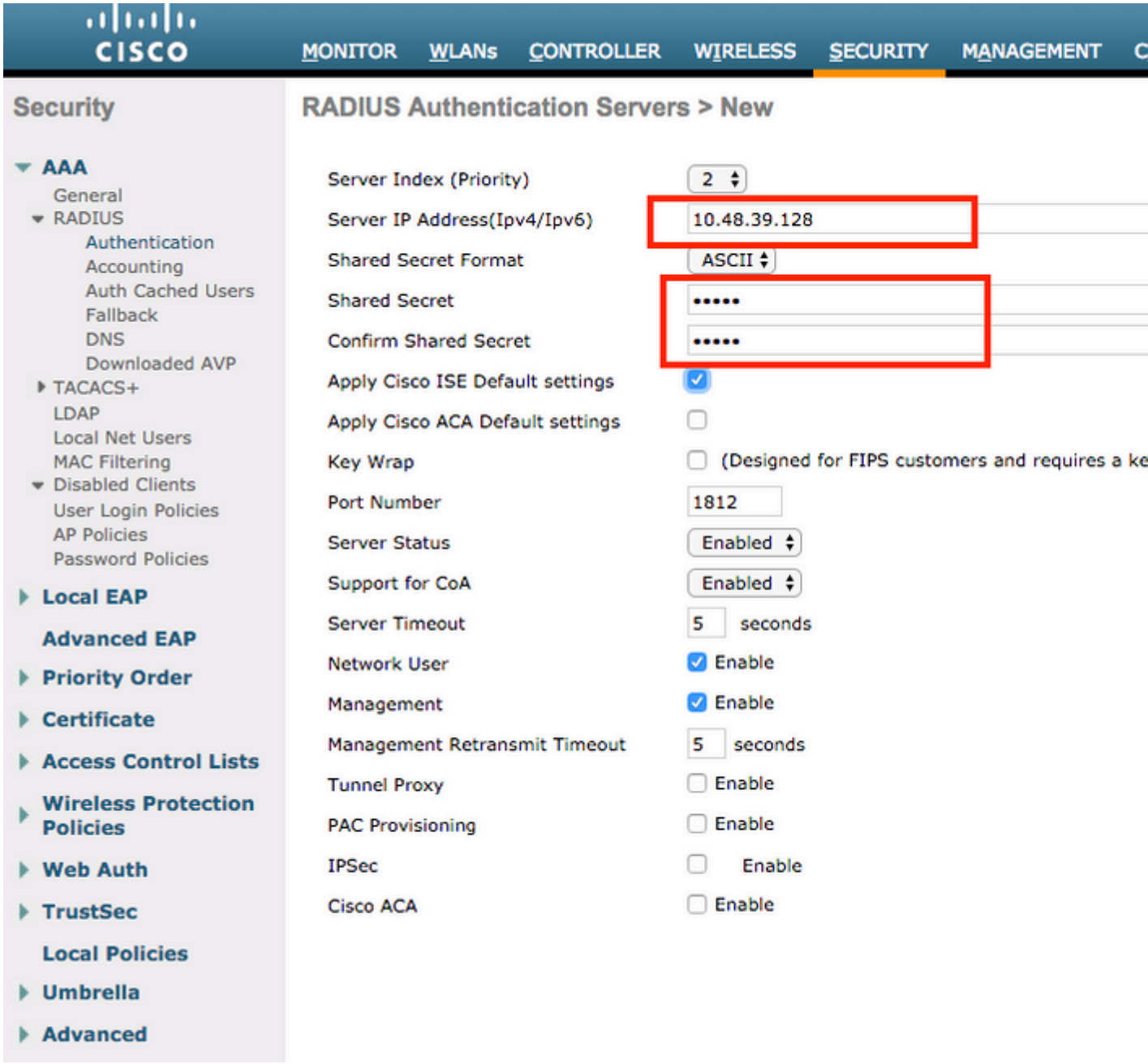
- Now you must create authorization policies for users that assign respective authorization profiles based on group membership. Navigate to Authorization policy section and create policies in order to accomplish that requirement.



WLC Configuration to Support dot1x Authentication and AAA Override for SSID 'office_hq'

1. Configure ISE as a RADIUS authentication server on WLC. Navigate to Security > AAA > RADIUS > Authentication section in the web UI interface and provide the ISE IP address and shared secret

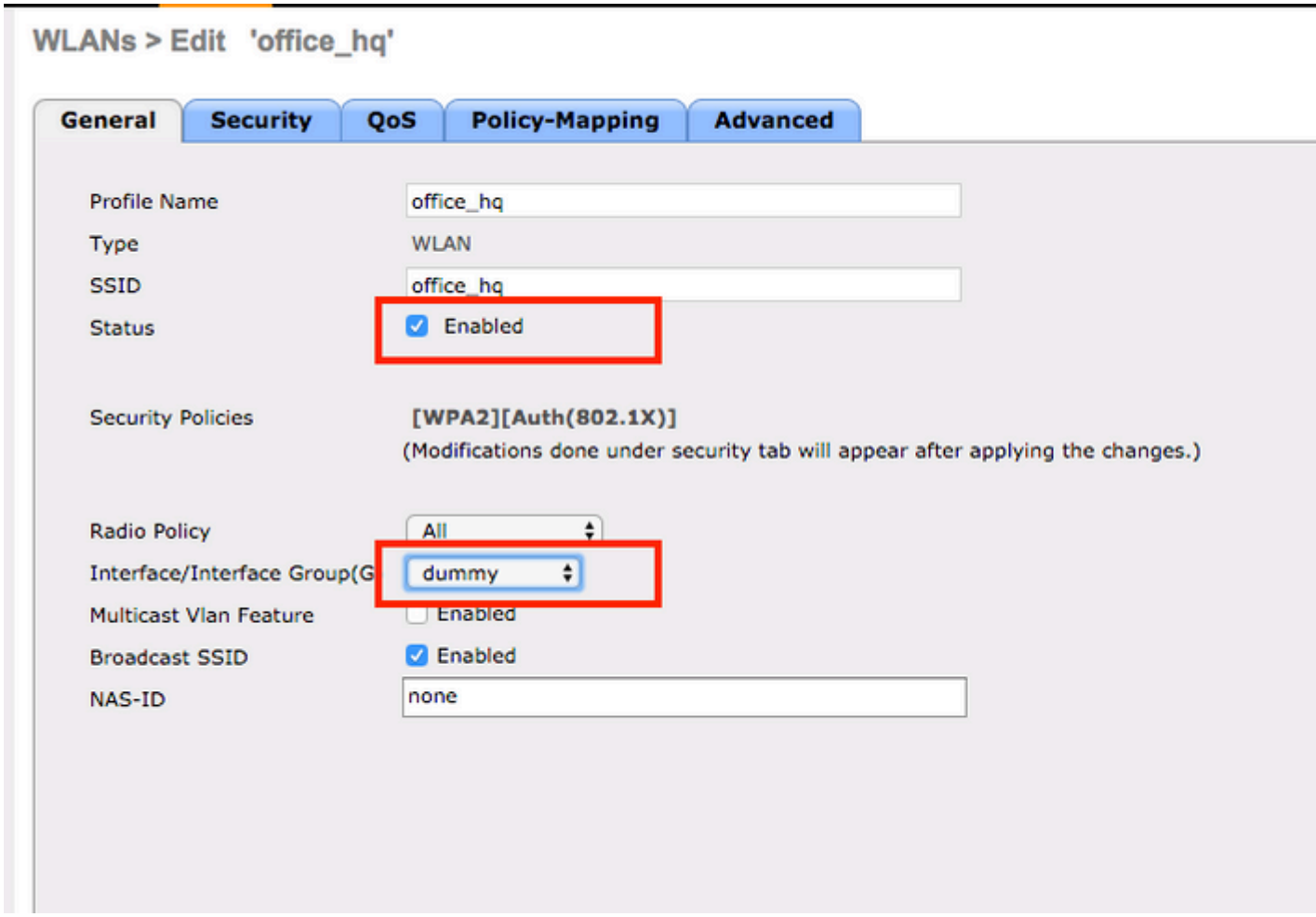
information.

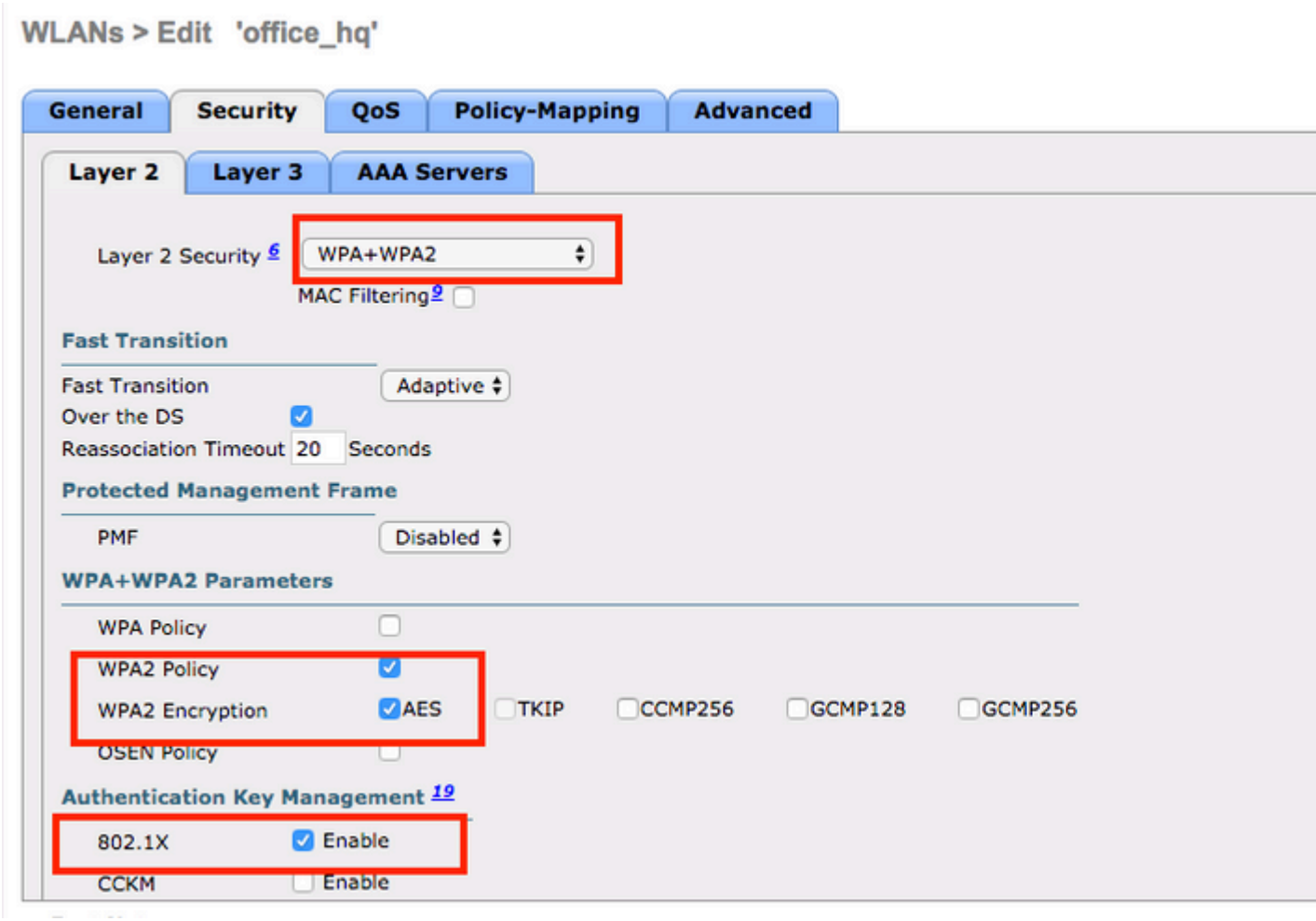


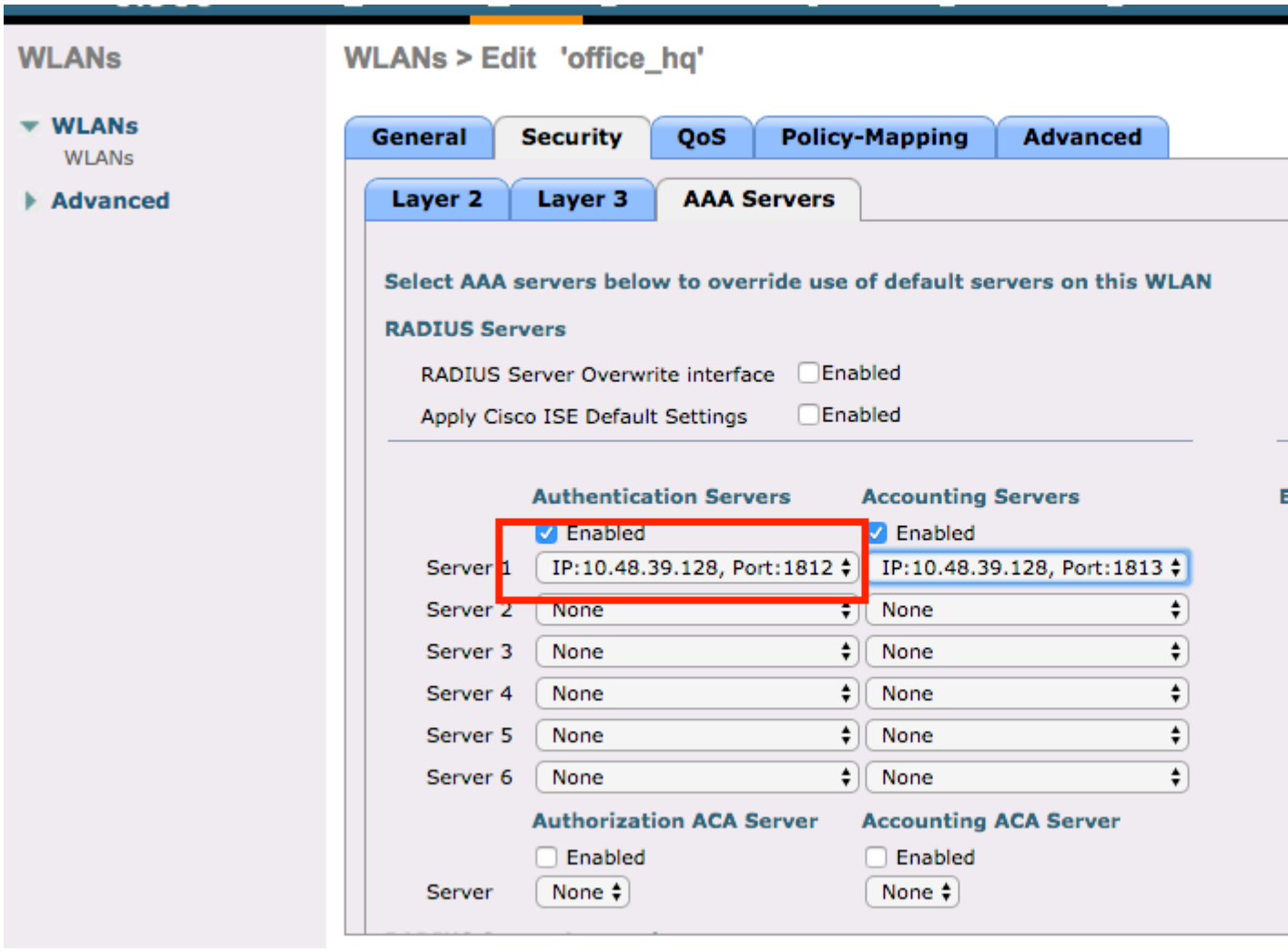
2. Configure SSID office_hq under the WLANs section on the WLC; this example configures SSID with WPA2/AES+dot1x and AAA override. Interface Dummy is chosen for the WLAN since the proper VLAN is assigned via RADIUS anyway. This dummy interface must be created on the WLC and given an IP address, but the IP address does not have to be valid and the VLAN in which it is put can not be created in the uplink switch so that if no VLAN is being assigned, the client cannot go anywhere.

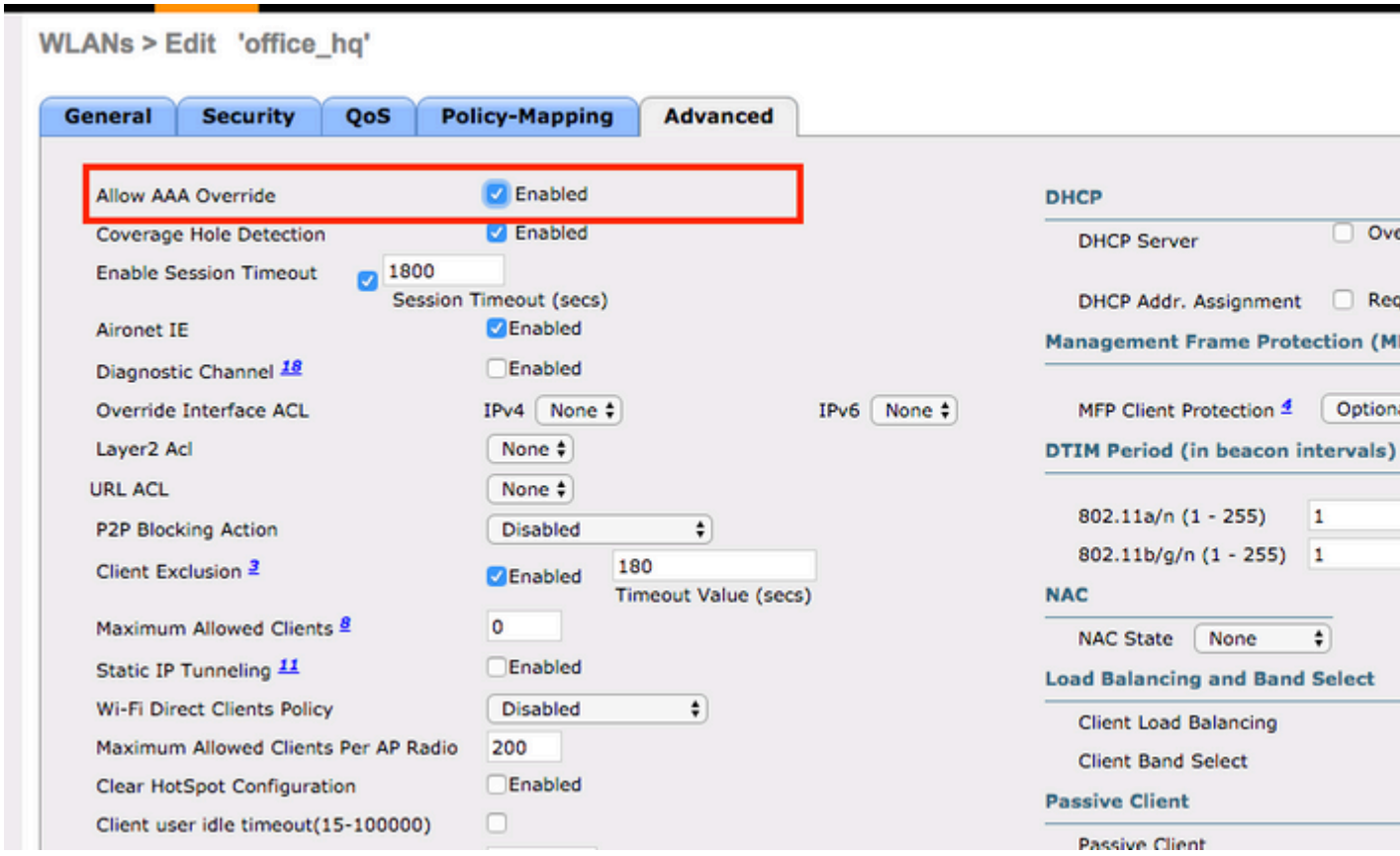

CISCO
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP FEEDBACK
WLANs
WLANs
WLANs
Advanced
Current Filter: None [Change Filter] [Clear Filter]
WLAN ID Type Profile Name WLAN SSID Admin Status
1 WLAN test test Enabled
2 WLAN AndroidAP AndroidAP Enabled
253 WLAN BTER-BTwifi-public BTwifi-public Enabled


CISCO
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP FEEDBACK
WLANs
WLANs > New
Type WLAN
Profile Name office_hq
SSID office_hq
ID 3

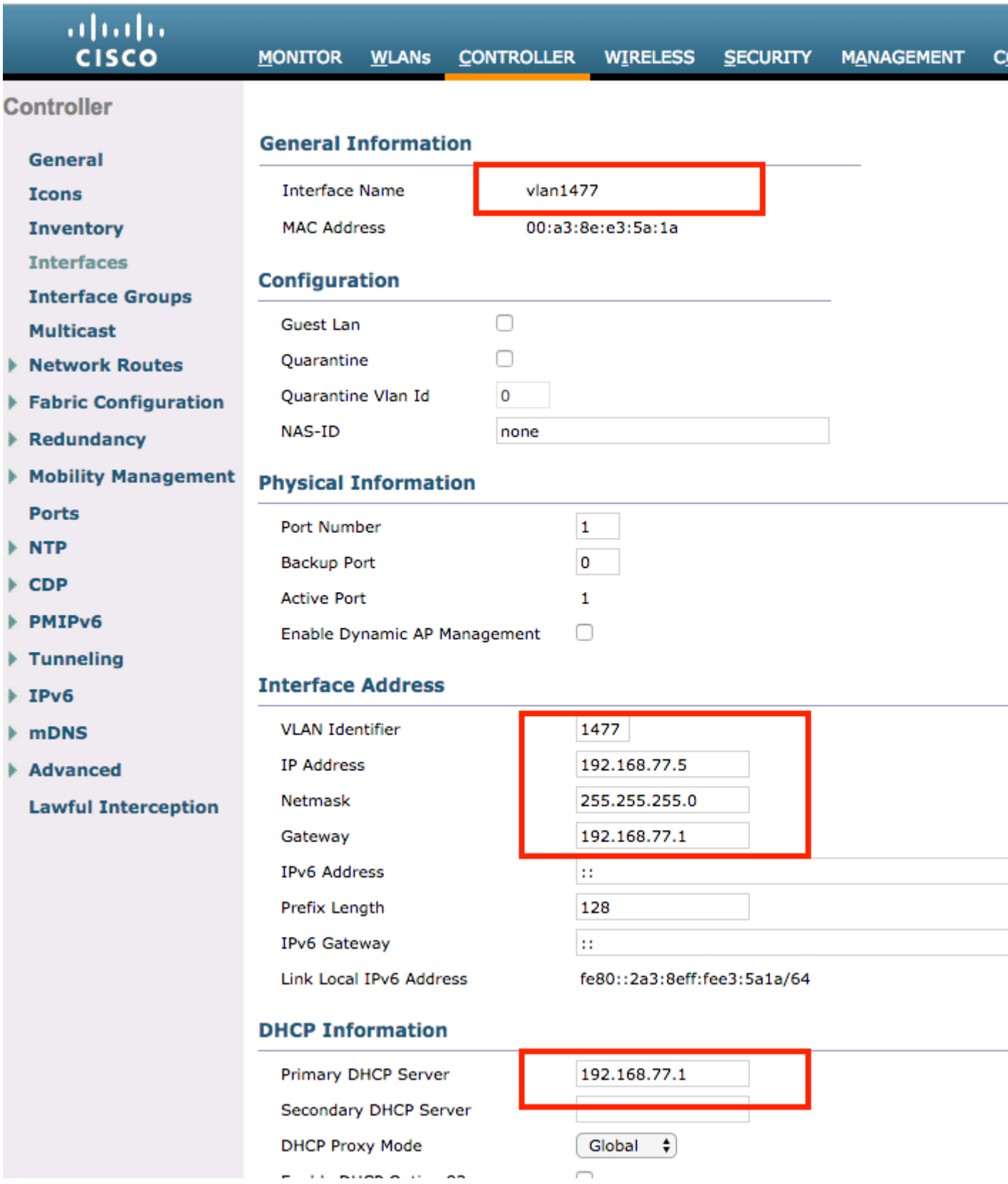

WLANs > Edit 'office_hq'
General Security QoS Policy-Mapping Advanced
Profile Name office_hq
Type WLAN
SSID office_hq
Status Enabled
Security Policies [WPA2][Auth(802.1X)]
(Modifications done under security tab will appear after applying the changes.)
Radio Policy All
Interface/Interface Group(G dummy
Multicast Vlan Feature Enabled
Broadcast SSID Enabled
NAS-ID none


WLANs > Edit 'office_hq'
General
Security
QoS
Policy-Mapping
Advanced
Layer 2
Layer 3
AAA Servers
Layer 2 Security 6
WPA+WPA2
MAC Filtering 9
Fast Transition
Fast Transition
Adaptive
Over the DS
Reassociation Timeout
20
Seconds
Protected Management Frame
PMF
Disabled
WPA+WPA2 Parameters
WPA Policy
WPA2 Policy
WPA2 Encryption
AES
TKIP
CCMP256
GCMP128
GCMP256
OSEN Policy
Authentication Key Management 19
802.1X
Enable
CCKM
Enable


WLANs
WLANs
Advanced
WLANs > Edit 'office_hq'
General
Security
QoS
Policy-Mapping
Advanced
Layer 2
Layer 3
AAA Servers
Select AAA servers below to override use of default servers on this WLAN
RADIUS Servers
RADIUS Server Overwrite interface
Enabled
Apply Cisco ISE Default Settings
Enabled
Authentication Servers
Accounting Servers
Enabled
Enabled
Server 1
IP:10.48.39.128, Port:1812
IP:10.48.39.128, Port:1813
Server 2
None
None
Server 3
None
None
Server 4
None
None
Server 5
None
None
Server 6
None
None
Authorization ACA Server
Accounting ACA Server
Enabled
Enabled
Server
None
None


WLANs > Edit 'office_hq'
General
Security
QoS
Policy-Mapping
Advanced
Allow AAA Override
Enabled
Coverage Hole Detection
Enabled
Enable Session Timeout
1800
Session Timeout (secs)
Aironet IE
Enabled
Diagnostic Channel 18
Enabled
Override Interface ACL
IPv4
None
IPv6
None
Layer2 Acl
None
URL ACL
None
P2P Blocking Action
Disabled
Client Exclusion 3
Enabled
180
Timeout Value (secs)
Maximum Allowed Clients 8
0
Static IP Tunneling 11
Enabled
Wi-Fi Direct Clients Policy
Disabled
Maximum Allowed Clients Per AP Radio
200
Clear HotSpot Configuration
Enabled
Client user idle timeout(15-100000)
DHCP
DHCP Server
DHCP Addr. Assignment
Management Frame Protection (M
MFP Client Protection 4
DTIM Period (in beacon intervals)
802.11a/n (1 - 255)
1
802.11b/g/n (1 - 255)
1
NAC
NAC State
None
Load Balancing and Band Select
Client Load Balancing
Client Band Select
Passive Client

3. You must also create dynamic interfaces on the WLC for user VLANs. Navigate to Controller > Interfaces UI menu. The WLC can only honor the VLAN assignment received via AAA if it has a dynamic interface in that VLAN.



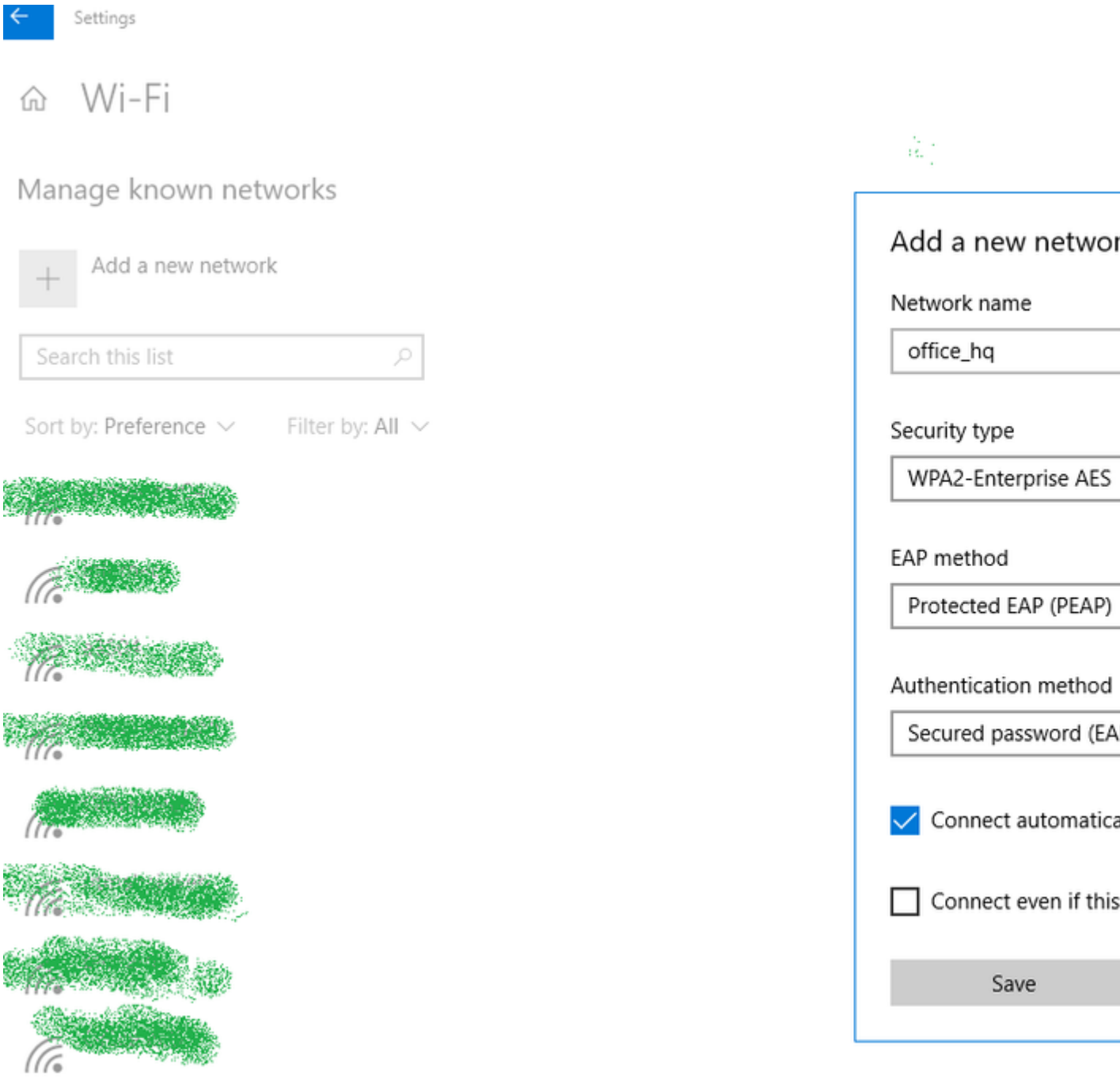
Verify

Use the Windows 10 native supplicant and Anyconnect NAM in order to test connections.

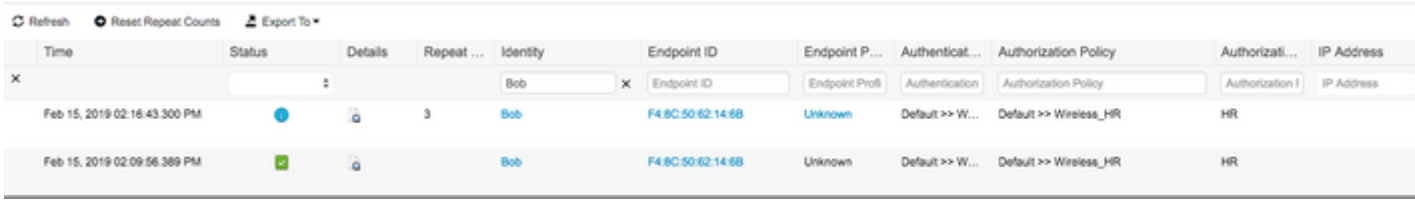
Since you are using EAP-PEAP authentication and ISE is using a Self-Signed Certificate (SSC), you must agree to a certificate warning or disable certificate validation. In a corporate environment, you must use a signed and trusted certificate on ISE and ensure that the end-user devices have the appropriate root certificate installed under the Trusted CA list.

Test connection with Windows 10 and native supplicant:

1. Open Network & Internet settings > Wi-Fi > Manage known networks and create a new network profile by pressing the Add new network button;fill in the required information.



2. Check the authentication log on ISE and ensure the right profile is selected for the user.



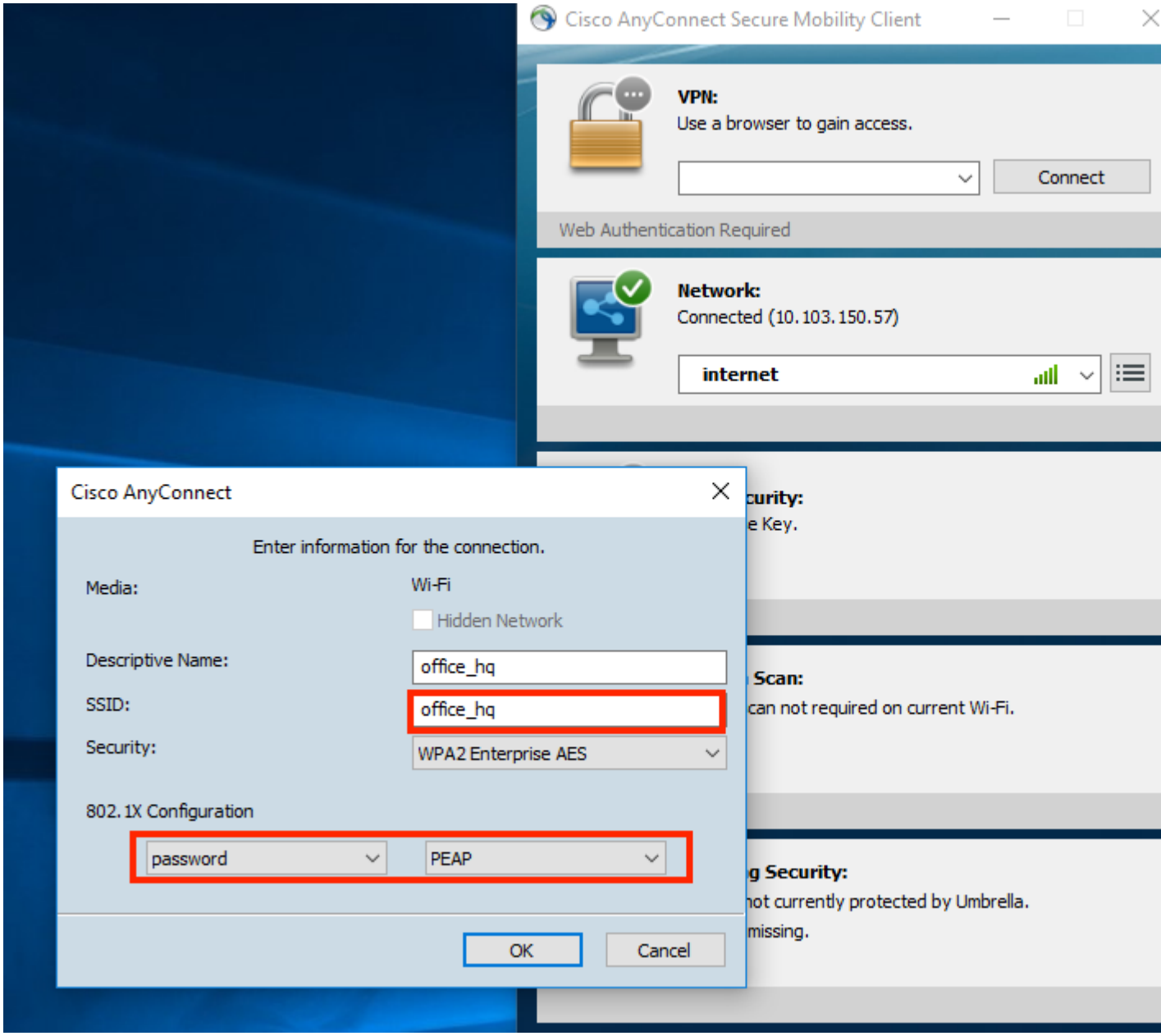
3. Check client entry on WLC and ensure it is assigned to the right VLAN and is in the **RUN** state.

4. From the **WLC CLI**, the client status can be checked with the show client dertails <mac-address>:

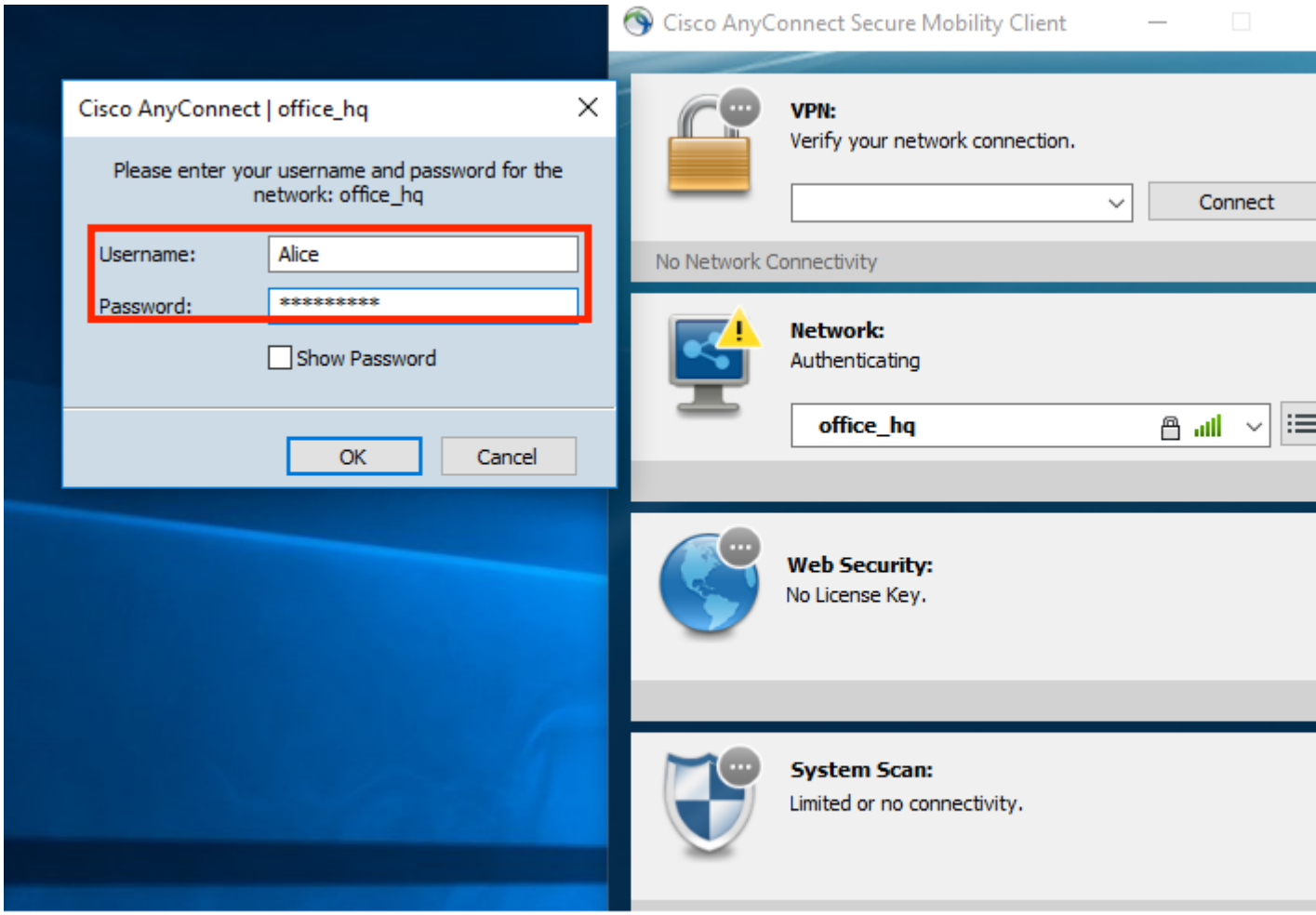
```
show client detail f4:8c:50:62:14:6b
Client MAC Address.............................. f4:8c:50:62:14:6b
Client Username ................................ Bob
Client Webauth Username ........................ N/A
Hostname: ......................................
Device Type: ................................... Intel-Device
AP MAC Address.................................. 70:69:5a:51:4e:c0
AP Name......................................... AP4C77.6D9E.6162
AP radio slot Id................................ 1
Client State.................................... Associated
User Authenticated by .......................... RADIUS Server
Client User Group............................... Bob
Client NAC OOB State............................ Access
Wireless LAN Id................................. 3
Wireless LAN Network Name (SSID)................ office_hq
Wireless LAN Profile Name....................... office_hq
Hotspot (802.11u)............................... Not Supported
Connected For .................................. 242 secs
BSSID........................................... 70:69:5a:51:4e:cd
Channel......................................... 36
IP Address...................................... 192.168.78.36
Gateway Address................................. 192.168.78.1
Netmask......................................... 255.255.255.0
...
Policy Manager State............................ RUN
...
EAP Type........................................ PEAP
Interface....................................... vlan1478
VLAN............................................ 1478
Quarantine VLAN................................. 0
Access VLAN..................................... 1478
```

Test connection with Windows 10 and Anyconnect NAM:

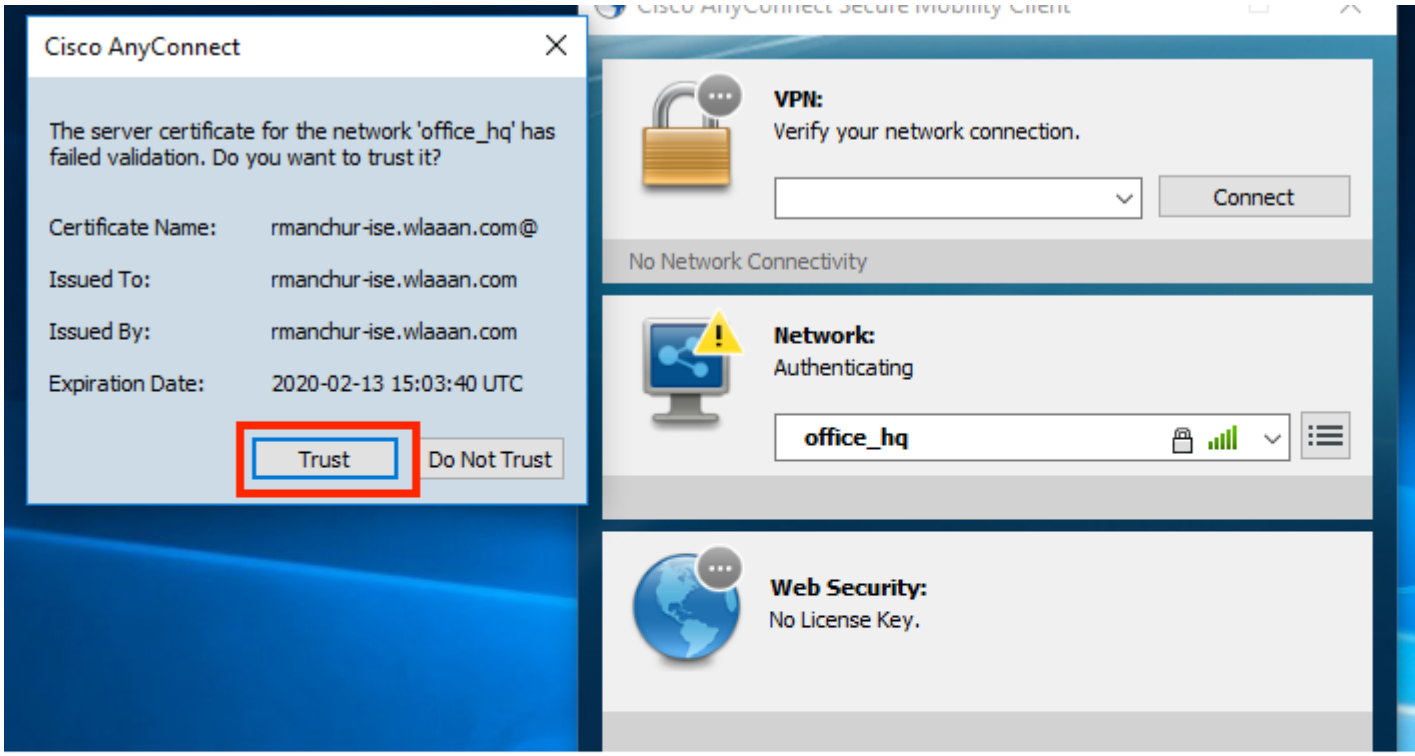
1. Choose the SSID from the available SSIDs list and the respective EAP authentication type (in this example PEAP) and the inner authentication form.



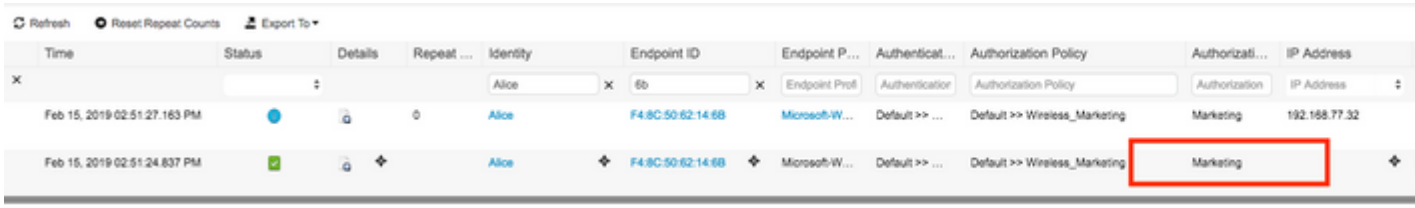
2. Provide username and password for user authentication.



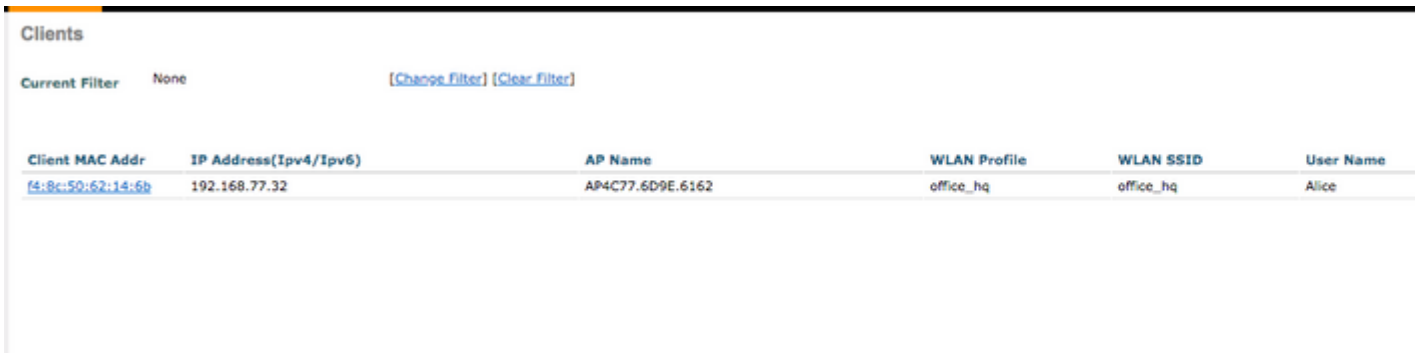
3. Since ISE is sending an SSC to the client, you must manually choose to trust the certificate (in the production environment it is highly recommended to install the trusted certificate on ISE).



4. Check authentication logs on ISE and ensure the right authorization profile is selected for the user.



5. Check client entry on the WLC and ensure it is assigned to the right VLAN and is in the **RUN** state.



6. From the **WLC CLI**, the client status can be checked with the show client dertails <mac-address>:

```
Client MAC Address.............................. f4:8c:50:62:14:6b
Client Username ................................ Alice
Client Webauth Username ........................ N/A
Hostname: .....................................
Device Type: ................................... Intel-Device
AP MAC Address.................................. 70:69:5a:51:4e:c0
AP Name......................................... AP4C77.6D9E.6162
AP radio slot Id................................ 1
Client State.................................... Associated
User Authenticated by .......................... RADIUS Server
Client User Group............................... Alice
Client NAC OOB State............................ Access
Wireless LAN Id................................. 3
Wireless LAN Network Name (SSID)................ office_hq
Wireless LAN Profile Name....................... office_hq
Hotspot (802.11u)............................... Not Supported
Connected For .................................. 765 secs
BSSID........................................... 70:69:5a:51:4e:cd
Channel......................................... 36
IP Address...................................... 192.168.77.32
Gateway Address................................. 192.168.77.1
Netmask......................................... 255.255.255.0
...
Policy Manager State............................ RUN
...
Policy Type..................................... WPA2
Authentication Key Management................... 802.1x
Encryption Cipher............................... CCMP-128 (AES)
Protected Management Frame ..................... No
Management Frame Protection..................... No
EAP Type........................................ PEAP
Interface....................................... vlan1477
VLAN............................................ 1477
```

Troubleshoot

1. Use the test aaa radius username <user> password <password> wlan-id <id> in order to test the RADIUS connection between WLC and ISE and the test aaa show radius in order to show the results.

```
test aaa radius username Alice password <removed> wlan-id 2

Radius Test Request
  Wlan-id....................................... 2
  ApGroup Name.................................. none

  Attributes                    Values
  ----------                    ------
  User-Name                     Alice
  Called-Station-Id             00-00-00-00-00-00:AndroidAP
  Calling-Station-Id            00-11-22-33-44-55
  Nas-Port                      0x00000001 (1)
  Nas-Ip-Address                10.48.71.20
  NAS-Identifier                0x6e6f (28271)
  Airespace / WLAN-Identifier   0x00000002 (2)
```

```
  User-Password                  cisco!123
  Service-Type                   0x00000008 (8)
  Framed-MTU                     0x00000514 (1300)
  Nas-Port-Type                  0x00000013 (19)
  Cisco / Audit-Session-Id       1447300a0000003041d5665c
  Acct-Session-Id                5c66d541/00:11:22:33:44:55/743


test radius auth request successfully sent. Execute 'test aaa show radius' for response

(Cisco Controller) >test aaa show radius

Radius Test Request
  Wlan-id..................................... 2
  ApGroup Name................................ none
Radius Test Response

Radius Server            Retry Status
-------------            ----- ------
10.48.39.128             1     Success

Authentication Response:
  Result Code: Success

  Attributes                     Values
  ----------                     ------
  User-Name                      Alice
  State                          ReauthSession:1447300a0000003041d5665c
  Class                          CACS:1447300a0000003041d5665c:rmanchur-ise/339603379/59
  Tunnel-Type                    0x0000000d (13)
  Tunnel-Medium-Type             0x00000006 (6)
  Tunnel-Group-Id                0x000005c5 (1477)


(Cisco Controller) >
```

2. Use the debug client <mac-address> in order to troubleshoot wireless client connectivity issues.
3. Use the debug aaa all enable in order to troubleshoot authentication and authorization issues on the WLC.

> **Note**: Use this command only with the debug mac addr in order to limit the output based on the MAC address for which debugging is done.

---

4. Refer to ISE live logs and session logs in order to identify problems authentication failures and AD communication issues.