FlexConnect Wireless Branch Controller Deployment Guide

Last Updated: July, 2018

Introduction

This document describes how to deploy a Cisco Flex Connect AP. The purpose of this document is to:

- Explain various network elements of the Cisco FlexConnect solution, along with their communication flow.
- Provide general deployment guidelines for designing the Cisco FlexConnect wireless branch solution.

The Cisco WLCs can manage Flex Connect wireless access points in up to 2000 branch locations and allows IT managers to configure, manage, and troubleshoot up to 6000 access points (APs) and 64,000 clients from the data center. The Cisco Flex Connect deployments support secure guest access, rogue detection for Payment Card Industry (PCI) compliance, and in-branch (locally switched) Wi-Fi voice and video.

The following table highlights the FC scalability differences between the Flex 3504, 5520, 8540, Mobility Express and vWLC controllers:

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Additional Scale Specifications	WLC 3504	WLC5520	WLC8540	ME	vWLC-Small	vWLC-Large
Maximum Access Points	150	1500	6000	100	200	3000
Maximum Clients	3000	20000	64000	2000	6000	32000
Maximum # of AP Groups	150	1500	6000	50	200	3000
Max Flex Connect Groups	100	1500	2000	1	100	1500
Max # of VLANs	4094	4095	4095	16		
Max WLANs	512	512	512	16		
Max # interfaces	512	1500	1500	n/a		
Maximum RFIDs	1500	25000	50000	2000	6000	25000
Maximum Rogue APs	600	24000	24000	200	800	12000
Maximum Rogue Clients	150	32000	32000	400	3000	16000
Maximum APs in one RRM/RF group	1000	3000	6000	100	400	5000
NBAR Max Profiles	16	16	16	n/a		
NBAR Max Rules single profile	32	32	32	n/a		
NBAR Max # FlowTable Entries	160000	320000	320000	n/a		
Maximum L2 ACL rules per L2 ACL	16	16	16	n/a		
Maximum L2 ACLs allowed	64	64	64	n/a		
Max # L3 ACLs (ipv4/ipv6)	64/64	64/64	64/64	n/a		
Max # of Rules in L3 ACL IP/DNS	64/64	64/64	64/64	64/32		
Max # of Radius servers supported (unique)	16	16	16	6		
Max Bonjour Service Providers	16000	16000	16000	n/a		
Max FC groups with max APs per group	100	100	100	1	100	100

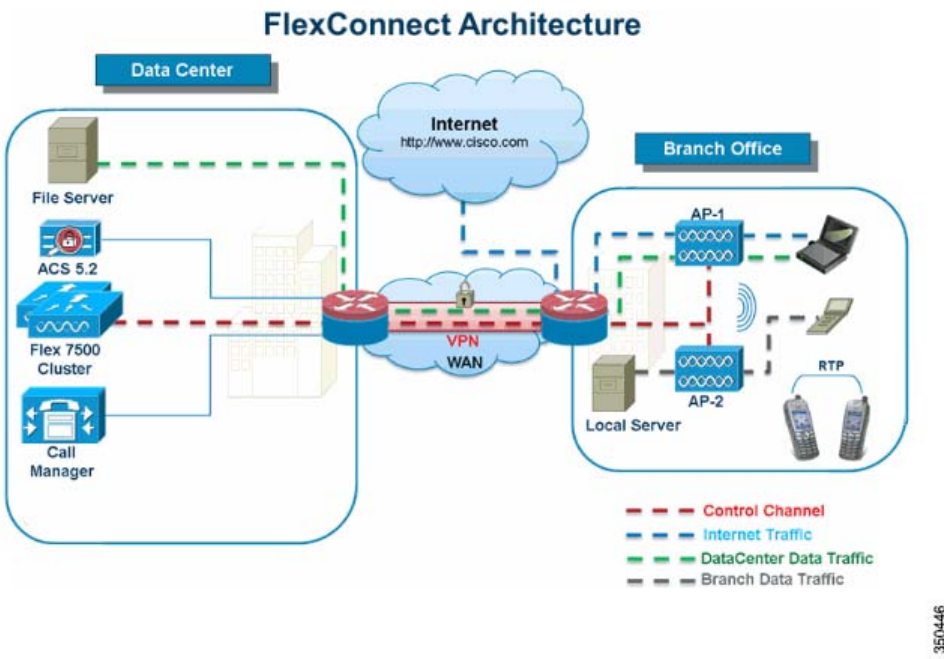
Supported Access Points

Access Points

- Wave-1 APs: 3700, 2700, 1700, 702, 702W, 1530, 1570
- Wave-2 APs: 1800 series, 2800 series, 3800 series, 4800 series (starting rel 8.7.5); 1540, 1560

FlexConnect Architecture

Figure 1 Typical Wireless Branch Topology



FlexConnect is a wireless solution for branch office and remote office deployments.

The FlexConnect solution enables the customer to:

- Centralize control and manage traffic of APs from the Data Center.
- Distribute the client data traffic at each Branch Office.
  - Each traffic flow is going to its final destination in the most efficient manner.

Controllers Supporting FlexConnect Mode

- Cisco WLC 3504, 5520, 8500 Series, vWLC

Advantages of Centralizing Access Point Control Traffic

- Single pane of monitoring and troubleshooting.
- Ease of management.
- Secured and seamless mobile access to Data Center resources.
- Reduction in branch footprint.
- Increase in operational savings.

Advantages of Distributing Client Data Traffic

- No operational downtime (survivability) against complete WAN link failures or controller unavailability.
- Mobility resiliency within branch during WAN link failures.
- Increase in branch scalability. Supports branch size that can scale up to 100 APs and 250,000 square feet (5000 sq. feet per AP).

The Cisco FlexConnect solution also supports Central Client Data Traffic, but it is limited to Guest data traffic only. This next table describes the restrictions on WLAN L2 security types only for non-guest clients whose data traffic is also switched centrally at the Data Center.

Table 1 L2 Security Support for Centrally Switched Non-Guest Users

WLAN L2 Security	Type	Result
None	N/A	Allowed
WPA + WPA2	802.1x	Allowed
	CCKM	Allowed
	802.1x + CCKM	Allowed
	PSK	Allowed
802.1x	WEP	Allowed
Static WEP	WEP	Allowed
WEP + 802.1x	WEP	Allowed
CKIP	-	Allowed

Note These authentication restrictions do not apply to clients whose data traffic is distributed at the branch.

Table 2 L3 Security Support for Centrally and Locally Switched Users

WLAN L3 Security	Type	Result
Web Authentication	Internal	Allowed
	External	Allowed
	Customized	Allowed
Web Pass-Through	Internal	Allowed
	External	Allowed
	Customized	Allowed
Conditional Web Redirect	External	Allowed
Splash Page Web Redirect	External	Allowed

For more information on Flexconnect external webauth deployment, please refer to Flexconnect External WebAuth Deployment Guide

For more information on HREAP/FlexConnect AP states and data traffic switching options, refer to Configuring FlexConnect.

FlexConnect Modes of Operation

FlexConnect Mode	Description
Connected	A FlexConnect is said to be in Connected Mode when its CAPWAP control plane back to the controller is up and operational, meaning the WAN link is not down.
Standalone	Standalone mode is specified as the operational state the FlexConnect enters when it no longer has the connectivity back to the controller. FlexConnect APs in Standalone mode will continue to function with last known configuration, even in the event of power failure and WLC or WAN failure.

For more information on FlexConnect Theory of Operations, refer to the H-Reap/FlexConnect Design and Deployment Guide.

WAN Requirements

FlexConnect APs are deployed at the Branch site and managed from the Data Center over a WAN link. The maximum transmission unit (MTU) must be at least 500 bytes.

Deployment Type	WAN Bandwidth (Min)	WAN RTT Latency (Max)	Max APs per Branch	Max Clients per Branch
Data	64 Kbps	300 ms	5	25
Data	640 Kbps	300 ms	50	1000
Data	1.44Mbps	1 sec	50	1000
Data + Voice	128 Kbps	100 ms	5	25
Data + Voice	1.44Mbps	100 ms	50	1000
Monitor	64 Kbps	2 sec	5	N/A
Monitor	640 Kbps	2 sec	50	N/A

Note It is highly recommended that the minimum bandwidth restriction remains 12.8 Kbps per AP with the round trip latency no greater than 300 ms for data deployments and 100 ms for data + voice deployments.

For large deployments with scale for max APs per branch = 100 and max clients per branch = 2000.

Key Features

Adaptive wIPS, Context Aware (RFIDs), Rogue Detection, Clients with central 802.1X auth and CleanAir.

Test Results

For 100 APs, 2000 Clients, 1000 RFIDs, 500 Rogue APs, and 2500 Rogue Clients (Features above turned on):

Recommended BW = 1.54 Mbps

Recommended RTT latency = 400 ms

Test Results

For 100 APs, 2000 Clients, no rogue, and no RFIDs. (Features above turned off).

Recommended BW = 1.024 Mbps

Recommended Latency = 300 ms

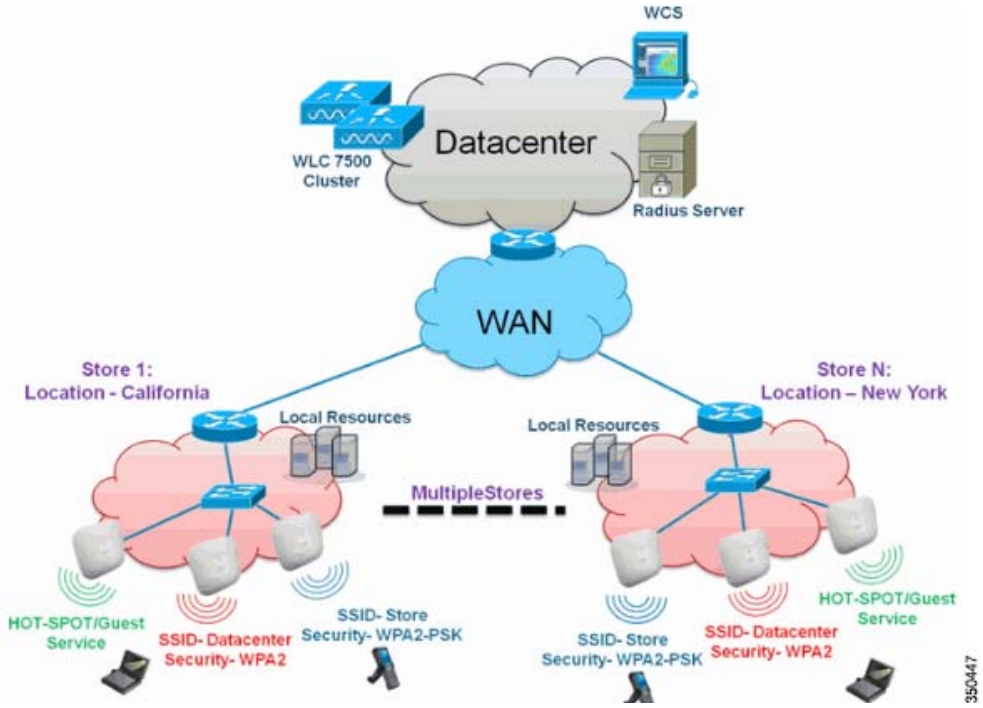
Wireless Branch Network Design

The rest of this document highlights the guidelines and describes the best practices for implementing secured distributed branch networks. FlexConnect architecture is recommended for wireless branch networks that meet these design requirements.

Primary Design Requirements

- Branch size that can scale up to 100 APs and 250,000 square feet (5000 sq. feet per AP)
- Central management and troubleshooting
- No operational downtime
- Client-based traffic segmentation
- Seamless and secured wireless connectivity to corporate resources
- PCI compliant
- Support for guests

Figure 2 Wireless Branch Network Design



Overview

Branch customers find it increasingly difficult and expensive to deliver full-featured scalable and secure network services across geographic locations. In order to support customers, Cisco is addressing these challenges by introducing the FlexConnect deployment mode.

The FlexConnect solution virtualizes the complex security, management, configuration, and troubleshooting operations within the data center and then transparently extends those services to each branch. Deployments using FlexConnect are easier for IT to set up, manage and, most importantly, scale.

Advantages

- Increase scalability with 6000 AP support.
- Increased resiliency using FlexConnect Fault Tolerance.
- Increase segmentation of traffic using FlexConnect (Central and Local Switching).
- Ease of management by replicating store designs using AP groups and FlexConnect groups.

Features Addressing Branch Network Design

The rest of the sections in the guide captures feature usage and recommendations to realize the network design shown in Figure 2.

Table 3 Features

Primary Features	Highlights
AP Groups	Provides operational/management ease when handling multiple branch sites. Also, gives the flexibility of replicating configurations for similar branch sites.
FlexConnect Groups	FlexConnect Groups provide the functionality of Local Backup Radius, CCKM/OKC fast roaming, and Local Authentication.
Fault Tolerance	Improves the wireless branch resiliency and provides no operational downtime.
ELM (Enhanced Local Mode for Adaptive wIPS)	Provide Adaptive wIPS functionality when serving clients without any impact to client performance.
Client Limit per WLAN	Limiting total guest clients on branch network.
AP Pre-image Download	Reduces downtime when upgrading your branch.
Auto-convert APs in FlexConnect	Functionality to automatically convert APs in FlexConnect for your branch.
Guest Access	Continue existing Cisco's Guest Access Architecture with FlexConnect.

Note Flexconnect APs implemented with WIPS mode can increase bandwidth utilization significantly based on the activity being detected by the APs. If the rules have forensics enabled, the link utilization can go up by almost 100 Kbps on an average.

Feature Matrix

Refer to FlexConnect Feature Matrix for a feature matrix for the FlexConnect feature.

AP Groups

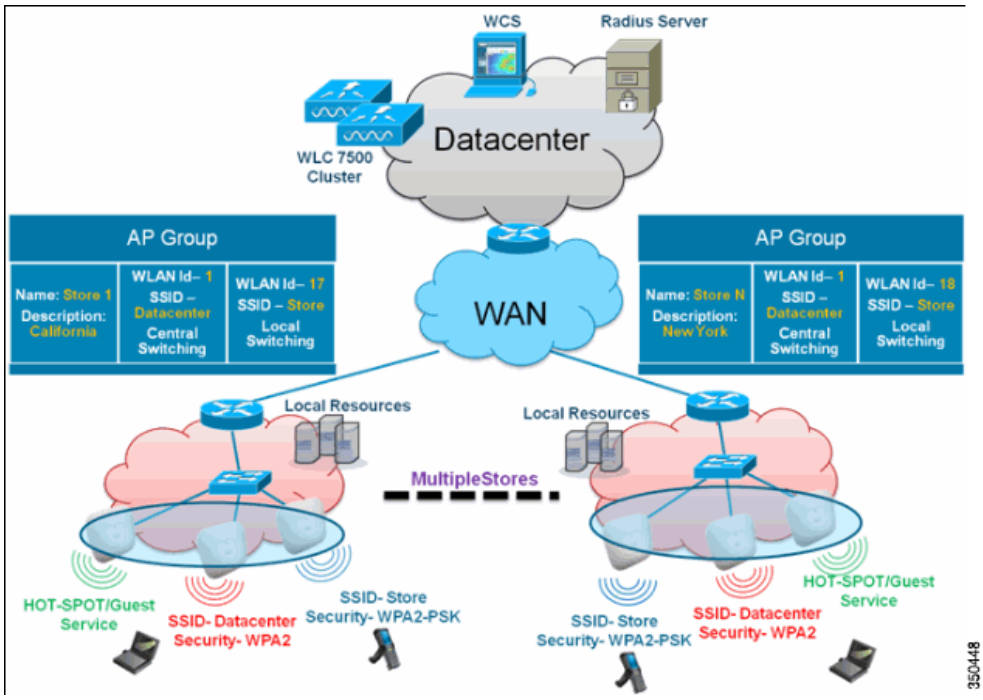
After creating WLANs on the controller, you can selectively publish them (using access point groups) to different access points in order to better manage your wireless network. In a typical deployment, all users on a WLAN are mapped to a single interface on the controller. Therefore, all users associated with that WLAN are on the same subnet or VLAN. However, you can choose to distribute the load among

several interfaces or to a group of users based on specific criteria such as individual departments (such as Marketing, Engineering or Operations) by creating access point groups. Additionally, these access point groups can be configured in separate VLANs to simplify network administration.

This document uses AP groups to simplify network administration when managing multiple stores across geographic locations. For operational ease, the document creates one AP-group per store to satisfy these requirements:

- Centrally Switched SSID Data center across all stores for Local Store Manager administrative access.
- Locally Switched SSID Store with different WPA2-PSK keys across all stores for hand-held scanners.

Figure 3 Wireless Network Design Reference Using AP Groups



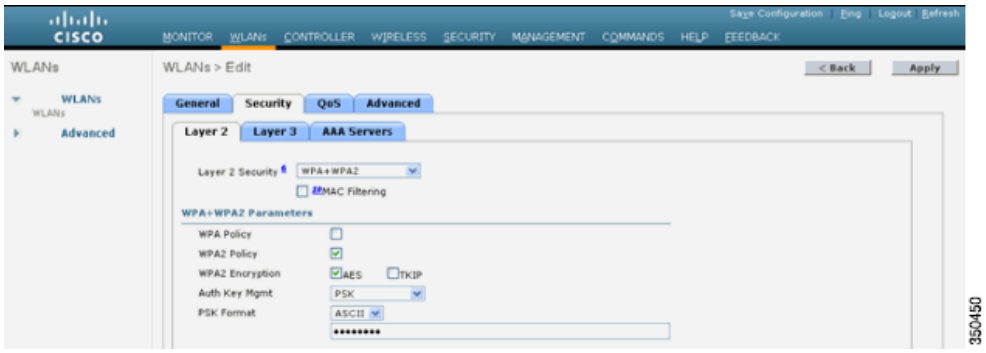
Configurations from WLC

Complete the following steps:

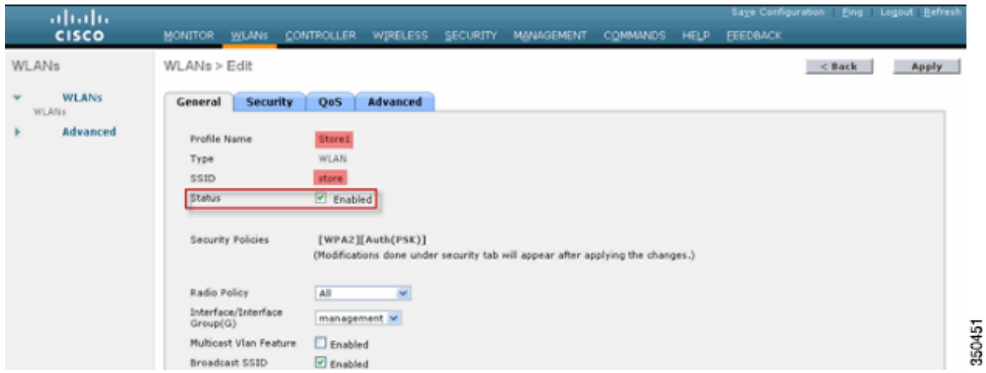
Step 1 On the **WLANs > New page**, enter **Store1** in the **Profile Name** field, enter **store** in the **SSID** field, and choose **17** from the **ID** drop-down list.

Note WLAN IDs 1-16 are part of the default group and cannot be deleted. In order to satisfy our requirement of using same SSID store per store with a different WPA2-PSK, you need to use WLAN ID 17 and beyond because these are not part of the default group and can be limited to each store.

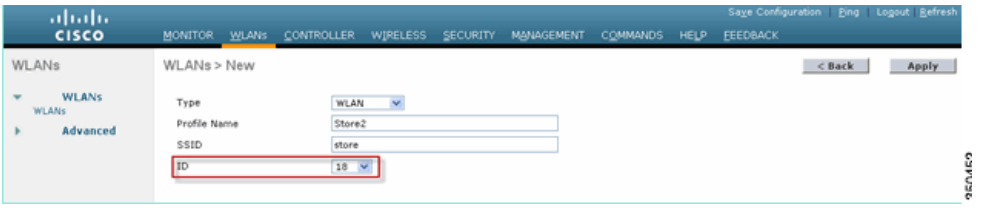
Step 2 Under **WLAN > Security**, choose **PSK** from the **Auth Key Mgmt** drop-down list, choose **ASCII** from the PSK Format drop-down list, and click **Apply**.

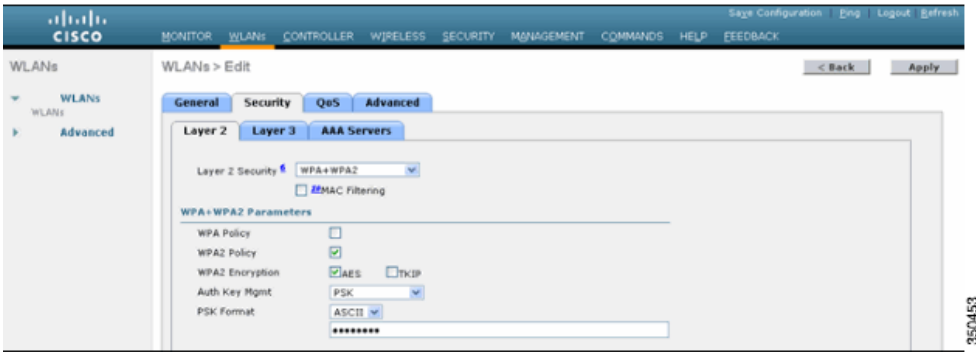


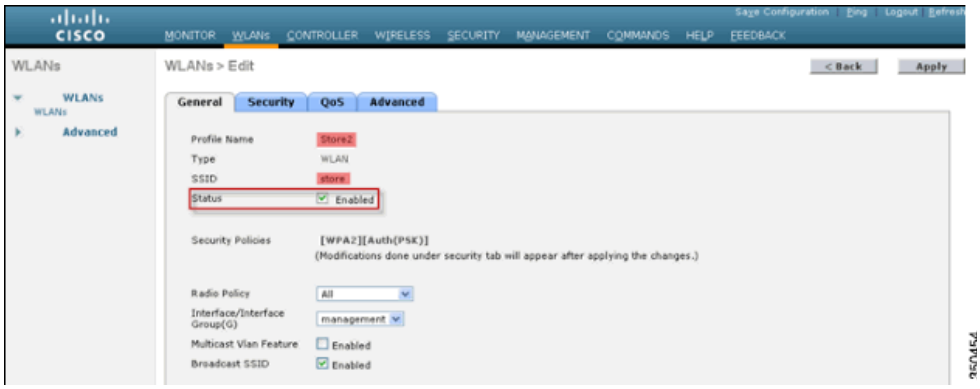
Step 3 Click **WLAN > General**, verify the Security Policies change, and check the **Status** box to enable the WLAN.



Step 4 Repeat steps 1, 2 and 3 for new WLAN profile **Store2**, with SSID as **store** and ID as **18.**







Step 5 Create and enable the WLAN profile with Profile Name **DataCenter**, SSID **DataCenter** and ID **1**.

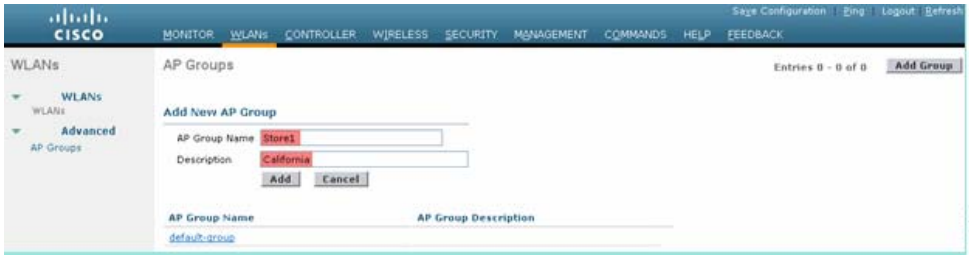
Note On creation, WLAN IDs from 1-16 are automatically part of the default-ap-group.

Step 6 Under WLAN, verify the status of WLAN IDs 1, 17 and 18.

Step 7 Click **WLAN > Advanced > AP group > Add Group.**

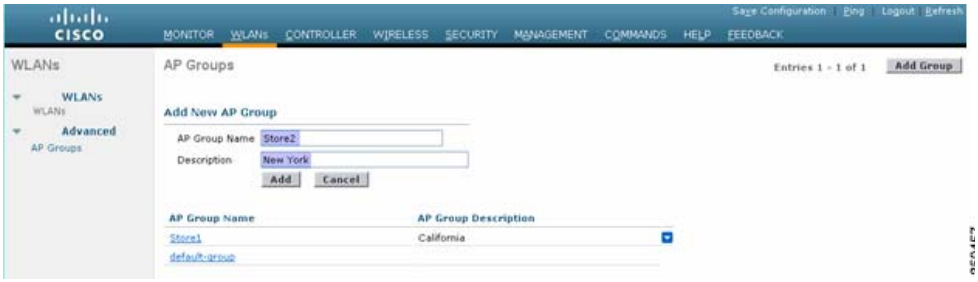
Step 8 Add AP Group Name as **Store1**, same as WLAN profile **Store1,** and Description as the Location of the Store. In this example, California is used as the location of the store.

Step 9 Click **Add** when done.



Step 10 Click **Add Group** and create the AP Group Name as **Store2** and the description as **New York**.

Step 11 Click **Add.**



Step 12 Verify the group creation by navigating to **WLAN > Advanced > AP Groups.**

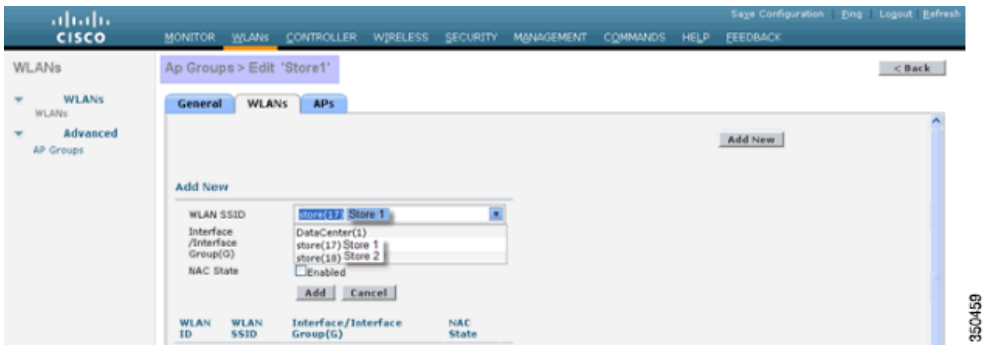
Step 13 Click AP Group Name **Store1** to add or edit the WLAN.

Step 14 Click **Add New** to select the WLAN.

Step 15 Under WLAN, from the WLAN SSID drop-down, choose **WLAN ID 17 store(17)**.

Step 16 Click **Add** after WLAN ID 17 is selected.

Step 17 Repeat steps (14 -16) for WLAN ID 1 DataCenter(1). This step is optional and needed only if you want to allow Remote Resource access.



Step 18 Go back to the **WLAN > Advanced > AP Groups** screen.

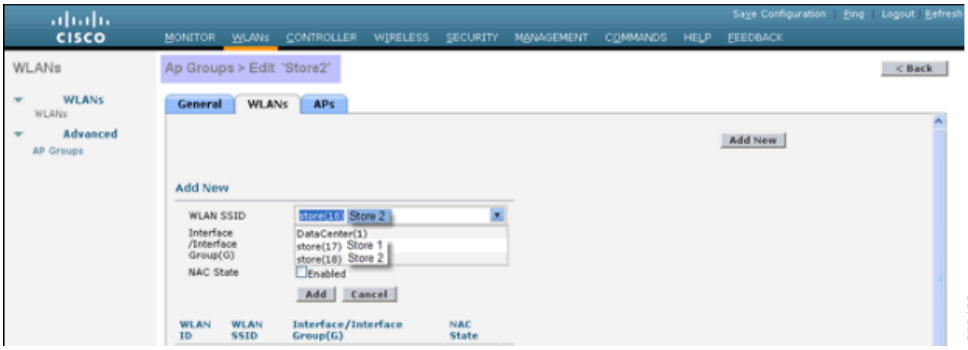
Step 19 Click AP Group Name **Store2** to add or edit WLAN.

Step 20 Click **Add New** to select the WLAN.

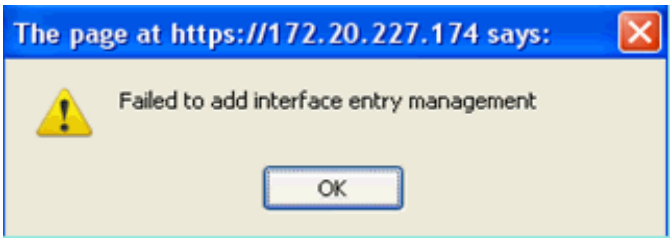
Step 21 Under WLAN, from WLAN SSID drop-down, choose **WLAN ID 18 store(18)**.

Step 22 Click **Add** after WLAN ID 18 is selected.

Step 23 Repeat steps 14 -16 for WLAN ID 1 DataCenter(1).



Note Adding multiple WLAN profiles with the same SSID under a single AP group is not permitted.



Note Adding APs to the AP group is not captured in this document, but it is needed for clients to access network services.

Summary

- AP groups simplify network administration.
- Troubleshooting ease with per branch granularity
- Increased flexibility

FlexConnect Groups

In most typical branch deployments, it is easy to foresee that client 802.1X authentication takes place centrally at the Data Center. Because the above scenario is perfectly valid, it raises these concerns:

- How can wireless clients perform 802.1X authentication and access Data Center services if WLC fails?

- How can wireless clients perform 802.1X authentication if WAN link between Branch and Data Center fails?
- Is there any impact on branch mobility during WAN failures?
- Does the FlexConnect Solution provide no operational branch downtime?

FlexConnect Group is primarily designed and should be created to address these challenges. In addition, it eases organizing each branch site, because all the FlexConnect access points of each branch site are part of a single FlexConnect Group.

Note FlexConnect Groups are not analogous to AP Groups.

Primary Objectives of FlexConnect Groups

Backup RADIUS Server Failover

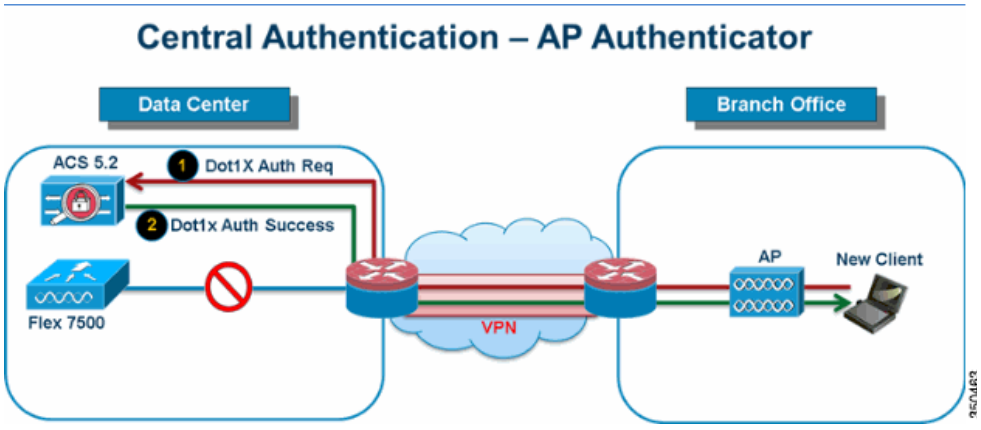
You can configure the controller to allow a FlexConnect access point in standalone mode to perform full 802.1X authentication to a backup RADIUS server. In order to increase the resiliency of the branch, administrators can configure a primary backup RADIUS server or both a primary and secondary backup RADIUS server. These servers are used only when the FlexConnect access point is not connected to the controller.

Note Backup RADIUS accounting is not supported.

Local Authentication

Before the 7.0.98.0 code release, local authentication was supported only when FlexConnect is in Standalone Mode to ensure client connectivity is not affected during WAN link failure. With the 7.0.116.0 release, this feature is now supported even when FlexConnect access points are in Connected Mode.

Figure 4 Central Dot1X Authentication (FlexConnect APs Acting as Authenticator)



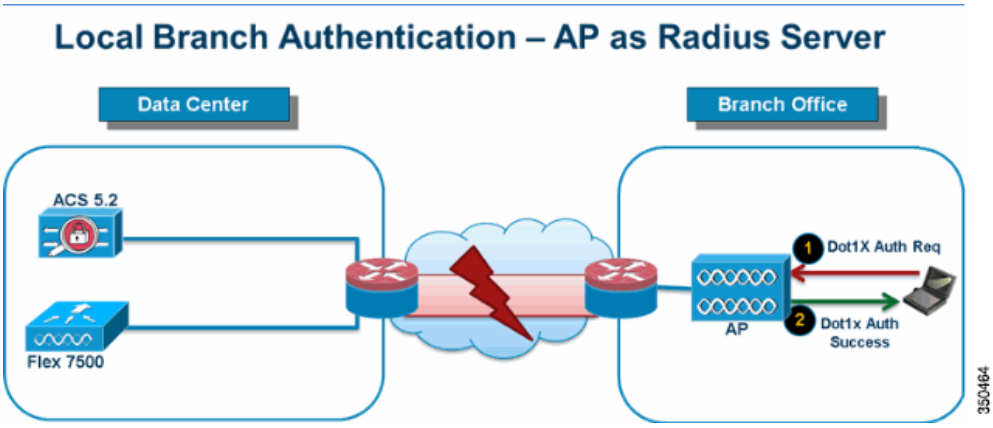
As shown in Figure 4, branch clients can continue to perform 802.1X authentication when the FlexConnect Branch APs lose connectivity with the WLC. As long as the RADIUS/ACS server is reachable from the Branch site, wireless clients will continue to authenticate and access wireless services. In other words, if the RADIUS/ACS is located inside the Branch, then clients will authenticate and access wireless services even during a WAN outage.

Note With Local Authentication turned on, the AP will always authenticate the clients locally, even when it is in connected mode. When Local Authentication is disabled, the controller will authenticate clients to the Central RADIUS server when the FlexConnect AP is in connected mode. When the AP is in Standalone mode, the AP will authenticate clients to the Local RADIUS / Local EAP on AP configured on the FlexConnect Group.

Note This feature can be used in conjunction with the FlexConnect backup RADIUS server feature. If a FlexConnect Group is configured with both backup RADIUS server and local authentication, the FlexConnect access point always attempts to authenticate clients using the primary backup RADIUS server first, followed by the secondary backup RADIUS server (if the primary is not reachable), and finally the Local EAP Server on FlexConnect access point itself (if the primary and secondary are not reachable).

Local EAP (Local Authentication Continuation)

Figure 5 Dot1X Authentication (FlexConnect APs Acting as Local-EAP Server)



- You can configure the controller to allow a FlexConnect AP in standalone or connected mode to perform LEAP or EAP-FAST authentication for up to 100 statically configured users. The controller sends the static list of user names and passwords to each FlexConnect access point of that particular FlexConnect Group when it joins the controller. Each access point in the group authenticates only its own associated clients.
- This feature is ideal for customers who are migrating from an autonomous access point network to a lightweight FlexConnect access point network and are not interested in maintaining a large user database, or adding another hardware device to replace the RADIUS server functionality available in the autonomous access point.

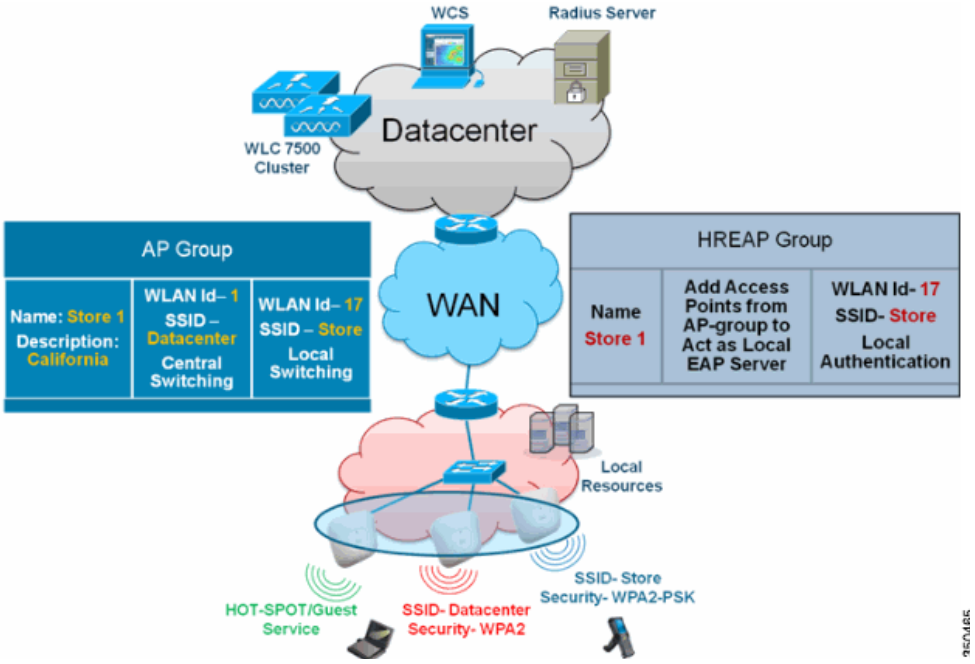
- As shown in Figure 5, if the RADIUS/ACS server inside the Data Center is not reachable, then FlexConnect APs automatically acts as a Local-EAP Server to perform Dot1X authentication for wireless branch clients.

CCKM/OKC Fast Roaming

- FlexConnect Groups are required for CCKM/OKC fast roaming to work with FlexConnect access points. Fast roaming is achieved by caching a derivative of the master key from a full EAP authentication so that a simple and secure key exchange can occur when a wireless client roams to a different access point. This feature prevents the need to perform a full RADIUS EAP authentication as the client roams from one access point to another. The FlexConnect access points need to obtain the CCKM/OKC cache information for all the clients that might associate so they can process it quickly instead of sending it back to the controller. If, for example, you have a controller with 300 access points and 100 clients that might associate, sending the CCKM/OKC cache for all 100 clients is not practical. If you create a FlexConnect Group comprising a limited number of access points (for example, you create a group for four access points in a remote office), the clients roam only among those four access points, and the CCKM/OKC cache is distributed among those four access points only when the clients associate to one of them.
- This feature along with Backup Radius and Local Authentication (Local-EAP) ensures **no operational downtime** for your branch sites.

Note CCKM/OKC fast roaming among FlexConnect and non-FlexConnect access points is not supported.

Figure 6 Wireless Network Design Reference Using FlexConnect Groups



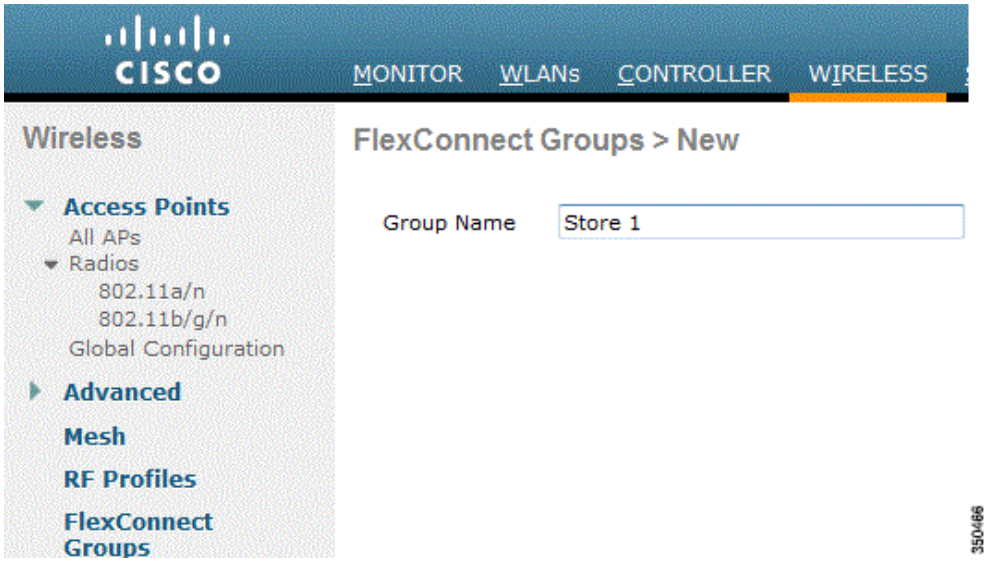
FlexConnect Group Configuration from WLC

Complete the steps in this section in order to configure FlexConnect groups to support Local Authentication using LEAP, when FlexConnect is either in Connected or Standalone mode. The configuration sample in Figure 6 illustrates the objective differences and 1:1 mapping between the AP Group and FlexConnect group.

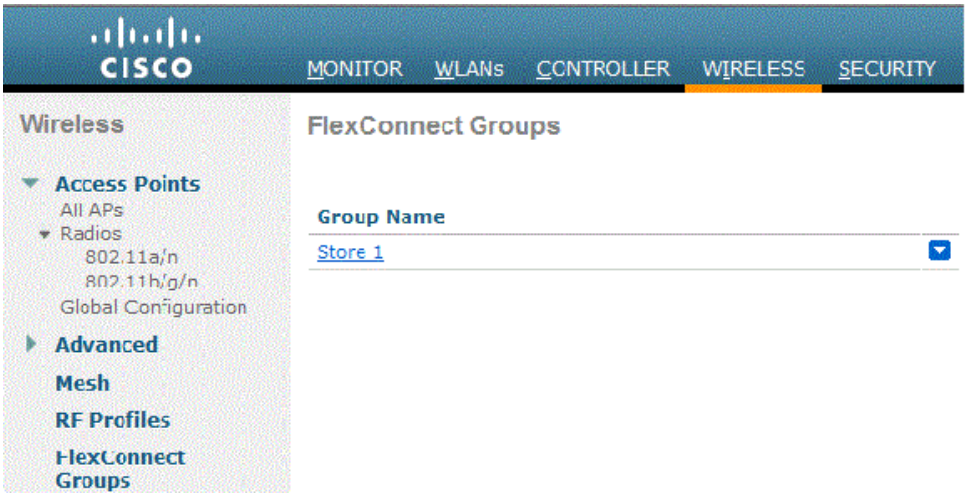
Step 1 Click **New** under **Wireless > FlexConnect Groups**.

Step 2 Assign Group Name Store 1, similar to the sample configuration as shown in Figure 6.

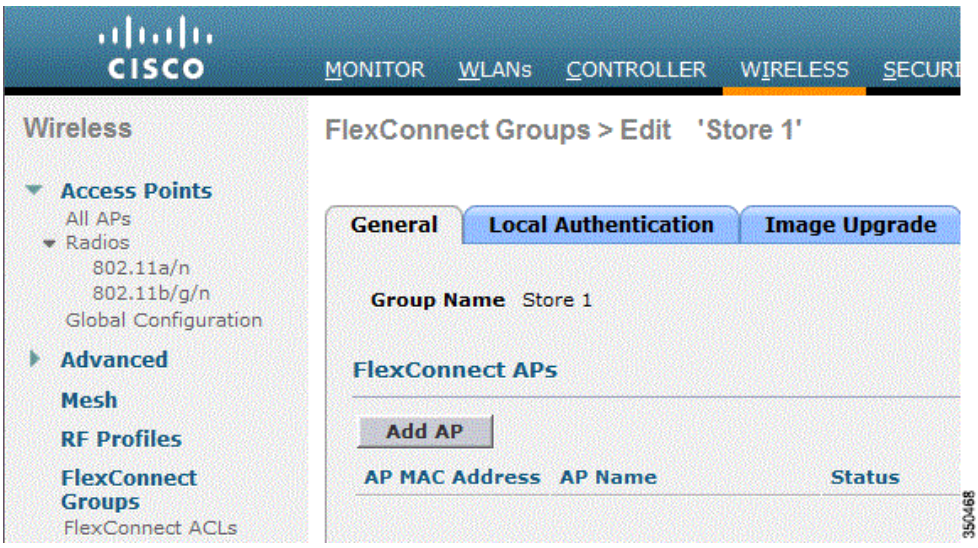
Step 3 Click **Apply** when the Group Name is set.



Step 4 Click the Group Name **Store 1** that you just created for further configuration.



Step 5 Click **Add AP**.



Step 6 Check the **Enable AP Local Authentication** box in order to enable Local Authentication when the AP is in Standalone Mode.

Note Step 20 shows how to enable Local Authentication for Connected Mode AP.

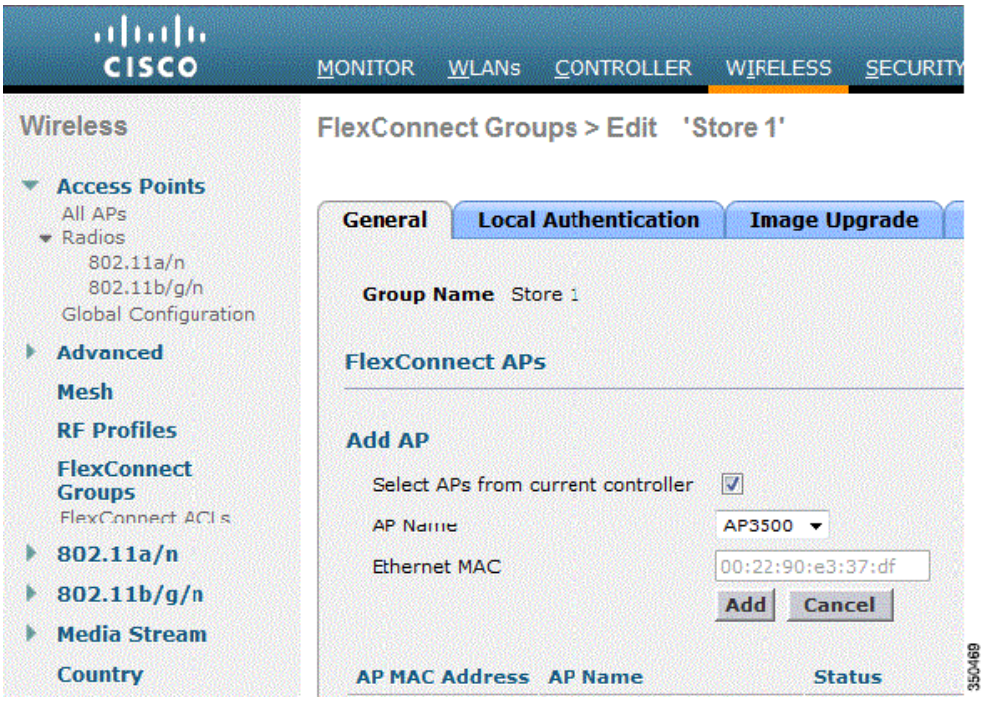
Step 7 Check the **Select APs from current controller** box in order to enable the AP Name drop-down menu.

Step 8 Choose the AP from the drop-down that needs to be part of this FlexConnect Group.

Step 9 Click **Add** after the AP is chosen from the drop-down.

Step 10 Repeat steps 7 and 8 to add all the APs to this FlexConnect group that are also part of AP-Group Store 1. See Figure 6 to understand the 1:1 mapping between the AP-Group and FlexConnect group.

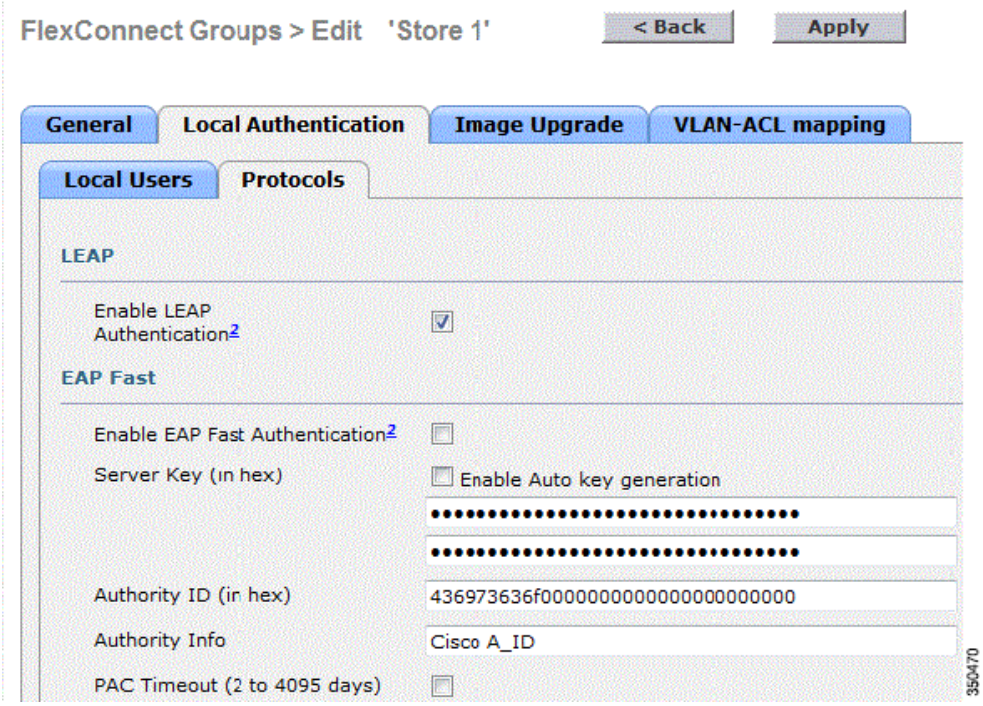
If you have created an AP-Group per Store (Figure 3), then ideally all the APs of that AP-Group should be part of this FlexConnect Group (Figure 6. Maintaining 1:1 ratio between the AP-Group and FlexConnect group simplifies network management.



Step 11 Click Local **Authentication > Protocols** and check the **Enable LEAP Authentication** box.

Step 12 Click **Apply** after the check box is set.

Note If you have a backup controller, make sure the FlexConnect groups are identical and AP MAC address entries are included per FlexConnect group.

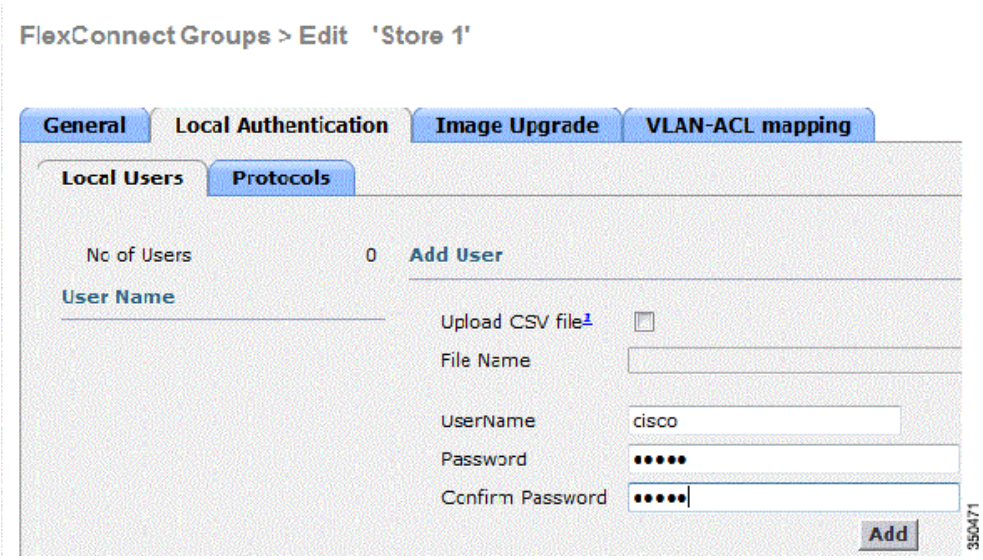


Step 13 Under Local Authentication, click **Local Users**.

Step 14 Set the UserName, Password and Confirm Password fields, then click **Add** in order to create user entry in the Local EAP server residing on the AP.

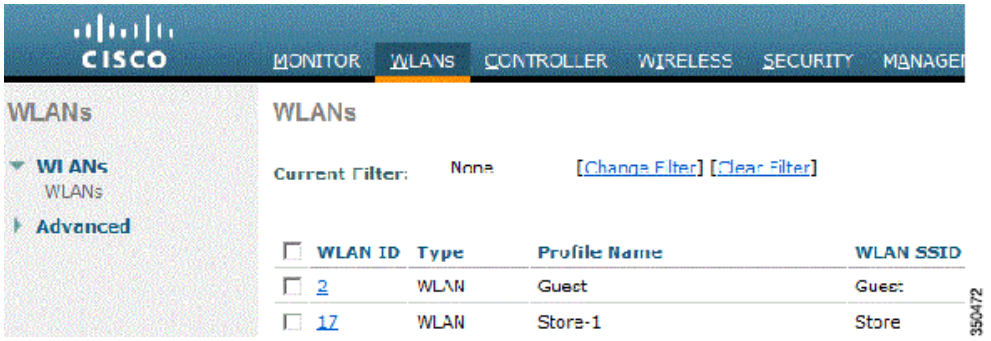
Step 15 Repeat step 13 until your local user name list is exhausted. You cannot configure or add more than 100 users.

Step 16 Click **Apply** after step 14 is completed and the No of Users count is verified.



Step 17 From the top pane, click **WLANs.**

Step 18 Click **WLAN ID 17**. This was created during the AP Group creation. See Figure 3.

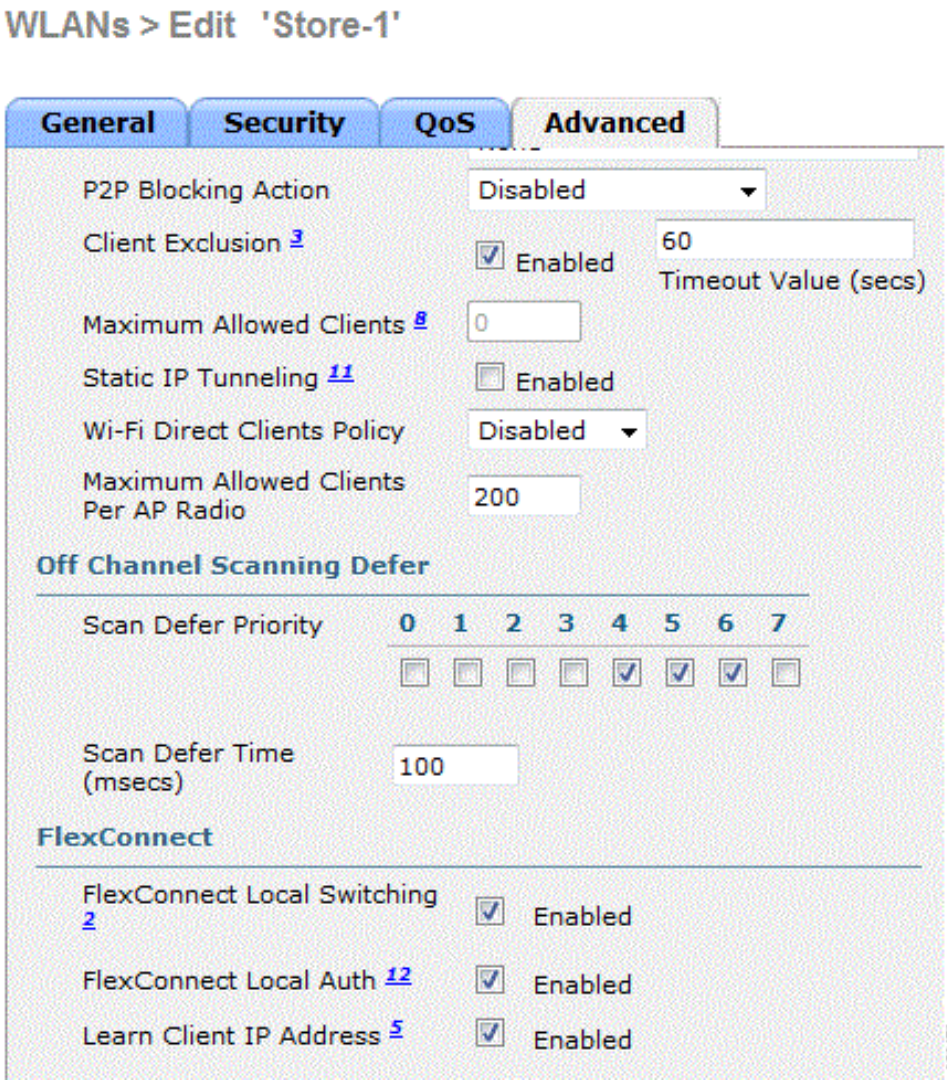


Step 19 Under **WLAN > Edit** for WLAN ID 17, click **Advanced.**

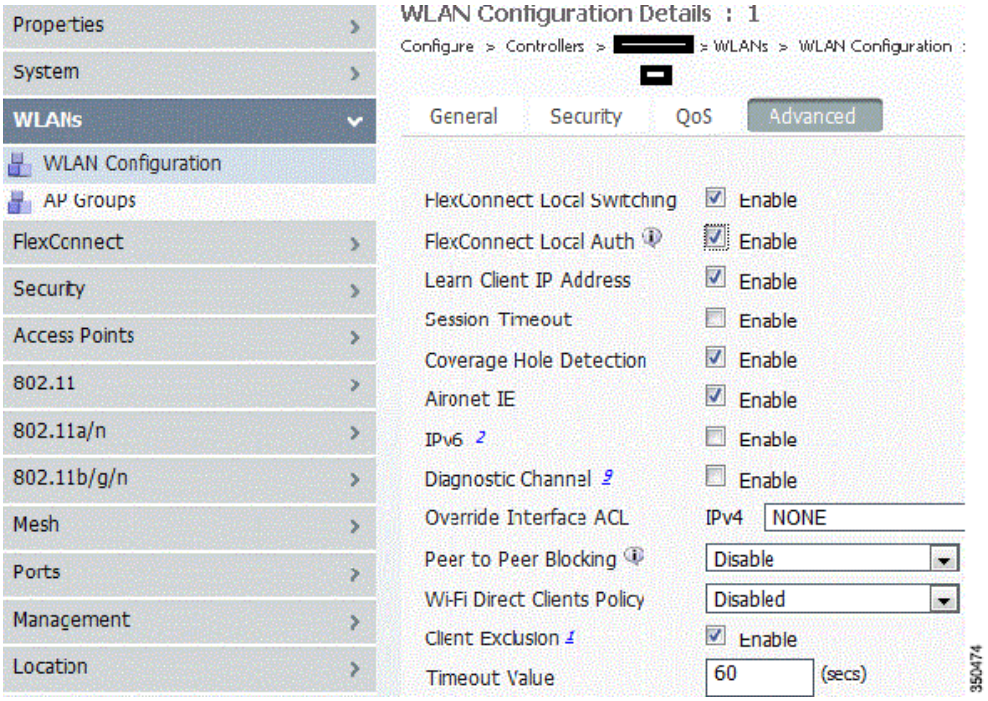
Step 20 Check the **FlexConnect Local Auth** box in order to enable Local Authentication in Connected Mode.

Note Local Authentication is supported only for FlexConnect with Local Switching.

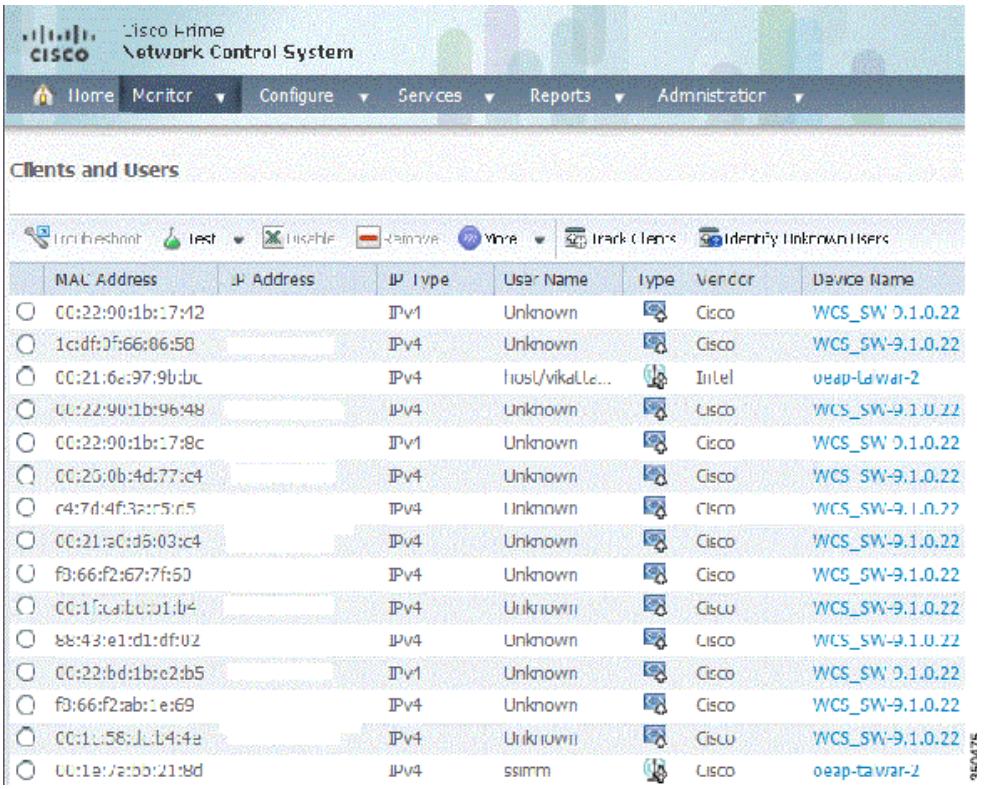
Note Always make sure to create the FlexConnect Group before enabling Local Authentication under WLAN.

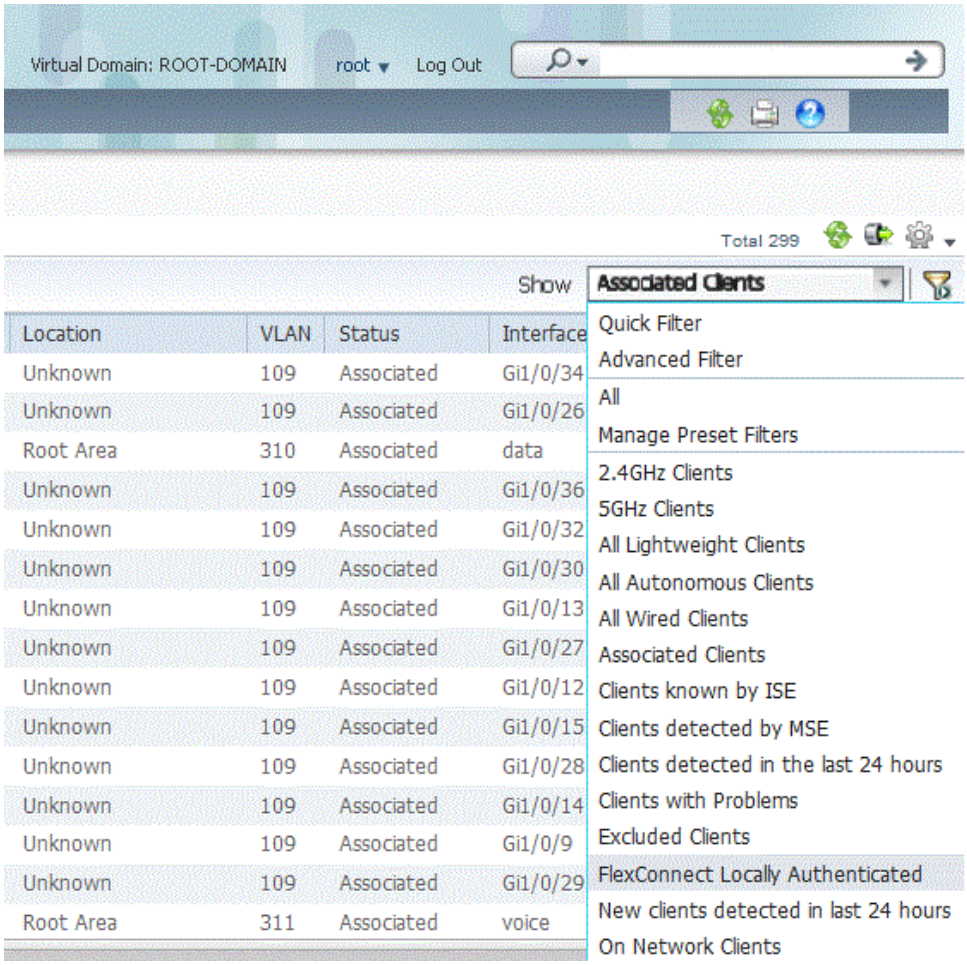


NCS and Cisco Prime also provides the FlexConnect Local Auth check box in order to enable Local Authentication in Connected Mode as shown here:



NCS and Cisco Prime also provides facility to filter and monitor FlexConnect Locally Authenticated clients as shown here:




Virtual Domain: ROOT-DOMAIN
root
Log Out
Total 299
Show
Associated Clients
Quick Filter
Advanced Filter
All
Manage Preset Filters
2.4GHz Clients
5GHz Clients
All Lightweight Clients
All Autonomous Clients
All Wired Clients
Associated Clients
Clients known by ISE
Clients detected by MSE
Clients detected in the last 24 hours
Clients with Problems
Excluded Clients
FlexConnect Locally Authenticated
New clients detected in last 24 hours
On Network Clients
Location VLAN Status Interface
Unknown 109 Associated Gi1/0/34
Unknown 109 Associated Gi1/0/26
Root Area 310 Associated data
Unknown 109 Associated Gi1/0/36
Unknown 109 Associated Gi1/0/32
Unknown 109 Associated Gi1/0/30
Unknown 109 Associated Gi1/0/13
Unknown 109 Associated Gi1/0/27
Unknown 109 Associated Gi1/0/12
Unknown 109 Associated Gi1/0/15
Unknown 109 Associated Gi1/0/28
Unknown 109 Associated Gi1/0/14
Unknown 109 Associated Gi1/0/9
Unknown 109 Associated Gi1/0/29
Root Area 311 Associated voice

Verification Using CLI

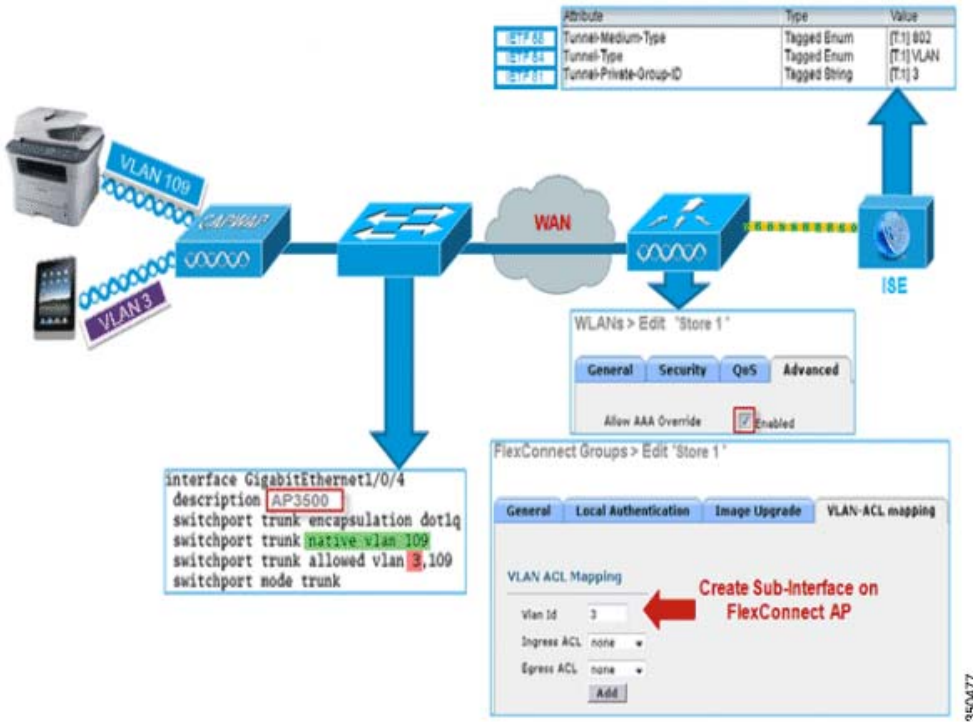
Client authentication state and switching mode can quickly be verified using this CLI on the WLC:

```
(Cisco Controller) >show client detail 00:24:d7:2b:7c:0c
Client MAC Address.............................. 00:24:d7:2b:7c:0c
Client Username ................................ N/A
AP MAC Address.................................. d0:57:4c:08:e6:70
Client State.................................... Associated
H-REAP Data Switching........................... Local
H-REAP Authentication........................... Local
```

FlexConnect VLAN Override

In the current FlexConnect architecture, there is a strict mapping of WLAN to VLAN, and thus the client getting associated on a particular WLAN on FlexConnect AP has to abide by a VLAN which is mapped to it. This method has limitations, because it requires clients to associate with different SSIDs in order to inherit different VLAN-based policies.

From 7.2 release onwards, AAA override of VLAN on individual WLAN configured for local switching is supported. In order to have dynamic VLAN assignment, AP would have the interfaces for the VLAN pre-created based on a configuration using existing WLAN-VLAN Mapping for individual FlexConnect AP or using ACL-VLAN mapping on a FlexConnect group. The WLC is used to pre-create the sub-interfaces at the AP.



Summary

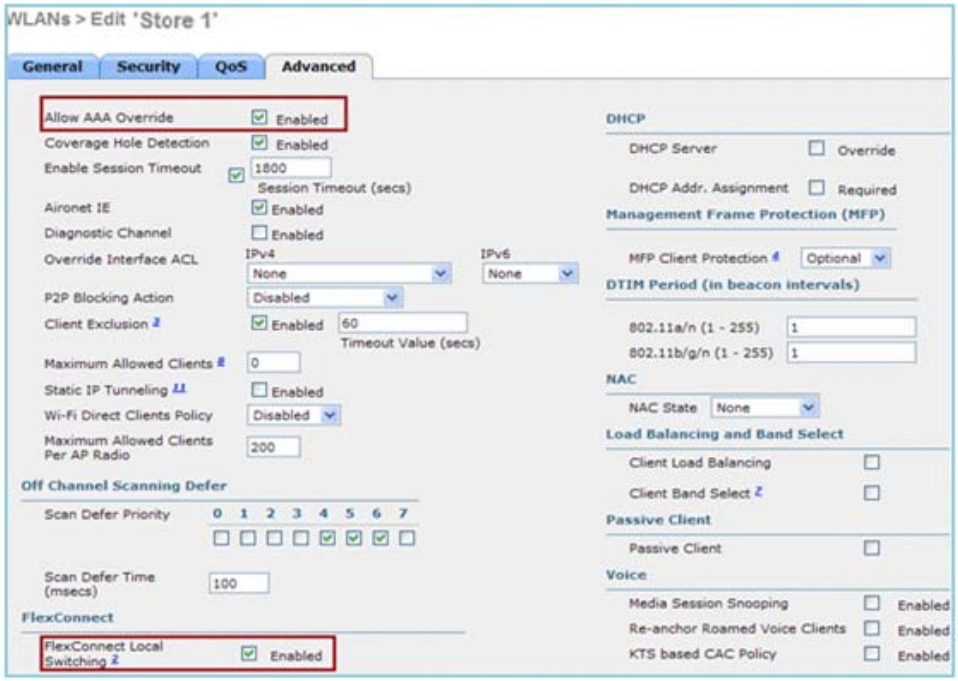
- AAA VLAN override is supported from release 7.2 for WLANs configured for local switching in central and local authentication mode.
- AAA override should be enabled on WLAN configured for local switching.
- The FlexConnect AP should have VLAN pre-created from WLC for dynamic VLAN assignment.
- If VLANs returned by AAA override are not present on AP client, they will get an IP from the default VLAN interface of the AP.

Procedure

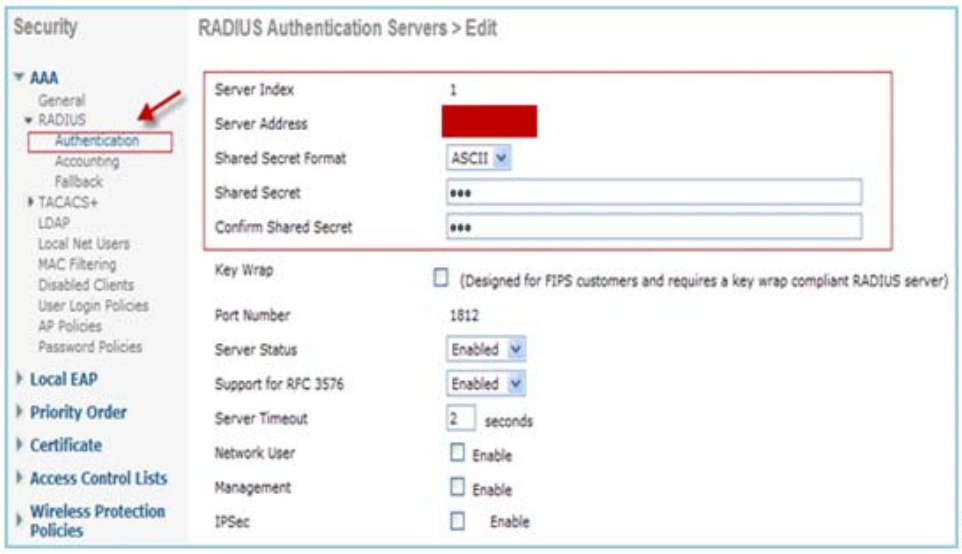
Complete these steps:

Step 1 Create a WLAN for 802.1x authentication.

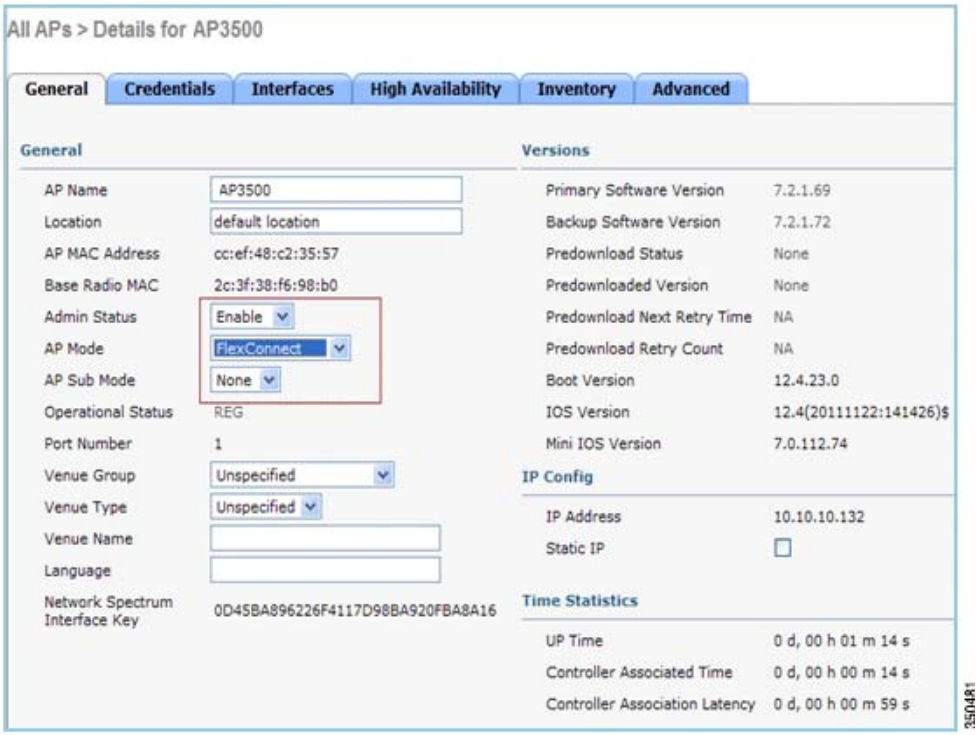
Step 2 Enable AAA override support for local switching WLAN on the WLC. Navigate to **WLAN GUI > WLAN > WLAN ID > Advance** tab.



Step 3 Add the AAA server details on the controller for 802.1x authentication. In order to add the AAA server, navigate to **WLC GUI > Security > AAA > Radius > Authentication > New**.

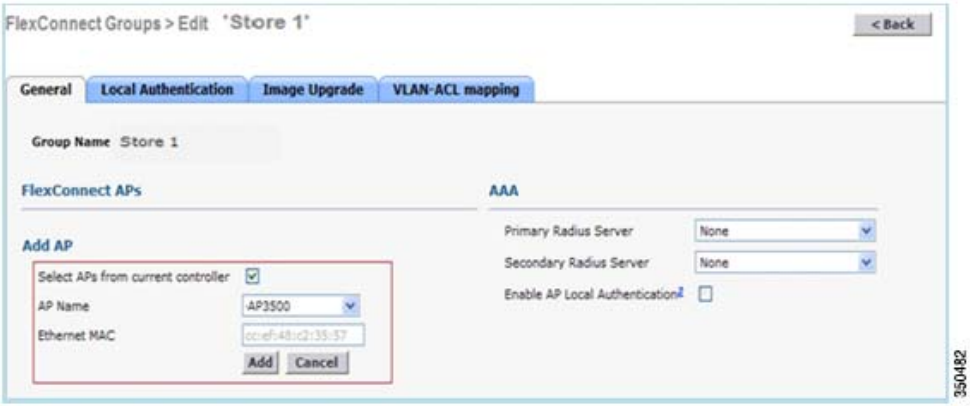


Step 4 The AP is in local mode by default, so covert the mode to FlexConnect mode. Local mode APs can be converted to FlexConnect mode by going to **Wireless > All APs,** and click the Individual AP.

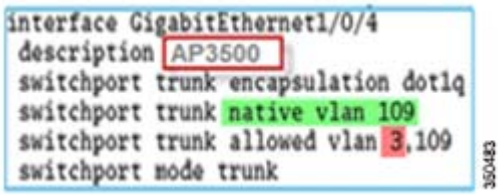


Step 5 Add the FlexConnect APs to the FlexConnect group.

Navigate under **WLC GUI > Wireless > FlexConnect Groups > Select FlexConnect Group > General tab > Add AP**.



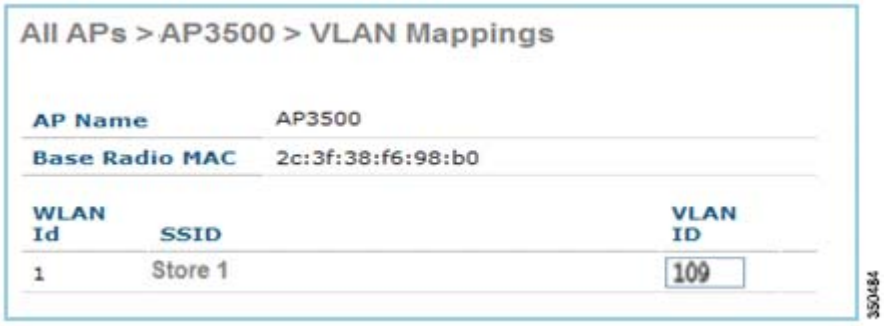
Step 6 The FlexConnect AP should be connected on a trunk port and WLAN mapped VLAN and AAA overridden VLAN should be allowed on the trunk port.



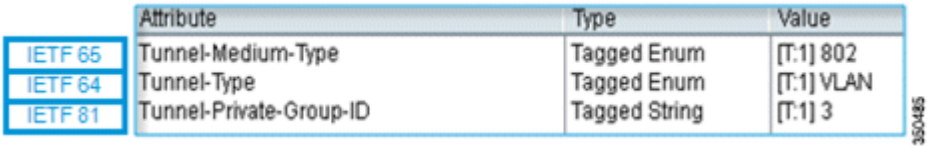
Note In this configuration, VLAN 109 is used for WLAN VLAN mapping and VLAN 3 is used for AAA override.

Step 7 Configure WLAN to VLAN Mapping for the FlexConnect AP. Based on this configuration, the AP would have the interfaces for the VLAN. When the AP receives the VLAN configuration, corresponding dot11 and Ethernet sub-interfaces are created and added to a bridge-group. Associate a client on this WLAN and when the client associates, its VLAN (default, based on the WLAN-VLAN mapping) is assigned.

Navigate to **WLAN GUI > Wireless > All APs**, click the specific **AP > FlexConnect** tab, and click **VLAN Mapping**.



Step 8 Create a user in the AAA server and configure the user to return VLAN ID in IETF Radius attribute.



Step 9 In order to have dynamic VLAN assignment, the AP would have the interfaces for the dynamic VLAN pre-created based on the configuration using existing WLAN-VLAN Mapping for the individual FlexConnect AP or using ACL-VLAN mapping on FlexConnect group.

In order to configure AAA VLAN on the FlexConnect AP, navigate to **WLC GUI > Wireless > FlexConnect Group**, click the specific **FlexConnect group > VLAN-ACL mapping**, and enter VLAN in the **Vlan ID** field.

Step 10 Associate a client on this WLAN and authenticate using the user name configured in the AAA server in order to return the AAA VLAN.

Step 11 The client should receive an IP address from the dynamic VLAN returned via the AAA server.

Step 12 In order to verify, click **WLC GUI > Monitor > Client**, click the specific client MAC address in order to check the client details.

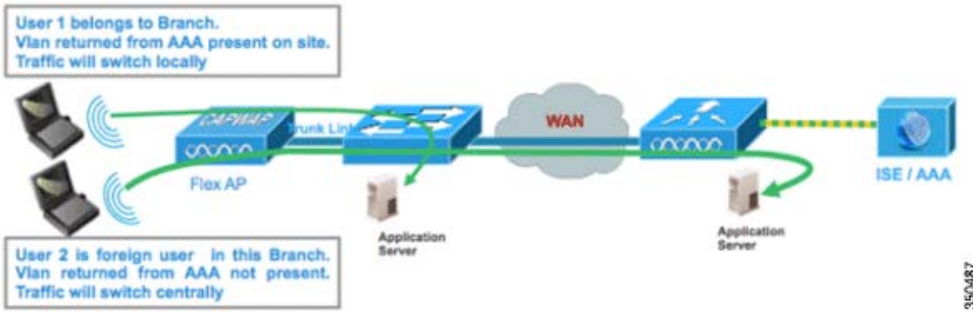
Limitations

- Cisco Airespace-specific attributes will not be supported and IETF attribute VLAN ID will only be supported.
- A maximum of 16 VLANs can be configured in per-AP configuration either via WLAN-VLAN Mapping for individual FlexConnect AP or using ACL-VLAN mapping on the FlexConnect group.

FlexConnect VLAN Based Central Switching

In controller software releases 7.2, AAA override of VLAN (Dynamic VLAN assignment) for locally switched WLANs will put wireless clients to the VLAN provided by the AAA server. If the VLAN provided by the AAA server is not present at the AP, the client is put to a WLAN mapped VLAN on that AP and traffic will switch locally on that VLAN. Further, prior to release 7.3, traffic for a particular WLAN from FlexConnect APs can be switched Centrally or Locally depending on the WLAN configuration.

From release 7.3 onwards, traffic from FlexConnect APs can be switched Centrally or Locally depending on the presence of a VLAN on a FlexConnect AP.



Summary

Traffic flow on WLANs configured for Local Switching when Flex APs are in Connected Mode:

- If the VLAN is returned as one of the AAA attributes and that VLAN is not present in the Flex AP database, traffic will switch centrally and the client will be assigned this VLAN/Interface returned from the AAA server provided that the VLAN exists on the WLC.
- If the VLAN is returned as one of the AAA attributes and that VLAN is not present in the Flex AP database, traffic will switch centrally. If that VLAN is also not present on the WLC, the client will be assigned a VLAN/Interface mapped to a WLAN on the WLC.

- If the VLAN is returned as one of the AAA attributes and that VLAN is present in the FlexConnect AP database, traffic will switch locally.
- If the VLAN is not returned from the AAA server, the client will be assigned a WLAN mapped VLAN on that FlexConnect AP and traffic will switch locally.

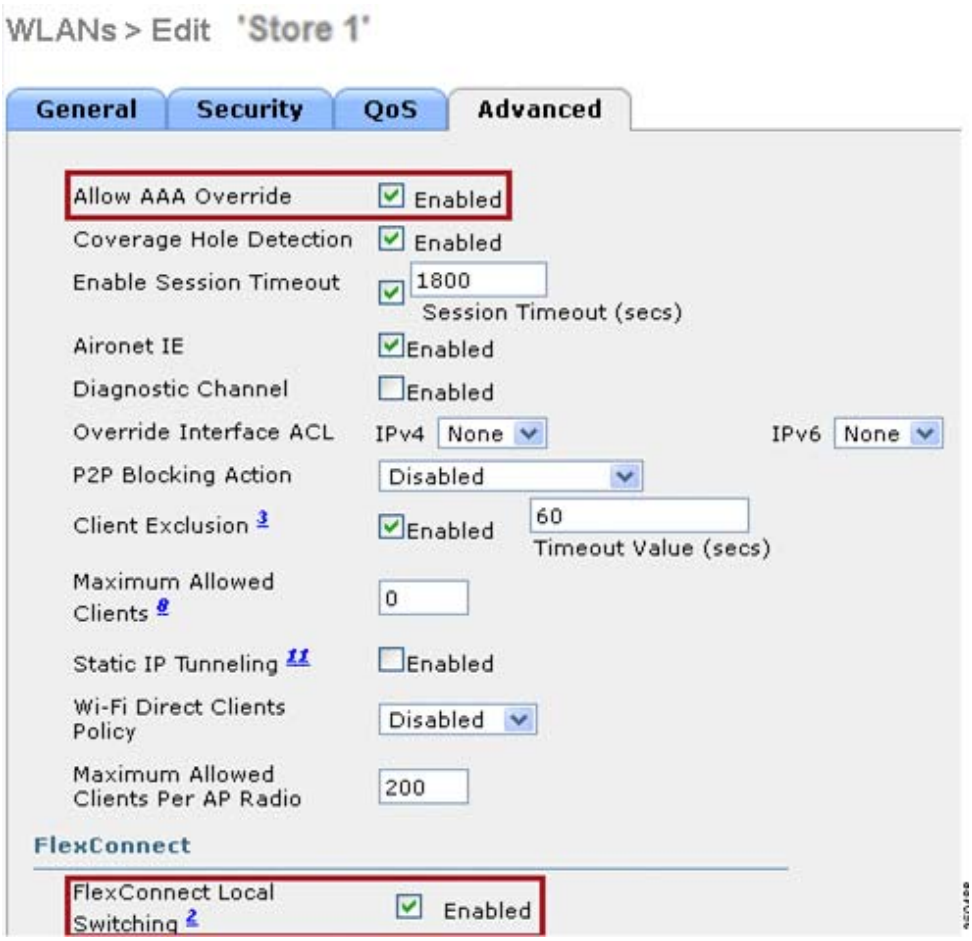
Traffic flow on WLANs configured for Local Switching when Flex APs are in Standalone Mode:

- If the VLAN returned by an AAA server is not present in the Flex AP database, the client will be put to default VLAN (that is, a WLAN mapped VLAN on Flex AP). When the AP connects back, this client will be de-authenticated and will switch traffic centrally.
- If the VLAN returned by an AAA server is present in the Flex AP database, the client will be put into a returned VLAN and traffic will switch locally.
- If the VLAN is not returned from an AAA server, the client will be assigned a WLAN mapped VLAN on that FlexConnect AP and traffic will switch locally.

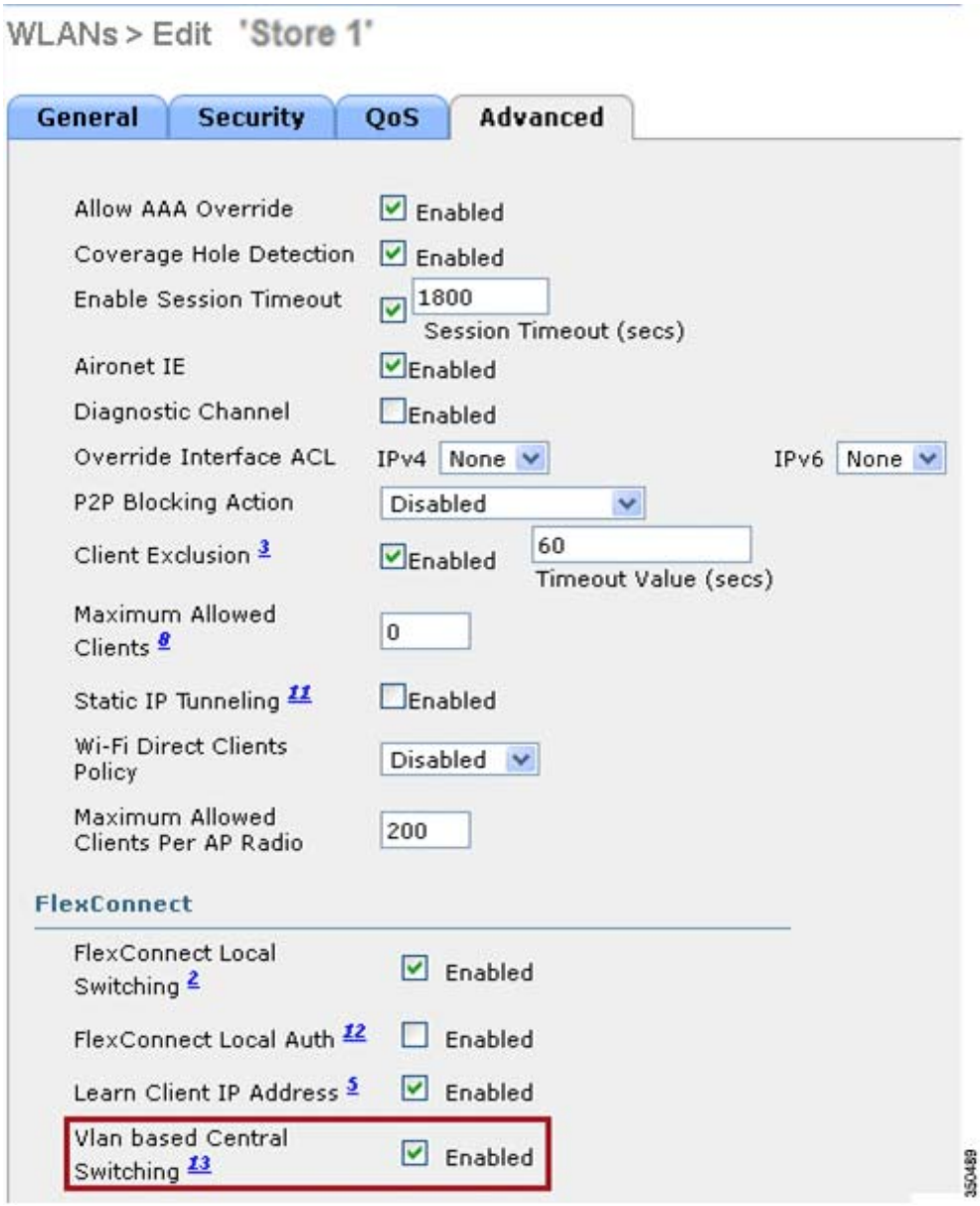
Procedure

Complete these steps:

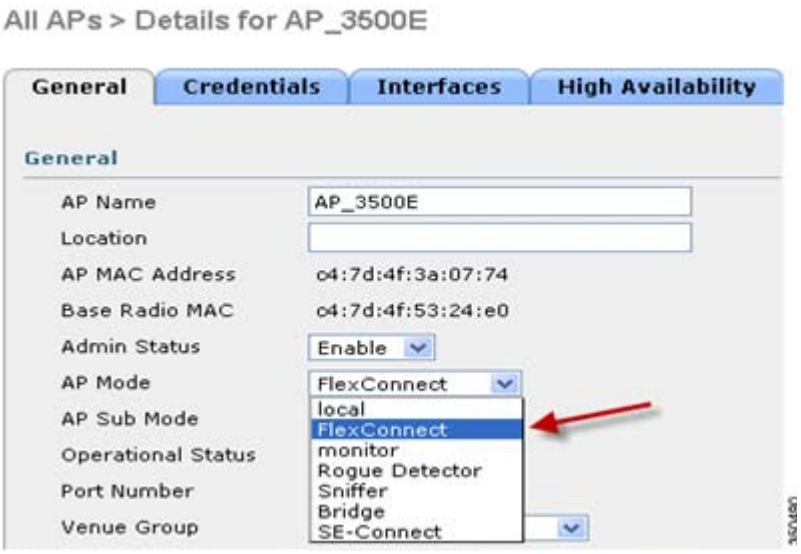
Step 1 Configure a WLAN for Local Switching and enable AAA override.



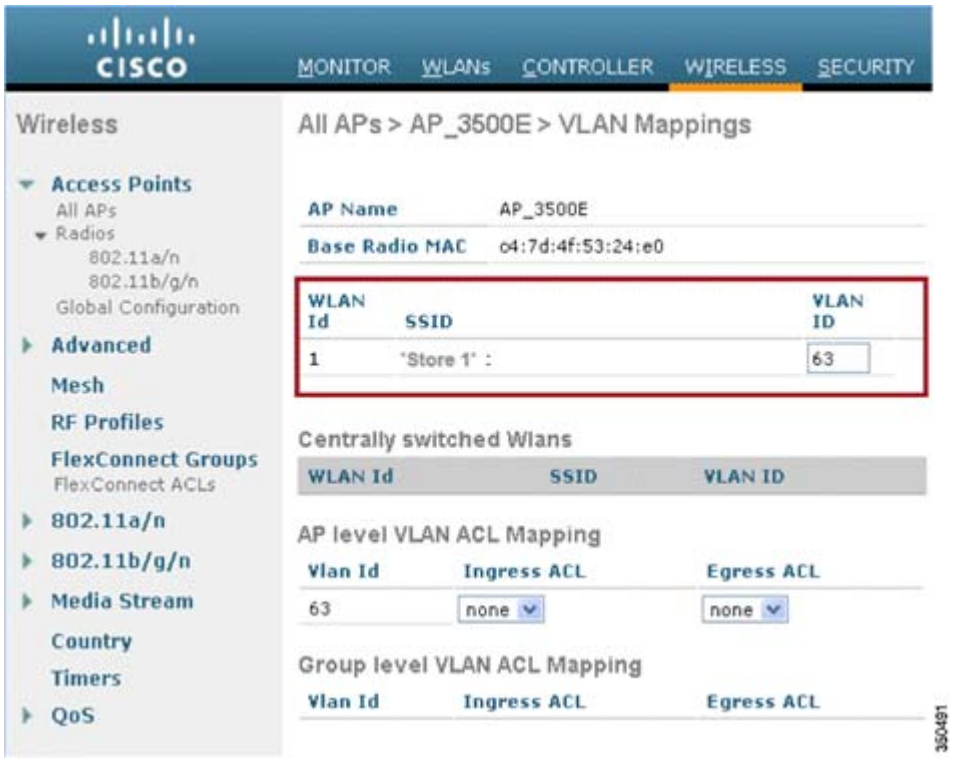
Step 2 Enable **Vlan based Central Switching** on the newly created WLAN.



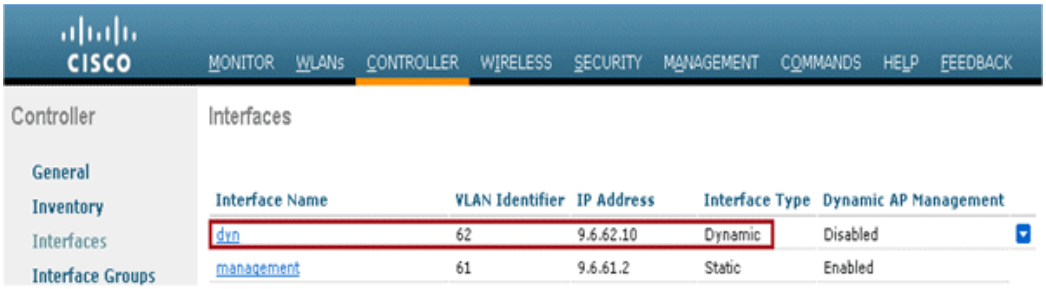
Step 3 Set AP Mode to **FlexConnect.**



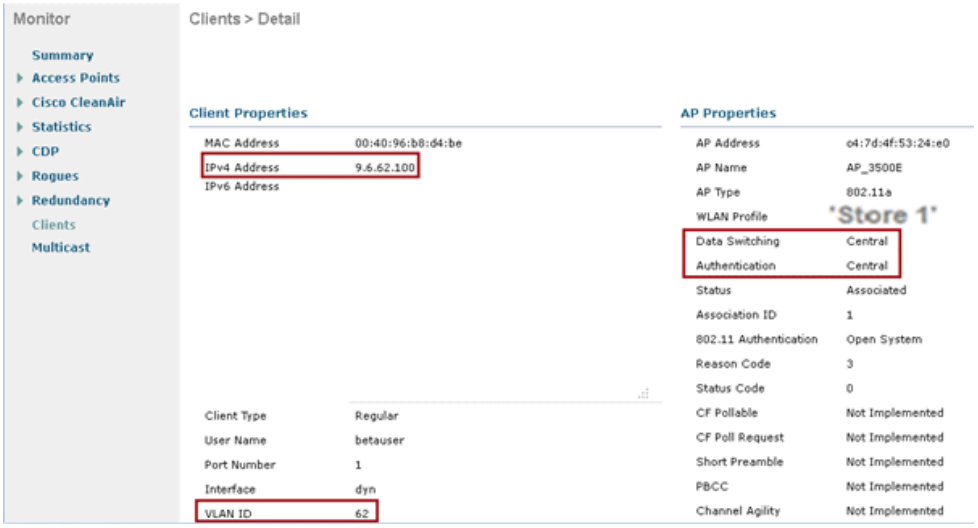
Step 4 Make sure that the FlexConnect AP has some sub-interface present in its database, either via WLAN-VLAN Mapping on a particular Flex AP or via configuring VLAN from a Flex group. In this example, VLAN 63 is configured in WLAN-VLAN mapping on Flex AP.



Step 5 In this example, VLAN 62 is configured on WLC as one of the dynamic interfaces and is not mapped to the WLAN on the WLC. The WLAN on the WLC is mapped to Management VLAN (that is, VLAN 61).

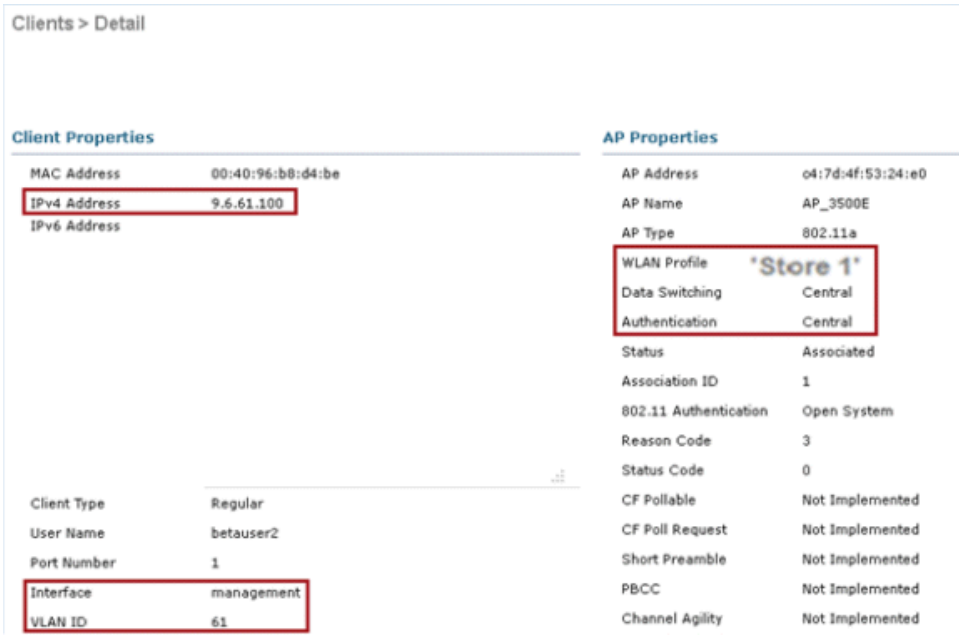


Step 6 Associate a client to the WLAN configured in Step 1 on this Flex AP and return VLAN 62 from the AAA server. VLAN 62 is not present on this Flex AP, but it is present on the WLC as a dynamic interface so traffic will switch centrally and the client will be assigned VLAN 62 on the WLC. In the output captured here, the client has been assigned VLAN 62 and Data Switching and Authentication are set to Central.



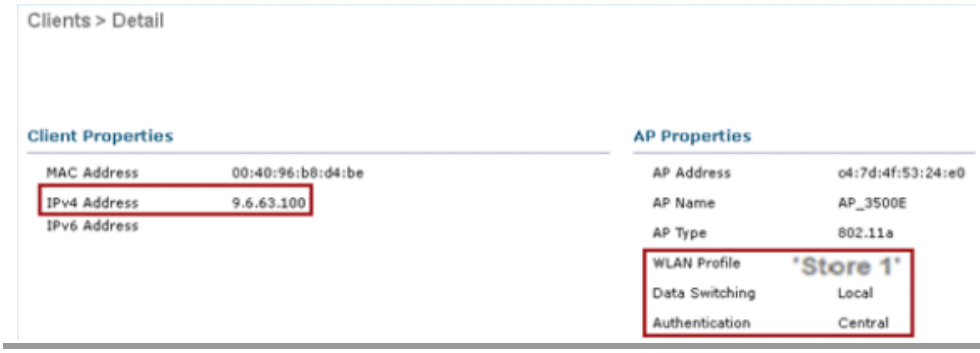
Note Observe that although WLAN is configured for Local Switching, the Data Switching field for this client is Central based on the presence of a VLAN (that is, VLAN 62, which is returned from the AAA server, is not present in the AP Database).

Step 7 If another user associates to the same AP on this created WLAN and some VLAN is returned from the AAA server which is not present on the AP as well as the WLC, traffic will switch centrally and the client will be assigned the WLAN mapped interface on the WLC (that is, VLAN 61 in this example setup), because the WLAN is mapped to the Management interface which is configured for VLAN 61.



Note Observe that although WLAN is configured for Local Switching, the Data Switching field for this client is Central based on the presence of a VLAN. That is, VLAN 61, which is returned from the AAA server, is not present in the AP Database but is also not present in the WLC database. As a result, the client is assigned a default interface VLAN/Interface which is mapped to the WLAN. In this example, the WLAN is mapped to a management interface (that is, VLAN 61) and so the client has received an IP address from VLAN 61.

Step 8 If another user associates to it on this created WLAN and VLAN 63 is returned from the AAA server (which is present on this Flex AP), the client will be assigned VLAN 63 and traffic will switch locally.

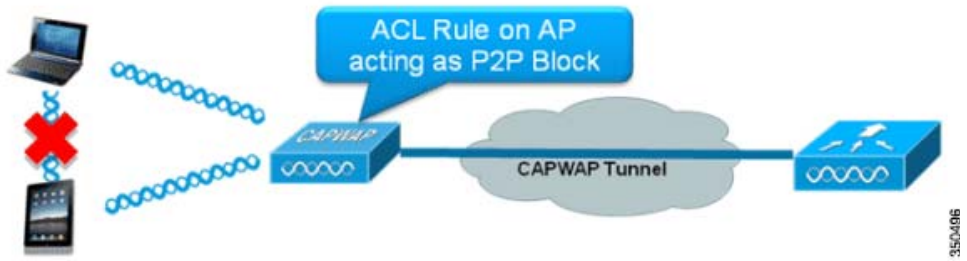


Limitations

- VLAN Based Central Switching is only supported on WLANs configured for Central Authentication and Local Switching.
- The AP sub-interface (that is, VLAN Mapping) should be configured on the FlexConnect AP.

FlexConnect ACL

With the introduction of ACLs on FlexConnect, there is a mechanism to cater to the need of access control at the FlexConnect AP for protection and integrity of locally switched data traffic from the AP. FlexConnect ACLs are created on the WLC and should then be configured with the VLAN present on the FlexConnect AP or FlexConnect group using VLAN-ACL mapping which will be for AAA override VLANs. These are then pushed to the AP.



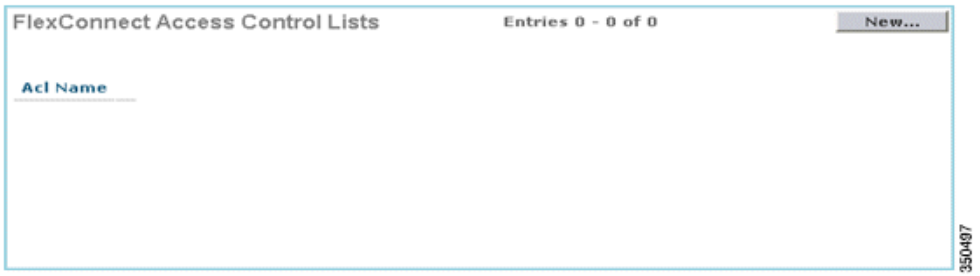
Summary

- Create FlexConnect ACL on the controller.
- Apply the same on a VLAN present on FlexConnect AP under AP Level VLAN ACL mapping.
- Can be applied on a VLAN present in FlexConnect Group under VLAN-ACL mapping (generally done for AAA overridden VLANs).
- While applying ACL on VLAN, select the direction to be applied which will be “ingress”, “egress” or “ingress and egress”.

Procedure

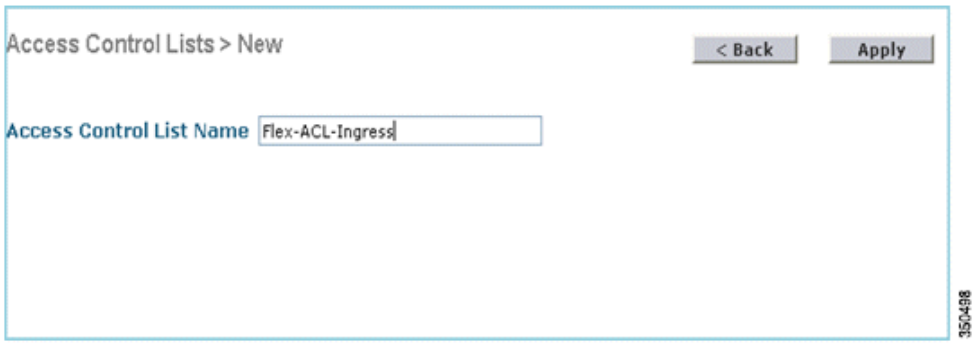
Complete these steps:

Step 1 Create a FlexConnect ACL on the WLC. Navigate to **WLC GUI > Security > Access Control List > FlexConnect ACLs**.



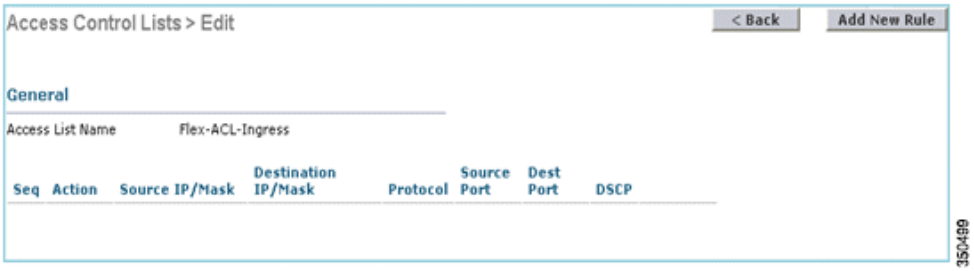
Step 2 Click **New.**

Step 3 Configure the ACL Name.

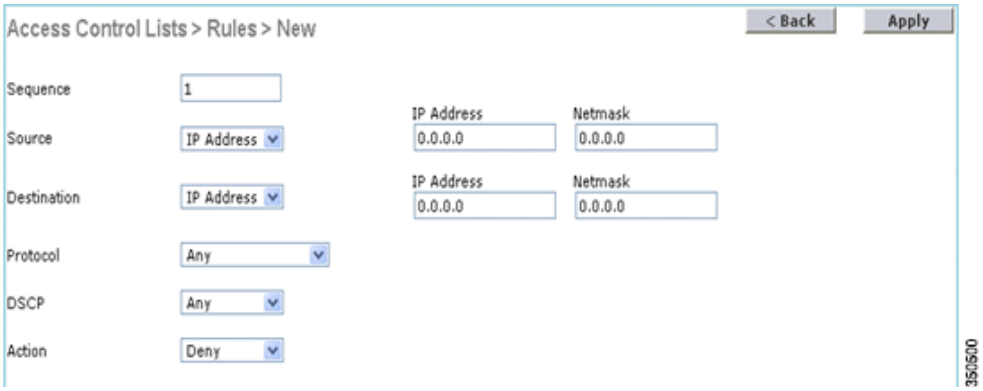


Step 4 Click **Apply.**

Step 5 Create rules for each ACL. In order to create rules, navigate to **WLC GUI > Security > Access Control List > FlexConnect ACLs**, and click the above created ACL.



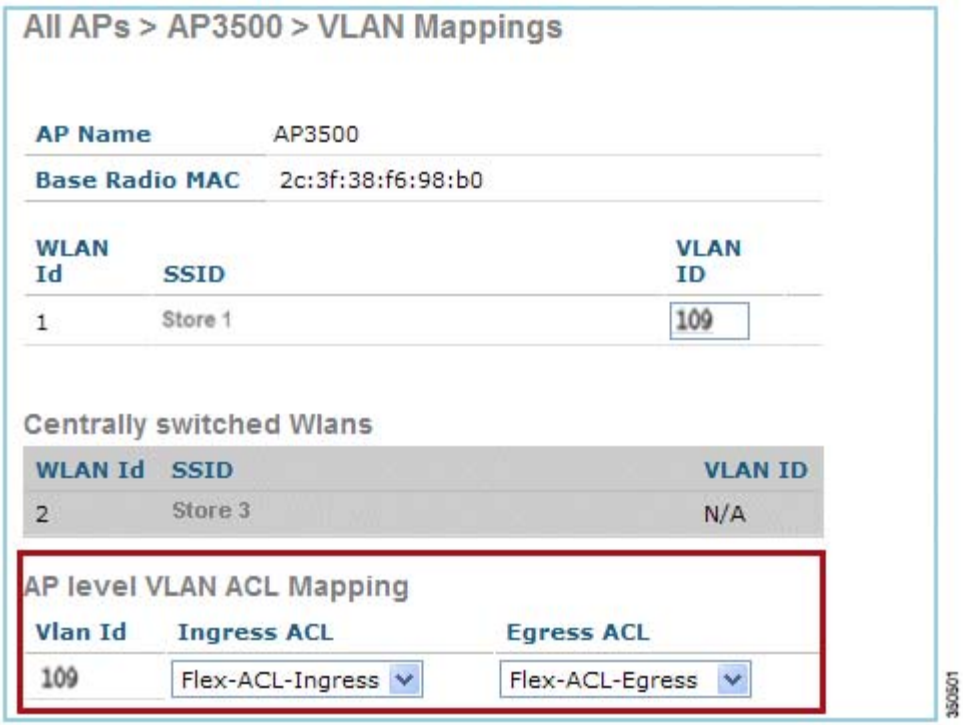
Step 6 Click **Add New Rule.**



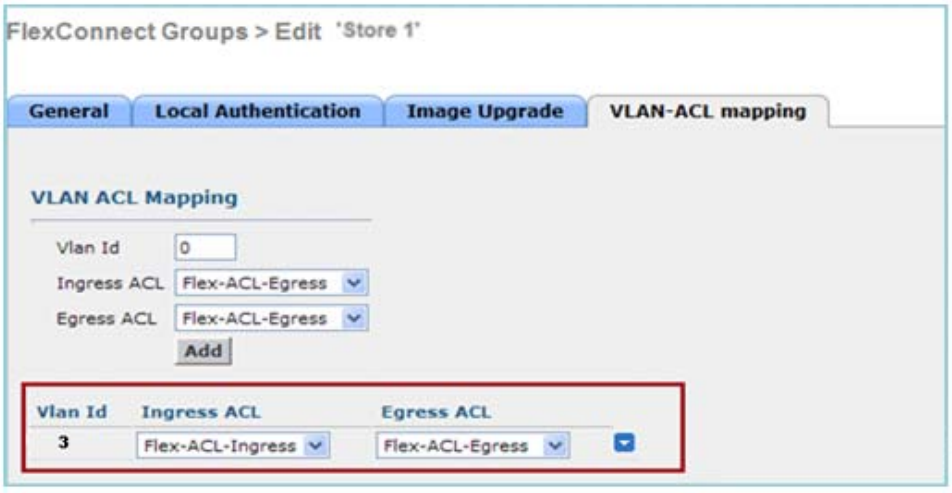
Note Configure the rules as per the requirement. If the permit any rule is not configured at the end, there is an implicit deny which will block all traffic.

Step 7 Once the FlexConnect ACLs are created, it can be mapped for WLAN-VLAN mapping under individual FlexConnect AP or can be applied on VLAN-ACL mapping on the FlexConnect group.

Step 8 Map FlexConnect ACL configured above at AP level for individual VLANs under VLAN mappings for individual FlexConnect AP. Navigate to **WLC GUI > Wireless > All AP**, click the specific **AP > FlexConnect tab > VLAN Mapping**.



Step 9 FlexConnect ACL can also be applied on VLAN-ACL mapping in the FlexConnect group. VLANs created under VLAN-ACL mapping in FlexConnect group are mainly used for dynamic VLAN override.



Limitations

- A maximum of 512 FlexConnect ACLs can be configured on WLC.
- Each individual ACL can be configured with 64 rules.
- A maximum of 32 ACLs can be mapped per FlexConnect group or per FlexConnect AP.
- At any given point in time, there is a maximum of 16 VLANs and 32 ACLs on the FlexConnect AP.

FlexConnect Split Tunneling

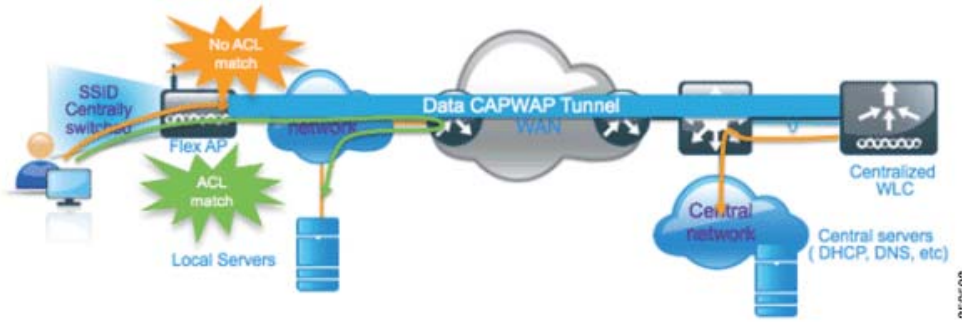
In WLC releases prior to 7.3, if a client connecting on a FlexConnect AP associated with a centrally switched WLAN needs to send some traffic to a device present in the local site/network, they need to send traffic over CAPWAP to the WLC and then get the same traffic back to the local site over CAPWAP or using some off-band connectivity.

From release 7.3 onwards, **Split Tunneling** introduces a mechanism by which the traffic sent by the client will be classified based on packet contents **using Flex ACL**. Matching packets are switched locally from Flex AP and the rest of the packets are centrally switched over CAPWAP.

From release 8.8 onwards, Split Tunneling is also supported on Wave-2 802.11ac based AP as noted in the beginning of this guide. Matching packets are switched locally from Flex AP and the rest of the packets are centrally switched over CAPWAP.

The Split Tunneling functionality is an added advantage for OEAP AP setup where clients on a Corporate SSID can talk to devices on a local network (printers, wired machine on a Remote LAN Port, or wireless devices on a Personal SSID) directly without consuming WAN bandwidth by sending packets over CAPWAP. Split tunneling is not supported on OEAP 600 APs. Flex ACL can be created with rules in order to permit all the devices present at the local site/network. When packets from a wireless client on the Corporate SSID matches the rules in Flex ACL configured on OEAP AP, that traffic is switched locally and the rest of the traffic (that is, implicit deny traffic) will switch centrally over CAPWAP.

The Split Tunneling solution assumes that the subnet/VLAN associated with a client in the central site is not present in the local site (that is, traffic for clients which receive an IP address from the subnet present on the central site will not be able to switch locally). The Split Tunneling functionality is designed to switch traffic locally for subnets which belong to the local site in order to avoid WAN bandwidth consumption. Traffic which matches the Flex ACL rules are switched locally and NAT operation is performed changing the client's source IP address to the Flex AP's BVI interface IP address which is routable at the local site/network.



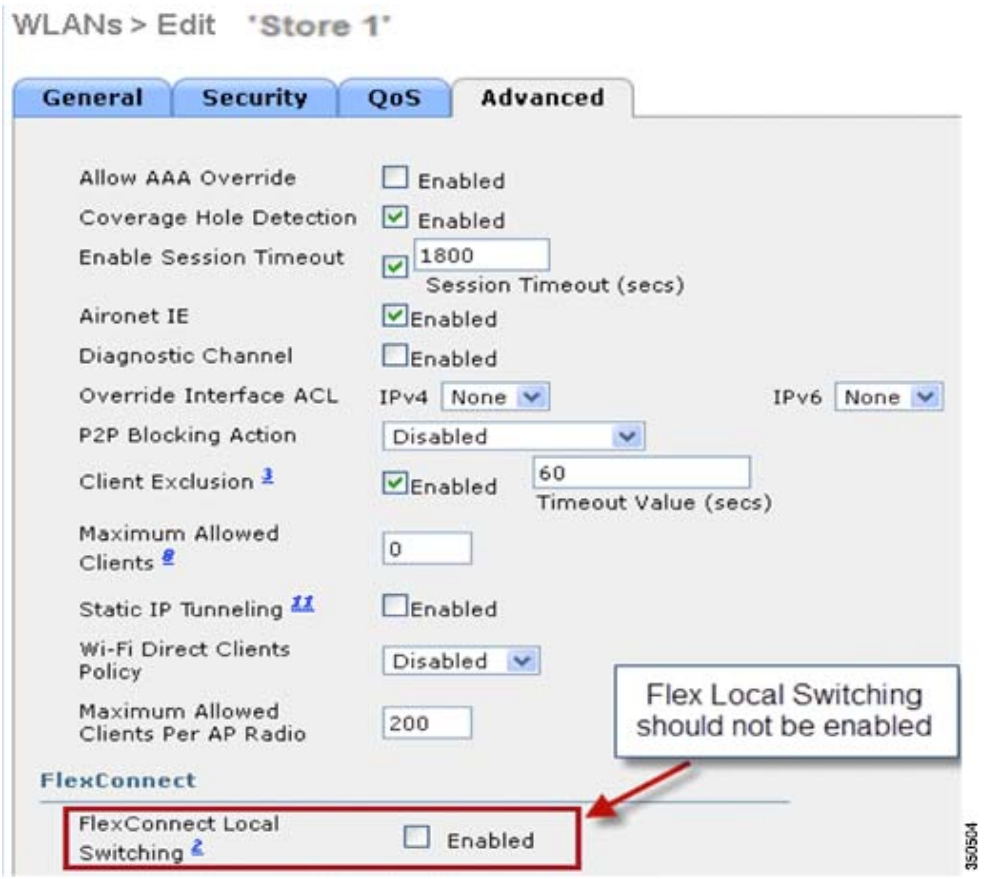
Summary

- The Split Tunneling functionality is supported on WLANs configured for Central Switching advertised by Flex APs only.
- The DHCP required should be enabled on WLANs configured for Split Tunneling.
- The Split Tunneling configuration is applied per WLAN configured for central switching on per Flex AP or for all the Flex APs in a FlexConnect Group.

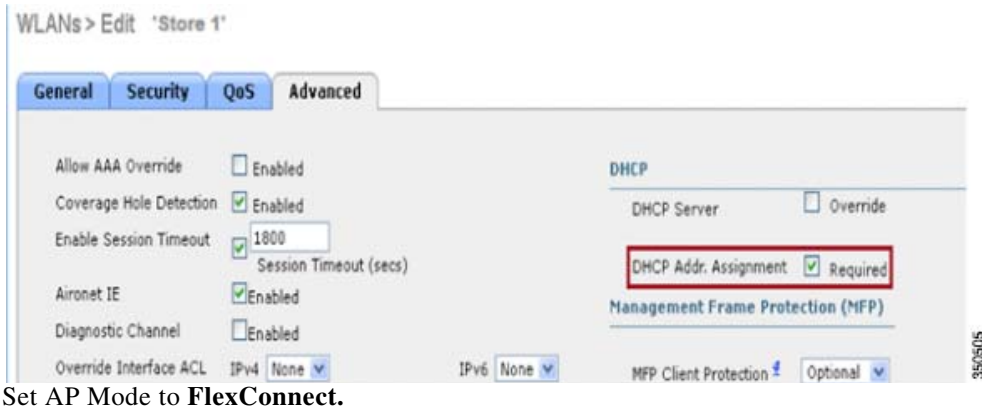
Procedure

Complete these steps:

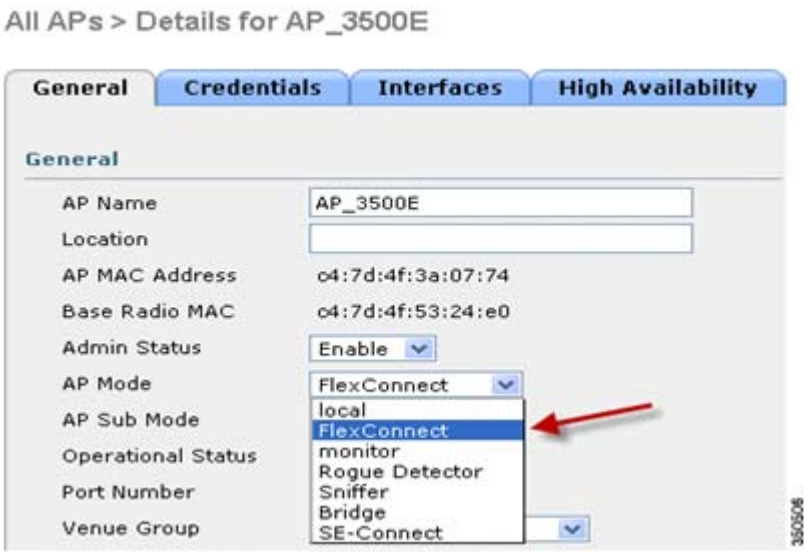
Step 1 Configure a WLAN for Central Switching (that is, **Flex Local Switching** should not be enabled).



Step 2 Set DHCP Address Assignment to **Required.**



Step 3 Set AP Mode to **FlexConnect.**



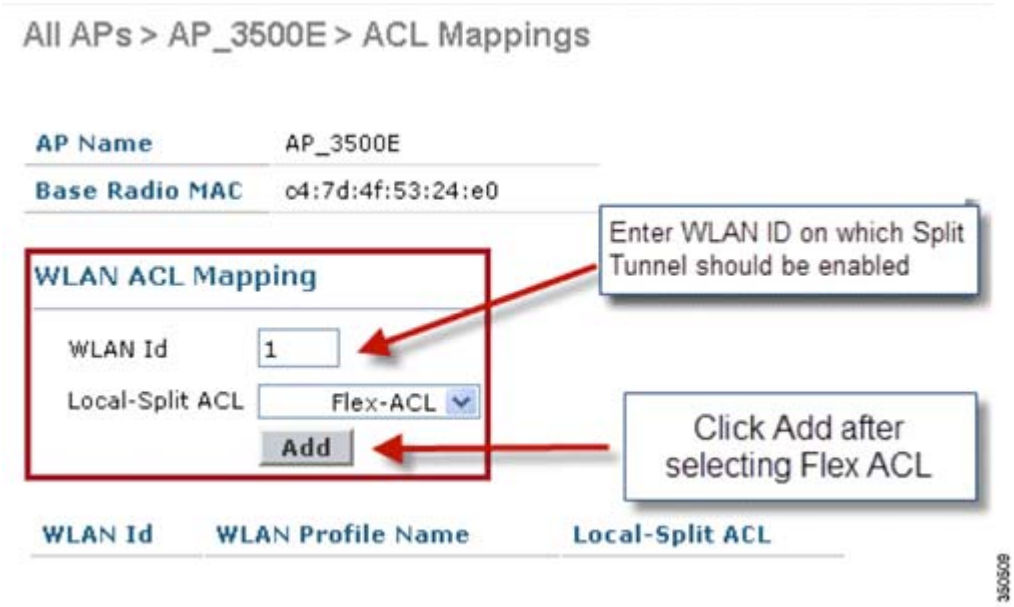
Step 4 Configure FlexConnect ACL with a permit rule for traffic which should be switched locally on the Central Switch WLAN. In this example, the FlexConnect ACL rule is configured so it will alert ICMP traffic from all the clients which are on the 9.6.61.0 subnet (that is, exist on the Central site) to 9.1.0.150 to be switched locally after the NAT operation is applied on Flex AP. The rest of the traffic will hit an implicit deny rule and be switched centrally over CAPWAP.

Step 5 This created FlexConnect ACL can be pushed as a Split Tunnel ACL to individual Flex AP or can also be pushed to all the Flex APs in a Flex Connect group.

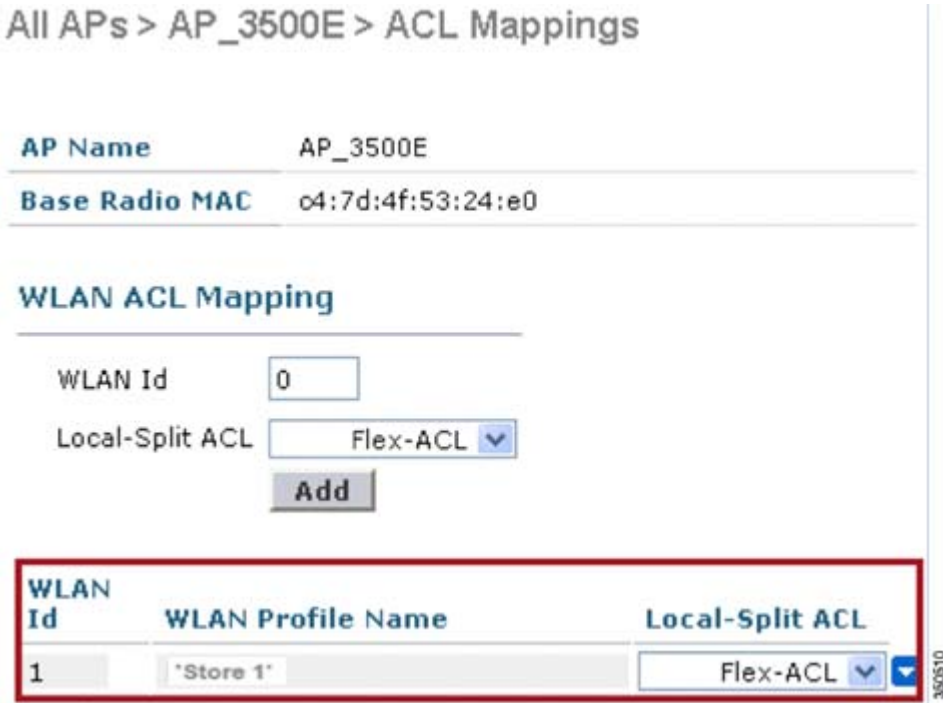
Complete these steps in order to push Flex ACL as a Local Split ACL to individual Flex AP:

a. Click **Local Split ACLs.**

b. Select **WLAN Id** on which Split Tunnel feature should be enabled, choose **Flex-ACL**, and click **Add**.

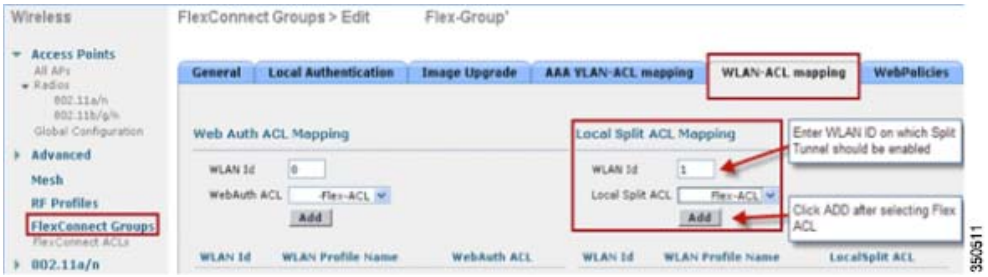


c. Flex-ACL is pushed as Local-Split ACL to the Flex AP.

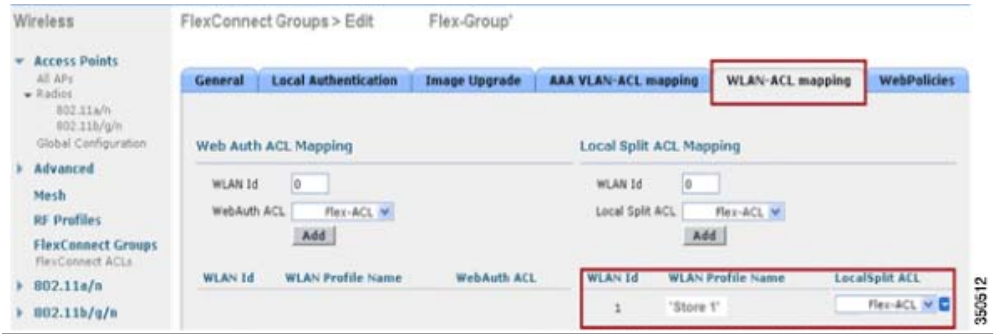


Complete these steps in order to push Flex ACL as Local Split ACL to a FlexConnect Group:

a. Select the WLAN Id on which the Split Tunneling feature should be enabled. On the **WLAN-ACL mapping** tab, select FlexConnect ACL from the FlexConnect group where particular Flex APs are added, and click **Add.**



b. The Flex-ACL is pushed as LocalSplit ACL to Flex APs in that Flex group.



Limitations

- Flex ACL rules should not be configured with permit/deny statement with same subnet as source and destination.
- Traffic on a Centrally Switched WLAN configured for Split Tunneling can be switched locally only when a wireless client initiates traffic for a host present on the local site. If traffic is initiated by clients/host on a local site for wireless clients on these configured WLANs, it will not be able to reach the destination.
- Split Tunneling is not supported for Multicast/Broadcast traffic. Multicast/Broadcast traffic will switch centrally even if it matches the Flex ACL.

Fault Tolerance

FlexConnect Fault Tolerance allows wireless access and services to branch clients when:

- FlexConnect Branch APs lose connectivity with the primary controller.
- FlexConnect Branch APs are switching to the secondary controller.
- FlexConnect Branch APs are re-establishing connection to the primary controller.

FlexConnect Fault Tolerance, along with Local EAP as outlined above and PEAP/EAP-TLS authentication on FlexConnect AP with release 7.5, together provide zero branch downtime during a network outage. This feature is enabled by default and cannot be disabled. It requires no configuration on the controller or AP. However, to ensure Fault Tolerance works smoothly and is applicable, this criteria should be maintained:

- WLAN ordering and configurations have to be identical across the primary and backup controllers.
- VLAN mapping has to be identical across the primary and backup controllers.
- Mobility domain name has to be identical across the primary and backup controllers.

Summary

- FlexConnect will not disconnect clients when the AP is connecting back to the same controller provided there is no change in configuration on the controller.
- FlexConnect will not disconnect clients when connecting to the backup controller provided there is no change in configuration and the backup controller is identical to the primary controller.
- FlexConnect will not reset its radios on connecting back to the primary controller provided there is no change in configuration on the controller.

Limitations

- Supported only for FlexConnect with Central/Local Authentication with Local Switching.
- Centrally authenticated clients require full re-authentication if the client session timer expires before the FlexConnect AP switches from Standalone to Connected mode.
- FlexConnect primary and backup controllers must be in the same mobility domain.

Client Limit per WLAN

Along with traffic segmentation, the need for restricting the total client accessing the wireless services arises. For example, limiting total Guest Clients from branch tunneling back to the Data Center.

In order to address this challenge, Cisco is introducing Client Limit per WLAN feature that can restrict the total clients allowed on a per WLAN basis.

Primary Objective

- Set limits on maximum clients
- Operational ease

Note This is not a form of QoS.

By default, the feature is disabled and does not force the limit.

Limitations

This feature does not enforce client limit when the FlexConnect is in Standalone state of operation.

Any configuration mismatch across WLCs in any of below will result in radio reset at AP:

1. Flexconnect group (all possible configs)
2. WLAN to WLAN mapping per AP / AP Group / WLAN
3. Radio related configs (rates / power) etc.
4. WLAN configurations

WLC Configuration

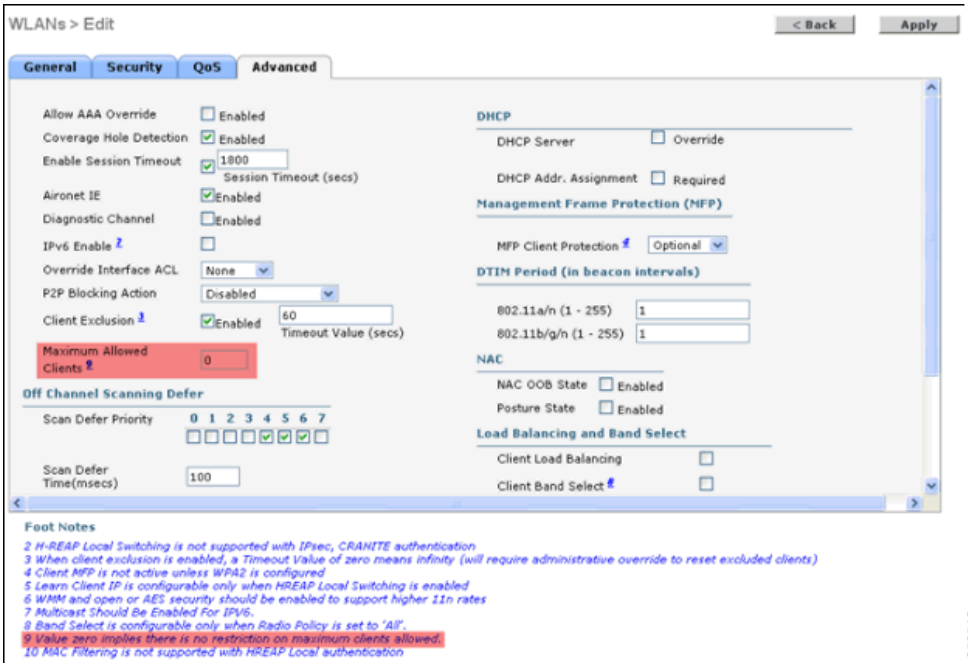
Complete these steps:

Step 1 Select the Centrally Switched WLAN ID 1 with SSID **DataCenter**. This WLAN was created during THE AP Group creation. See Figure 3.

Step 2 Click the **Advanced** tab for WLAN ID 1.

Step 3 Set the client limit value for the Maximum Allowed Clients text field.

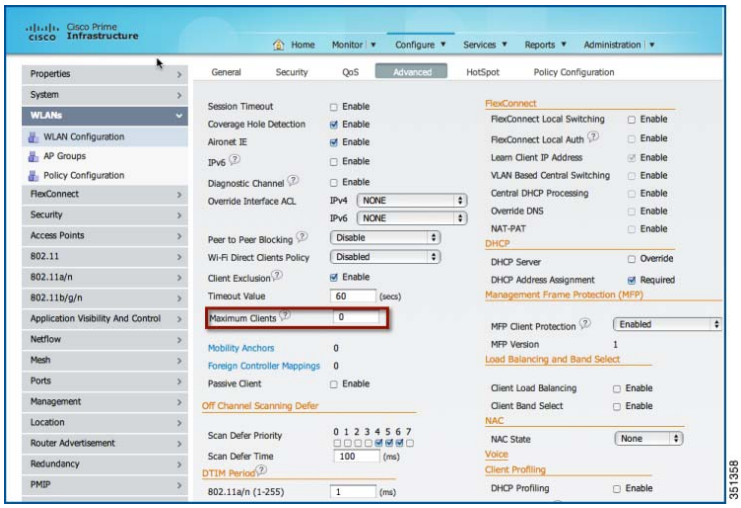
Step 4 Click **Apply** after the text field for Maximum Allowed Clients is set.



Default for Maximum Allowed Clients is set to 0, which implies there is no restriction and the feature is disabled.

Configuration through Cisco Prime

In order to enable this feature from the Cisco Prime, go to **Configure > Controllers > Controller IP > WLANs > WLAN Configuration > WLAN Configuration Details.**

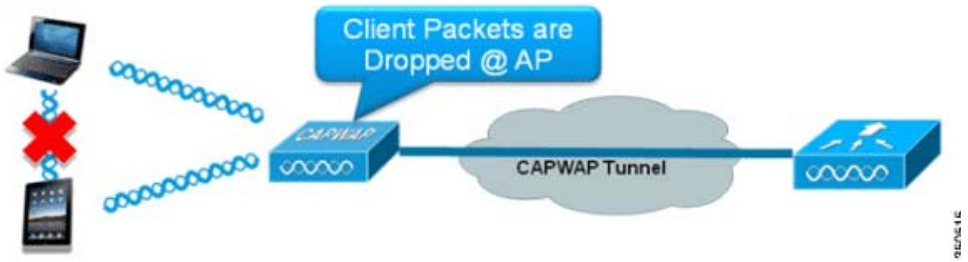


Peer-to-Peer Blocking

In controller software releases prior to 7.2, peer-to-peer (P2P) blocking was only supported for central switching WLANs. Peer-to-peer blocking can be configured on WLAN with any of these three actions:

- Disabled – Disables peer-to-peer blocking and bridged traffic locally within the controller for clients in the same subnet. This is the default value.
- Drop – Causes the controller to discard packets for clients in the same subnet.
- Forward Up-Stream – Causes the packet to be forwarded on the upstream VLAN. The devices above the controller decide what action to take regarding the packet.

From release 7.2 onwards, peer-to-peer blocking is supported for clients associated on local switching WLAN. Per WLAN, peer-to-peer configuration is pushed by the controller to FlexConnect AP.



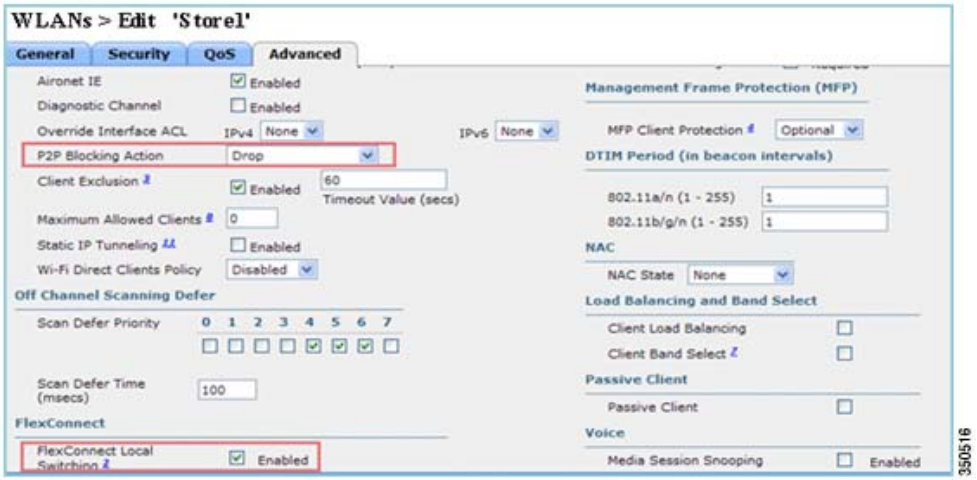
Summary

- Peer-to-peer Blocking is configured per WLAN
- Per WLAN, peer-to-peer blocking configuration is pushed by WLC to FlexConnect APs.
- Peer-to-peer blocking action configured as drop or upstream-forward on WLAN is treated as peer-to-peer blocking enabled on FlexConnect AP.

Procedure

Complete these steps:

Step 1 Enable peer-to-peer blocking action as **Drop** on WLAN configured for FlexConnect Local Switching.



Step 2 Once the P2P Blocking action is configured as **Drop** or **Forward-Upstream** on WLAN configured for local switching, it is pushed from the WLC to the FlexConnect AP. The FlexConnect APs will store this information in the reap config file in flash. With this, even when FlexConnect AP is in standalone mode, it can apply the P2P configuration on the corresponding sub-interfaces.

Limitations

- In FlexConnect, solution P2P blocking configuration cannot be applied only to a particular FlexConnect AP or sub-set of APs. It is applied to all FlexConnect APs that broadcast the SSID.
- Unified solution for central switching clients supports P2P upstream-forward. However, this will not be supported in the FlexConnect solution. This is treated as P2P drop and client packets are dropped instead of forwarded to the next network node.
- Unified solution for central switching clients supports P2P blocking for clients associated to different APs. However, this solution targets only clients connected to the same AP. FlexConnect ACLs can be used as a workaround for this limitation.

AP Pre-Image Download

This feature allows the AP to download code while it is operational. The AP pre-image download is extremely useful in reducing the network downtime during software maintenance or upgrades.

Summary

- Ease of software management
- Schedule per store upgrades: NCS or Cisco Prime is needed to accomplish this.
- Reduces downtime

Procedure

Complete these steps:

Step 1 Upgrade the image on the primary and backup controllers.

Navigate under **WLC GUI > Commands > Download File** to start the download.

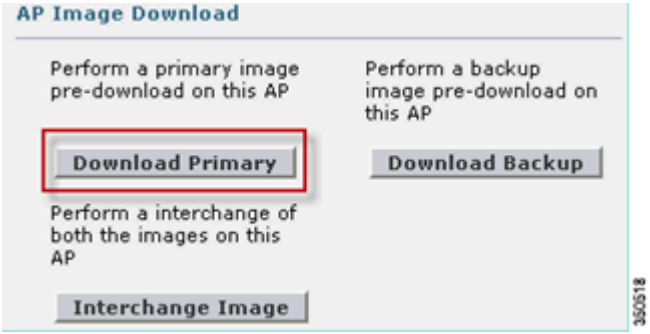
Step 2 Save the configurations on the controllers, but do not reboot the controller.

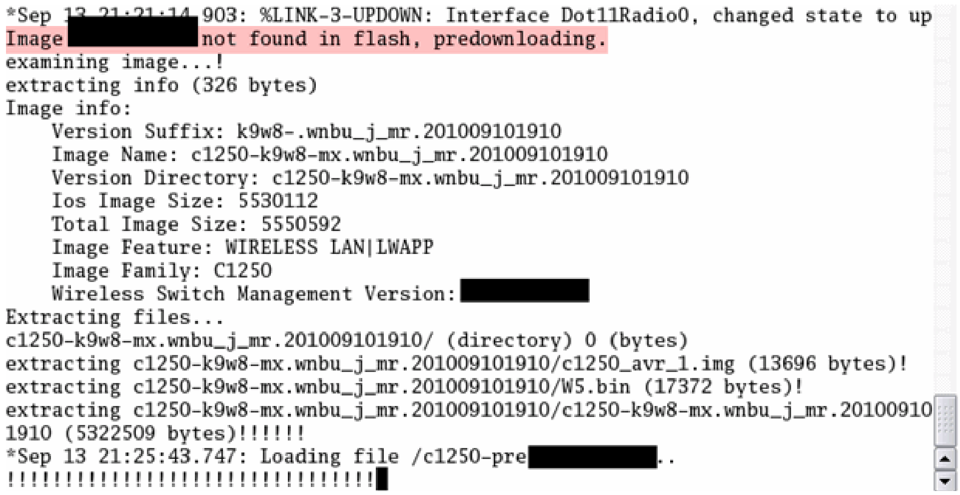
Step 3 Issue the AP pre-image download command from the primary controller.

a. Navigate to **WLC GUI > Wireless > Access Points > All APs** and choose the access point to start pre-image download.

b. Once the access point is chosen, click the **Advanced** tab.

c. Click **Download Primary** to initiate pre-image download.





```
*Sep [redacted]903: %LINK-3-UPDOWN: Interface Dot11Radio0, changed state to up
Image [redacted]not found in flash, predownloading.
examining image...!
extracting info (326 bytes)
Image info:
    Version Suffix: k9w8-.wnbu_j_mr.201009101910
    Image Name: c1250-k9w8-mx.wnbu_j_mr.201009101910
    Version Directory: c1250-k9w8-mx.wnbu_j_mr.201009101910
    Ios Image Size: 5530112
    Total Image Size: 5550592
    Image Feature: WIRELESS LAN|LWAPP
    Image Family: C1250
    Wireless Switch Management Version: [redacted]
Extracting files...
c1250-k9w8-mx.wnbu_j_mr.201009101910/ (directory) 0 (bytes)
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/c1250_avr_1.img (13696 bytes)!
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/W5.bin (17372 bytes)!
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/c1250-k9w8-mx.wnbu_j_mr.20100910
1910 (5322509 bytes)!!!!!!
*Sep 13 21:25:43.747: Loading file /c1250-pre[redacted]..
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

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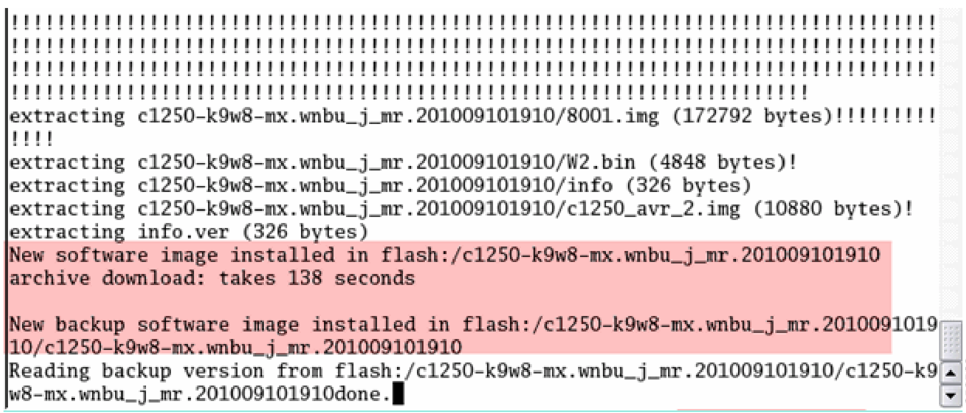

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/8001.img (172792 bytes)!!!!!!!!!
!!!!
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/W2.bin (4848 bytes)!
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/info (326 bytes)
extracting c1250-k9w8-mx.wnbu_j_mr.201009101910/c1250_avr_2.img (10880 bytes)!
extracting info.ver (326 bytes)
New software image installed in flash:/c1250-k9w8-mx.wnbu_j_mr.201009101910
archive download: takes 138 seconds

New backup software image installed in flash:/c1250-k9w8-mx.wnbu_j_mr.2010091019
10/c1250-k9w8-mx.wnbu_j_mr.201009101910
Reading backup version from flash:/c1250-k9w8-mx.wnbu_j_mr.201009101910/c1250-k9
w8-mx.wnbu_j_mr.201009101910done.
```

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Step 4 Reboot the controllers after all the AP images are downloaded.

The APs now fall back to Standalone mode until the controllers are rebooting.

Note In Standalone mode, Fault Tolerance will keep Clients associated.

Once the controller is back, the APs automatically reboot with the pre-downloaded image. After rebooting, the APs re-join the primary controller and resume client's services.

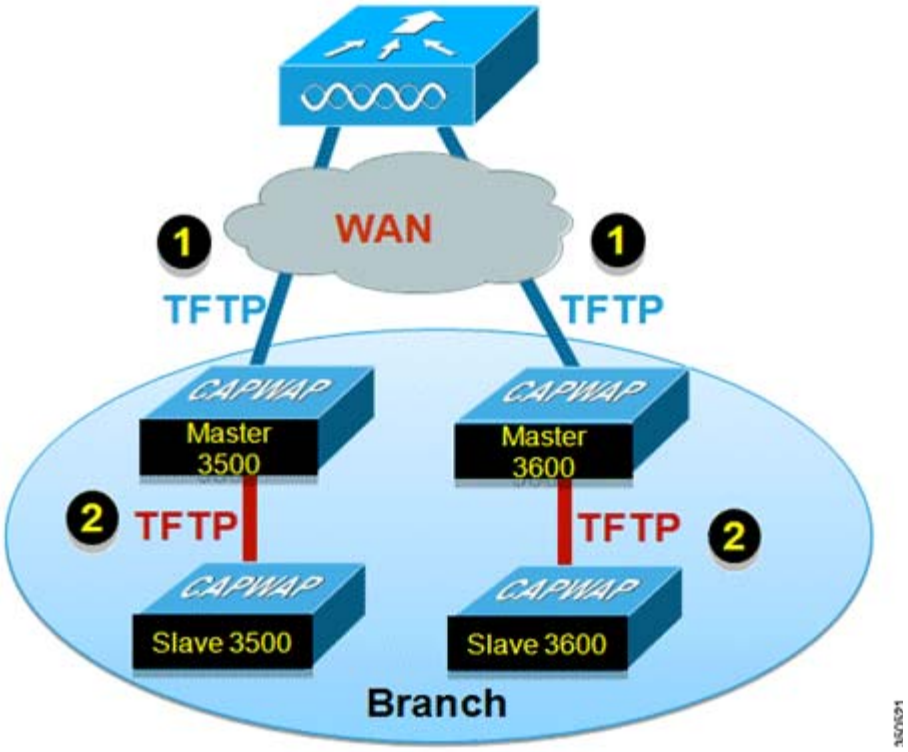
Limitations

- Works only with CAPWAP APs.

FlexConnect Smart AP Image Upgrade

The pre-image download feature reduces the downtime duration to a certain extent, but still all the FlexConnect APs have to pre-download the respective AP images over the WAN link with higher latency.

Efficient AP Image Upgrade will reduce the downtime for each FlexConnect AP. The basic idea is only one AP of each AP model will download the image from the controller and will act as Primary/Server, and the rest of the APs of the same model will work as Secondary/Client and will pre-download the AP image from the primary. The distribution of AP image from the server to the client will be on a local network and will not experience the latency of the WAN link. As a result, the process will be faster.



Summary

- Primary and Secondary APs are selected for each AP Model per FlexConnect Group
- Primary downloads image from WLC
- Secondary downloads image from Primary AP
- Reduces downtime and saves WAN bandwidth

Procedure

Complete these steps:

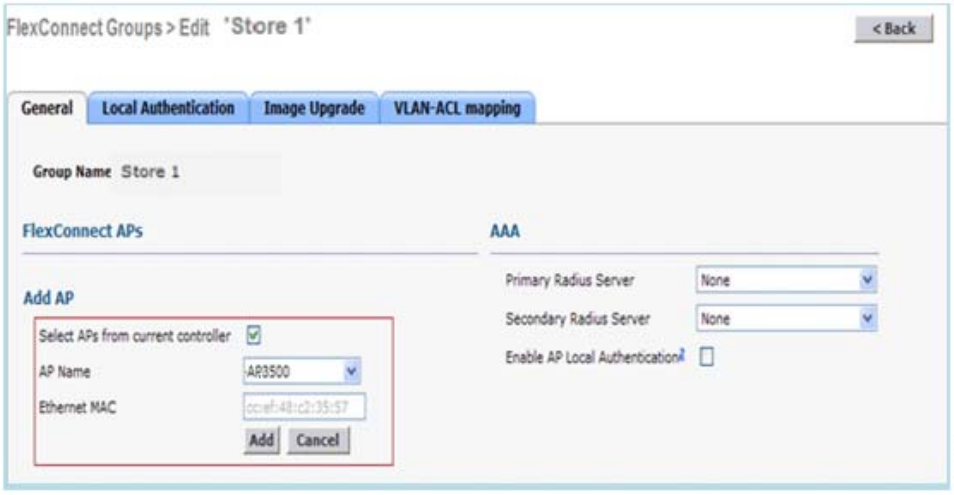
Step 1 Upgrade the image on the controller.

Navigate to **WLC GUI > Commands > Download File** in order to begin the download.

Step 2 Save the configurations on the controllers, but do not reboot the controller.

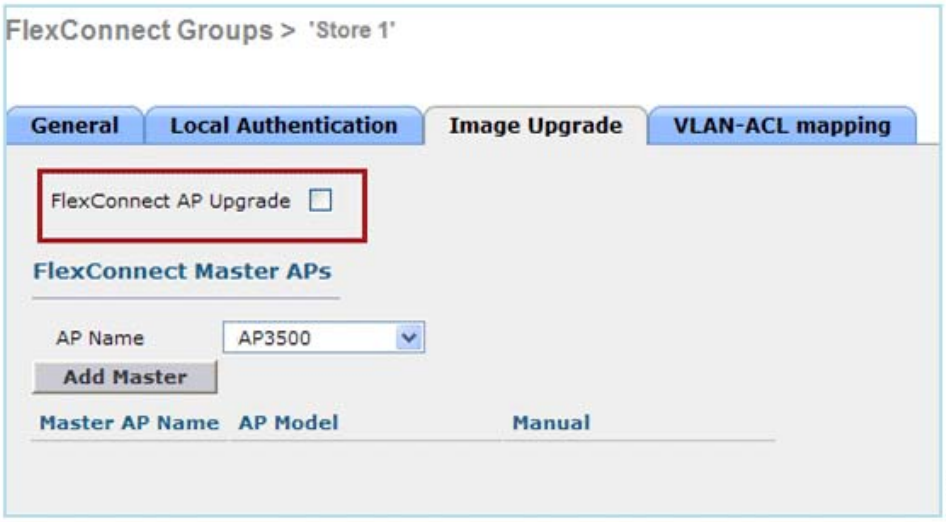
Step 3 Add the FlexConnect APs to FlexConnect group.

Navigate to **WLC GUI > Wireless > FlexConnect Groups,** select **FlexConnect Group > General tab > Add AP**.



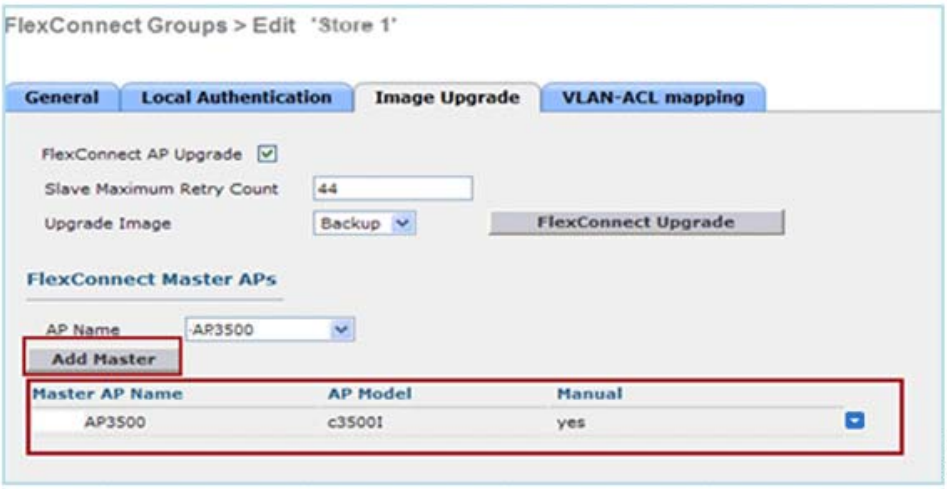
Step 4 Click the **FlexConnect AP Upgrade** check box in order to achieve efficient AP image upgrade.

Navigate to **WLC GUI > Wireless > FlexConnect Groups,** select **FlexConnect Group > Image Upgrade** tab.



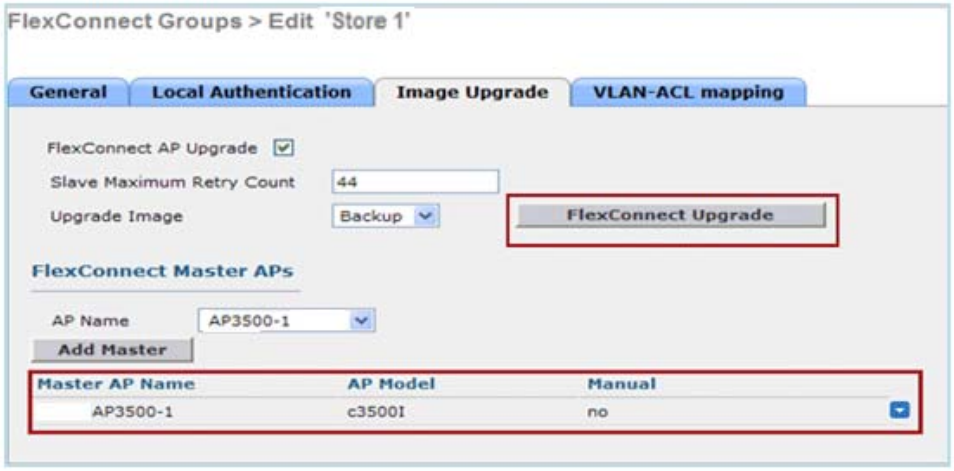
Step 5 The Primary AP can be selected manually or automatically:

a. In order to manually select the Primary AP, navigate to **WLC GUI > Wireless > FlexConnect Groups**, select **FlexConnect Group > Image Upgrade tab > FlexConnect Master APs,** and select **AP** from the drop-down list, and click **Add Master**.



Note Only one AP per model can be configured as Primary AP. If Primary AP is configured manually, the Manual field will be updated as yes.

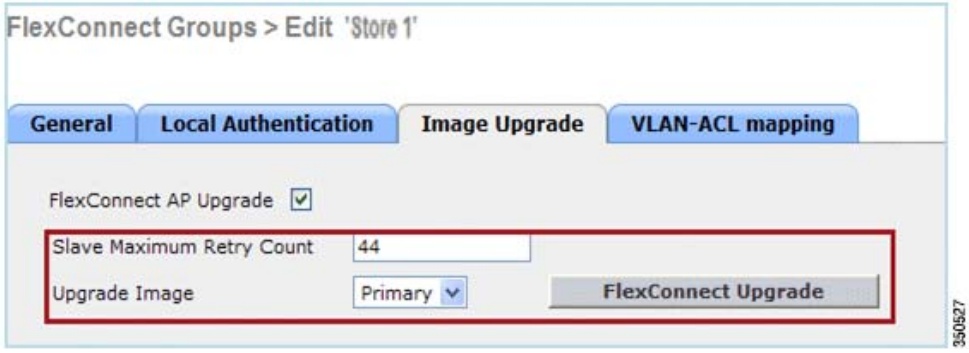
b. In order to automatically select Primary AP, navigate to **WLC GUI > Wireless > FlexConnect Groups**, select **FlexConnect Group > Image Upgrade** tab, and click **FlexConnect Upgrade**.



Note If Primary AP is selected automatically, the Manual field will be updated as **no**.

Step 6 In order to start efficient AP image upgrade for all the APs under a specific FlexConnect group, click **FlexConnect Upgrade**.

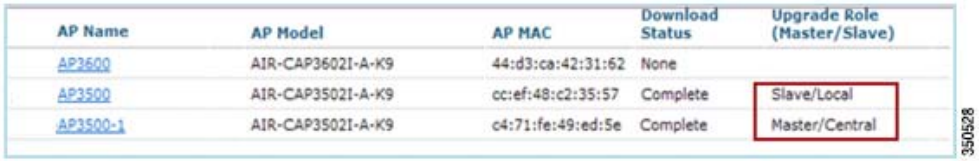
Navigate to **WLC GUI > Wireless > FlexConnect Groups**, select **FlexConnect group > Image Upgrade** tab and click **FlexConnect Upgrade**.



Note Secondary Maximum Retry Count is the number of attempts (44 by default) in which the secondary AP will make in order to download an image from the Primary AP, after which it will fall back to download the image from the WLC. It will make 20 attempts against WLC in order to download a new image after which the administrator has to re-initiate the download process.

Step 7 Once FlexConnect Upgrade is initiated, only the Primary AP will download the image from the WLC. Under All AP page, **Upgrade Role** will be updated as **Master/Central** which means Primary AP has downloaded the image from the WLC which is at the central location. The Secondary AP will download the image from the Primary AP which is at the local site and is the reason under All AP page **Upgrade Role** will be updated as **Slave/Local.**

In order to verify this, navigate to **WLC GUI > Wireless.**



AP Name	AP Model	AP MAC	Download Status	Upgrade Role (Master/Slave)
AP3600	AIR-CAP3602I-A-K9	44:d3:ca:42:31:62	None	
AP3500	AIR-CAP3502I-A-K9	cc:ef:48:c2:35:57	Complete	Slave/Local
AP3500-1	AIR-CAP3502I-A-K9	c4:71:fe:49:ed:5e	Complete	Master/Central

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Step 8 Reboot the controllers after all the AP images are downloaded. The APs now fall back to Standalone mode until the controllers are rebooting.

Note In Standalone mode, Fault Tolerance will keep Clients associated.

Once the controller is back, the APs automatically reboot with the pre-downloaded image. After rebooting, the APs re-join the primary controller and resume the client's services.

Limitations

- Primary AP selection is per FlexConnect group and per AP model in each group.
- Only 3 secondary APs of same model can upgrade simultaneously from their primary AP and rest of the secondary APs will use the random back-off timer to retry for the Primary AP in order to download the AP image.
- In the instance that the Secondary AP fails to download the image from the Primary AP for some reason, it will go to the WLC in order to fetch the new image.
- This works only with CAPWAP APs.
- Smart AP image upgrade does not work when the Primary AP is connected over CAPWAPv6.

Auto Convert APs in FlexConnect Mode

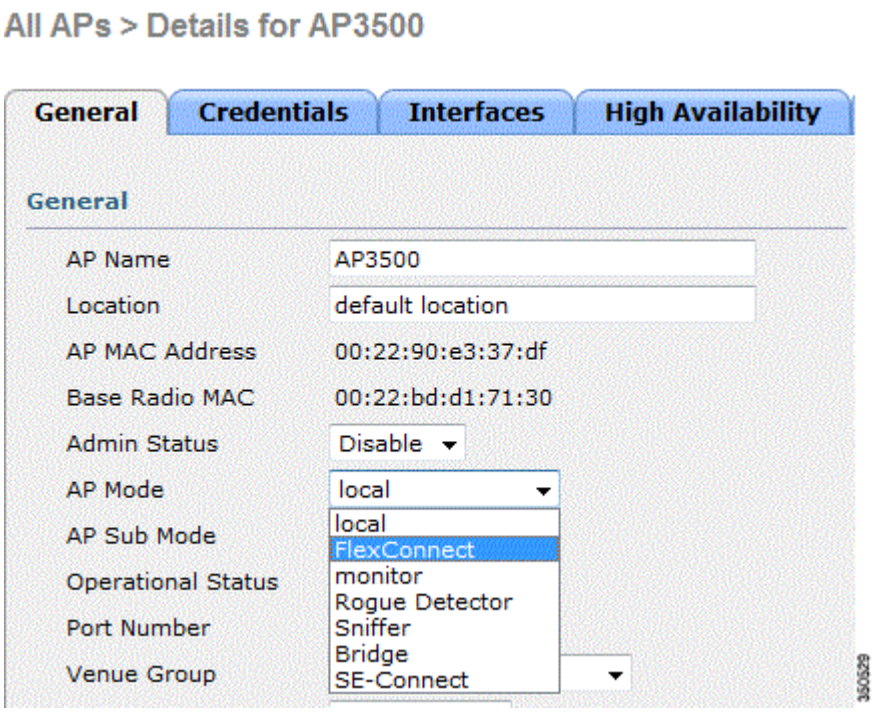
The WLC provides these two options to convert the AP mode to FlexConnect:

- Manual mode
- Auto convert mode

Manual Mode

This mode is available on all the platforms and allows the change to take place only on per AP basis.

1. Navigate to **WLC GUI > Wireless > All APs** and choose the AP.
2. Select **FlexConnect** as the AP Mode, then click **Apply**.
3. Changing the AP mode causes the AP to reboot.



This option is also available on all the current WLC platforms.

Auto Convert Mode

This mode triggers the change on all the connected APs. It is recommended that FlexConnect WLC is deployed in a different mobility domain than existing WLC campus controllers before you enable this CLI:

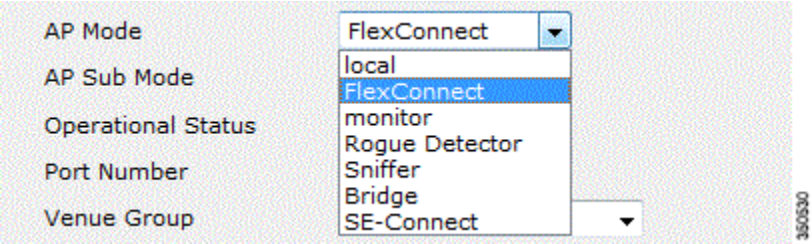
- This feature is also supported on the 8510, 5520 and 8540 controllers.

```
(Cisco Controller) >config ap autoconvert ?

disable.............Disables auto conversion of unsupported mode APs to supported modes
when AP joins

flexconnect........Converts unsupported mode APs to flexconnect mode when AP joins
monitor............Converts unsupported mode APs to monitor mode when AP joins

(Cisco Controller) >
```

Step 1 The Auto-conversion feature is disabled by default, which can be verified by using this **show** command:

```
(Cisco Controller) >show ap autoconvert

AP Autoconvert ................................. Disabled
```

Non-supported AP modes = Local Mode, Sniffer, Rogue Detector and Bridge.



This option is currently available only via CLIs.

Step 2 Performing **config ap autoconvert flexconnect** CLI converts all the APs in the network with non-supported AP mode to FlexConnect mode. Any APs that are already in FlexConnect or Monitor Mode are not affected.

```
(Cisco Controller) >config ap autoconvert flexconnect
(Cisco Controller) >show ap autoconvert
AP Autoconvert ................................ FlexConnect
(Cisco Controller) >
```

Step 3 Performing **config ap autoconvert monitor** CLI converts all the APs in the network with non-supported AP mode to Monitor mode. Any APs that are already in FlexConnect or Monitor mode are not affected.

```
(Cisco Controller >config ap autoconvert monitor
(Cisco Controller) >show ap autoconvert
AP Autoconvert ................................ Monitor
```

There is no option to perform both **config ap autoconvert flexconnect** and **config ap autoconvert monitor** at the same time.

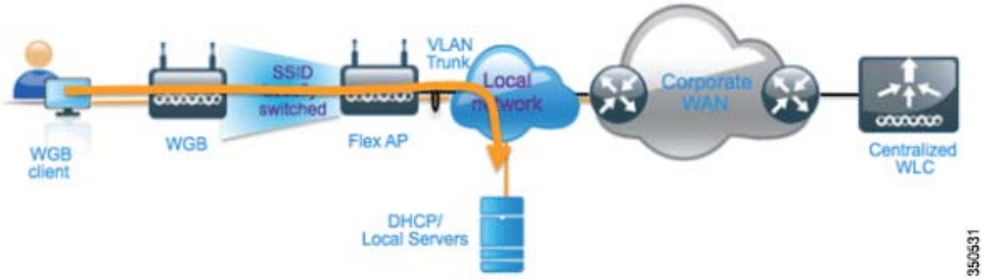
FlexConnect WGB/uWGB Support for Local Switching WLANs

From release 7.3 onwards, WGB/uWGB and wired/wireless clients behind WGBs are supported and will work as normal clients on WLANs configured for local switching.

After association, WGB sends the IAPP messages for each of its wired/wireless clients, and Flex AP will behave as follows:

- When Flex AP is in connected mode, it forwards all the IAPP messages to the controller and the controller will process the IAPP messages the same as Local mode AP. Traffic for wired/wireless clients will be switched locally from Flex APs.
- When AP is in standalone mode, it processes the IAPP messages, wired/wireless clients on the WGB must be able to register and de-register. Upon transition to connected mode, Flex AP will send the information of wired clients back to the controller. WGB will send registration messages three times when Flex AP transitions from Standalone to Connected mode.

Wired/Wireless clients will inherit WGB's configuration, which means no separate configuration like AAA authentication, AAA override, and FlexConnect ACL is required for clients behind WGB.



Summary

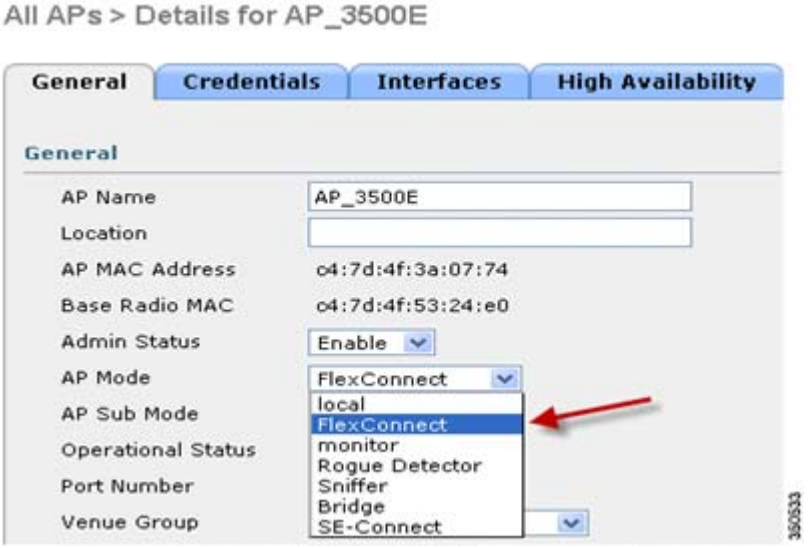
- No special configuration is required on WLC in order to support WGB on Flex AP.
- Fault Tolerance is supported for WGB and clients behind WGB.
- WGB is supported on an IOS AP: 3700, 2700, 1700, 702, 702W, 1530, 1570.
- Starting with release 8.8 WGB will be supported on the Wave-2 APs 2800, 3800 and 1562.

Procedure

Complete these steps:

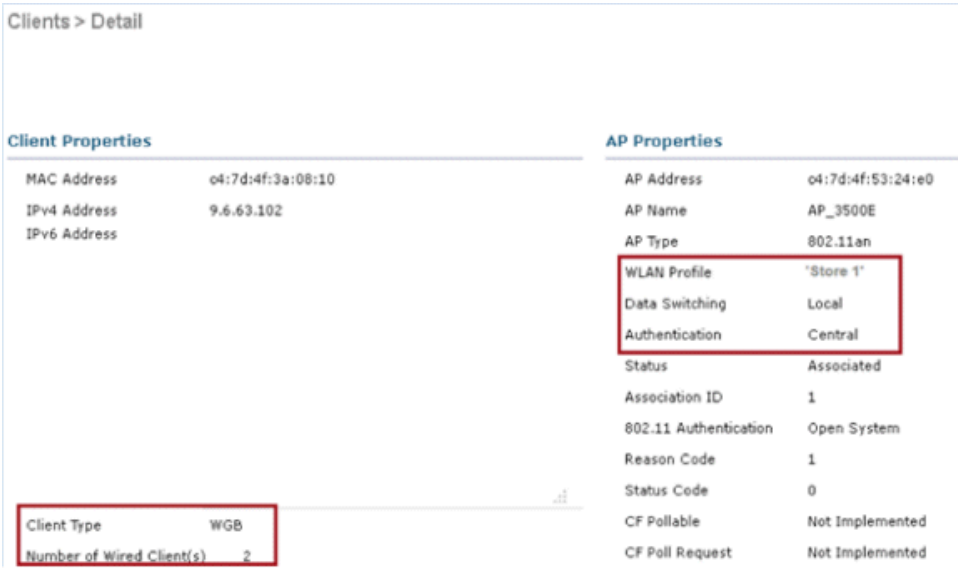
Step 1 No special configuration is needed in order to enable WGB/uWGB support on FlexConnect APs for WLANs configured for local switching as WGB. Also, clients behind WGB are treated as normal clients on local switching configured WLANs by Flex APs. Enable **FlexConnect Local Switching** on a WLAN.

Step 2 Set AP Mode to **FlexConnect.**



Step 3 Associate WGB with wired clients behind this configured WLAN.

Step 4 In order to check the details for WGB, go to **Monitor > Clients**, and select **WGB** from the list of clients.



Step 5 In order to check the details of the wired/wireless clients behind WGB, go to **Monitor > Clients**, and select the client.

Limitations

- Wired clients behind WGB will always be on the same VLAN as WGN itself. Multiple VLAN support for clients behind WGB is not supported on Flex AP for WLANs configured for Local Switching.
- A maximum of 20 clients (wired/wireless) are supported behind WGB when associated to Flex AP on WLAN configured for local switching. This number is the same as what we have today for WGB support on Local mode AP.
- Web Auth is not supported for clients behind WGB associated on WLANs configured for local switching.

Support for an Increased Number of Radius Servers

Prior to release 7.4, the configuration of RADIUS servers at the FlexConnect group was done from a global list of RADIUS servers on the controller. The maximum number of RADIUS servers, which can be configured in this global list, is 17. With an increasing number of branch offices, it is a requirement to be able to configure a RADIUS server per branch site. In release 7.4 onwards, it will be possible to configure Primary and Backup RADIUS servers per FlexConnect group which may or may not be part of the global list of 17 RADIUS authentication servers configured on the controller.

An AP specific configuration for the RADIUS servers will also be supported. The AP specific configuration will have greater priority than the FlexConnect group configuration.

The existing configuration command at the FlexConnect Group, which needs the index of the RADIUS server in the global RADIUS server list on the controller, will be deprecated and replaced with a configuration command, which configures a RADIUS server at the Flexconnect Group using the IP address of the server and shared secret.

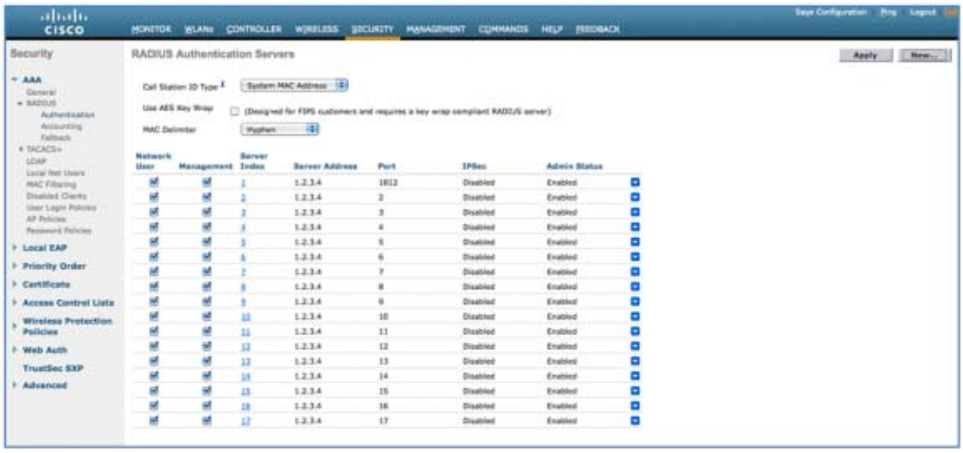
Summary

- Support for configuration of Primary and Backup RADIUS servers per FlexConnect group, which may or may not be present in the global list of RADIUS authentication servers.
- The maximum number of unique RADIUS servers that can be added on a WLC is the number of FlexConnect groups that can be configured on a given platform times two. An example is one primary and one secondary RADIUS server per FlexConnect group.
- Software upgrade from a previous release to release 7.4 will not cause any RADIUS configuration loss.
- The deletion of the primary RADIUS server is allowed without having to deleting the secondary RADIUS server. This is consistent with the present FlexConnect group configuration for the RADIUS server.

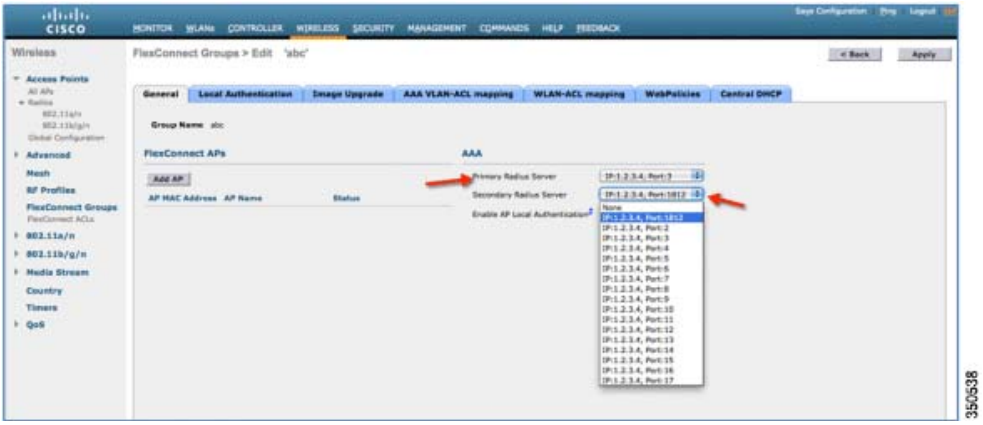
Procedure

Step 1 Mode of configuration prior to release 7.4.

A maximum of 17 RADIUS servers can be configured under the AAA Authentication configuration.

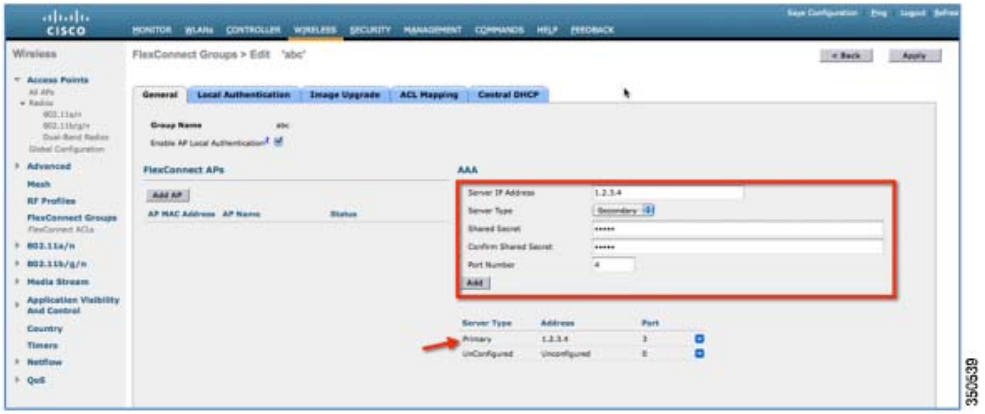


Step 2 Primary and Secondary RADIUS servers can be associated with a FlexConnect Group using a drop-down list comprising of RADIUS servers configured on the AAA Authentication page.



Step 3 Mode of configuration at FlexConnect Group in release 7.4.

Primary and Secondary RADIUS servers can be configured under the FlexConnect Group using an IP address, port number and Shared Secret.



Limitations

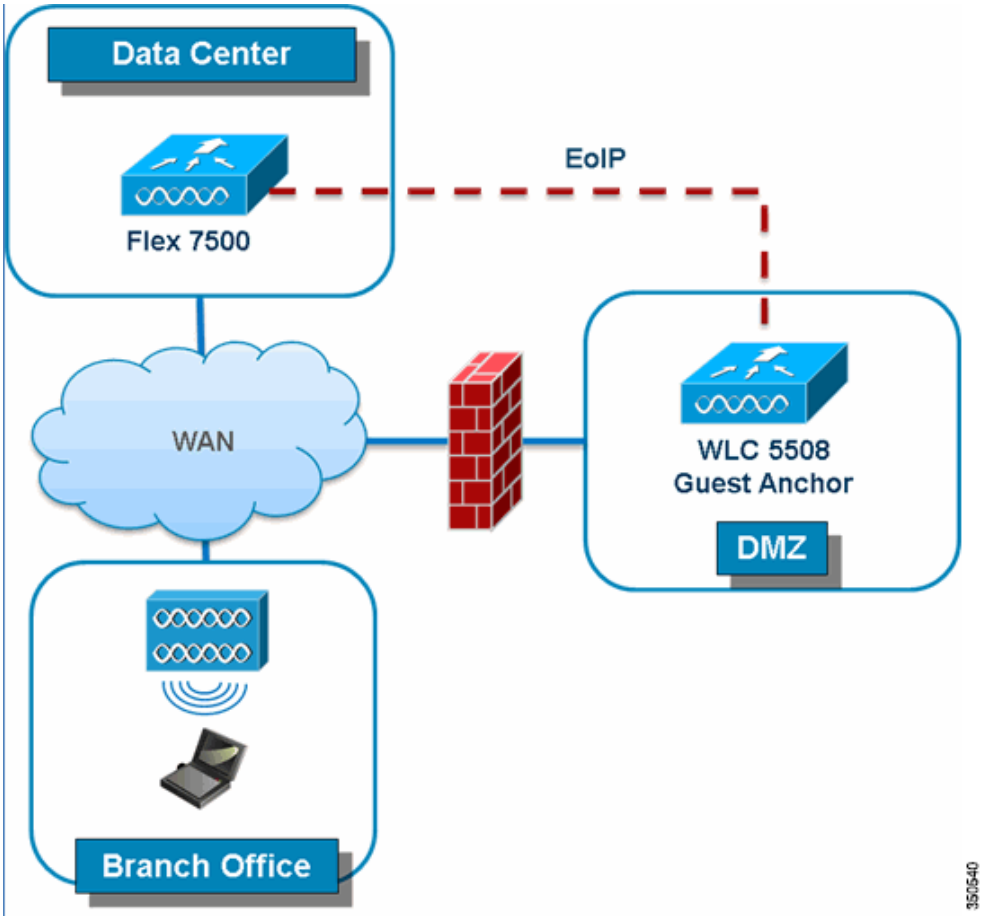
- Software downgrade from release 7.4 to a previous release will retain the configuration but with some limitations.
- Configuring a primary/secondary RADIUS server when a previous one is configured will cause the older entry to be replaced by the new one.

Enhanced Local Mode (ELM)

ELM is supported on the FlexConnect solution. Refer to the best practices guide on ELM for more information.

Guest Access Support in FlexConnect

Figure 7 Guest Access Support in FlexConnect



FlexConnect WLC will allow and continue to support creation of EoIP tunnel to your guest anchor controller in DMZ. For best practices on the wireless guest access solution, refer to the Guest Deployment Guide.

Support for PEAP and EAP-TLS Authentication

FlexConnect AP can be configured as a RADIUS server for LEAP and EAP-FAST client authentication. In standalone mode and also when local authentication feature is enabled on the WLANs, FlexConnect AP will do dot1x authentication on the AP itself using the local radius. With controller release 7.5, PEAP and EAP-TLS EAP methods are also supported.

EAP-TLS

Certificate Generation for EAP-TLS

The following steps are needed on the WLC and the client in order to authenticate the client to the FlexConnect AP using EAP-TLS authentication.

On WLC:

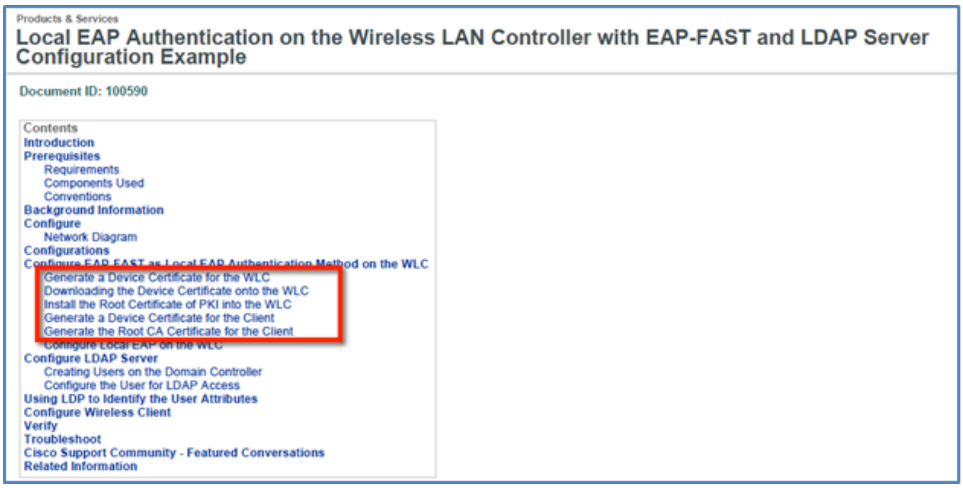
1. Generate device certificate for the WLC.
2. Get device certificate signed by CA server.
3. Generate CA certificate from the CA server.
4. Import device and CA certificate into the WLC in .pem format.

On Client:

1. Generate client certificate.
2. Get client certificate signed by CA server.
3. Generate CA certificate from the CA server.
4. Install client and CA certificate on the client.

Detailed steps on how to accomplish the above steps are listed in Document-100590 (http://www.cisco.com/en/US/products/ps6366/products_configuration_example09186a008093f1b9.shtml)

Figure 8 Document 100590

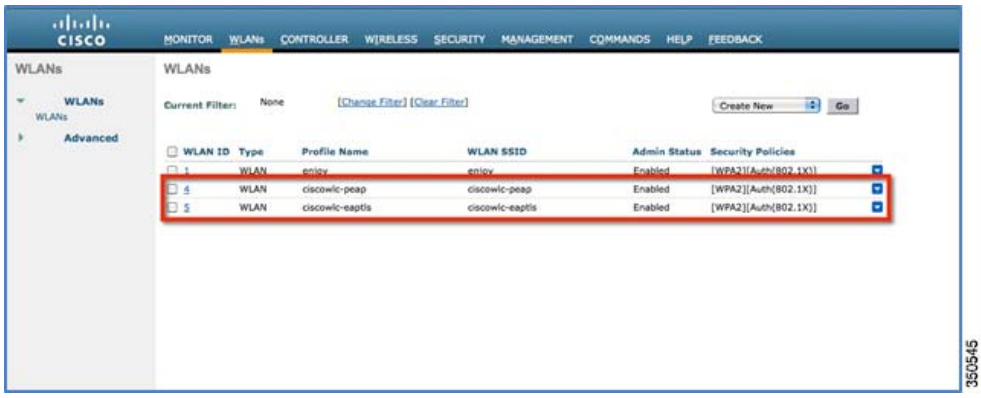


Configuration of EAP-TLS on FlexConnect AP

1. Create WLAN for Local Switching and Local Authentication.

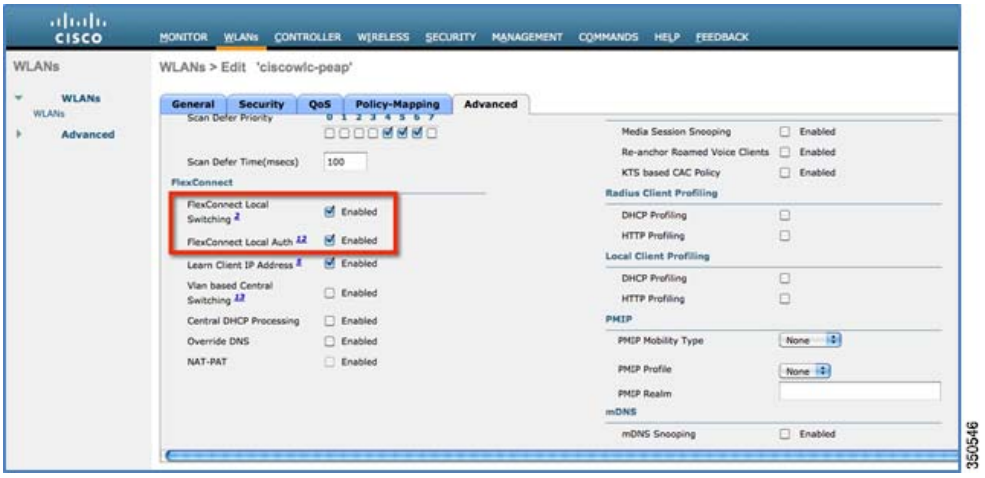
   In the example below, two WLANs have been created, one for EAP-TLS and the other for PEAP authentication.

Figure 9 WLAN Configuration for PEAP and EAP-TLS



2. Enable **FlexConnect Local Switching** and **FlexConnect Local Auth**

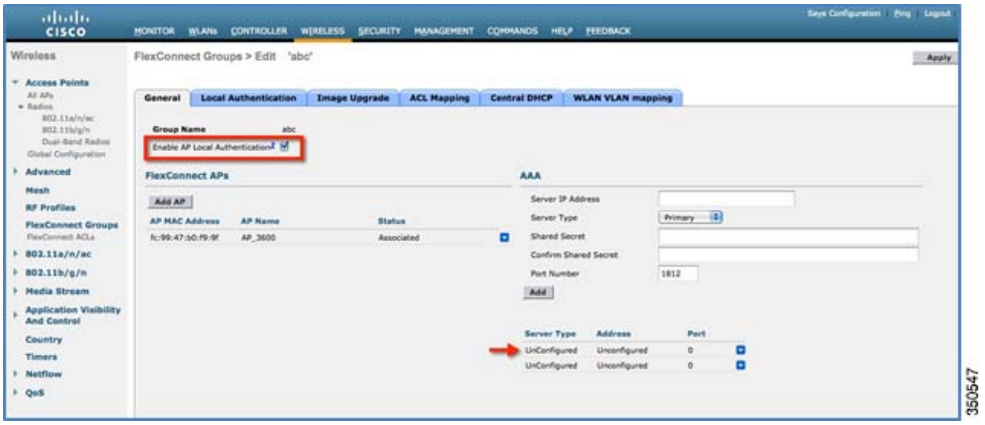
Figure 10 WLANs for Local Switching and Local Authentication



3. Enable AP Local Authentication.

   Enable the **Enable AP Local Authentication** check box on the FlexConnect groups edit page. Radius Servers on the FlexConnect group must be 'Unconfigured'. If any RADIUS servers are configured on the FlexConnect group, the AP tries to authenticate the wireless clients using the RADIUS servers first. AP Local Authentication is attempted only if no RADIUS servers are found, either because the RADIUS servers timed out or no RADIUS servers were configured.

Figure 11 FlexConnect Group Configuration for AP Local Authentication



4. Selecting EAP methods will now have two more options, PEAP and EAP-TLS under the FlexConnect group with the existing LEAP and EAP-FAST options.

   a. Current controller release supports downloading of EAP device and root (CA) certificates to the controller and the same is stored in PEM format on the flash.

Figure 12 Downloading Vendor Device Certificate

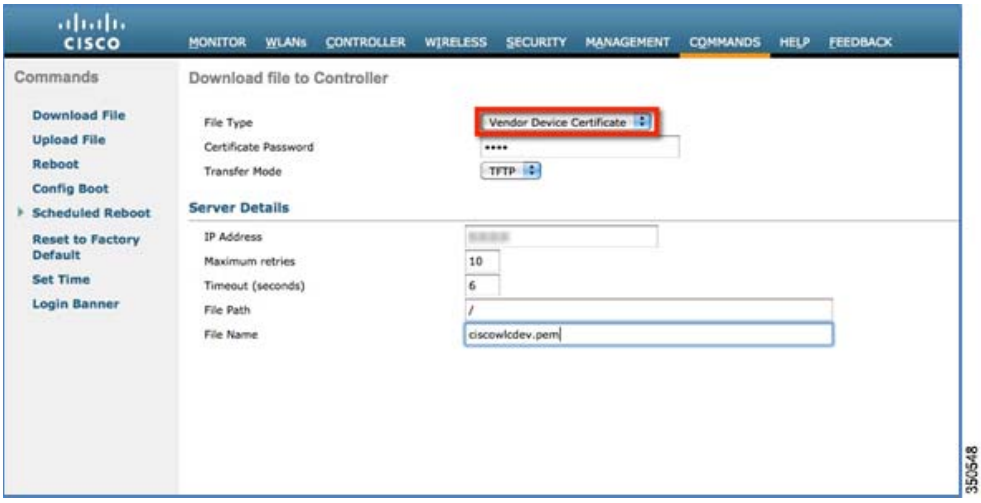
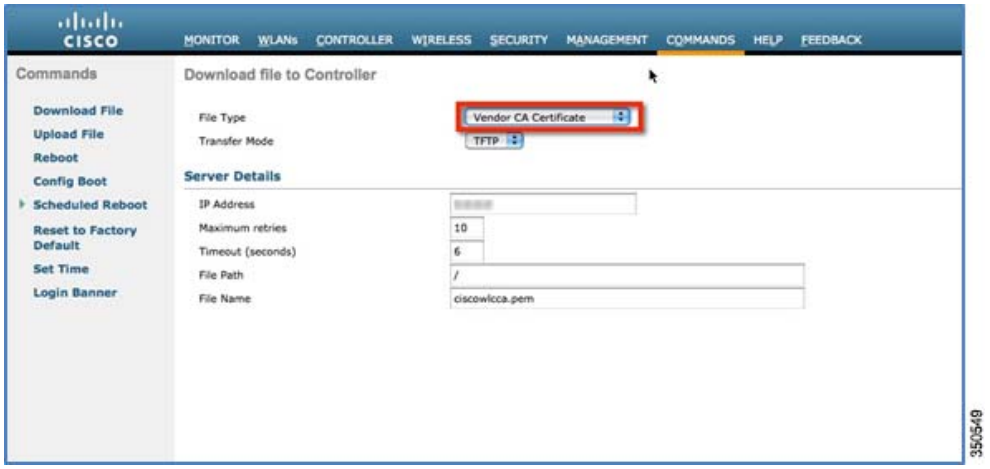


Figure 13 Downloading Vendor CA Certificate



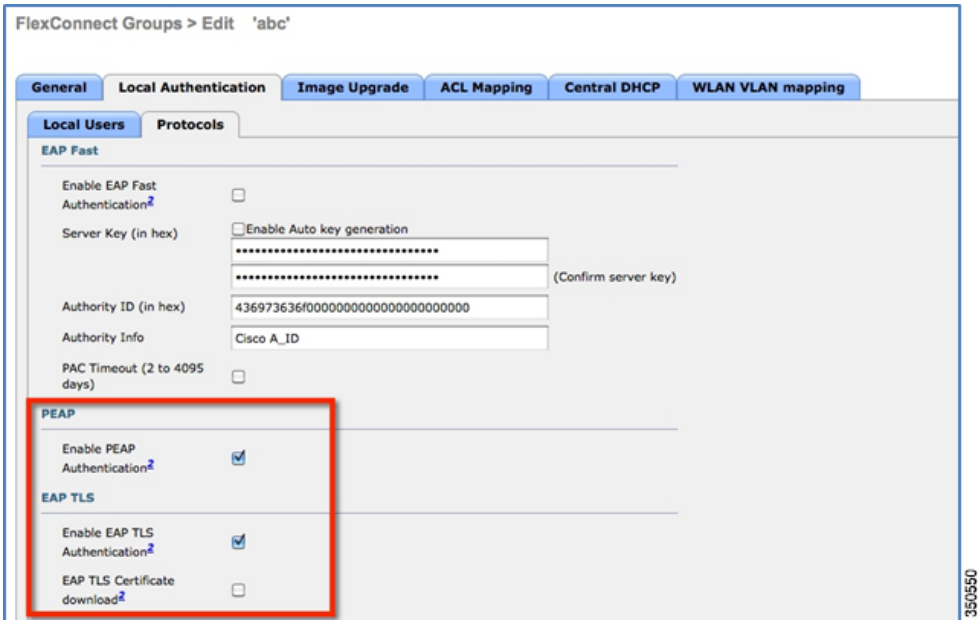
b. With release 7.5, these certificates will be used for authenticating clients using EAP-TLS. Both the device and root certificates will be downloaded to all the FlexConnect APs in the FlexConnect group if the EAP-TLS method is enabled, and the same is used at the AP to authenticate the clients.

c. When a new AP joins the group, certificates will be pushed to the AP along with other configurations. The user has to download the EAP device and Root certificates to controller prior to enabling EAP-TLS on the FlexConnect group.

d. Upon receiving a certificate message from the controller, the AP will import these certificates, store them in memory and use them for authenticating clients.

e. **EAP TLS Certificate Download** option is provided to push any updated certificates to the AP.

Figure 14 Enabling PEAP and EAP TLS on AP Local Authentication under FlexConnect Group

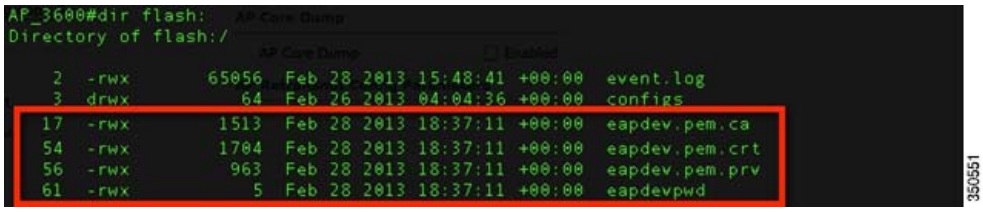


Certificate Files on AP

Four files are downloaded to the AP, when EAP-TLS is enabled.

- eapdev.pem.ca – This is the CA (root) certificate.
- eapdev.pem.crt –This is the public certificate of the device.
- eapdev.pem.prv –This is the RSA private key of the device.
- eapdevpwd – This is the password file to protect the private key.

Figure 15 Files Stored in the Flash on AP



Client Configuration

Configure the wireless profile for EAP-TLS by selecting EAP Type **EAP-TLS** and specifying the Trusted Root certificate Authorities and the client certificate.

Figure 16 Wireless Profile for EAP-TLS

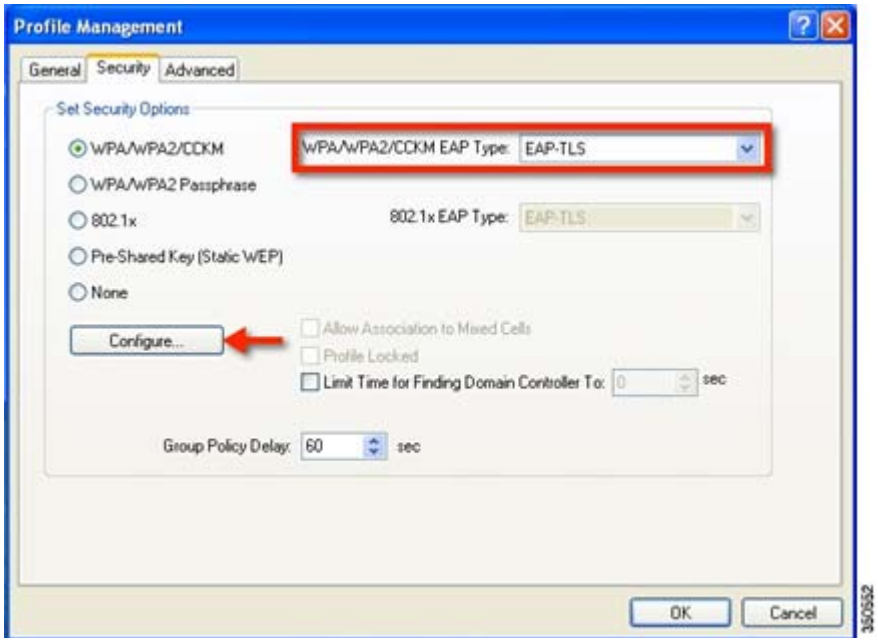
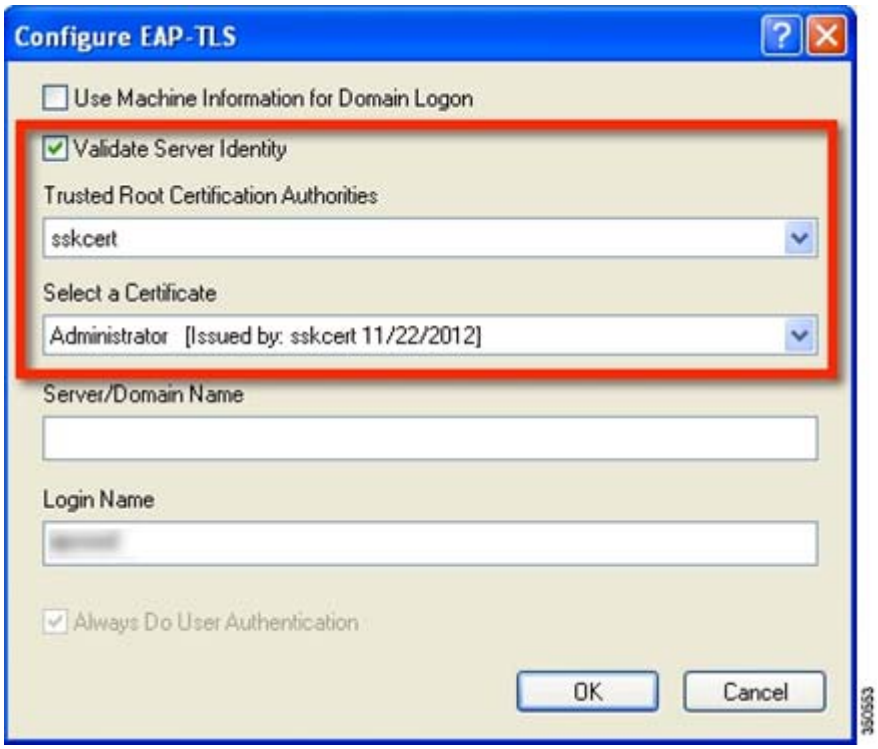
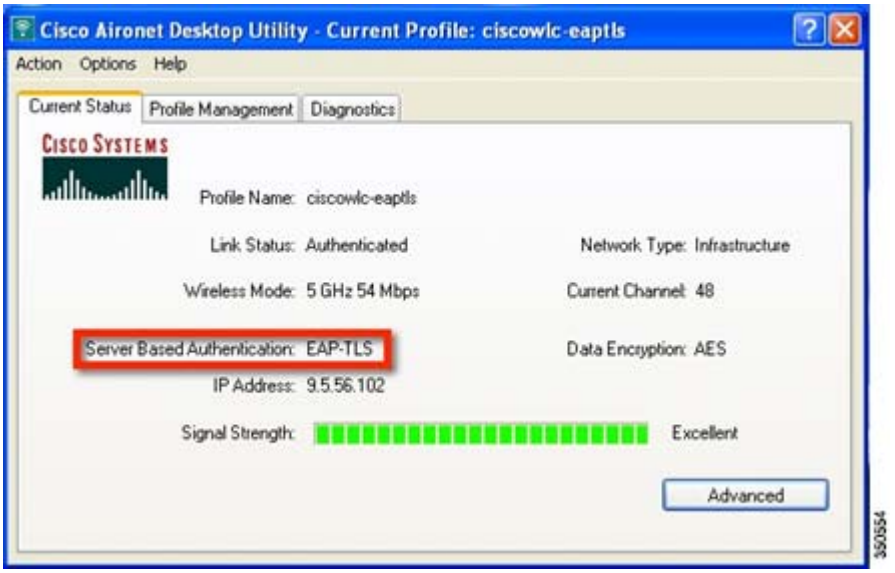


Figure 17 Validate Server Identity



Once the client is connected, Server Based Authentication will reflect EAP-TLS.

Figure 18 Client Authentication using EAP-TLS



Client Certificates

The Trusted Root and Client Certificates can be viewed as follows (These are the certificates as generated earlier)

Figure 19 Certificates on Client

Figure 20 Trusted Root (CA) Certificate on Client

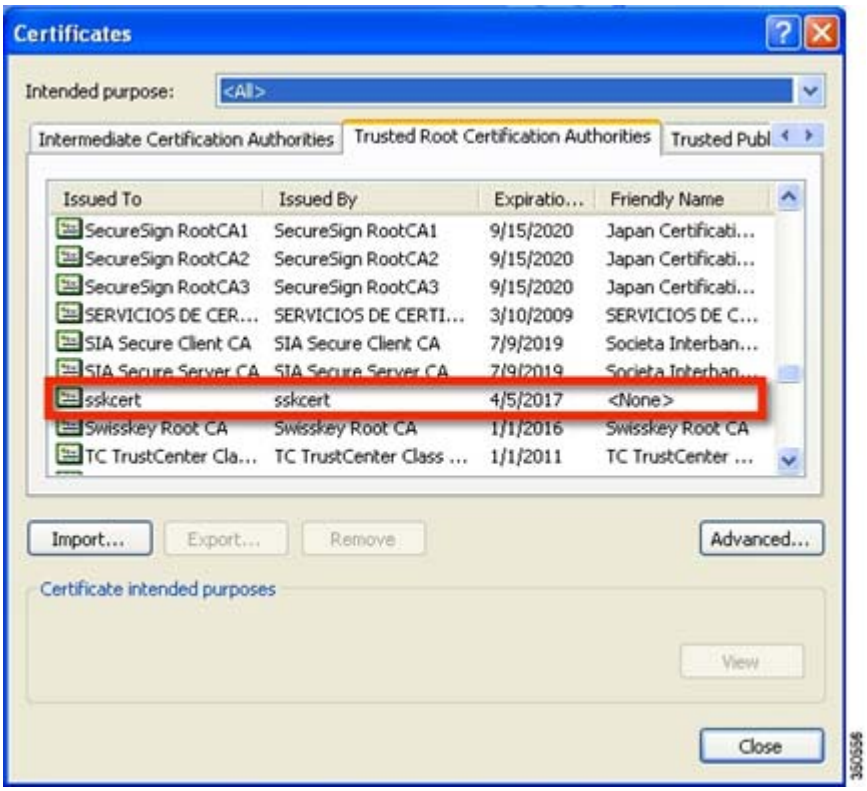
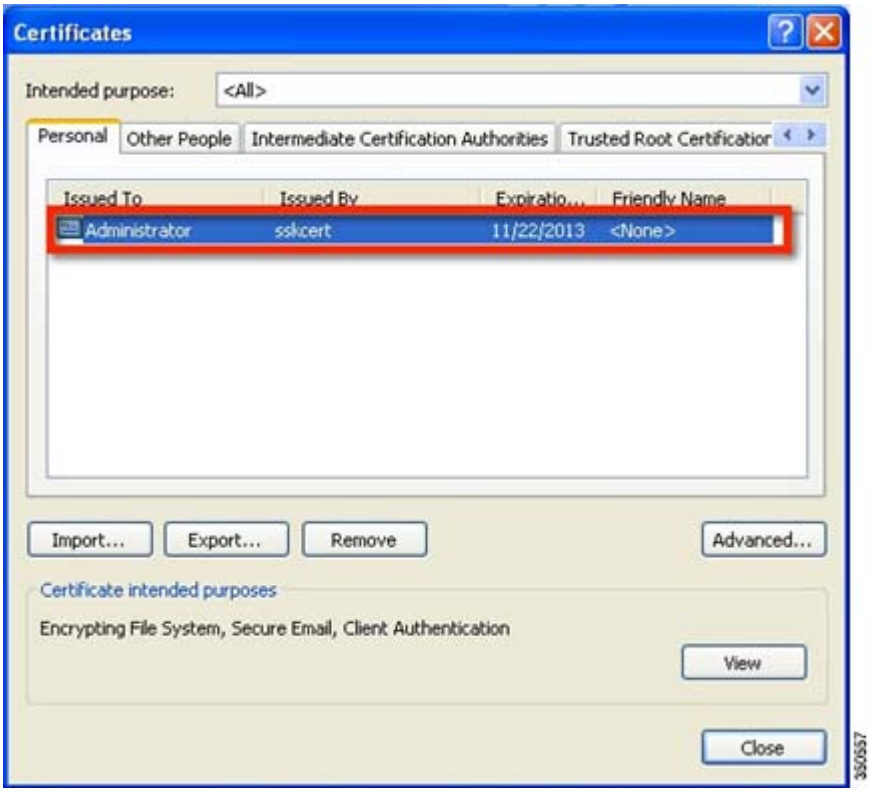


Figure 21 Trusted Client Certificate



Show Commands

The EAP type of the client will be reflected on the WLC and can be seen in the output of **show client detail**

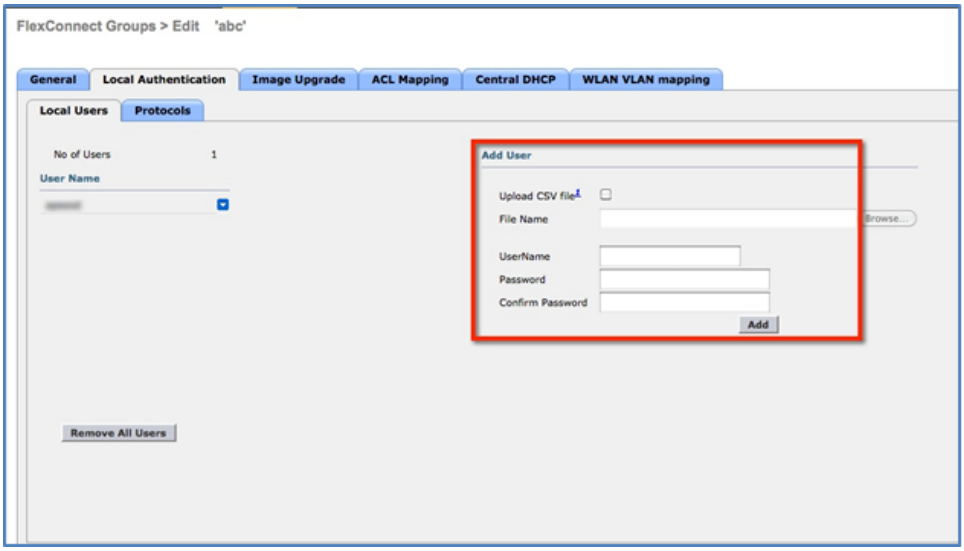
Figure 22 EAP Type for Client Authenticated using EAP-TLS

EAP-PEAP

PEAP (EAP-MSCHAPv2 and EAP-GTC) EAP Type is supported with release 7.5 and Users need to be added on the WLC as shown below. A maximum of 100 users can be added per FlexConnect group.

User Creation

Figure 23 User Addition for Local Authentication



Client Configuration

Selecting EAP Type EAP-MSCHAPv2 or GTC can configure the wireless profile for EAP-PEAP.

Figure 24 Wireless Profile for EAP-PEAP (EAP-MSCHAPv2)

Users created on the controller need to be configured on the client.

Figure 25 User Name and Password for PEAP

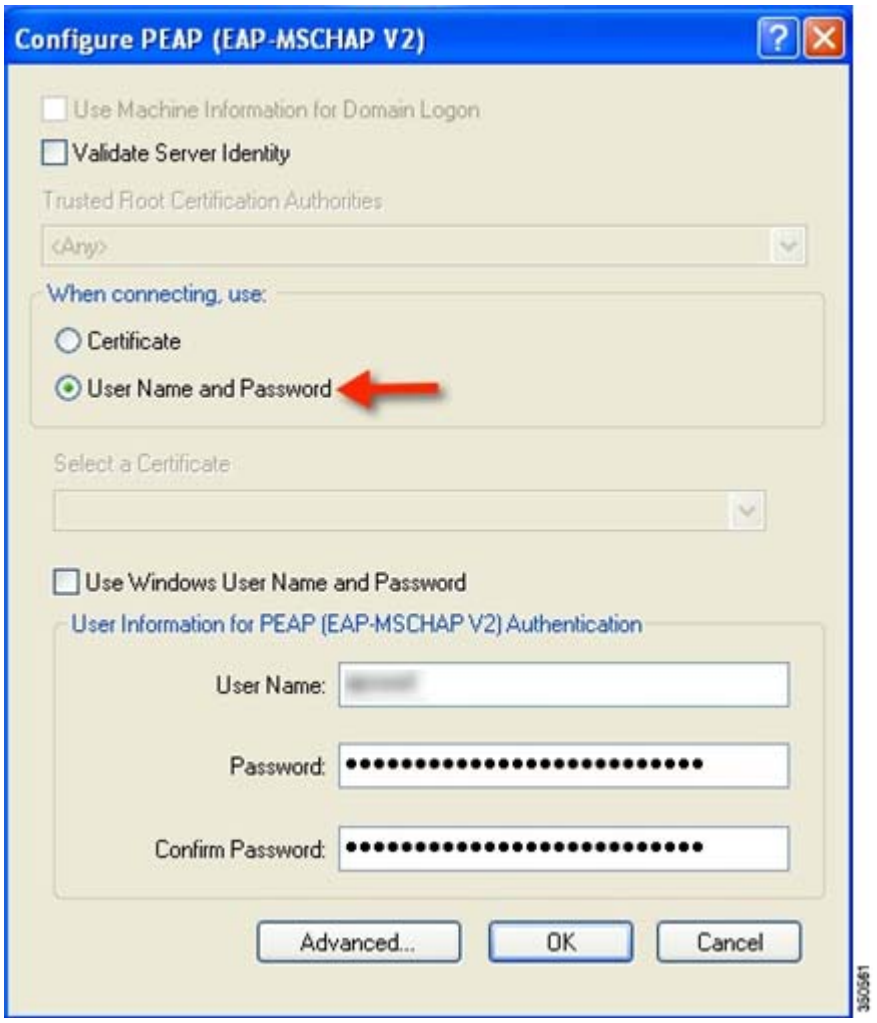
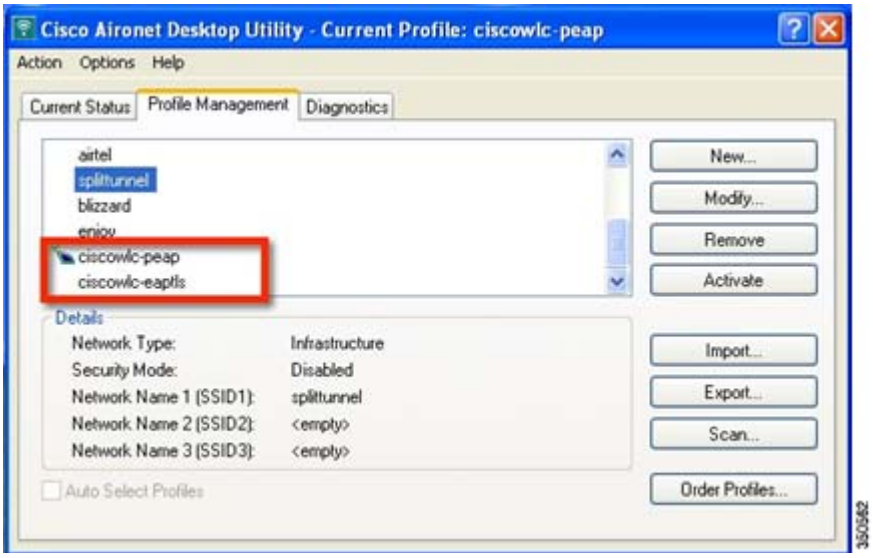
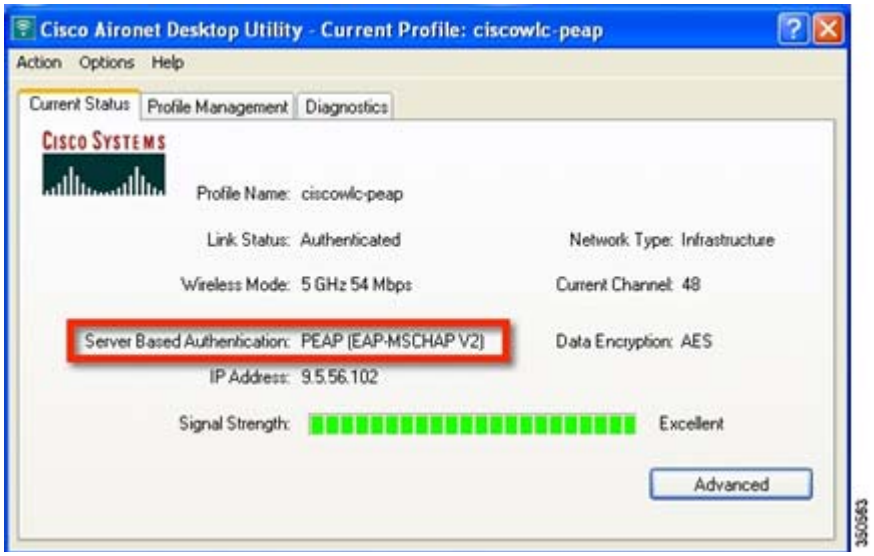


Figure 26 Cisco Aironet Desktop Utility Profile Management



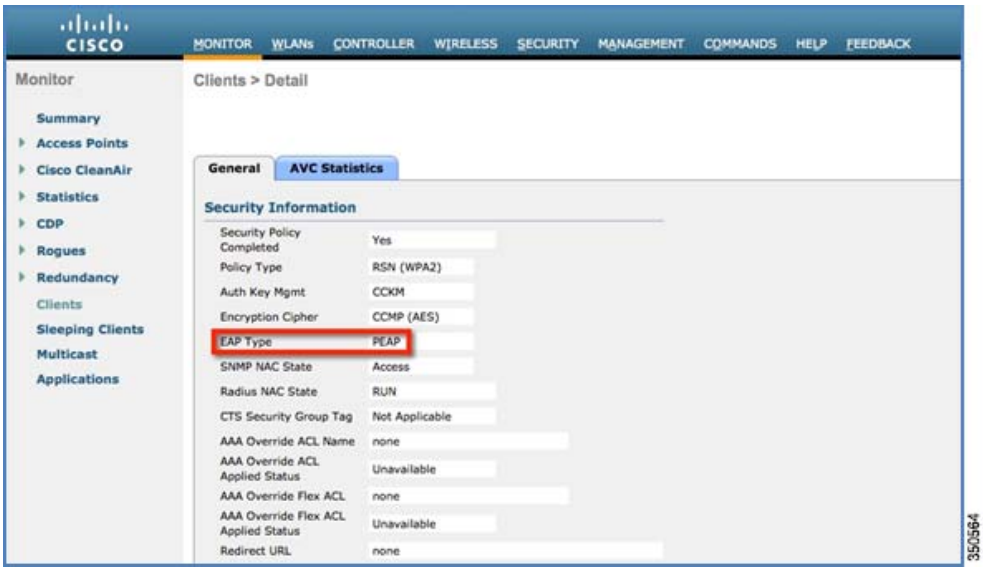
Once the client is connected, Server Based Authentication will reflect PEAP(EAP-MSCHAPv2)

Figure 27 Client Authentication using PEAP(EAP-MSCHAPv2)



Once the client is authenticated, the EAP Type can be seen under the Client Detail page.

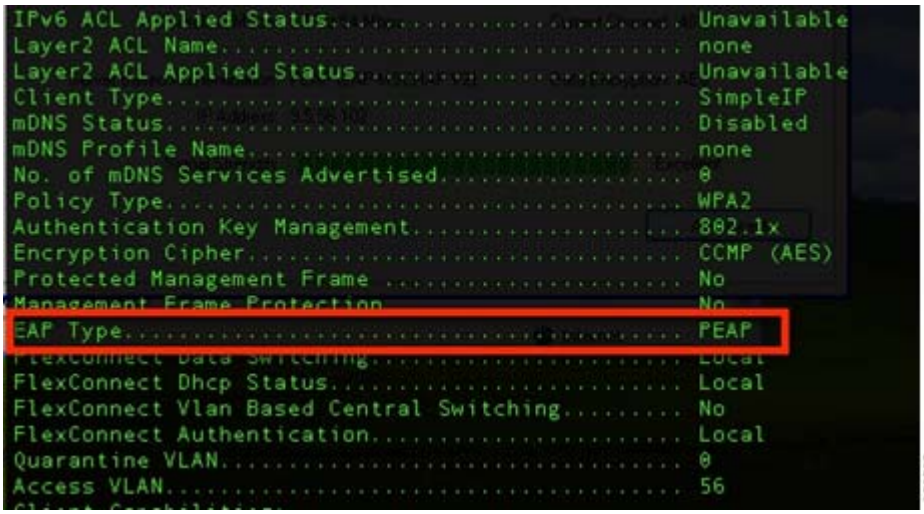
Figure 28 Web GUI Client Details



Show Commands

The EAP type of the client will be reflected on the WLC and can be seen in the output of **show client detail**

Figure 29 EAP Type of Client Authenticated using PEAP



CLI Support for PEAP and EAP-TLS on FlexConnect APs

Two new CLIs have been added to configure PEAP and EAP-TLS from the controller.

```
config flexconnect group <groupName> radius ap     peap         <enable | disable>
config flexconnect group <groupName> radius ap     eap-tls      <enable | disable>
```

A CLI for certificate download has been added as well.

```
config flexconnect  group <groupName>  radius ap eap-cert  download
```

Configurations at the AP can be seen from the console.

Figure 30 CLI Commands on AP Console

The following commands can be used to troubleshoot this feature:

```
debug eap all
debug aaa authentication
debug dot11 aaa  authenticator all
debug aaa api
debug aaa subsys
debug dot11 aaa dispatcher
debug aaa protocol local
debug radius
debug aaa dead-criteria transaction
```

Guidelines

- FlexConnect AP should be in standalone mode or configured for Local authentication.
- Certificates must be present on the AP for EAP-TLS to work.

WLAN-VLAN mapping at FlexConnect Group Level

Prior to release 7.5, WLAN to VLAN mapping was done on a per AP basis.

With increasing number of APs in a deployment, there is a need to provide the capability of adding WLAN to VLAN maps from the FlexConnect group. This will be supported in release 7.5.

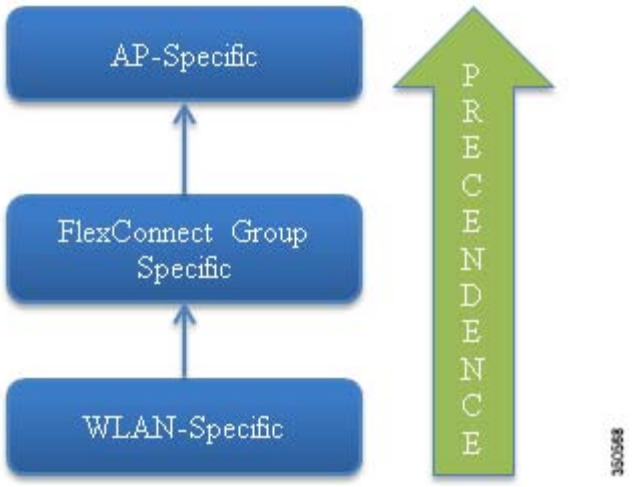
This will push the WLAN to VLAN mapping to all the APs present in the FlexConnect group. The FlexConnect level configuration will have a higher precedence compared to the WLAN-VLAN mapping configured on the WLAN.

WLAN-VLAN Mapping Inheritance

- WLAN level WLAN-VLAN mapping has the lowest precedence.
- Higher precedence mapping will override the mapping of lower precedence
- AP level WLAN-VLAN mapping has the highest precedence
- On deletion of a higher precedence mapping, the next highest precedence mapping will take effect.

The following figure depicts the order of precedence as it refers to WLAN-VLAN mapping at the WLAN, FlexConnect group and at the AP.

Figure 31 Flow of Inheritance



GUI Configuration

1. Create WLAN for Local Switching

Figure 32 WLAN for Local Switching

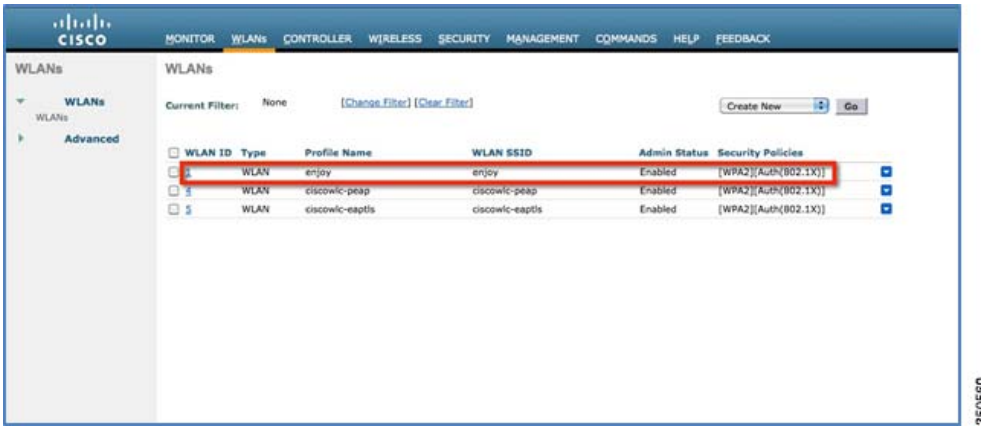
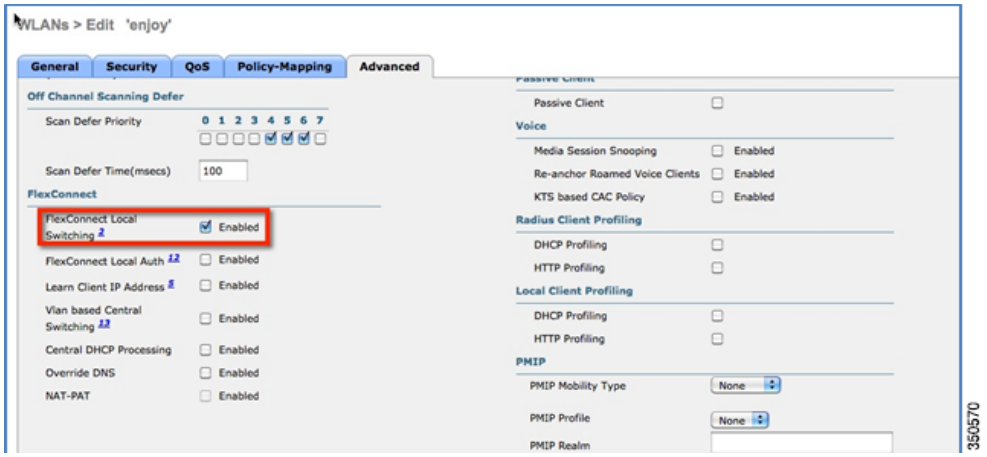


Figure 33 FlexConnect Local Switching



The WLAN is mapped to the management VLAN 56.

Figure 34 WLAN Mapped to VLAN 56 Management Interface

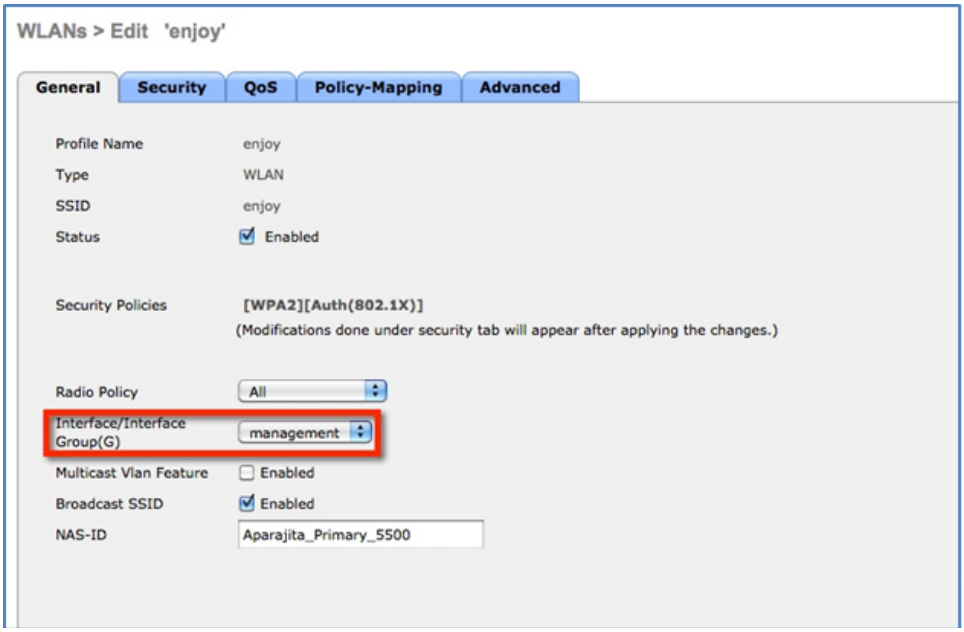
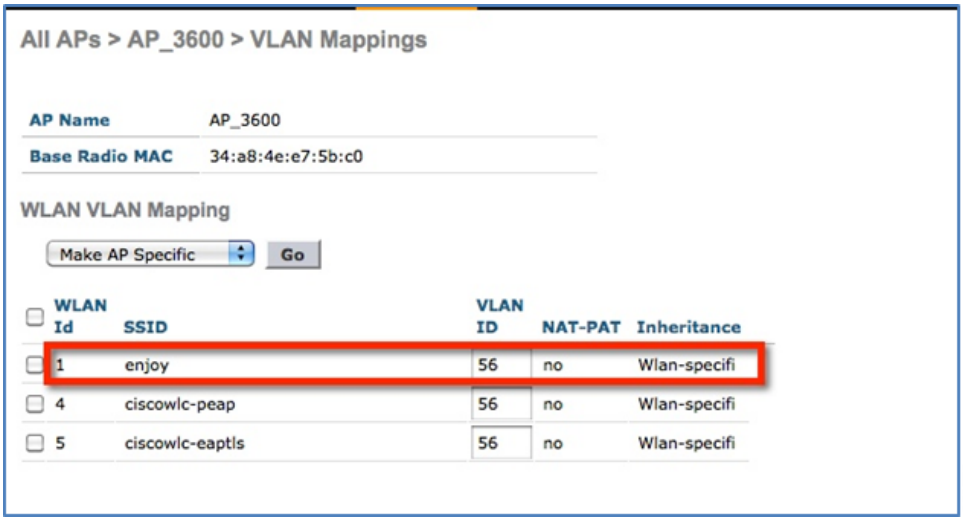
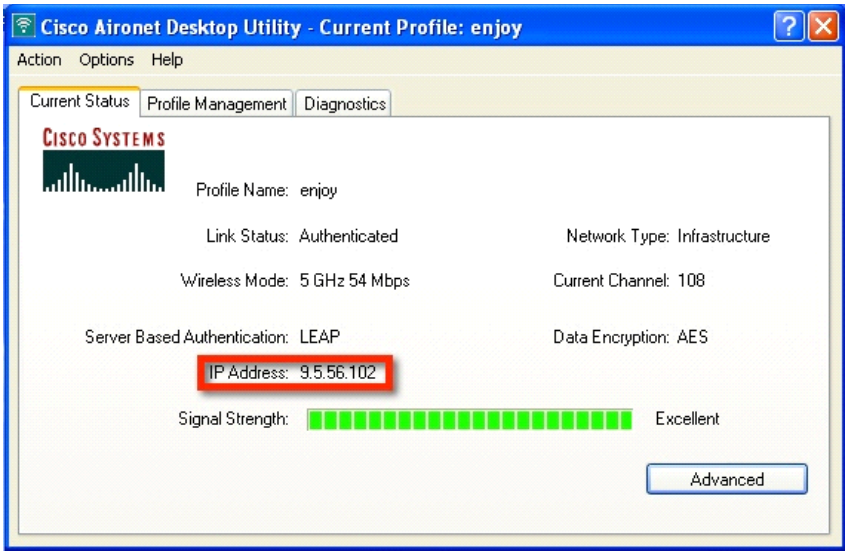


Figure 35 WLAN Mapped to VLAN 56 as Per WLAN-Specific Mapping



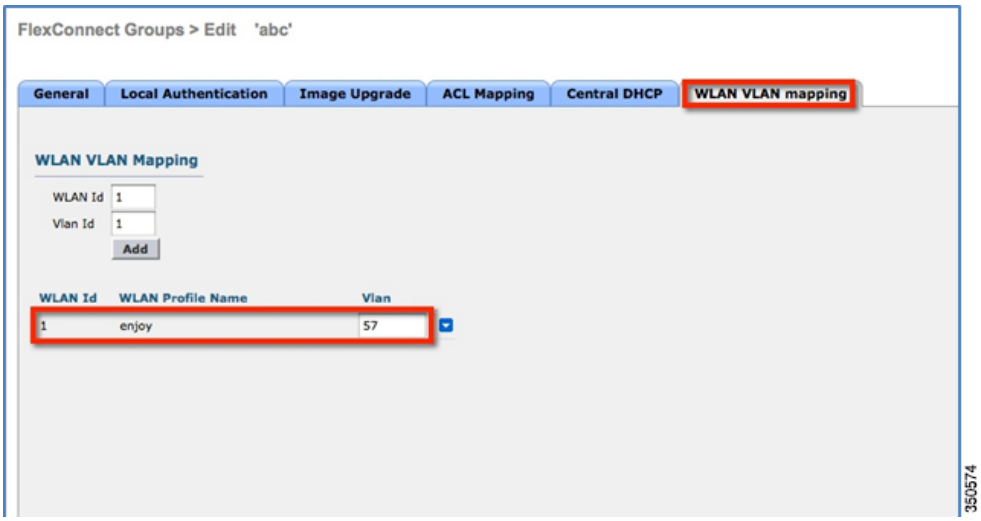
When a client connects to this WLAN, it will get an IP in VLAN 56.

Figure 36 Client in VLAN 56



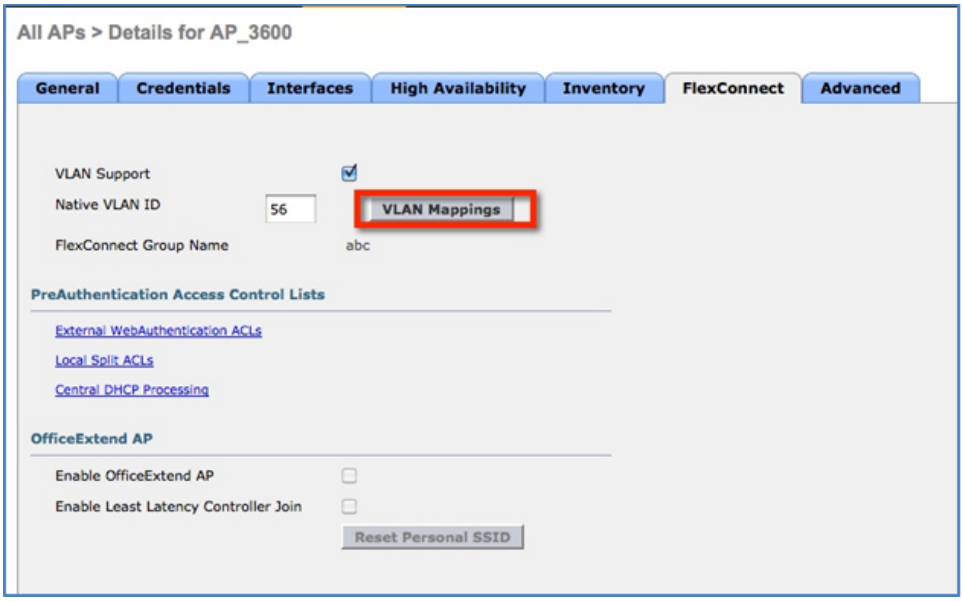
2. Create WLAN-VLAN mapping under FlexConnect Groups. This capability is the new feature in release 7.5.

Figure 37 WLAN Mapped to VLAN 57 under FlexConnect Group



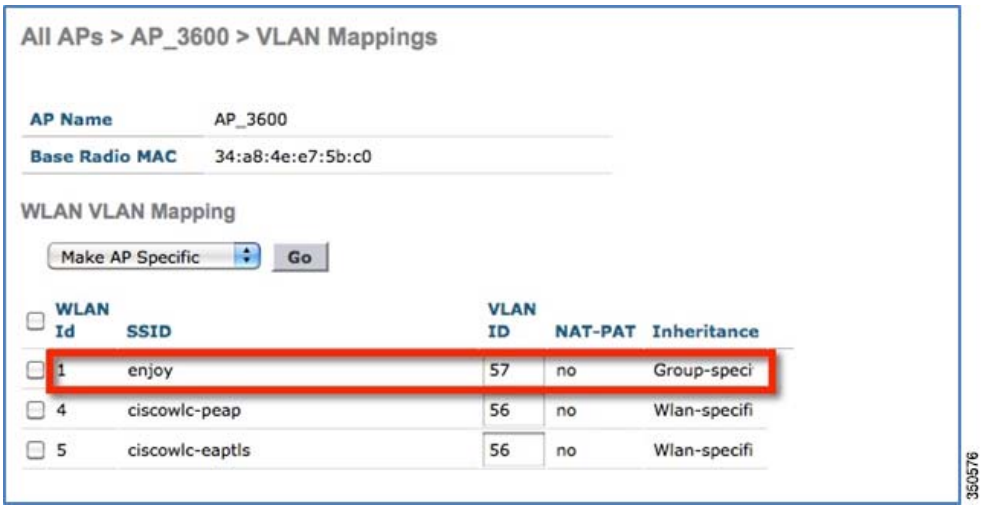
WLAN-VLAN mappings can be viewed per AP from the VLAN Mappings page

Figure 38 VLAN Mappings at AP



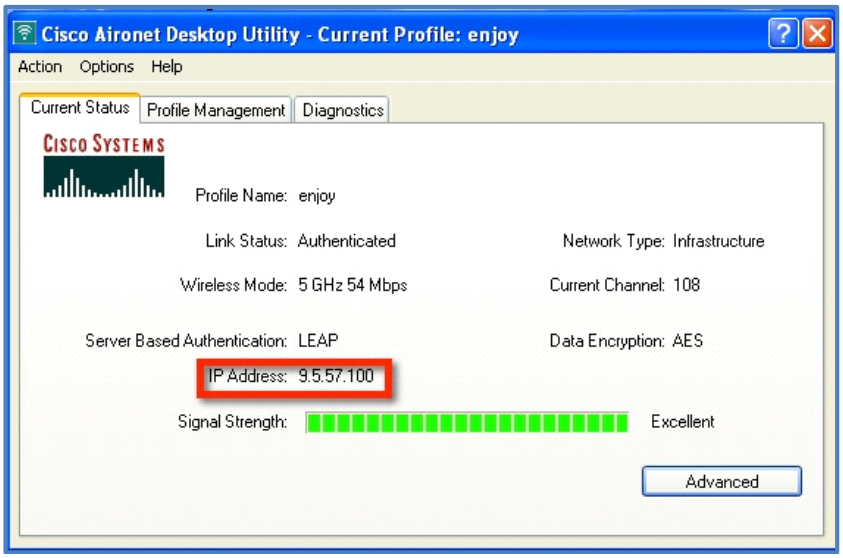
In this example, the WLAN is mapped to VLAN 57 on the FlexConnect Group, since the Group-specific mappings take precedence over WLAN-specific mappings.

Figure 39 WLAN 1 Mapped to VLAN 57 as Per Group-Specific Configuration Inheritance



The client is assigned an IP address in VLAN 57.

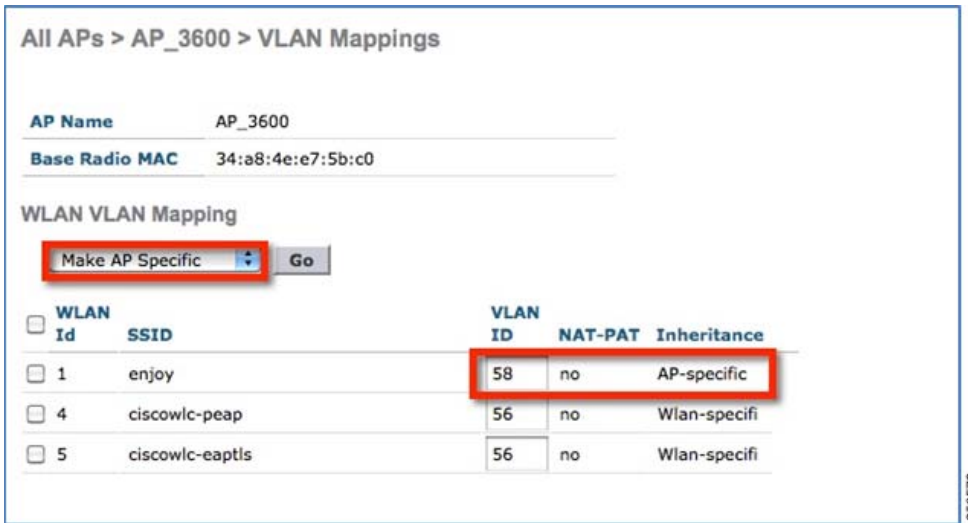
Figure 40 Client in VLAN 57



3. To create a WLAN-VLAN mapping at the AP, select **Make AP Specific** under **VLAN Mappings**.

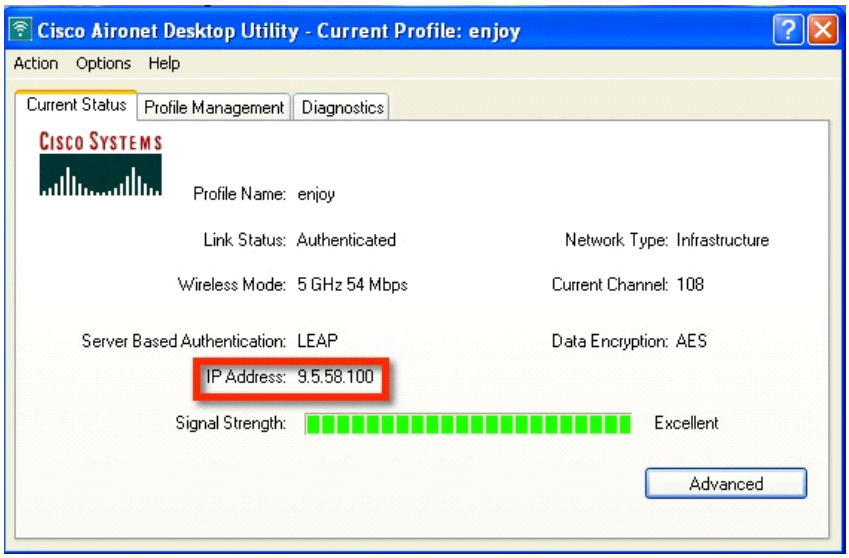
Once this is done, the WLAN is mapped to VLAN 58 since AP-specific mappings take precedence over Group-specific and WLAN-specific mappings.

Figure 41 WLAN Mapped to VLAN 58 as Per AP-Specific Mapping Inheritance



The client is assigned an IP address in VLAN 58.

Figure 42 Client in VLAN 58

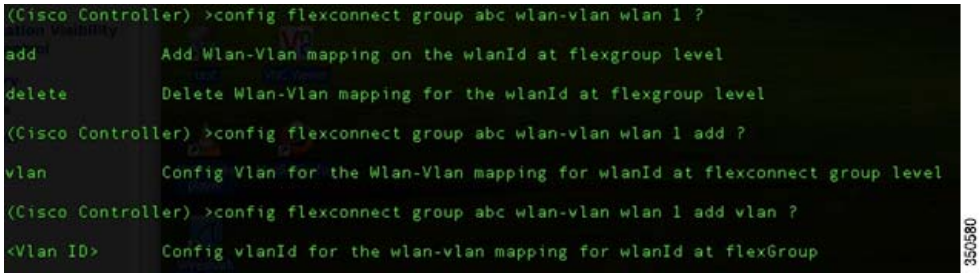


CLI Configuration

The following CLIs have been added as part of this feature:

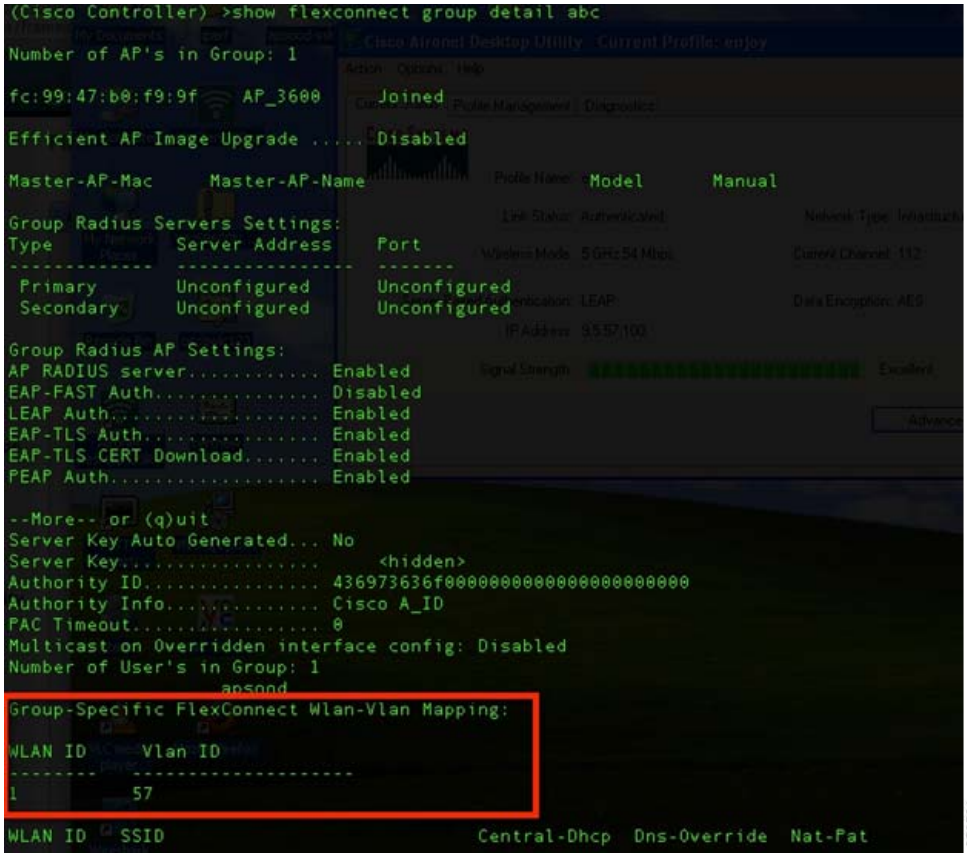
- `config flexconnect group <group> wlan-vlan wlan <wlan-id> add vlan <vlan-id>`
- `config flexconnect group <group> wlan-vlan wlan <wlan-id> delete`
- `config ap flexconnect vlan remove wlan <wlan_id> <ap_name>`

Figure 43 WLAN-VLAN Configuration at FlexConnect Group from CLI



The command **show flexconnect group detail** can be used to see the WLAN-VLAN mapping for the FlexConnect group

Figure 44 `show flexconnect group detail` Output



The command **show ap config general <AP name>** can be used to view the WLAN-VLAN mappings per AP.

Figure 45 show ap config general Output

The following commands can be used to troubleshoot this feature:

On WLC:

- `debug flexconnect wlan-vlan <enable | disable>`

On AP:

- `debug capwap flexconnect wlan-vlan`

Guidelines

- The WLAN should be locally switched.
- The configuration will be pushed to the AP only if the WLAN is broadcasted on that AP.

Client ACL Support

Prior to release 7.5, we support FlexConnect ACLs on the VLAN. We also support AAA override of VLANs. If a client gets an AAA override of VLAN, it is placed on the overridden VLAN and the ACL on the VLAN applies for the client. If an ACL is received from the AAA for locally switched clients, we ignore the same. With release 7.5, we address this limitation and provide support for client based ACLs for locally switched WLANs.

Client ACL Overview

a. This feature allows application of Per-Client ACL for locally switching WLANs.

b. Client ACL is returned from the AAA server on successful Client L2 Authentication/Web Auth as part of Airespace Radius Attributes.

c. The controller will be used to pre-create the ACLs at the AP. When the AP receives the ACL configuration, it will create the corresponding IOS ACL. Once, AAA server provides the ACL, the client structure will be updated with this information.

d. There will be configuration per FlexConnect group as well as per AP. A maximum of 16 ACLs can be created for a FlexConnect group and a maximum of 16 ACLs can be configured per-AP.

e. In order to support fast roaming (CCKM/PMK) for the AAA overridden clients, the controller will maintain these ACL in the cache and push them to all APs which are part of the FlexConnect group.

f. In the case of central authentication, when the controller receives the ACL from the AAA server, it will send the ACL name to the AP for the client. For locally authenticated clients, the ACL will be sent from the AP to the controller as part of CCKM/PMK cache, which will then be distributed to all APs belonging to the FlexConnect-group.

g. Maximum of 16 Client ACLs per FlexConnect group, maximum of 16 Client ACLs per-AP

h. Total of 96 ACLs can be configured on the AP (32 VLAN-ACL, 16 WLAN-ACL, 16 Split tunnel, 16 FlexConnect Client ACL, 16 AP Client ACL), each ACL with 64 rules.

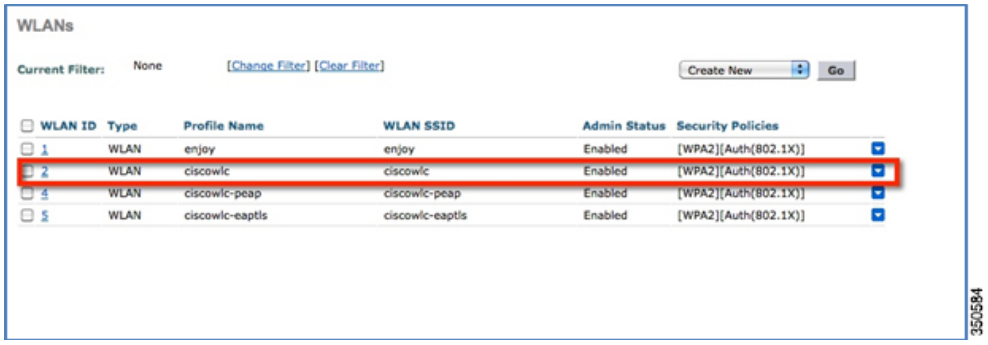
i. The ACL will be applied on the dot11 side for the client in question. This ACL will be applied in addition to the VLAN ACL, which is applied on the VLAN of the Ethernet interface of the AP.

j. Client ACL applied in addition to VLAN-ACL, both can exist simultaneously and are applied serially.

Steps to Configure Client ACL

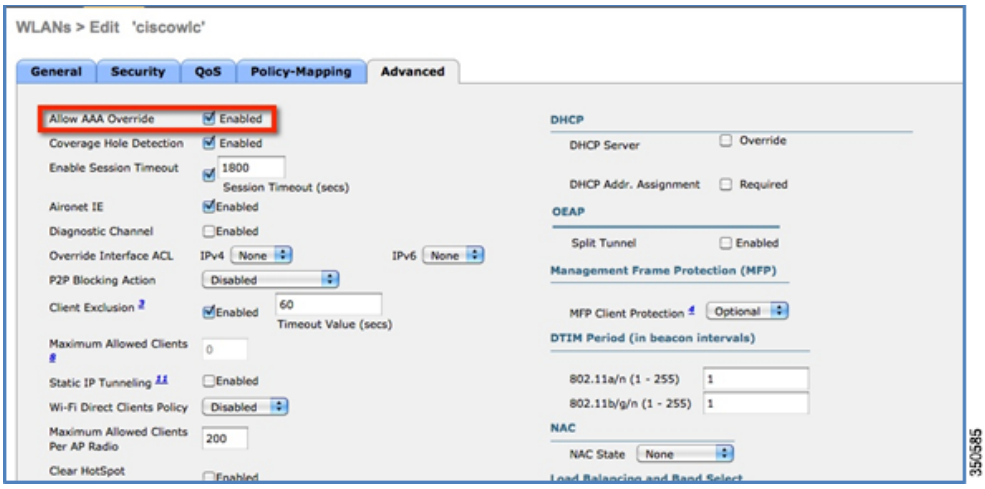
1. Create a Local Switching WLAN, which is either centrally switched or locally switched.

Figure 46 Create Local Switching WLAN



2. Turn on AAA override for the WLAN

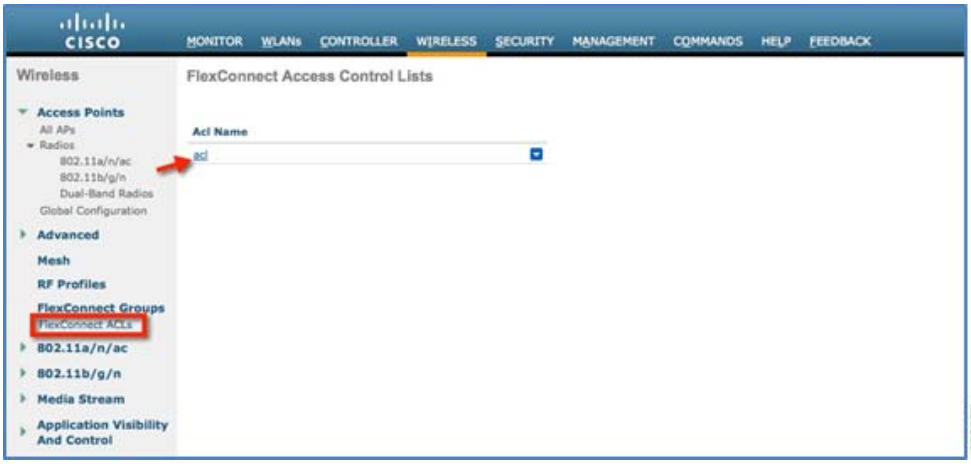
Enable AAA override



3. Create a FlexConnect ACL

FlexConnect ACL can be configured from the Security page as well as from the Wireless page.

Figure 47 Configure FlexConnect ACL



4. Assign the FlexConnect ACL to the FlexConnect group or to the AP

Figure 48 ACL Mapping on FlexConnect Group

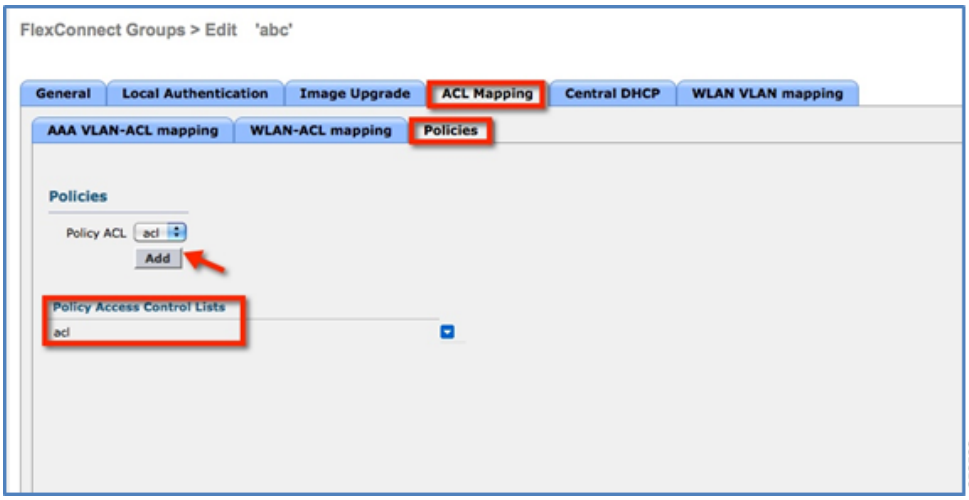
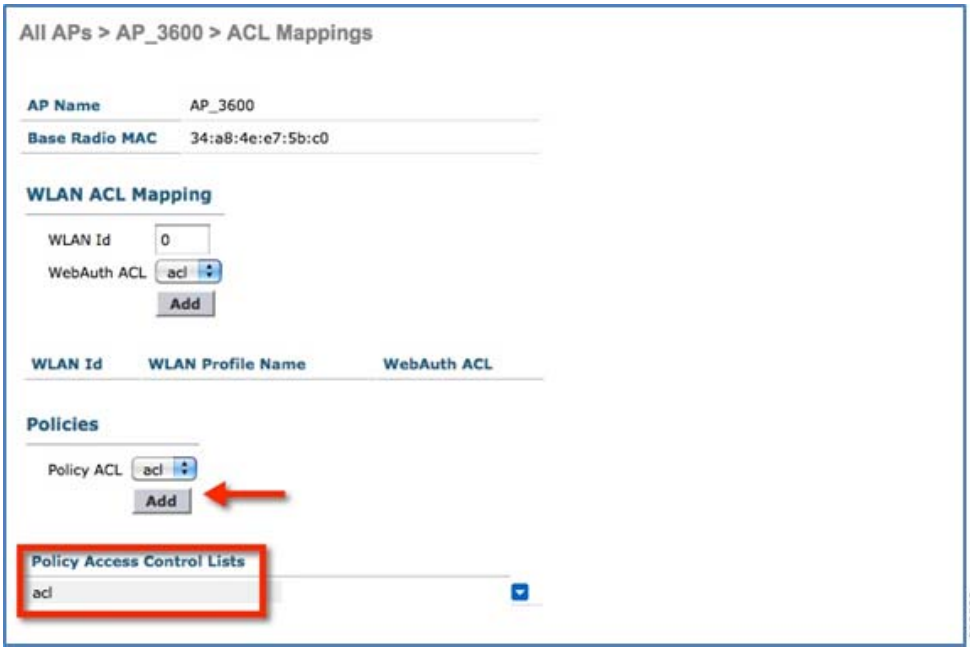


Figure 49 ACL Mapping on AP



5. Configure the Airespace attribute on the Radius/Cisco ACS server/ISE.

Figure 50 Aire-Acl-Name on Cisco ACS Server

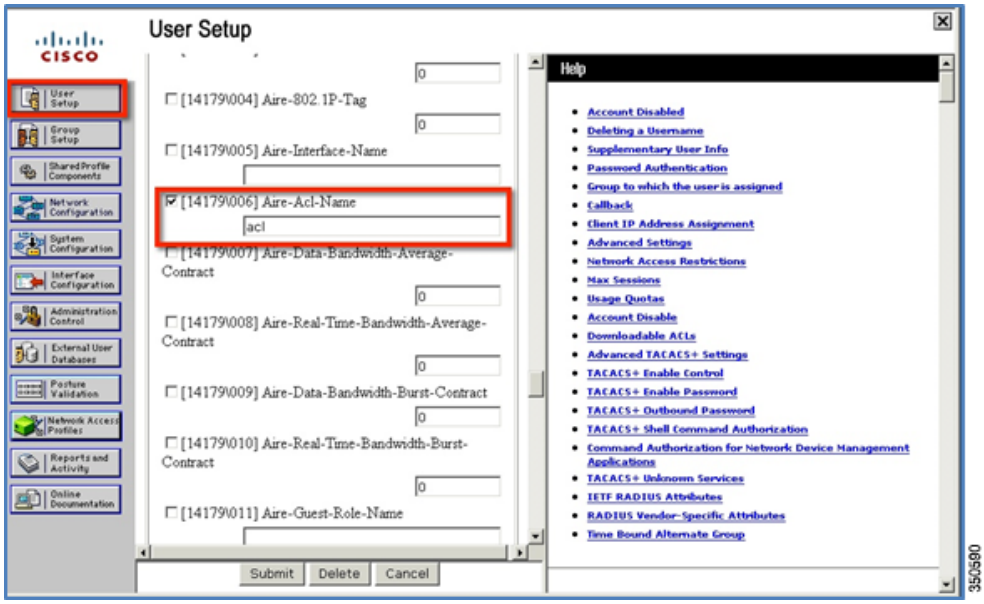
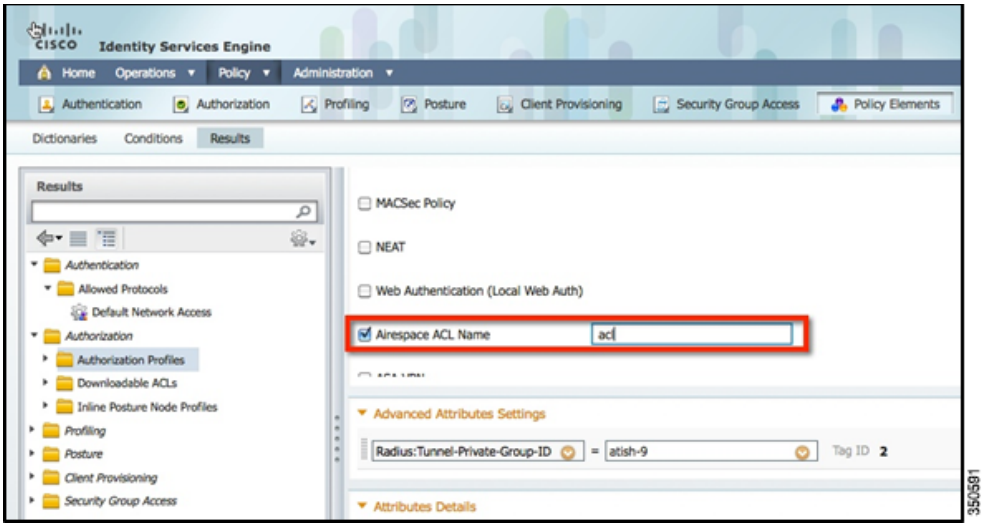
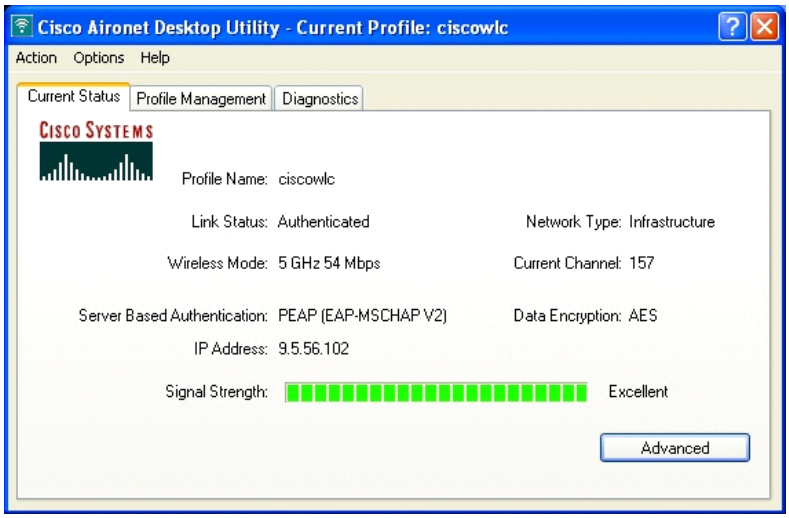


Figure 51 Airespace ACL Name on ISE



6. Authenticate the client.

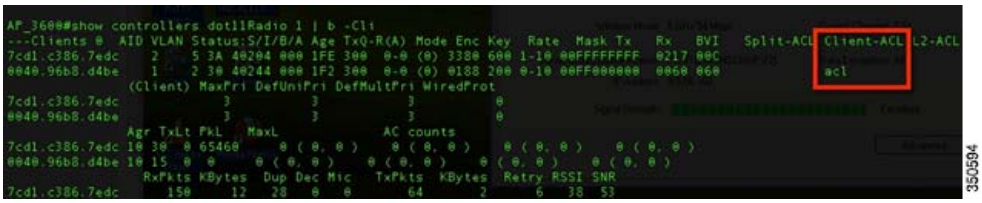


CLI Configuration

The Client ACL can be seen on the AP using the commands **show access-list** and **show controllers dot11Radio**

Figure 52 show access-lists Output

Figure 53 Client ACL on AP



http://www.cisco.com/en/US/products/ps11635/products_tech_note09186a0080b7f141.shtml

Guidelines

- Prior to AAA sending the client ACL, the ACL should be pre-created on the group or AP. The ACL will not be dynamically downloaded to the AP at the time of client join.
- A maximum of 96 ACLs can be configured on the AP.
- Each ACL will have a maximum of 64 rules.
- If client is already authenticated, and ACL name is changed on the radius, then client will have to do a full authentication again to get the correct client ACL.
- Since ACL not saved in cache at the controller, if the AP reboots/crashes, its cache will not be updated and the client will have to do full authentication for correct client ACL to be applied.
- If an ACL is returned from the AAA server but the corresponding ACL is not present on the AP, the client will be de-authenticated. A log message will be generated at the AP and WLC console.

On AP:

```
*Mar  4 09:20:43.255: %LWAPP-3-CLIENT_ACL_ENTRY_NOT_EXIST: Deleting Mobile for
0040.96b8.d4be: CLIENT ACL not exist on AP
```

On WLC:

```
*spamApTask7: Mar 04 14:51:03.989: #HREAP-3-CLIENT_ACL_ENTRY_NOT_EXIST:
spam_lrad.c:36670 The client 00:40:96:b8:d4:be could not join AP : 34:a8:4e:e7:5b:c0 for
slot 1, Reason: acl returned from RADIUS/local policy not present at AP
```

The various scenarios are listed in the table below:

ACL present on AP	ACL returned from AAA	Behavior
No	No	N/A
No	Yes	Client will be de-authenticated
Yes	No	Normal L2 authentication. No ACL will be applied.
Yes	Yes	L2 Authentication with client ACL being applied.

VideoStream for FlexConnect Local Switching

Introduction

Cisco Unified Wireless Network (CUWN) release 8.0 introduces a new feature—VideoStream for Local Switching, for branch office deployments. This feature enables the wireless architecture to deploy multicast video streaming across the branches, just like it is currently possible for enterprise deployments. This feature recompenses the drawbacks that degrade the video delivery as the video streams and clients scale in a branch network. VideoStream makes video multicast to wireless clients more reliable and facilitates better usage of wireless bandwidth in the branch.

Components Used

VideoStream feature for Local Switching is available in CUWN software version 8.0. This feature is supported on all wireless LAN controllers (WLANs) and newer generation indoor access points (APs). This feature is unavailable on autonomous access points.

Supported Wireless Hardware and Software

VideoStream is supported on all the following Cisco Wireless LAN controllers:

- Cisco 5500 Controller
- Cisco 7510 Controller
- Cisco 8510 Controller
- Cisco WiSM-2 Controller
- Cisco 2504 Controller
- vWLC

IGMPv2 is the supported version on all of the controllers.

VideoStream is supported on 802.11n models of APs consisting of Cisco Aironet 1140, 1250, 1260, 1520, 1530, 1550, 1600, 2600, 3500, 3600 series APs and 802.11ac models 3700 and 2700 series APs.

Theory of Operation

Before going into details about the VideoStream feature, you should understand some of the shortfalls in Wi-Fi multicast. 802.11n is a prominently discussed wireless technology for indoor wireless deployments. Equally prominent requirement is seen in multimedia service on an enterprise and branch network, in particular, video. Multicast does not provide any MAC layer recovery on multicast and broadcast frames. Multicast and broadcast packets do not have an Acknowledgement (ACK), and all packet delivery is best effort. Multicast over wireless with 802.11a/b/g/n does not provide any mechanism for reliable transmission.

Wireless deployments are prone to interference, high channel utilization, and low SNR at the edge of the cell. There are also many clients sharing the same channel but have different channel conditions, power limitations, and client processing capabilities. Therefore, multicast is not a reliable transmission protocol to all the clients in the same channel because each client has different channel conditions.

Wireless multicast does not prioritize the video traffic even though it is marked as Differentiated Service Code Point (DSCP) by the video server. The application will see a loss of packets with no ACK, and retries to the delivery will be bad. In order to provide reliable transmissions of multicast packet, it is

necessary that the network classify queues and provisions using Quality of Service (QoS). This virtually removes the issue of unreliability by eliminating dropped packets and delay of the packets to the host by marking the packets and sorting them to the appropriate queue.

Even though the 802.11n, and now 802.11ac, adaptation has gained momentum both with the network and clients, wireless multicast has not been able to use the 802.11n and 802.11ac data rates. This has also been one of the factors for an alternate mechanism for wireless multicast propagation.

VideoStream

VideoStream provides efficient bandwidth utilization by removing the need to broadcast multicast packets to all WLANs on the AP regardless if there is a client joined to a multicast group. In order to get around this limitation, the AP has to send multicast traffic to the host using Unicast forwarding, only on the WLAN that the client is joined and at the data rate the client is joined at.

VideoStream can be enabled globally on the controller. The feature can also be enabled at the WLAN level, and provides more control to the administrator to identify specific video streams for Multicast Direct functionality.

Stream Admission

As mentioned earlier, while video is an efficient, high-impact means of communication, it is also very bandwidth intensive, and as is seen, not all video content is prioritized the same. From earlier discussion it is clear that organizations investing in video cannot afford to have network bandwidth consumed without any prioritization of business-critical media.

Multicast to Unicast

By enabling 802.11n data rates and providing packet error correction, multicast-to-unicast capabilities of Cisco VideoStream enhances reliability of delivering streaming video over Wi-Fi beyond best-effort features of traditional wireless networks.

A wireless client application subscribes to an IP multicast stream by sending an IGMP join message. With reliable multicast, this request is snooped by the infrastructure, which collects data from the IGMP messages. The AP checks the stream subscription and configuration. A response is sent to the wireless client attached to the AP in order to initiate reliable multicast once the stream arrives. When the multicast packet arrives, the AP replicates the multicast frame and converts it to 802.11 unicast frames. Finally, a reliable multicast service delivers the video stream as unicast directly to the client.

Higher Video Scaling on Clients

With Cisco VideoStream technology, all of the replication is done at the edge (on the AP), thus utilizing the overall network efficiently. At any point in time, there is only the configured media stream traversing the network, because the video stream is converted to unicast at the APs based on the IGMP requests initiated by the clients. Some other vendor implementations do a similar conversion of multicast to unicast, but do it inefficiently as evidenced by the load put on the wired network to support the stream.

Switch Configuration

VideoStream can be deployed on an existing branch wide wired and wireless network. The overall implementation and maintenance costs of a video over wireless network are greatly reduced. The assumption is that the wired network is multicast enabled. In order to verify that the access switch is part

of the layer 3 network, connect a client machine to the switchport and verify if the client machine is able to join a multicast feed.

Show run | include multicast displays if multicast is enabled on the layer 3 switch else if not enabled for multicast, you can enable multicast by executing the following command on the switch:

```
L3_Switch#show run | include multicast
ip multicast-routing distributed
```

Depending on the type of Protocol Independent Routing (PIM) configuration on the wired network, the layer 3 switch is configured either in PIM Sparse mode or in PIM dense mode. There is also a hybrid mode, PIM sparse-dense mode which is widely used.

```
interface Vlan56
 ip address 9.5.56.1 255.255.255.0
 ip helper-address 9.1.0.100
 ip pim sparse-dense-mode
end
```

show ip igmp interfaces display the SVI interfaces that are participating in the IGMP membership. This command displays the version of IGMP configured on the switch or the router. The IGMP activity on the interface can also be verified in the form of IGMP join and leave messages by the clients.

```
L3_Switch#show ip igmp interface
Vlan56 is up, line protocol is up
  Internet address is 9.5.56.1/24
  IGMP is enabled on interface
  Current IGMP host version is 2
  Current IGMP router version is 2
  IGMP query interval is 60 seconds
  IGMP configured query interval is 60 seconds
  IGMP querier timeout is 120 seconds
  IGMP configured querier timeout is 120 seconds
  IGMP max query response time is 10 seconds
  Last member query count is 2
  Last member query response interval is 1000 ms
  Inbound IGMP access group is not set
  IGMP activity: 6 joins, 3 leaves
  Multicast routing is enabled on interface
  Multicast TTL threshold is 0
  Multicast designated router (DR) is 9.5.56.1 (this system)
  IGMP querying router is 9.5.56.1 (this system)
  Multicast groups joined by this system (number of users):
      224.0.1.40(1)
```

The above configuration can be verified by running the **show ip mroute** command on the layer 3 switch. The above configuration has certain entries that need to be looked into. The special notation of (Source, Group), pronounced “S, G” where the source “S” is the source IP address of the multicast server and “G” is the Multicast Group Address that a client has requested to join. If the network has many sources, you will see on the routers an (S,G) for each of the source IP address and Multicast Group addresses. This output displayed below also has information of outgoing and incoming interfaces.

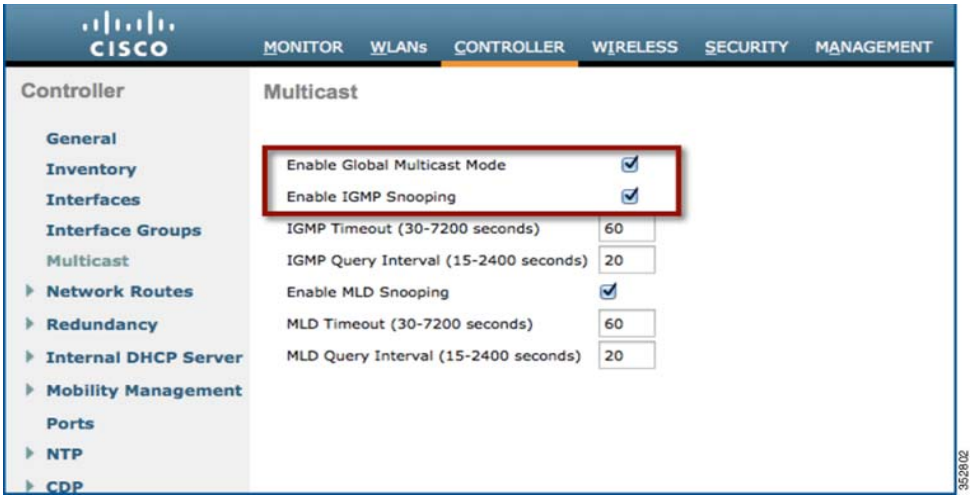
```
L3_Switch#show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       V - RD & Vector, v - Vector
Outgoing interface flags: H - Hardware switched, A - Assert winner
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode
(*, 239.255.255.250), 4d20h/00:02:35, RP 0.0.0.0, flags: DC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan56, Forward/Sparse-Dense, 4d20h/stopped
(*, 229.77.77.28), 4d15h/00:02:36, RP 0.0.0.0, flags: DC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan56, Forward/Sparse-Dense, 00:24:34/stopped
(*, 224.0.1.40), 5d17h/00:02:41, RP 0.0.0.0, flags: DCL
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan56, Forward/Sparse-Dense, 5d17h/stopped
```

Controller Configuration

Enabling VideoStream—Global

Enable Global Multicast Mode and IGMP snooping on the controller as shown below:

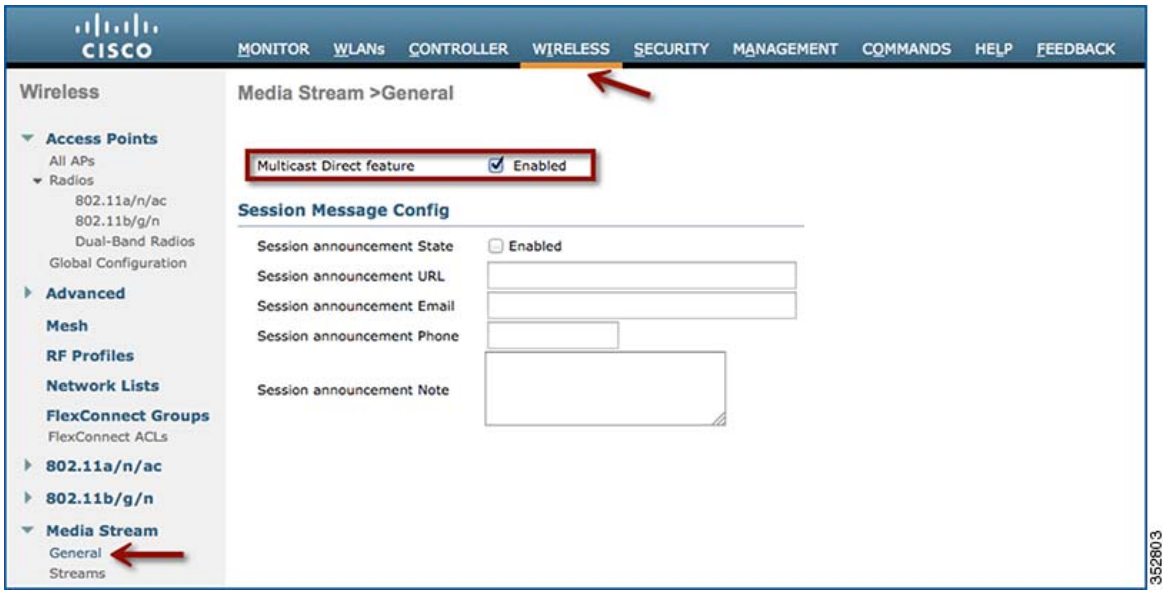
Figure 54 WLC Configuration




```
(Cisco Controller) >config network multicast global enable
(Cisco Controller) >config network multicast igmp snooping enable
```

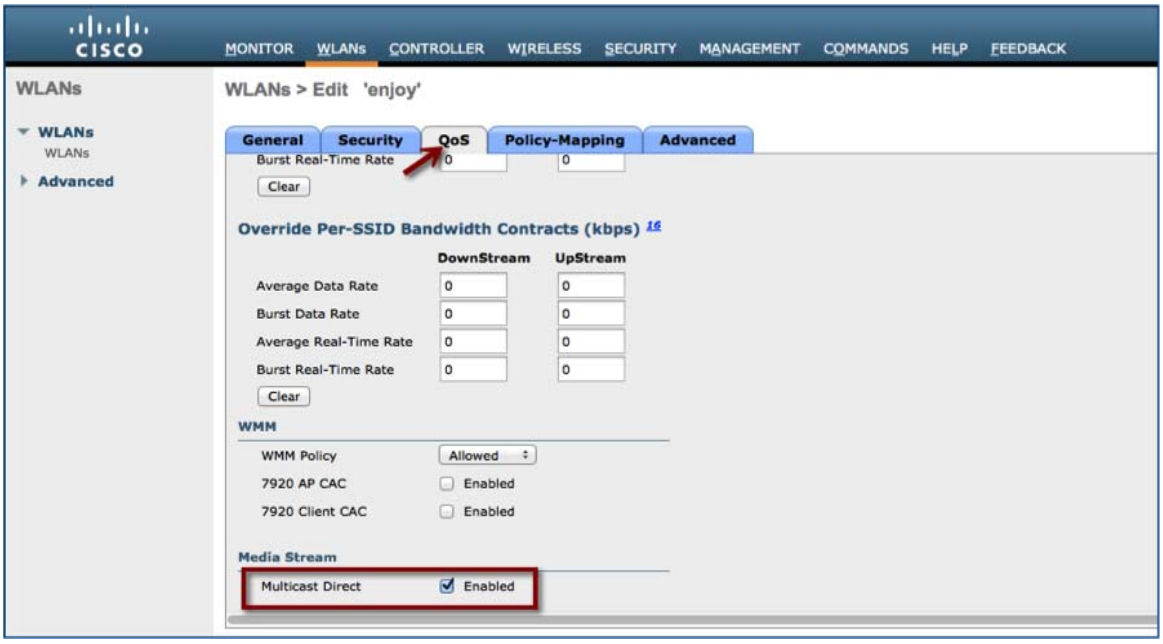
To enable the VideoStream feature globally on the controller, navigate to **Wireless > Media Stream > General** and check the **Multicast Direct Feature** check box. Enabling the feature here populates some of the configuration parameters on the controller for VideoStream.

Figure 55 Enable VideoStream - Global



```
(Cisco Controller) >config media-stream multicast-direct ?
enable          Enable Global Multicast to Unicast Conversion
disable         Disable Global Multicast to Unicast Conversion
```

The multicast direct button under **WLAN > QoS** appears on if the feature is enabled globally.



This provides the flexibility to enable VideoStream feature per SSID and is described later in this document.

Turn on Local Switching under **WLAN > Advanced** and ensure that the APs in the setup are in FlexConnect mode.

Figure 56 Enable Local Switching on WLAN

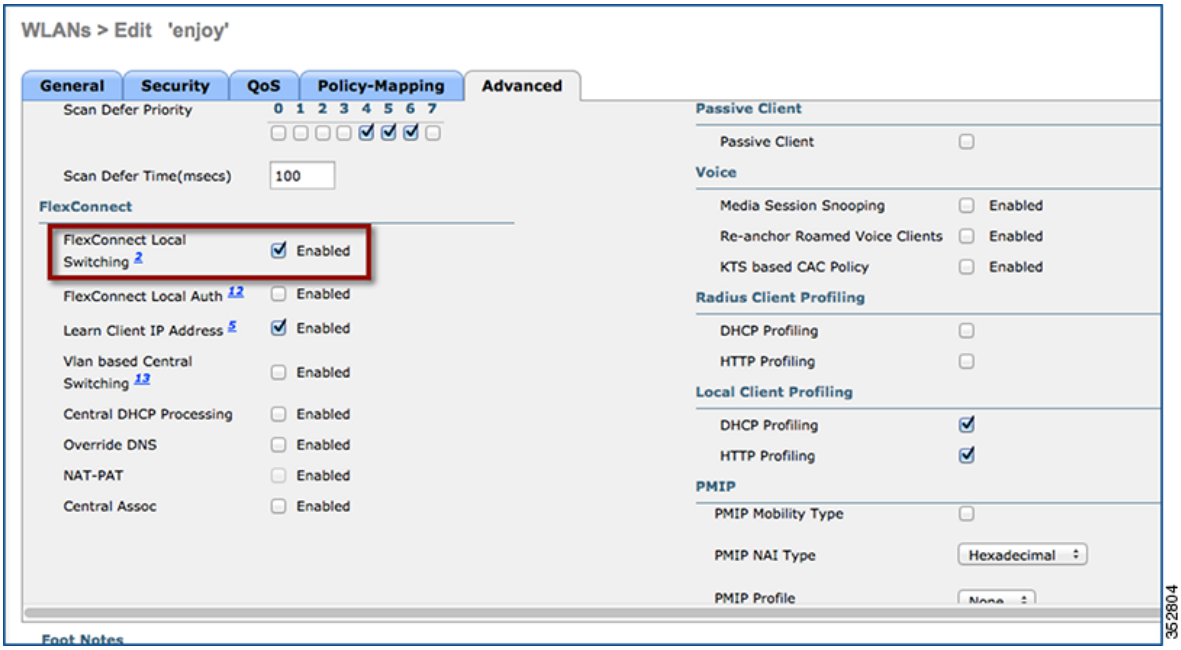
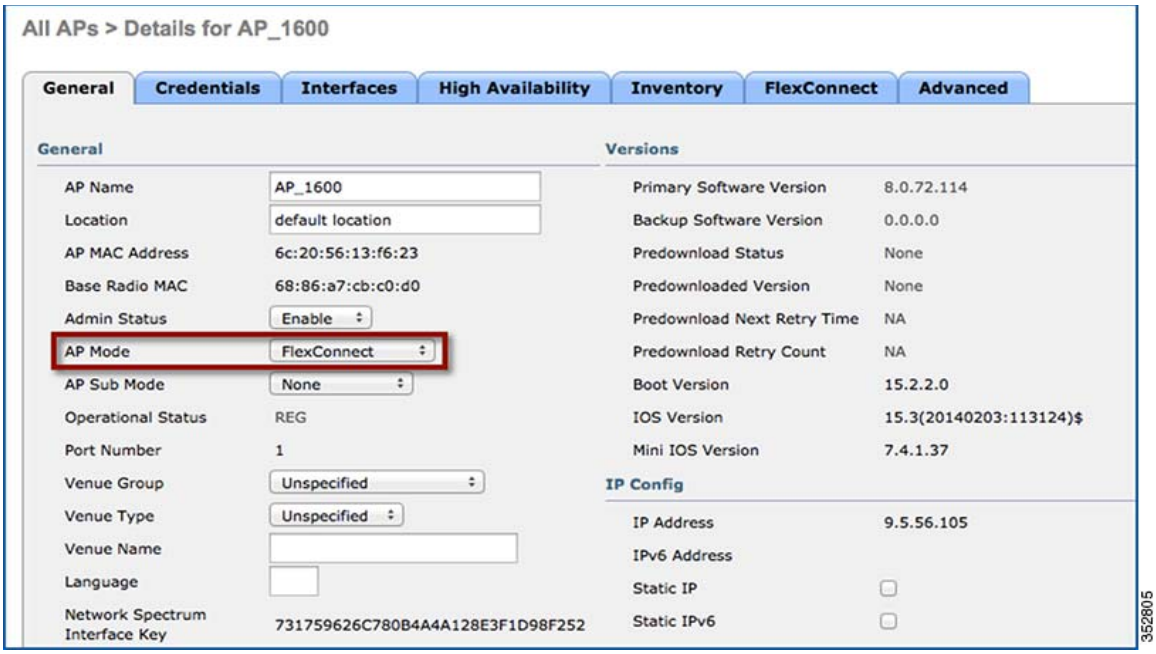


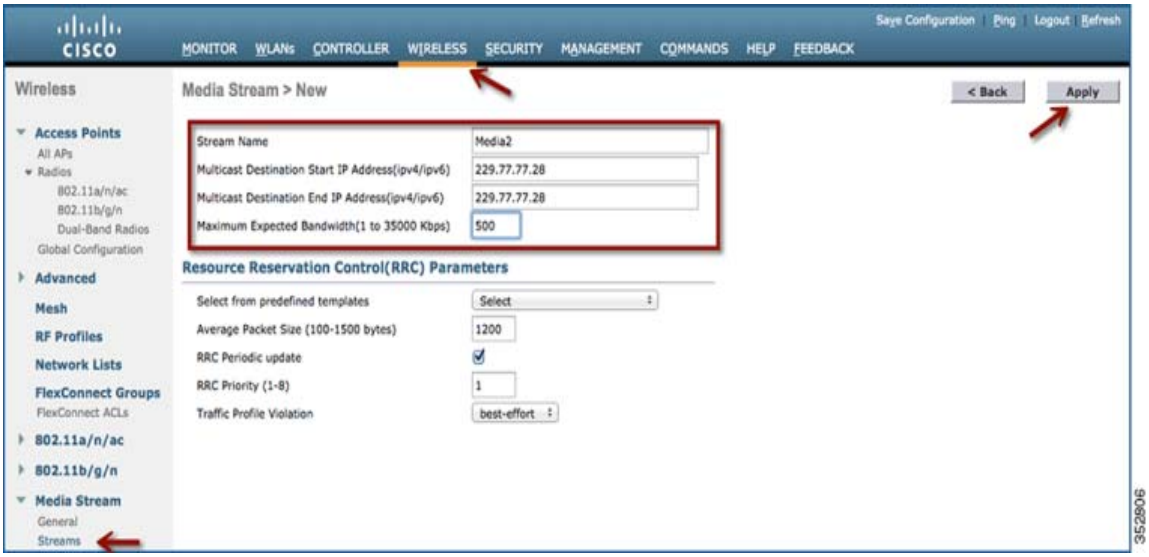
Figure 57 Change AP Mode to FlexConnect



Add Media Stream Configuration

To add a multicast stream to the controller, navigate to **Wireless > Media Stream > Streams** and click **Add New.**

Figure 58 Media Stream Configuration



For configuration using CLI use:

```
configure media-stream add multicast-direct   <media-stream-name> <start-IP> <end-IP>
[template | detail <bandwidth> <packet-size> <Re-evaluation> video <priority>
<drop|fallback>]
```

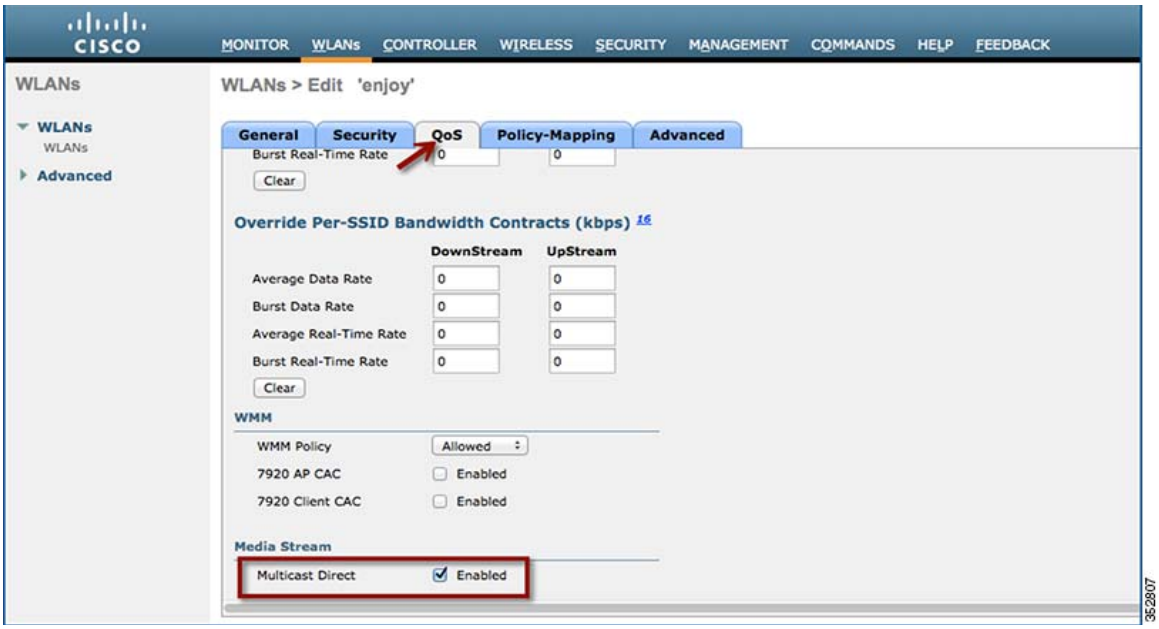
As mentioned it is necessary that the administrator is aware of the video characteristic streaming through a controller. A true balance must be drawn when the streams configuration are added. For example, if the stream bit rate varies between 1200 Kbps and 1500 Kbps the stream must be configured for a bandwidth of 1500 Kbps. If the stream is configured for 3000 Kbps then you will have lesser video client serviced by the AP. Similarly, configuring for 1000 Kbps will cause pixelization, bad audio, and bad user experience.

The multicast destination start IP address and end IP address can be the same address as shown in Figure 58. You can also configure a range of multicast address on the controller. There is a limitation of 100 on the number of multicast addresses entries or the number of stream entries that will be pushed to the APs.

Enabling VideoStream – WLAN

One or all WLANs/SSIDs configured can be enabled for streaming video with VideoStream. This is another configuration step that can control the enabling of the VideoStream feature. Enabling or disabling the VideoStream feature is non-disruptive. Click **WLAN > <WLAN ID> > QoS**.

Figure 59 Enable VideoStream – WLAN



Configure the Quality of Service (QoS) to Gold (video) to stream video to wireless client at a QoS value of gold (4). This will only enable video quality of service to wireless clients joined to a configured stream on the controller. The rest of the clients will be enabled for appropriate QoS. To enable Multicast Direct on the WLAN, check the **Multicast Direct** check box as shown in Figure 59. This will enable the WLAN to service wireless clients with the VideoStream feature.

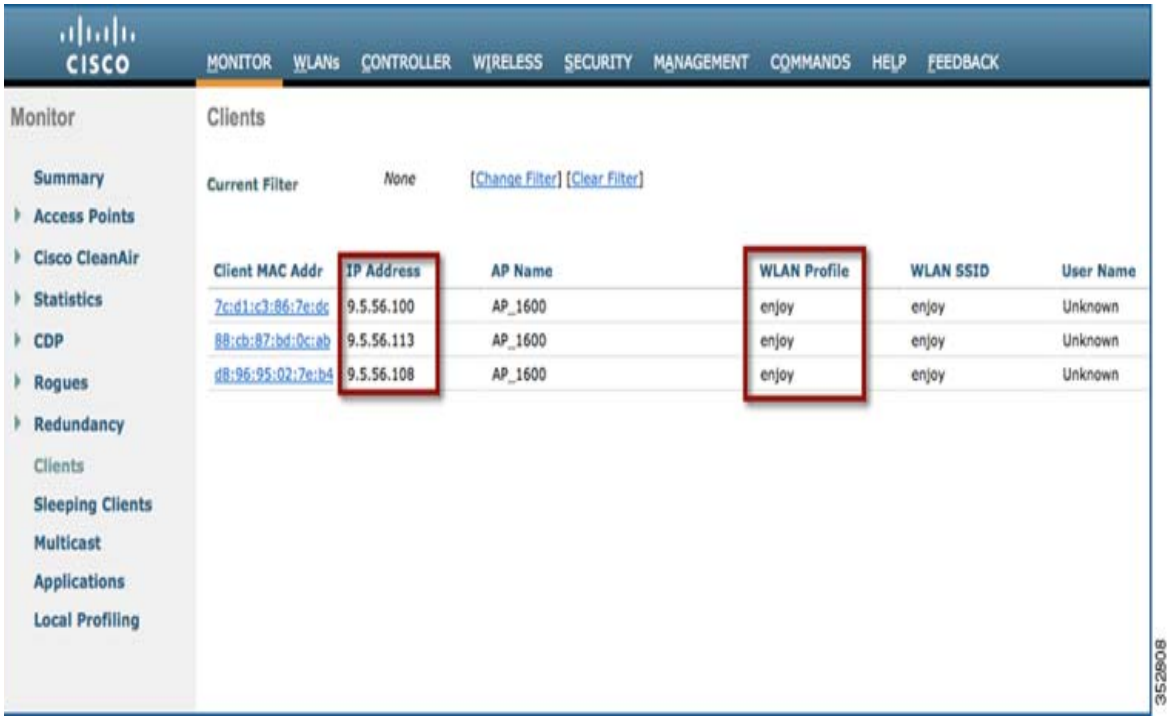
```
(Cisco Controller) >config wlan media-stream multicast-direct 1 ?
enable          Enables Multicast-direct on the WLAN
disable         Disables Multicast-direct on the WLAN.
```

All wireless clients requesting to join a stream will be assigned video QoS priority on admission. Wireless client streaming video prior to enabling the feature on the WLAN will be streaming using normal multicast. Enabling the feature switch the clients to multicast-direct automatically on the next IGMP snooping interval. Legacy multicast can be enabled on the WLAN by not checking the Multicast Direct feature. This will show that wireless clients streaming video are in Normal Multicast mode.

Verifying VideoStream Functionality

Make sure the wireless clients are associated to the access point(s), and are configured for a correct interface. As seen in the Figure 60, there are three clients associated to one AP. All three clients have an IP address from VLAN 56 (SSID name—enjoy).The associated clients have an IP address and good uplink connectivity to the AP.

Figure 60 Client Summary



Enable streaming on the wired side by connecting a video server with a configured multicast address 229.77.77.28. Refer the following link to know how to stream from a Video Sever: https://wiki.videolan.org/Documentation:Streaming_HowTo_New/#Streaming_using_the_GUI

Complete the steps:

Step 1 Join wireless clients to the multicast streaming video.

Note Use VLC player to stream and watch video.

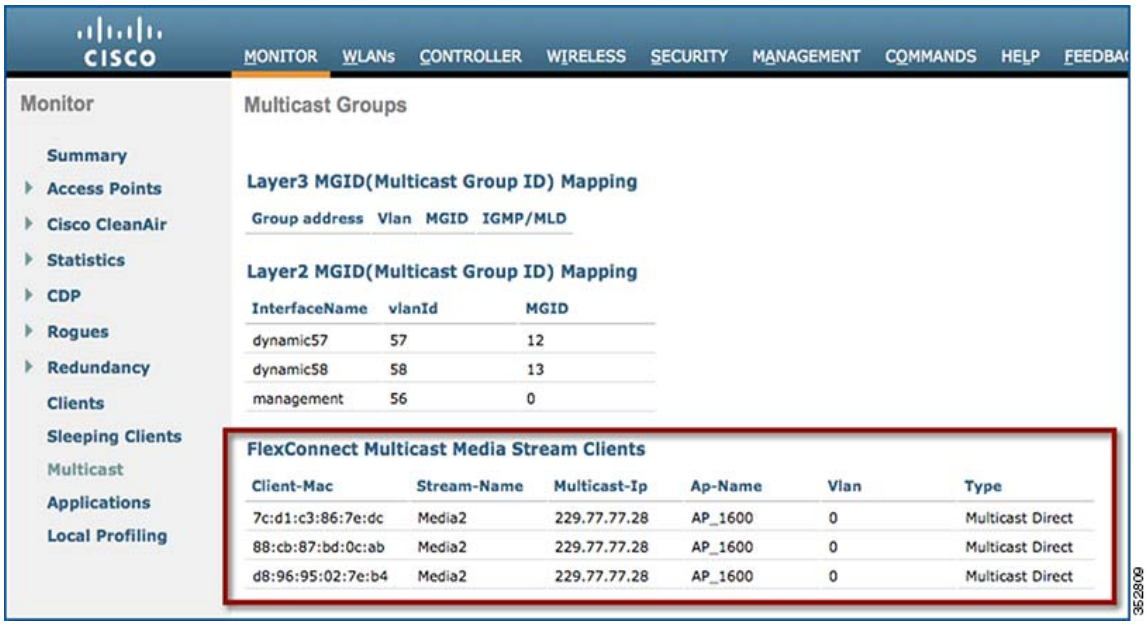
Step 2 Double click on the VLC icon on your desktop. Click **Media > Open Network stream**. Choose Protocol = UDP, Address = 229.77.77.28, Port = 1234 in the format **udp://@229.77.77.28:1234**

Step 3 Click **Play.**

```
L3_Switch#show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
       X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
       U - URD, I - Received Source Specific Host Report,
       Z - Multicast Tunnel, z - MDT-data group sender,
       Y - Joined MDT-data group, y - Sending to MDT-data group,
       V - RD & Vector, v - Vector
Outgoing interface flags: H - Hardware switched, A - Assert winner
 Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 239.255.255.250), 4d20h/00:02:47, RP 0.0.0.0, flags: DC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan56, Forward/Sparse-Dense, 4d19h/stopped

(*, 229.77.77.28), 4d15h/00:02:44, RP 0.0.0.0, flags: DC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan56, Forward/Sparse-Dense, 00:17:24/stopped

(*, 224.0.1.40), 5d17h/00:02:53, RP 0.0.0.0, flags: DCL
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan56, Forward/Sparse-Dense, 5d17h/stopped
```

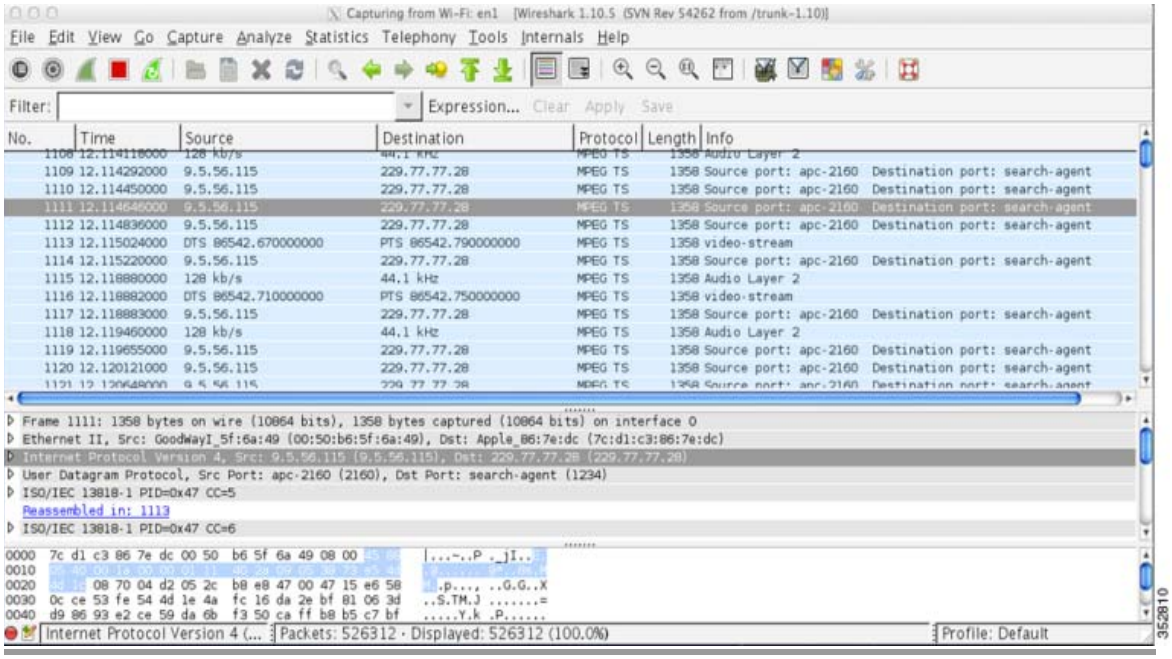
It is observed that the MAC address of the wireless clients is in a Multicast-Direct Allowed State.

Figure 61 FlexConnect VideoStream Clients



The Wireshark capture on the client shows the Multicast to Unicast Video Stream. The Ethernet header contains the MAC address of the client as the Destination MAC address, for example, 7c:d1:c3:86:7e:dc.

Figure 62 Wireshark Capture Depicting mc2uc



Limitations

The limitations to this feature scope include:

1. There is no admission control for local switched clients' multicast video requests, which means always admit the configured video stream subscriptions as mc2uc.
2. Due to the limit of CAPWAP payload length, only the first 100 media-streams will be pushed from the controller to the AP in this release. For example,
   `config media-stream add multicast-direct stream1 225.0.0.1 225.0.0.10 template coarse`, is considered as one entry.
3. Roaming support is limited to adding mobile payload. Whenever the client roams to another AP, the WLC will add the entry for the client in the mc2uc table. This means that roaming in standalone mode of FlexConnect AP will not be supported for this feature.
4. Currently this feature only has IPv4 support.

Show Commands – Controller

Some of the show commands are documented earlier in this document. The following section is only for your reference:

```
(Cisco Controller) >show ap summary
Number of APs.................................... 5
Global AP User Name.............................. Not Configured
Global AP Dot1x User Name........................ Not Configured

AP Name           Slots  AP Model            Ethernet MAC      Location        Country
IP Address   Clients   DSE Location
------------------  -----  --------------------  ------------------  -----------------
----------  -----------  --------  --------------
AP1142            2    AIR-LAP1142N-A-K9    f0:f7:55:f1:75:20  default location IN
9.5.56.109          0       [0 ,0 ,0 ]
AP_2600           2    AIR-CAP2602E-N-K9    fc:99:47:d9:86:90  default location IN
9.5.56.110          0       [0 ,0 ,0 ]
AP3700            2    AIR-CAP3702E-N-K9    7c:ad:74:ff:6b:46  default location IN
9.5.56.116          0       [0 ,0 ,0 ]
AP_3600-2         2    AIR-CAP3602I-N-K9    a4:4c:11:f0:e9:dc  default location IN
9.5.56.111          0       [0 ,0 ,0 ]
AP_1600           2    AIR-CAP1602I-N-K9    6c:20:56:13:f6:23  default location IN
9.5.56.105          2       [0 ,0 ,0 ]

(Cisco Controller) >show client summary
Number of Clients................................ 2
Number of PMIPV6 Clients......................... 0

                                                                    GLAN/
                                                                    RLAN/
MAC Address       AP Name           Slot Status        WLAN  Auth Protocol         Port
Wired PMIPV6  Role
```

```
---------------- ---------------- ---- ------------ ----- ---- ---------------- ----
----- ------- ----------------
88:cb:87:bd:0c:ab AP_1600          1   Associated    1    Yes  802.11a         1    No
No      Local
d8:96:95:02:7e:b4 AP_1600          1   Associated    1    Yes  802.11a         1    No
No      Local

(Cisco Controller) >show media-stream multicast-direct state
Multicast-direct State..................... enable
Allowed WLANs.............................. 1

(Cisco Controller) >show media-stream group summary
Stream Name   Start IP                          End IP                          Operation
Status
------------ ------------------------------------
------------------------------------ ----------------
Media1       239.1.1.1                           239.2.2.2
Multicast-direct
Media2       229.77.77.28                        229.77.77.28
Multicast-direct

(Cisco Controller) >show media-stream group detail Media2
Media Stream Name.............................. Media2
Start IP Address............................... 229.77.77.28
End IP Address................................. 229.77.77.28
 RRC Parmmeters
 Avg Packet Size(Bytes)......................... 1200
 Expected Bandwidth(Kbps)....................... 500
 Policy......................................... Admit
 RRC re-evaluation.............................. periodic
 QoS............................................ Video
 Status......................................... Multicast-direct
 Usage Priority................................. 1
 Violation...................................... fallback

(Cisco Controller) >show flexconnect media-stream client summary
Client Mac        Stream Name         Multicast IP    AP-Name                 VLAN   Type
-----------------  --------------------  ---------------  -------------------------
-----  ----------------
7c:d1:c3:86:7e:dc  Media2              229.77.77.28     AP_1600                  0
Multicast Direct
88:cb:87:bd:0c:ab  Media2              229.77.77.28     AP_1600                  0
Multicast Direct
d8:96:95:02:7e:b4  Media2              229.77.77.28     AP_1600                  0
Multicast Direct

(Cisco Controller) >show flexconnect media-stream client Media2
Media Stream Name.............................. Media2
IP Multicast Destination Address (start)......... 229.77.77.28
```

```
IP Multicast Destination Address (end)..... 229.77.77.28

Client Mac         Multicast IP     AP-Name                    VLAN   Type
-----------------  ---------------  -------------------------  -----  ----------------
7c:d1:c3:86:7e:dc  229.77.77.28     AP_1600                    0      Multicast Direct
88:cb:87:bd:0c:ab  229.77.77.28     AP_1600                    0      Multicast Direct
d8:96:95:02:7e:b4  229.77.77.28     AP_1600                    0      Multicast Direct
```

Show and Debug Commands – AP

- **Debug ip igmp snooping group**
- **Debug capw mcast**
- **Show capwap mcast flexconnect clients**
- **Show capwap mcast flexconnect groups**

```
AP_1600#show capwap mcast flexconnect clients
======
Bridge Group: 1
=======
Multcast Group Address 229.77.77.28::
MCUC List:
Number of MCUC Client: 3
88cb.87bd.0cab(Bridge Group = 1 Vlan = 0)
7cd1.c386.7edc(Bridge Group = 1 Vlan = 0)
d896.9502.7eb4(Bridge Group = 1 Vlan = 0)
--------
MC Only List:
Number of MC Only Client: 0

--------

AP_1600#show capwap mcast flexconnect groups
WLAN mc2uc configuration:
WLAN ID 1 , Enabled State 1
WLAN ID 2 , Enabled State 0
WLAN ID 3 , Enabled State 0
WLAN ID 4 , Enabled State 0
WLAN ID 5 , Enabled State 0
WLAN ID 6 , Enabled State 0
WLAN ID 7 , Enabled State 0
WLAN ID 8 , Enabled State 0
WLAN ID 9 , Enabled State 0
WLAN ID 10, Enabled State 0
WLAN ID 11, Enabled State 0
WLAN ID 12, Enabled State 0
WLAN ID 13, Enabled State 0
```

```
WLAN ID 14, Enabled State 0
WLAN ID 15, Enabled State 0
WLAN ID 16, Enabled State 0
Video Group Configuration:
Group startIp 239.1.1.1 endIp 239.2.2.2
Group startIp 229.77.77.28 endIp 229.77.77.28
```

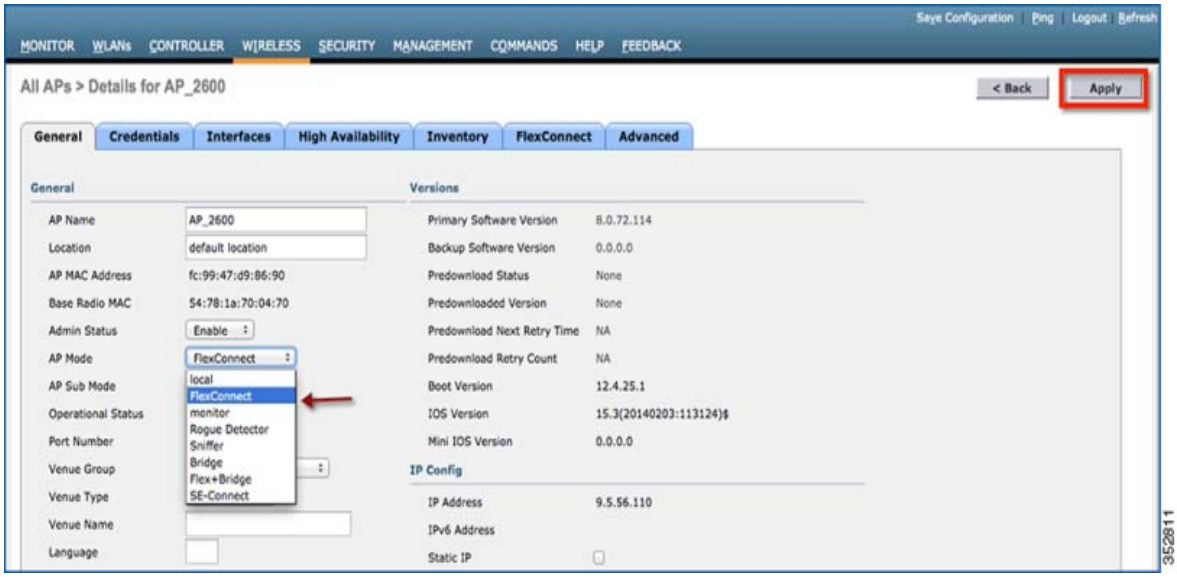
FlexConnect Faster Time to Deploy

The existing system requires an AP reboot when converted from Local mode to FlexConnect mode. Once the AP boots up, it joins back the controller and subsequently all the FlexConnect configuration is pushed down to the AP. This process increases the total time to deploy a FlexConnect solution in a branch. Time to deployment is a critical differentiator for any branch deployment.

This feature in release 8.0 eliminates the need to reboot when the AP is converted to FlexConnect mode. When the controller sends the AP a mode change message, the AP will get converted to FlexConnect mode without requiring a reload. The AP sub mode will also be configured if the AP receives the AP sub mode payload information from the controller. With this approach, the AP entry will be maintained at the controller and there will not be any AP disassociation.

Only Local mode to Flexconnect mode conversion is supported, any other mode change will cause an AP reboot. Similarly, changing of the AP sub mode to WIPS does not need reboot, but the rest of the sub mode configuration requires AP reboot.

Figure 63 Conversion to FlexConnect - No Reboot Required



FlexConnect Plus Bridge Mode

From release 8.0 onward, FlexConnect + Bridge mode allows the Flexconnect functionality across mesh APs. Flex + Bridge mode is used to enable Flexconnect capabilities on Mesh (Bridge mode) APs. Refer to the Information about FlexConnect plus Bridge Mode section in Cisco Wireless LAN Controller Configuration Guide, Release 8.0 for more details.

Default FlexConnect Group

Introduction

During the initial deployment, the customer configures all access points from a staging controller. Prior to 8.3, day 0 configuration for FlexConnect access points is missing. Therefore the user has to create FlexConnect groups, create policies for remote sites and manually place APs under each group. VLAN support and native VLAN setting is disabled by default on a newly created FlexConnect group, which implies that remote client traffic is placed in an AP VLAN and can access internal, secure resources. There is also a limitation on the number of APs supported within a group that prevents the creation of a generic catch all FlexConnect group for initial deployment.

To overcome these challenges and to make the Day 0 branch setup easier and faster, the concept of a Default FlexConnect group has been introduced in release 8.3.

When the controller boots up, the “default-flex-group” is created by default. This group cannot be deleted or added manually. Similarly access points cannot be manually added to or deleted from the default-flex-group.

The group has default configuration for the FlexConnect group parameters upon creation and has no maximum limit on the number of APs that can be part of it. Any change in configuration gets propagated to all the APs that are part of this group and the configuration of the group is retained across resets.

When an AP in FlexConnect mode, which is not part of any admin-configured FlexConnect group, joins the controller, it becomes part of the default-flex-group and gets the configuration from this group.

In controllers such as Cisco Flex 7500 Series Controller, when the autoconvert mode is set to “flexconnect”, during AP join, the AP gets converted to flexconnect mode and inherit config from default-flex-group thus supporting zero touch configuration.

Similarly when an admin configured FlexConnect group gets deleted or the AP is manually removed from such a group, the AP becomes part of the default-flex-group and inherits the config from this default group.

Features supported on Default FlexConnect Group

- VLAN support, Native VLAN, WLAN-VLAN mappings
- VLAN ACL mappings
- Webauth, Webpolicy, local split ACL
- Local authentication users
- RADIUS authentication
- Central DHCP/NAT-PAT

- Flex AVC
- VLAN name ID mappings
- Multicast override

Features Not Supported on Default FlexConnect Group

- Efficient image upgrade
- PMK cache distribution

Default FlexConnect Group with PnP

As a part of the zero-touch deployment, PnP server pushes configuration information to the AP. As of 8.2 the configuration contains WLC IPs, WLC names, AP mode and AP group name. This configuration has been extended to include the FlexConnect Group name starting release 8.3.

The feature is supported on the following APs that have PnP enabled:

AP 700,1600,1700,2600,2700,3600,3700, 1832,1852, 2802,3802,1810

When the AP joins the WLC it presents this FlexConnect group name to the WLC. The WLC then places the AP into an appropriate group after comparing pre-existing configurations and AP count on the FlexConnect Groups. There are various scenarios involved in deciding the FlexConnect group the AP will be placed in. The following specifically refer to scenarios where the AP will be placed as part of the default-flex-group.

Day 0 Setup Scenario

1. AP boots up and contacts the PnP server. PnP server does not have FlexConnect group configuration as part of the configured attributes. Also, the AP is not configured as part of any FlexConnect Group on the WLC. In this case, the AP is placed into the default-flex-group.
2. AP boots up and contacts the PnP server. PnP server returns a FlexConnect group configuration. The FlexConnect Group exists on the WLC but has reached the maximum capacity in terms of AP count. In this case, the AP is placed into the default-flex-group.

Day 1 Join Scenario

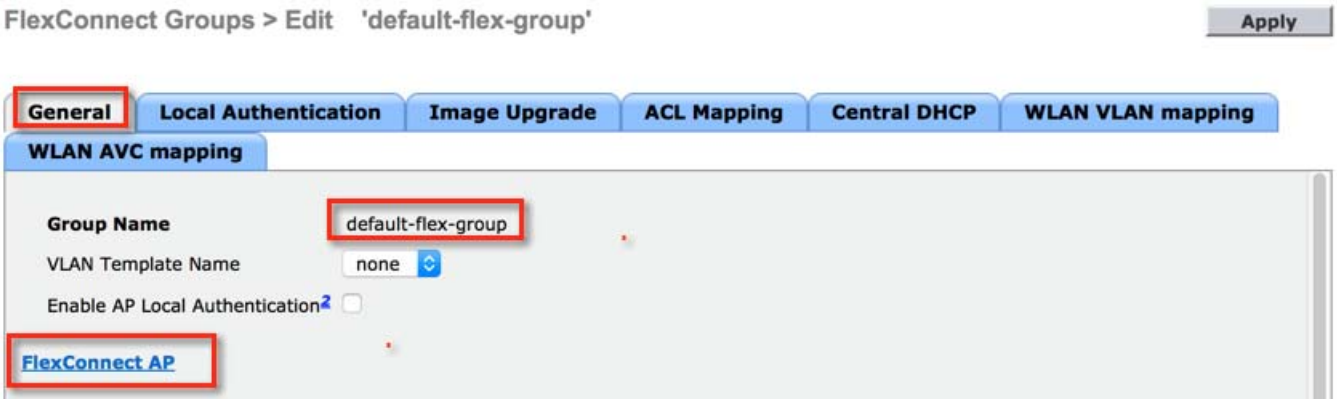
1. AP Joins WLC and does not have an AP to FlexConnect Group Mapping on the WLC
2. AP Joins WLC. AP has FlexConnect Group configuration present, but the FlexConnect group not configured on the WLC
3. AP has FlexConnect Group configuration present, but FlexConnect group has reached its limit in terms of number of APs

Default FlexConnect Group Web UI

Step 1 To view the default FlexConnect Group choose **WIRELESS > FlexConnect Groups > default-flex-group**

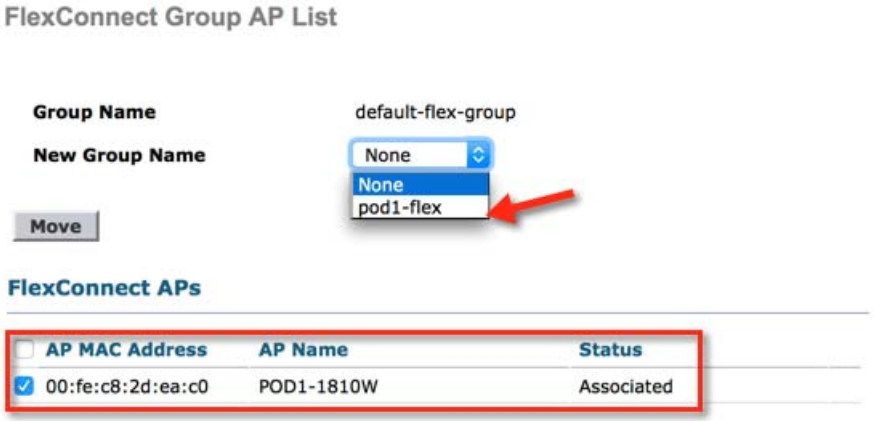
.

Step 2 To view APs that are a part of the default-flex-group click on the FlexConnect AP link in the General tab



Step 3 APs from default-flex-group can be moved to an admin configured FlexConnect group. Select the Group from "New Group Name" drop down menu and select the AP from the list and then click 'Move'

.



Upgrade or Downgrade behavior

Upon downgrading from release 8.3 to a lower version, the controller will retain the default-flex-group configuration. This group will be treated as any other admin-configurable FlexConnect group, i.e deletion and addition is possible, APs can be manually added or deleted from the group and the maximum limit on number of APs is applicable. Since the support for default-flex-group feature does not exist in earlier releases, FlexConnect APs will not join this group by default.

Upon upgrade to release 8.3 any FlexConnect AP that is not part of a FlexConnect group will join the default-flex-group and get the related default configuration. The rules of inheritance will continue to apply and therefore any AP specific FlexConnect Configuration will not be overwrited by the default FlexConnect group config.

CLI Commands

- The existing show command would display the configuration of the default-flex-group and the APs that are part of it.

```
show flexconnect group detail default-flex-group
```

- For all the APs that are part of this default group, the "show ap config general <apname>" command would reflect the default FlexConnect Group as shown below

```
FlexConnect Group.............................. default-flex-group
```

- A new cli command as below is introduced to display only the APs that are part of a specific group.

```
(Cisco Controller) >show flexconnect group detail default-flex-group aps

 Number of APs in Group: 1

 AP Ethernet MAC        Name         Status         Mode         Type    Conflict with PnP
 ----------- ----------- ------------ ----------------   --------   -----------------

7c:0e:ce:f5:b2:a4 AP7c0e.cef5.b2a4 Joined     Flexconnect   Manual      No
```

- A new cli command as below is introduced to allow copying of configuration from existing flexconnect group during creation of new groups. – VERIFY ?

```
config flexconnect group newGrpname add copy oldGrpName
```

- The default-flex-group cannot be created or deleted manually. Similarly APs cannot be added or deleted manually to the default-flex-group. So the following commands will throw an error upon execution:

```
(Cisco Controller) >config flexconnect group default-flex-group add
     Group default-flex-group has already been configured
 (Cisco Controller) >config flexconnect group default-flex-group delete
     Group default-flex-group cannot be deleted manually
(Cisco Controller) >config flexconnect group default-flex-group ap add 23:2f:d2:ff:12:7d
     AP cannot be manually added to the default-flex-group.
 (Cisco Controller) >config flexconnect group default-flex-group ap delete
23:2f:d2:ff:12:7d
     AP cannot be manually deleted from the default-flex-group.
```

Application Visibility and Control for FlexConnect rel 8.1-8.8

AVC provides application-aware control on a wireless network and enhances manageability and productivity. AVC is already supported on ASR and ISR G2 and WLC platforms. The support of AVC embedded within the FlexConnect AP extends as this is an end-to-end solution. This gives a complete visibility of applications in the network and allows the administrator to take some action on the application.

AVC has the following components:

- Next-generation Deep Packet Inspection (DPI) technology, called as Network Based Application Recognition (NBAR2), allows for identification and classification of applications. NBAR is a deep-packet inspection technology available on Cisco IOS based platforms, which supports stateful L4 – L7 classification. NBAR2 is based on NBAR and has extra requirements such as having a common flow table for all IOS features that use NBAR. NBAR2 recognizes application and passes this information to other features such as Quality of Service (QoS), and Access Control List (ACL), which can take action based on this classification.
- Ability to Apply Mark using QoS, Drop and Rate-limit applications.

The key use cases for NBAR AVC are capacity planning, network usage base lining, and better understanding of the applications that are consuming bandwidth. Trending of application usage helps the network administrator to plan for network infrastructure upgrade, improve quality of experience by protecting key applications from bandwidth-hungry applications when there is congestion on the network, capability to prioritize or de-prioritize, and drop certain application traffic.

AVC is supported on the 5520, 8540, 2500, 5508, 7500, 8500, and WiSM2 controllers on Local and FlexConnect modes (for WLANs configured for central switching only) since release 7.4. Release 8.1 introduces support for Application Visibility and Control for locally switched WLANs on FlexConnect APs on 5508, 7500, 75100, WiSM2, and vWLC.

- In release 8.3 the Protocol Pack and the NBAR engine got upgraded for Flex Connect Applications and now supports Protocol Pack 14 and NBAR engine 23 with a total support of the 1327 applications.
- In release 8.8 the Protocol Pack and the NBAR engine got upgraded for Flex Connect Applications and now supports Protocol Pack 37 and NBAR engine 31 with a total support of the 1408 applications.

Begin with release 8.6 AVC is supported on 3504, 5520 and 8540 series controllers and vWLC also supports AVC for FC mode only.

Note: For AVC Phase -6 release 8.8 The latest NBAR2 and Protocol Packs are supported on the 3504, 5520 and 8540 series controllers and vWLC supports AVC for Flex Connect APs only. The PP in rel 8.8 only supports Wave-2 COS based APs.

AVC Facts and Limitations

AVC on the FlexConnect AP can classify and take action on 1000+ different applications.

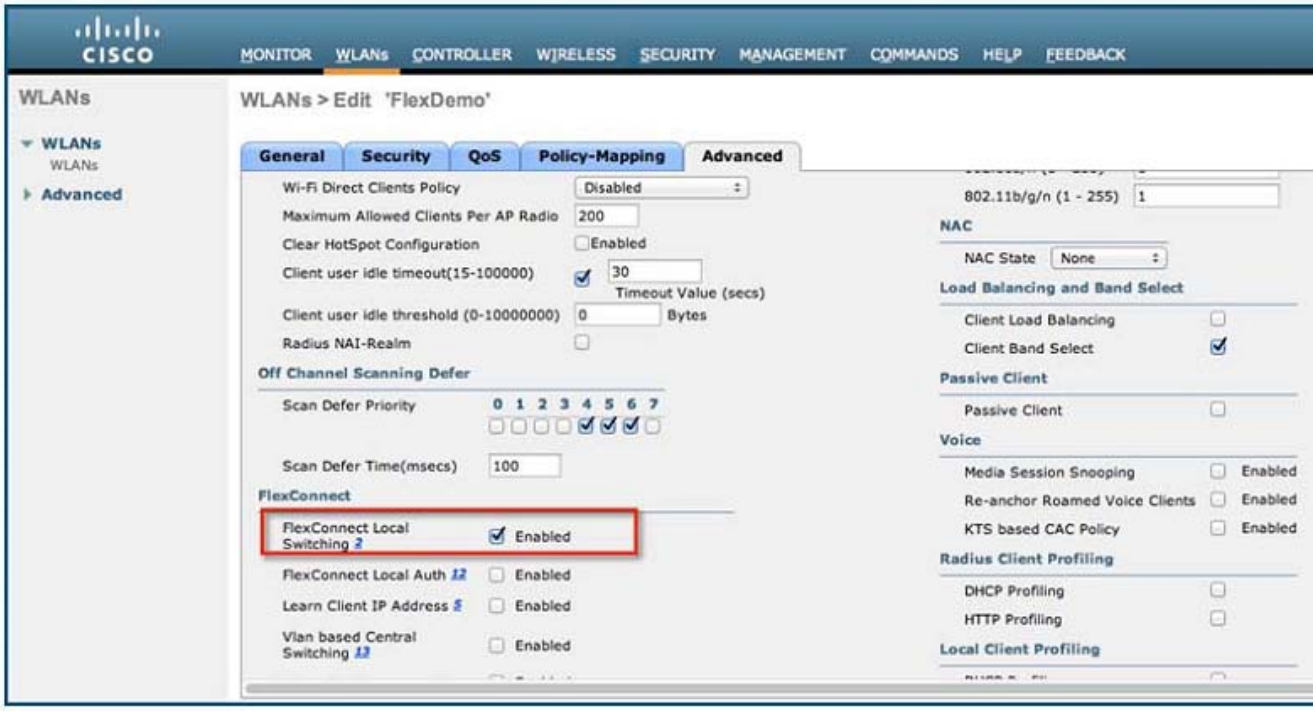
- The protocol pack running on the FlexConnect APs is different from the one running on the WLC.
- AVC stats on the GUI are displayed for the top 10 applications by default. This can be changed to top 20 or 30 applications as well.
- Intra FlexConnect Group roaming support.
- IPv6 traffic cannot be classified.
- AAA override of AVC profiles is not supported.

- Multicast traffic is not supported by AVC application.
- Netflow export for FlexConnect AVC is not supported

Configuring Application Visibility

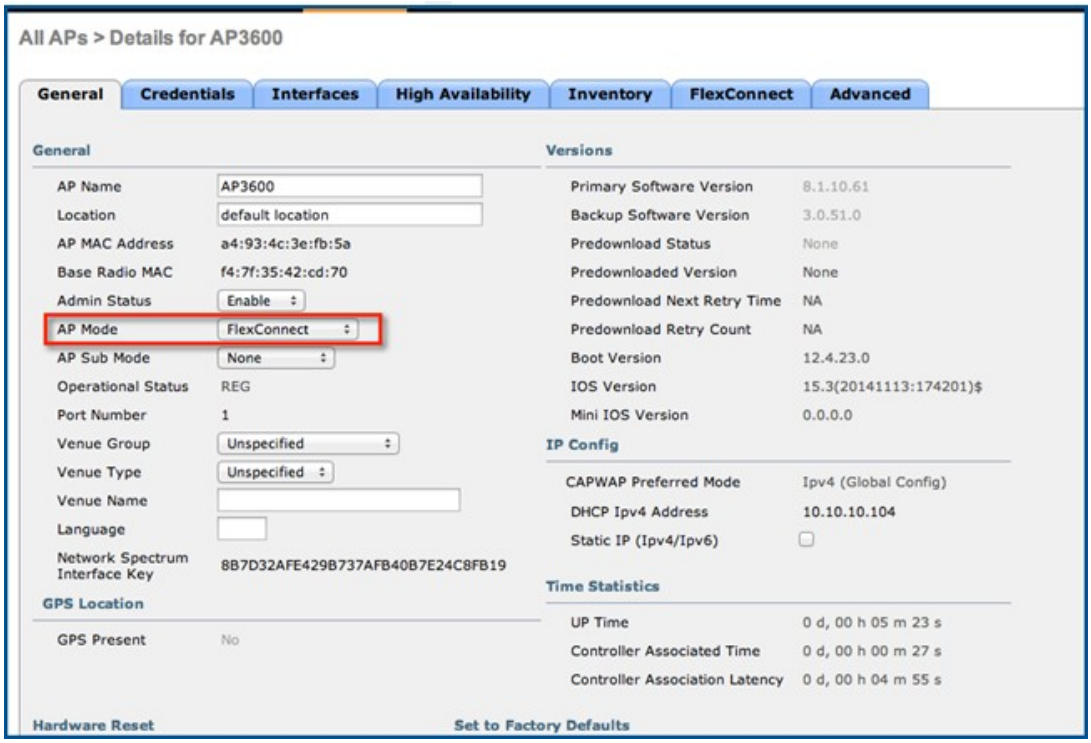
To configure the application visibility, perform these steps:

1. Open a web browser on the wired laptop, and then enter your WLC IP Address.
2. Create an OPEN WLAN with naming convention, for example, “FlexDemo”.
3. Enable FlexConnect Local Switching on the WLAN and then click Apply.



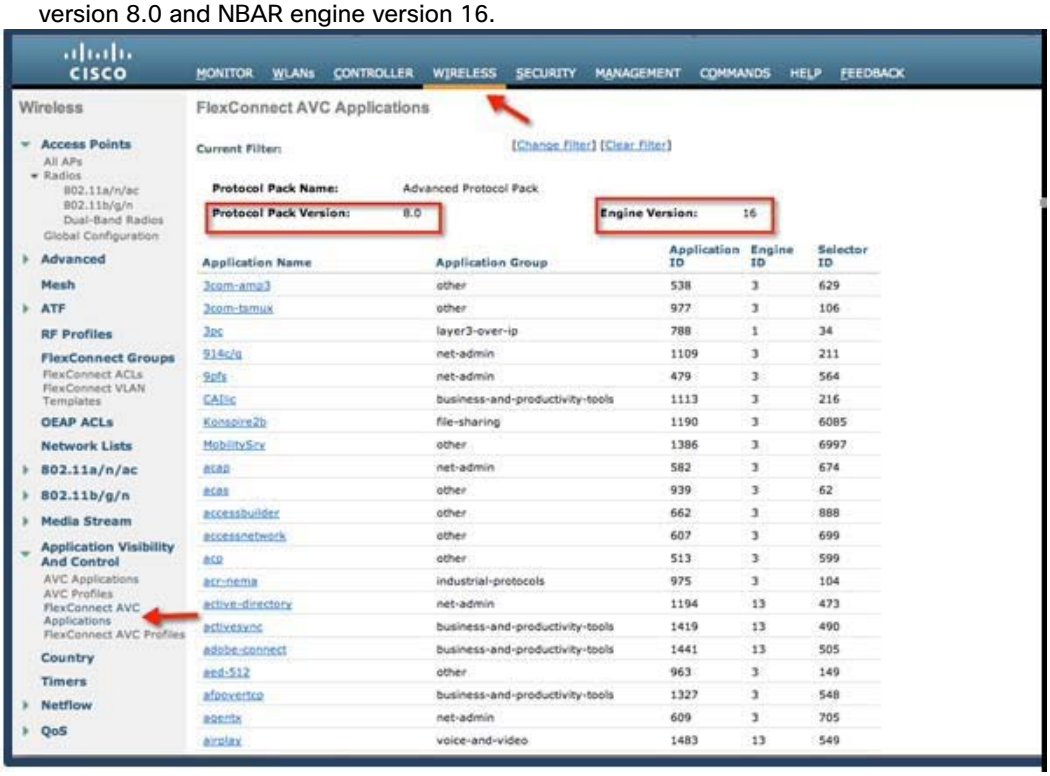
4. Make sure that the APs connected to this WLAN are among the list of supported access points for this feature.

5. Convert the AP to FlexConnect mode by selecting FlexConnect in the AP Mode drop-down menu, and then click **Apply.** The mode changes to FlexConnect without a reboot.



6. Create a FlexConnect Group and add the AP to the FlexConnect Group. In the following example, “FlexGroup” is the FlexConnect Group and the access point AP3600 is added to it.

7. Applications that can be identified, classified, and controlled are listed under **Wireless > Application Visibility and Control > FlexConnect AVC Applications**. The access points support Protocol Pack version 8.0 and NBAR engine version 16.

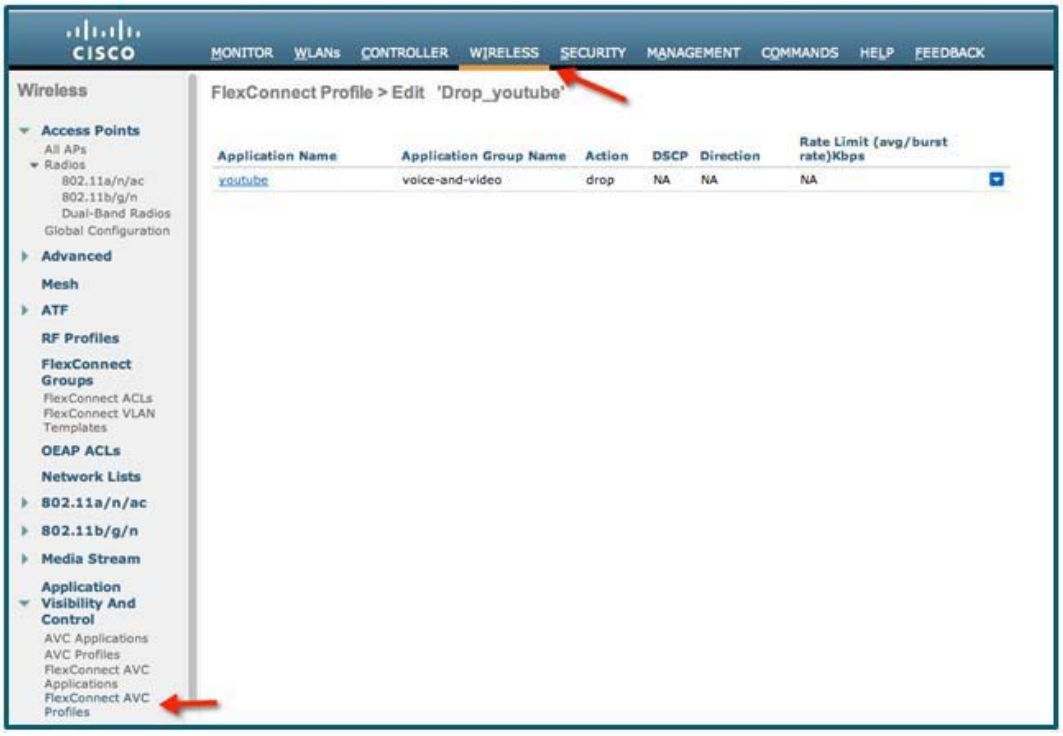


8. Create an AVC profile under **Wireless > Application Visibility and Control > FlexConnect AVC Profiles > New** with name “Drop_youtube”. And then Click **Apply**.

The AVC profile is created with the new name “Drop_youtube”.

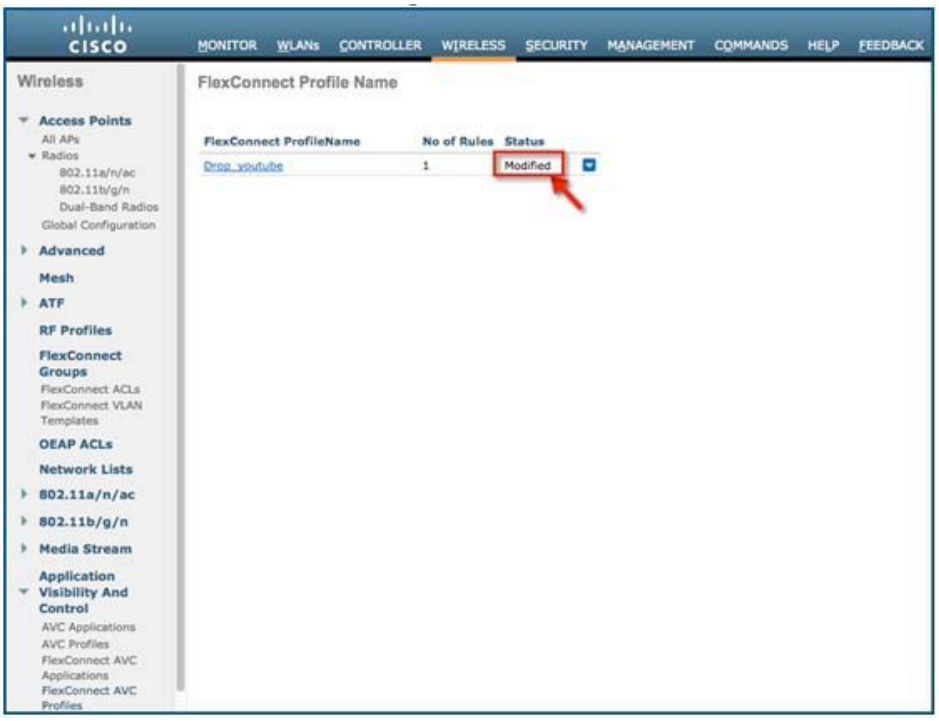
9. Click the Profile name and then click **Add New Rule.** Select the **Application Group, Application Name**, and **Action**, and then click **Apply**.

10. Verify that the rule is added as shown in the following figure.



The status of the FlexConnect AVC profile at this point is **Modified.**

11. Select the profile and click **Apply** for the profile to be applied and to take effect.



12. Select the profile and click **Apply** for the profile to be applied and to take effect.

The status of the FlexConnect AVC profile is changed to **Applied**.

13. Enable Application Visibility on the FlexConnect group under **Wireless > FlexConnect Group > FlexConnect Group name > WLAN AVC Mapping** by selecting the WLAN ID and choosing Enable from the drop-down menu.

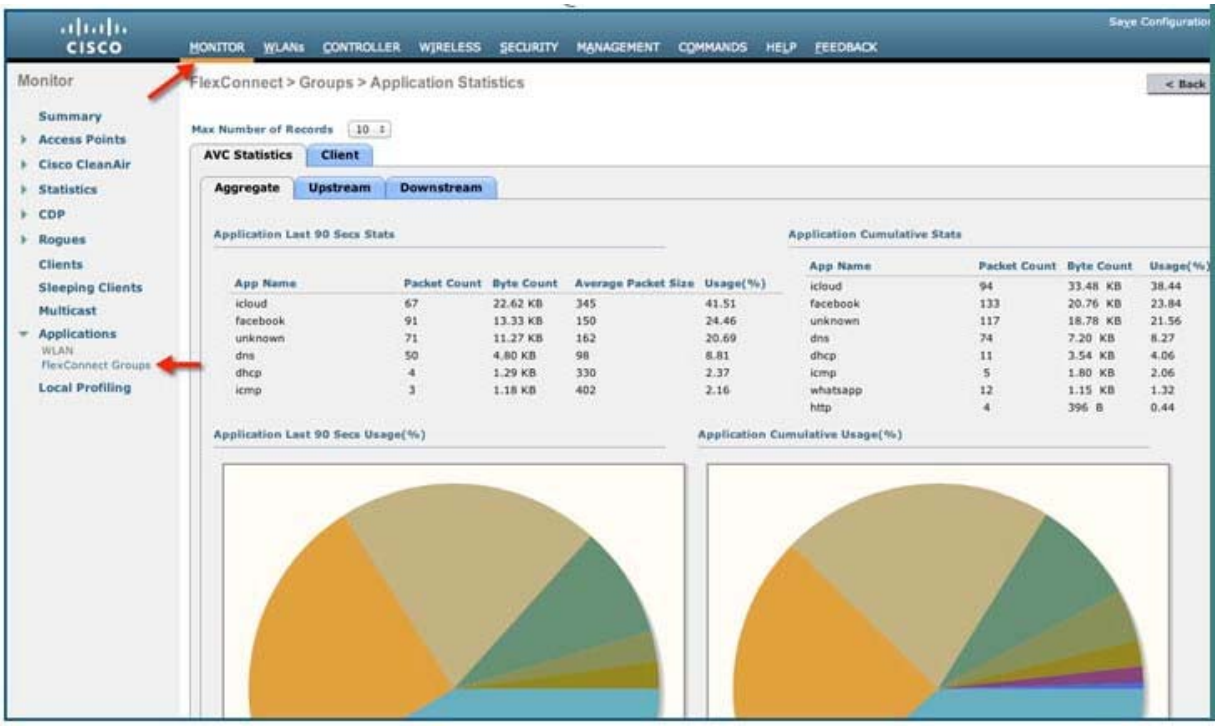
14. Apply the FlexConnect AVC profile by selecting the profile created in the previous set from the Flex AVC Profiledrop-down menu. Click **Add** and then click **Apply**.

15. Once AVC is enabled on the FlexConnect Group, from the associated wireless client, start different types of traffic using the applications (already installed) such as Cisco Jabber/WebEx Connect, Skype, Yahoo Messenger, HTTP, HTTPS/SSL, Microsoft Messenger, Ping, Trace route, and so on.

Once traffic is initiated from the wireless client, visibility of different traffic can be observed on a per FlexConnect Group and per client basis. This provides the administrator a good overview of the network bandwidth utilization and type of traffic in the network per client and per branch site

16. To check the visibility globally for all WLANs on a FlexConnect Group, click **Monitor > Applications > FlexConnect > FlexConnect Groups** and then select the FlexConnect group created earlier.

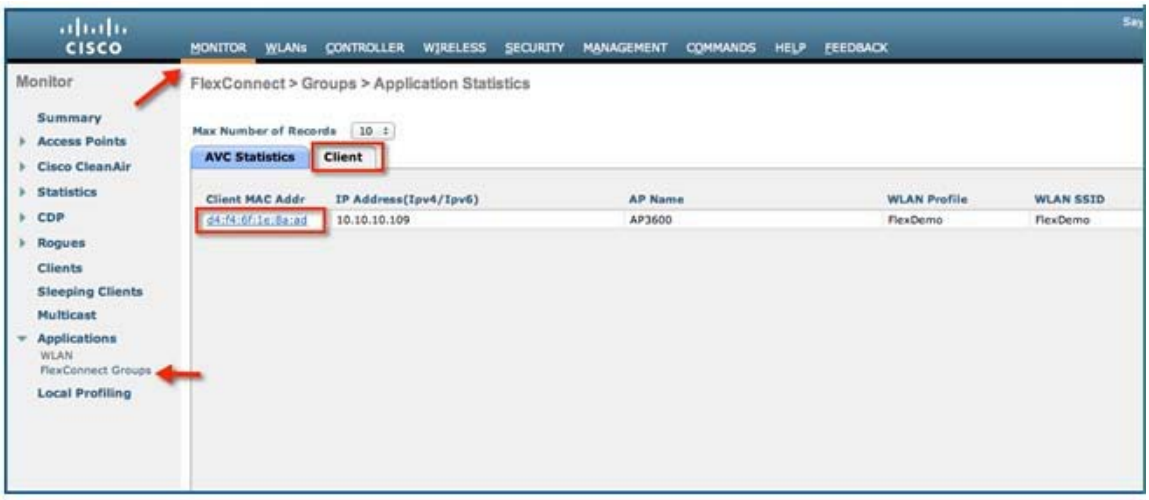
The following screen is visible which lists aggregate data for the top 10 applications running on that particular FlexConnect group.



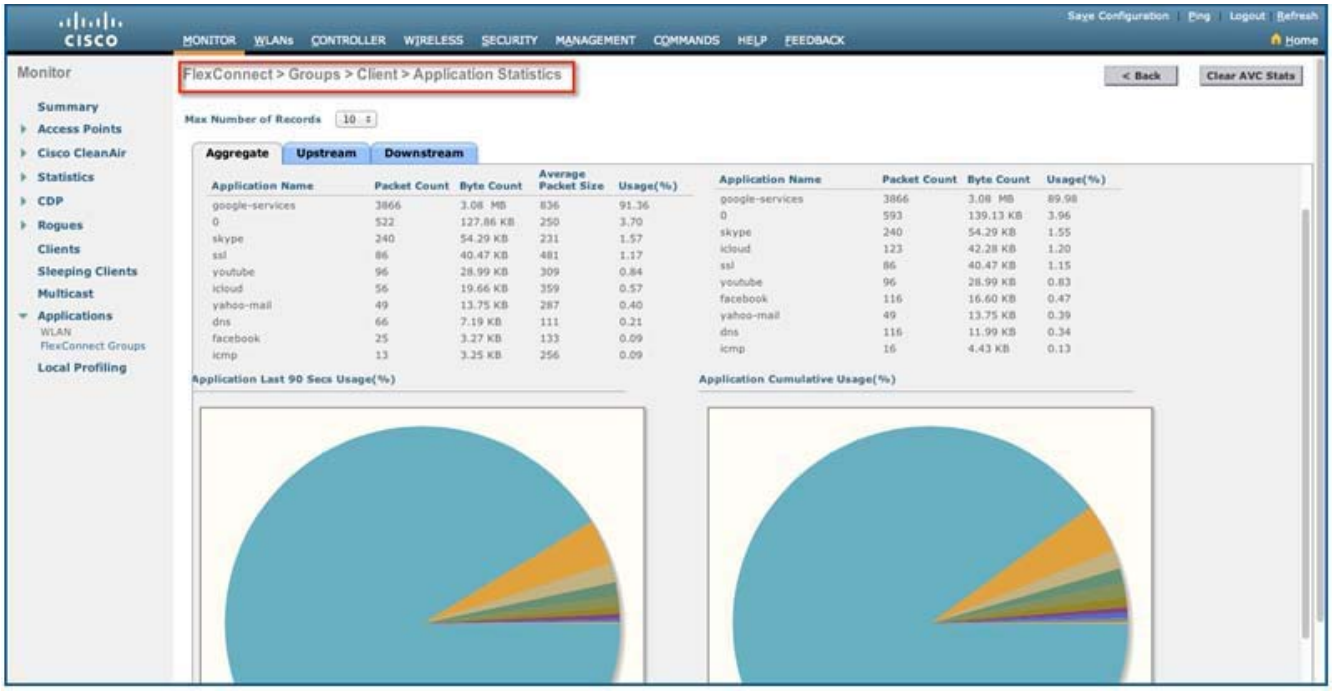
This page provides more granular visibility per FlexConnect Group and lists the top 10 applications in the last 90 seconds, as well as cumulative stats for the top 10 applications. You can view upstream and downstream statistics individually per FlexConnect Group from the same page by clicking the Upstream and Downstream tabs.

Note: The number of applications that are displayed on this page can be increased to 20 or 30 by modifying the Max Number of Records field on this page. The default value is 10.

17. To have more granular visibility of the top 10 applications per client on a particular locally switched WLAN where AVC visibility is enabled, click **Monitor > Applications > FlexConnect Group > FlexConnect Group name > Clients**. Then, click any individual client MAC entry listed on that page.



After clicking on an individual client MAC entry, the client details page appears.



This page provides further granular stats per client associated on locally switched WLANs, where AVC visibility is enabled on the WLAN itself or on the FlexConnect Group as in this example. The page lists the top 10 applications in last the 90 seconds as well as cumulative stats for top 10 applications.

18. You can view upstream and downstream stats individually per client from the same page by clicking the **Upstream** and **Downstream** tabs

.**Note:** The number of applications that are displayed on this page can be increased to 20 or 30 by modifying the **Max Number of Records Field** on this page. The default value is 10.

19. You can clear the AVC stats for the particular client by clicking the Clear AVC Stats button.

Now, if you open YouTube, from wireless clients, you will observe that client cannot play any YouTube videos. Also, if applicable, open your Facebook account and try to open any YouTube video. You will observe YouTube videos cannot be played. Because YouTube is blocked in the FlexConnect AVC profile, and AVC profile is mapped to WLAN on the FlexConnect Group. You cannot access YouTube videos via browser, or even via YouTube application or from any other website.

.**Note:** If your browser was already open with YouTube, refresh the browser for the AVC profile to take effect.

IPv4 DNS Filtering on Flex Connect APs

Feature Description and Functional Behavior

It is an 8.7 feature and extends Flex connect ACL to accept internet domain names in addition to existing IP address in its rules. The DNS-based ACLs are used for client devices. One of the use case of the feature is that to correctly configure the CMX Connect Social Login feature, it is necessary to add web sites to the walled garden. Mainly because the authentication is directly performed on the social network website and no password is stored or processed in our controller. Social Login will be configured to use Facebook as the provider.

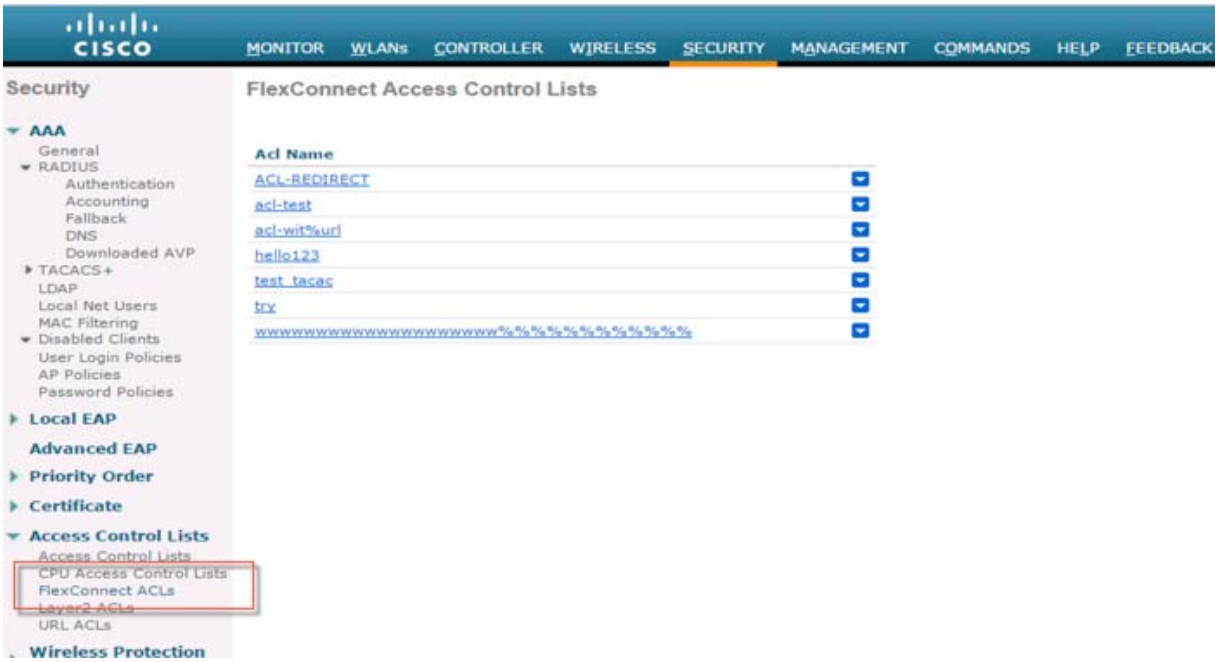
When using these devices, you can set pre-authentication ACLs on the Cisco WLC to determine where devices have the right to connect. In order to support such use cases, current implementation provides user an option to add URL based rules to the flex connect ACL and specify URL list to be allowed. Hence with this implementation the user has an option of configuring IP based rules as well as URL based rules or either of them.

With DNS-based ACLs, the client when in registration phase, is allowed to connect to the configured URLs only. WLC is configured with the ACL name that is returned by the AAA server for pre-authentication ACL to be applied. If the ACL name is returned by the AAA server, then the ACL is applied to the client for web-redirection. At the client authentication phase, the ISE server returns the pre-authentication ACL (url-redirect-acl).

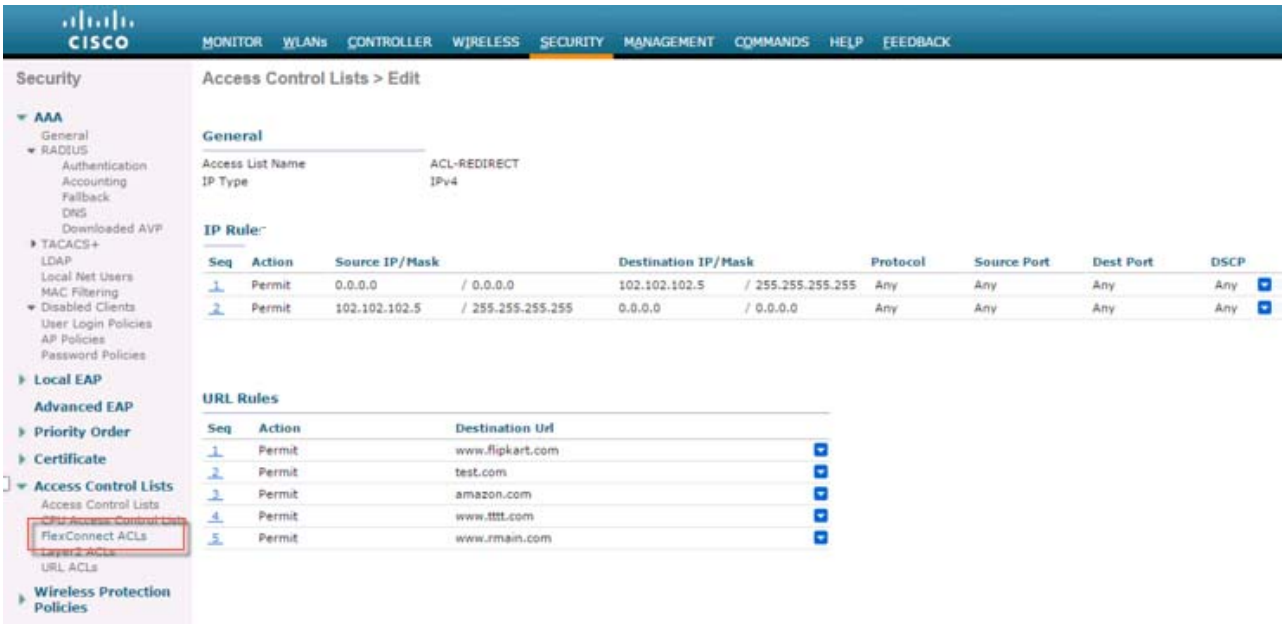
The DNS snooping is performed on the AP for each client until the registration is complete. When the ACL configured with the URLs is received on the WLC, the CAPWAP payload is pushed to AP and configuration is stored in the database maintained in the COS based AP. When client is associated and ACL is applied, DNS snooping is enabled on the client. With snooping in place, AP learns the IP address of the resolved domain name in the DNS response. If the domain name matches the configured URL, then the DNS response is parsed for the IP address, and the IP address is allowed in the ACL for locally switched traffic.

Configuration Steps From GUI

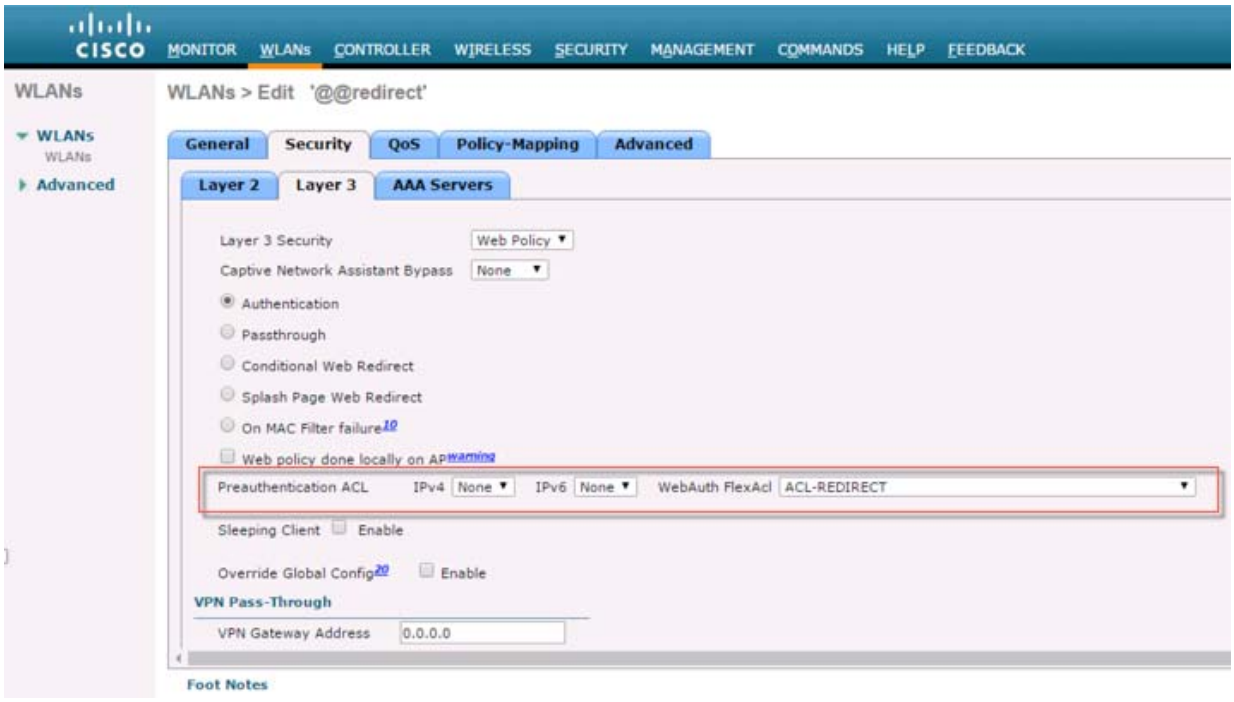
Step 1 Configure FC ACL on the WLC



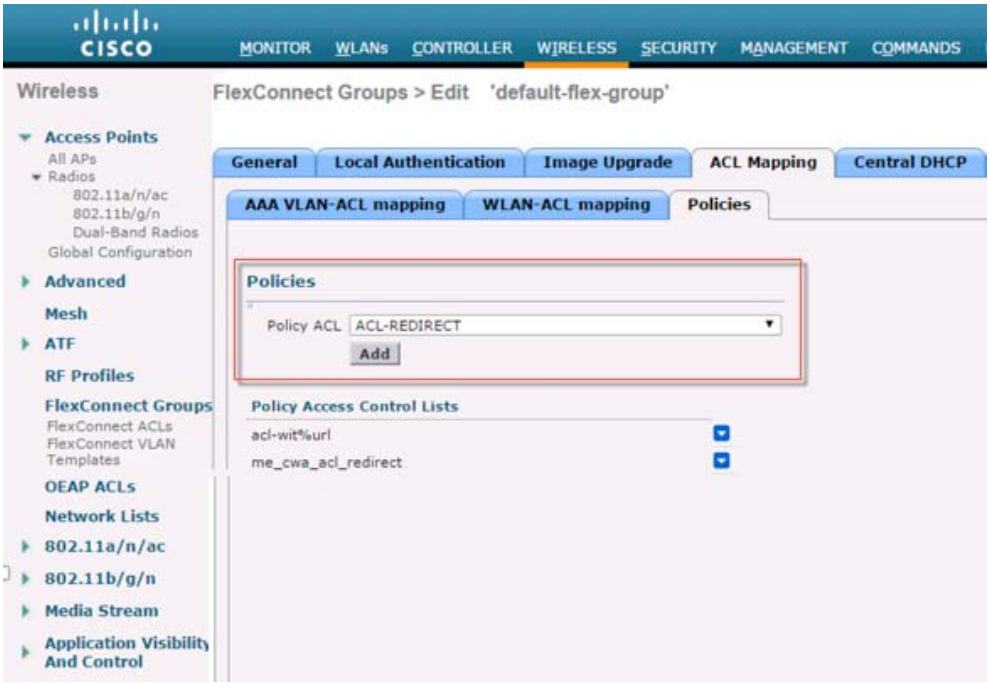
Step 2 Configure URL rules



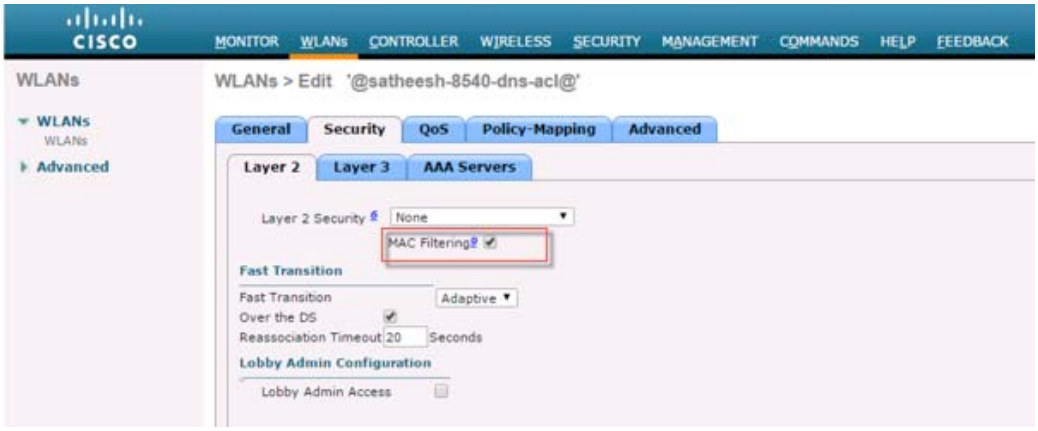
Step 3 Configure URL rules



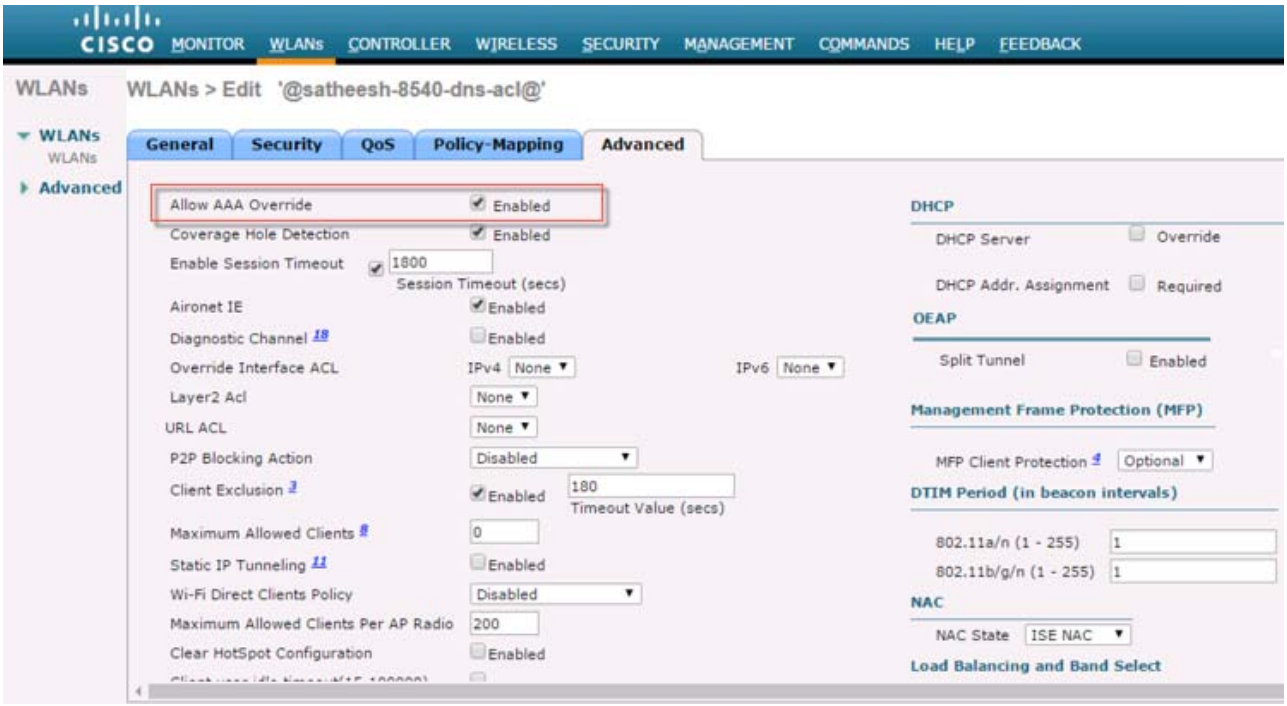
Step 4 Add ACL policy to the Flex Connect Group in case of Central WebAuth



Step 5 Configure WLAN with MAC Filtering enabled for CWA and ISE



Step 6 Configure WLAN with MAC Filtering enabled for CWA and ISE



Following controller CLIs will be used to configure ACLs.

To Create an ACL (existing CLI) :

```
config flexconnect acl create <acl-name>
```

Add URL to the ACL:

```
config flexconnect acl url-domain add <acl-name> <index>
config flexconnect acl url-domain url <acl-name> <index> <url-name>
```

This command is used to add a new url domain rule entry for the given index for the given flexconnect acl name. Default values will be added for url name and action.

Delete URL from the ACL:

```
config flexconnect acl url-domain delete <acl-name> <index>
```

This command can be used to delete the url domain rule from the given flexconnect acl.

Configure List-Type:

```
config flexconnect acl url-domain list-type <acl-name>
<whitelist/blacklist>
```

This command is used to set/modify the type of the list for all the URLs configured on a given Flex Connect ACLs. All the URLs in a given acl will have same action. Default list type would be blacklist.

To Apply the ACL: (existing CLIs)

```
config flexconnect group <group-name> policy acl add <acl-name>
config flexconnect acl apply <acl-name>
```

To apply the ACL to the WLAN at web-auth level :

```
config flexconnect group <group-name> web-auth wlan <wlan-id> acl
<acl-name> <enable/disable>
```

Show Commands & debugs:

```
show flexconnect acl summary
show flexconnect acl detailed <acl-name>
debug flexconnect acl enable
debug capwap payload enable
```

IPv6 Flex Connect Pre-Auth ACL and DNS Support Rel 8.8

Initially this feature was introduced in the release 8.7 with IPv4 support only. In release 8.8 this feature extends Flex connect IPv6 ACL to accept internet domain names in addition to IPv6 address in its rules.

This feature extends IPv6 Flex Connect ACL to accept internet domain names in addition to existing IPv4 and IPv6 address in its rules. The DNS-based ACLs are used for client devices. One of the use cases of the feature is that to correctly configure the CMX Connect Social Login feature, it is necessary to add websites to the walled garden. Mainly because the authentication is directly performed on the social network website and no password is stored or processed in our controller. Social Login will be configured to use Facebook as the provider.

When using these devices, you can set pre-authentication ACLs on the Cisco WLC to determine where devices have the right to connect. In order to support such use cases, current implementation provides a user an option to add URL based rules to the flex connect ACL and specify URL list to be allowed. Hence with this implementation, the user has an option of configuring IP based rules as well as URL based rules or either of them.

With DNS-based ACLs, the client when in registration phase, is allowed to connect to the configured URLs only. WLC is configured with the ACL name that is returned by the AAA server for pre-authentication ACL to be applied. If the ACL name is returned by the AAA server, then the ACL is applied to the client for web-redirection. At the client authentication phase, the ISE server returns the pre-authentication ACL (url-redirect-acl).

The DNS snooping is performed on the AP for each client until the registration is complete. When the ACL configured with the URLs is received on the WLC, the CAPWAP payload is pushed to AP and configuration is stored in the database maintained in the COS based AP. When a client is associated and ACL is applied, DNS snooping is enabled on the client. With snooping in place, AP learns the IP address of the resolved domain name in the DNS response. If the domain name matches the configured URL, then the DNS response is parsed for the IP address, and the IP address is allowed in the ACL for locally switched traffic.

1. The DNS name is communicated to AP data path using CAPWAP protocol
2. AP Data path monitors the DNS requests/responses and learns the IP address of the configured DNS names and allow traffic for the learned IP address during pre-auth phase
3. Maximum 20 URLs are allowed for the ACL
4. When a client moves from one AP to another AP (roaming), AP code will enable controller assisted context transfer
5. Transition scenario when the connection is broken between the controller and the AP is supported
6. A sub-string match is supported for the URL configuration. For example: if ‘google" is configured as the URL ACL, DNS response for play.google.com, google.com, google.in, abcgoogle.xyz will be matched

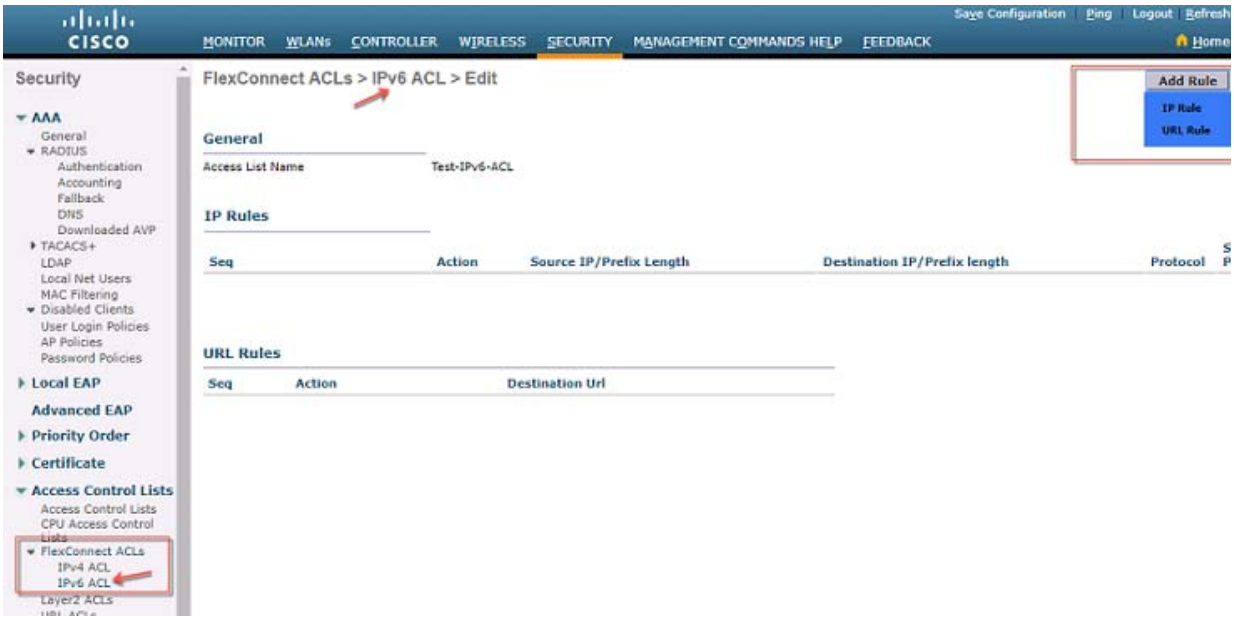
Since this feature is for the AP that operates in Flex Connect mode, DNS based ACLs need to take actual effect on the AP. On applying the ACL with URLs, respective configuration information is received on AP from the controller as new CAPWAP payload in the form of a TLV along with the other rules configured as part of ACL. The TLV payload to the AP will have an action per URL.

Below are the Scale numbers od supported ACLs and their size:

- 512 IPv6 ACLs for AireOS
- 20 URL Rules per ACL for AireOS & ME
- 32 IPv6 ACLs for ME
- Size of each URL: 255 characters
- 64 max DNS snooped IPs/Client

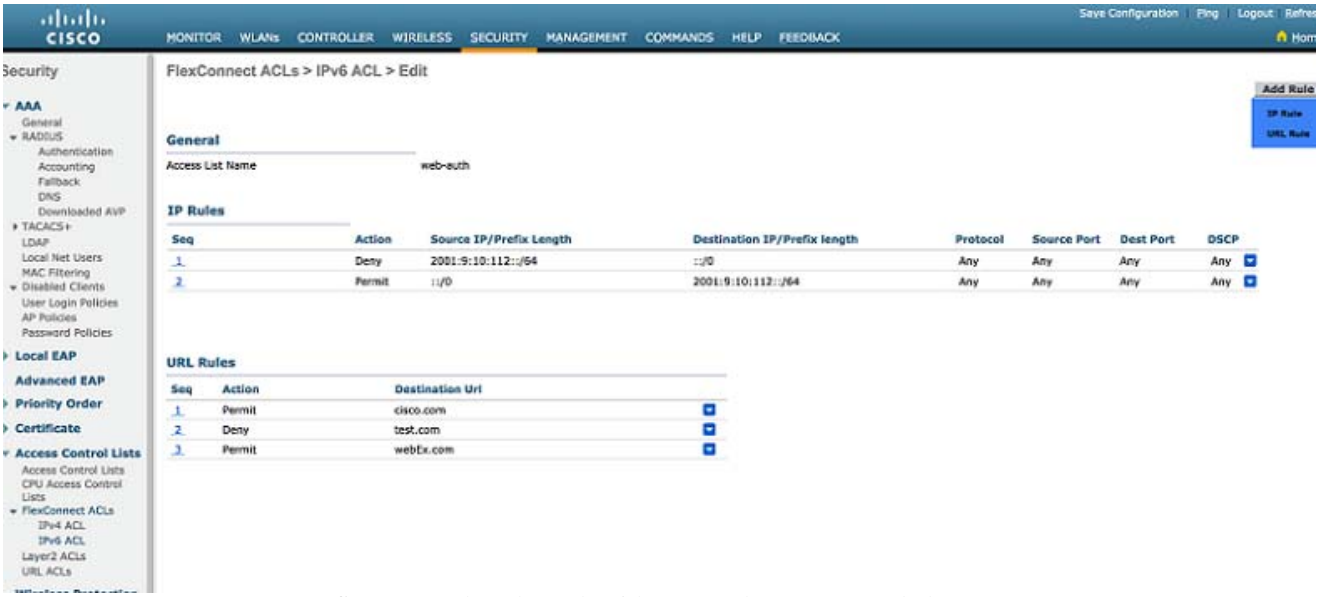
Flex Connect IPv6 ACL GUI Configuration Steps

1. Configure IPv6 FC ACL on the WLC.



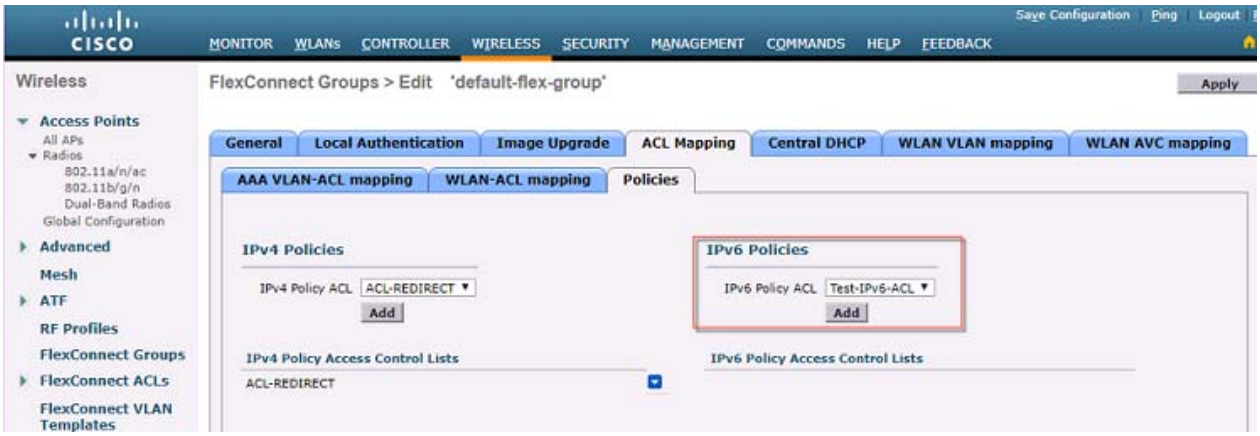
2. Create and apply IPv6 ACL rule.

3. In the same fashion create and apply URL rules as shown in the example below.



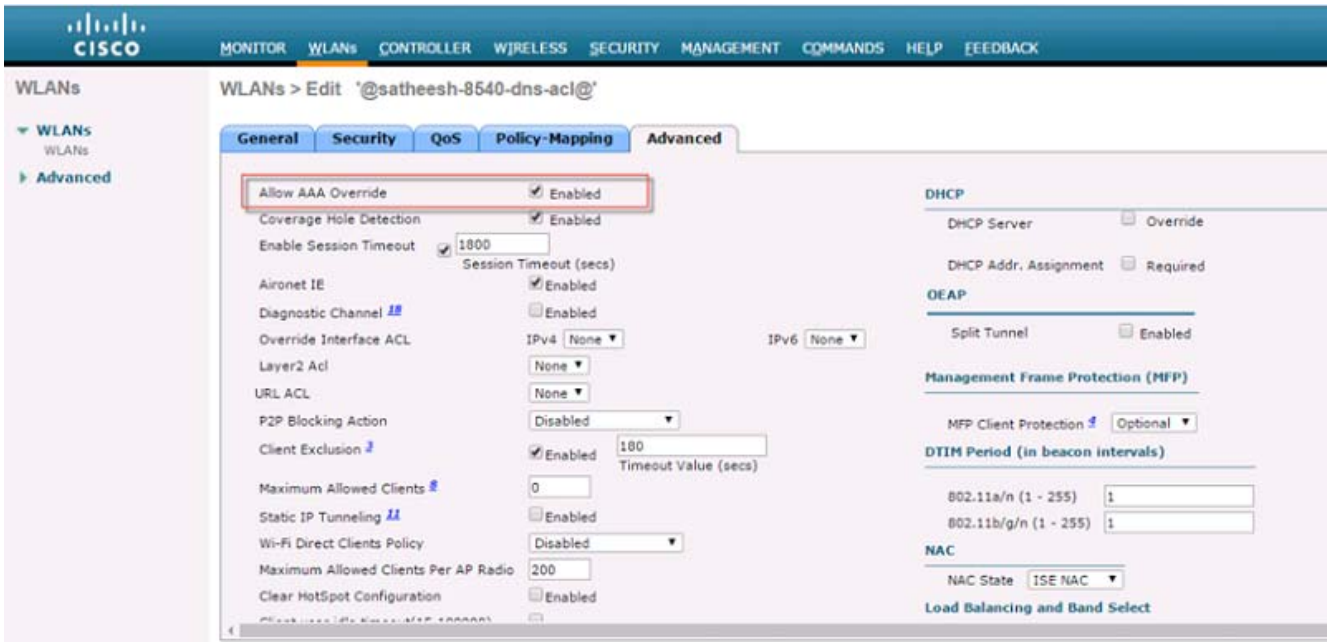
4. Configure Local Web Auth with pre-Auth ACL created above.

5. Add ACL policy to the Flex Connect Group in case of Central WebAuth.

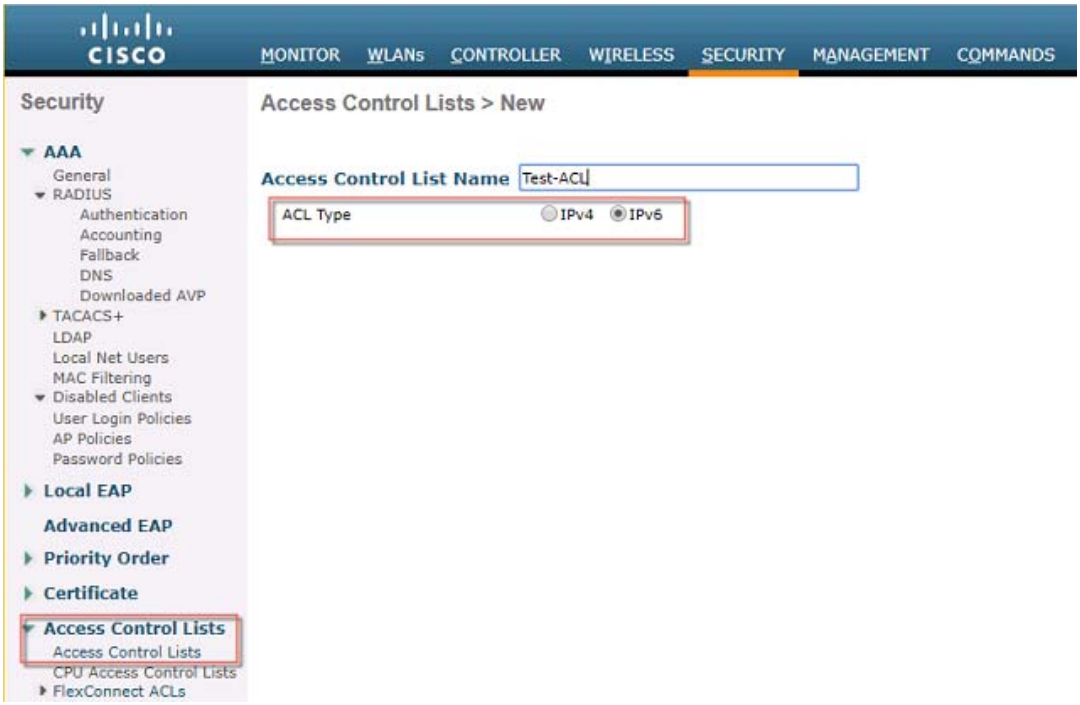


6. Configure WLAN with MAC Filtering enabled for CWA and ISE .

7. Configure WLAN with Advanced Option of the AAA override for CWA and for ISE to push the required policy to the FC AP. ISE NAC state also has to be enabled.



As indicated in the Executive summary, the IPv6 support was added to all IP and DNS ACL rules in release 8.8, not just the Flex Connect ACLs.



Flex Connect IPv6 ACL CLI Configuration Commands:

```
config flexconnect ipv6 acl apply <acl_name>
config flexconnect ipv6 acl create <acl_name>
config flexconnect ipv6 acl delete <acl_name>
config flexconnect ipv6 acl rule action <acl_name> <index> permit
config flexconnect ipv6 acl rule action <acl_name> <index> deny
config flexconnect ipv6 acl rule add <acl_name> <index>
config flexconnect ipv6 acl rule add change index acl_name <old_index> <new_index>
config flexconnect ipv6 acl rule delete <acl_name> <index>
config flexconnect ipv6 acl rule source port range <acl_name> <index> <start_port>
<end_port>
config flexconnect ipv6 acl rule source address <acl_name> <index> <ipv6_addr>
<prefix_len>
config flexconnect ipv6 acl rule destination port range <acl_name> <index> <start_port>
<end_port>
config flexconnect ipv6 acl rule destination address <acl_name> <index> <ipv6_addr>
<prefix_len>
config flexconnect ipv6 acl rule protocol <acl_name> <index> <protocol>
config flexconnect ipv6 acl rule swap index <acl_name> <index1> <index2>
config flexconnect ipv6 acl rule dscp acl_name index <0-63/any>
```

Wlan Mapping

```
config wlan security web-auth ipv6 flexacl <wlan_id> <acl_name>
```

Show CLI Commands:

```
show flexconnect ipv6 acl summary
show flexconnect ipv6 acl detailed <acl_name>
```

Sample Show Output

```
(Cisco Controller) >show flexconnect ipv6 acl summary
ACL Name                          Status
--------------------------------- -------
ipv6_flex                         Applied
v6acl                                Modified
(Cisco Controller)> show flexconnect ipv6 acl detailed v6acl
Rule Index..................................... 1
IPv6 source prefix............................. fe80::c664:13ff:fe8f:a6a0/128
IPv6 destination prefix........................ ::/0
Protocol....................................... Any
Source Port Range.............................. 0-65535
Destination Port Range......................... 0-65535
DSCP........................................... 4
Action......................................... Permit
Rule Index..................................... 2
IPv6 source prefix............................. ::/0
IPv6 destination prefix........................ fe80::c664:13ff:fe8f:a6a1/128
Protocol....................................... Any
Source Port Range.............................. 0-65535
Destination Port Range......................... 0-65535
DSCP........................................... Any
Action......................................... Deny
```

Auto-LAG Feature Overview in Rel 8.8

The AP Flexconnect mode of operation allows one of two types of data switching models to be associated with a WLAN, central switching or local switching. In the central switching case, client WLAN data is forwarded to the WLC in a CAPWAP tunnel, and the WLC handles switching the data to the correct VLAN. In the local switching case, it's the AP's responsibility switch the client WLAN data to the correct VLAN, bypassing the WLC. The intent of this specification is to support both of these modes along with LAG.

As stated earlier, this mode relies on the WLC to switch the client WLAN data to the correct VLAN. In order for this to occur the AP must have a CAPWAP session established to the WLC. When this session exists, the AP will be in Flexconnect "Connected" mode. When LAG is enabled the client WLAN data will be load balanced between the two AP Ethernet ports in same fashion it is done in the existing LAG implementation.

The Auto-LAG feature allows Cisco Wave-2 Access points to Auto-LAG when in Flex Connect mode with non-layer 4 LB switches. Currently LAG is only supported on 3K and 4K series switches, this new feature breaks that dependency and allows Auto-LAG on the no-layer 4 LB (Load Balanced) switches such as 3650 in FC Centrally and Locally Switched modes.

According with a Miercom report and some internal testing we have done we can achieve at least 1.2 gigabits of throughput with both radios (micro/macro) on 5 Ghz with 80mhz Channel width, this configuration lets us to achieve up to 35-37 Mbps per user with about 30 users per AP.

Configurations Steps for Auto LAG feature

The configuration for the two AP Ethernet ports used for the LAG connection can either be configured as "***switchport mode access***" ports, as in the existing LAG implementation, or they can be configured as "***switchport mode trunk***" ports as per the existing FC implementation.

If the desire is to solely use central switching for the client WLAN, without the possibility of changing the WLAN to local switching, then the two AP Ethernet ports should be configured as "***switchport mode access***" ports, with the native VLAN set to the VLAN ID associated with the WLC VLAN. Thus, the AP will send the client WLAN data to the WLC in the CAPWAP tunnel untagged (e.g., without the 802.1Q VLAN header inserted) and the switch will put them on the same VLAN as the WLC.

If there is a chance the client WLAN will be changed in the future to the local switching mode, then the two AP Ethernet ports should be configured as "***switchport mode trunk***" ports, with the native VLAN set to the VLAN ID associated with the WLC VLAN and VLAN IDs should be added for each supported client WLAN. Although defined as a trunk port, operation will be same as for the "switchport mode access", with the AP will sending untagged CAPWAP to the WLC.

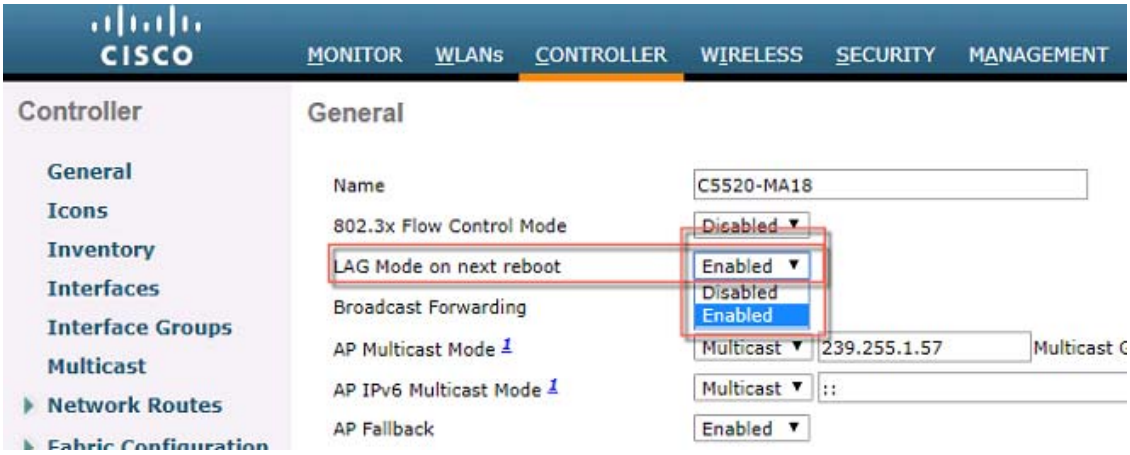
Prior to release 8.8, LAG implementation only "***switchport mode access***" ports were allowed to be configured.

Now, in rel 8.8, with the addition of the FC/LAG functionality, "switchport mode trunk" ports are also allowed to be configured and used. The choice depends on the Flexconnect switching mode associated with the client WLAN, with local switching requiring "***switchport mode trunk***" ports, while central switching can use either mode as described in the section above.

The configuration for the feature will use the existing methods for configuring LAG and Flex Connect.

WLC Configuration

```
config lag enable
config ap lag-mode support enable <ap-name>
```



Switch Ports Configuration Example for Locally Switched AP Mode

```
! interface Port-channel12
switchport trunk native vlan 110
switchport trunk allowed vlan 110-120
switchport mode trunk
spanning-tree portfast trunk
interface TenGigabitEthernet1/0/7
switchport trunk native vlan 110
switchport trunk allowed vlan 110-120
switchport mode trunk
channel-group 12 mode active
```

Managing 8.8 Auto LAG Feature

The following command is used to shows most of the configuration programmed to NSS, with the LAG related info highlighted.

```
ap#show controllers nss status
```

Sample Output:

NSS state is enable

Wired0 Configuration:

```
|ID:0|TYPE:0|STATE:1| |OPT:0x0000003F|MTU:1500|TPID:0x8100|NVLAN:0|POL:0|
```

Wired1 Configuration:

```
|ID:1|TYPE:0|STATE:1| |OPT:0x0000003F|MTU:1500|TPID:0x8100|NVLAN:0|POL:0|
```

QoS Configuration:

```
Policy Name: Background
Direction: Ingress
Default Priority: 2, Type: L2_L3
L2 to Priority Mapping:
PCP      | 0 1 2 3 4 5 6 7
Priority | 0 1 2 3 4 5 6 7
```

L3 to Priority Mapping:

```
DSCP |            Priority
0-15 | 0 0 1 0 1 0 1 0 1 1 2 1 2 1 2 1
16-31 | 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
32-47 | 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
```

```
48-63 | 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
```

Direction: Egress

```
Priority |  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15
UP       |  0  1  2  3  4  5  6  7  0  0  0  0  0  0  0  0
DSCP     |  0  2 10 18 26 34 46 48  0  0  0  0  0  0  0  0
PCP      |  0  1  2  3  4  5  6  7  0  0  0  0  0  0  0  0
```

LAG Configuration:

```
|ID:33|TYPE:1|STATE:1|
|LINKS:0x00000003|HASHPROF:1|
```

Hash Profile Configuration:

```
|ID:1|TCP-UDP:0x00000F00|IP:0x00001300|NON-IP:0x000000FC|
|KNEE0:0x80000000|KNEE1:0xFFFFFFFF|KNEE2:0x00000000|
```

CAPWAP Configuration:

```
|ID:34|TYPE:3|STATE:1|
|GATEWAY-MAC:F8:72:EA:67:7C:4D|AP-MAC:58:AC:78:DC:B2:50|
|RADIO-BASE-MAC:58:AC:78:DF:74:B0|PMTU:576|
|WLC-IP:1.4.8.2|AP-IP:1.4.8.236|WLC-PORT:5247|AP-PORT:5256|
|DEST-PORT:33|PROTO:0|TTL:250|FLBL:0|DTLS-ID:65535|
|VLAN-ID:0|OPT:0x0000000C|UQOSP:0|MQOSP:0|CSUM:1|
|L4RXBITS:  3|L4TXBITS:  3|L4HASHPROF:  1|
```

Client Configuration: Current Count: 4

```
|MAC     | OPAQUE |PRI POL|VLAN|BR|TN|QCF|BSS|RADID|MYMAC| |58:AC:78:DC:B2:50|00000000|
3|   0| 1| 1|  0|  2|    3|    1| |58:AC:78:DC:B2:51|00000000|      3|   0| 1| 1|  0|  2|
3|    1| |00:71:C0:A8:01:0C|B10B7BB4|      3|   0| 1| 1|  0|  0|    1|    0|
|00:71:C0:A8:01:0D|B10B7BB4|      3|   0| 1| 1|  0|  0|    1|    0|
```

The following command can be used to display the cumulative and five second statistics and exception counters of NSS with the LAG related info highlighted.

ap#show controllers nss stats

Sample Output:

```
NSS Statistics (Cumulative Total/Last 5 Seconds)
```

Wired0 Port Statistics:

```
ID          :              0      TYPE       :              0
RX PKTS     :          616/13     TX PKTS    :          67115/66964
RX OCTETS   :       97862/1280    TX OCTETS  :       26832505/26785264
RX ERR      :            0/0      TX ERR     :              0/0
Wired1 Port Statistics:
ID          :              1      TYPE       :              0
RX PKTS     :          179/8      TX PKTS    :          44643/44629
RX OCTETS   :       18004/512     TX OCTETS  :       17853919/17851328
RX ERR      :            0/0      TX ERR     :              0/0
```

CAPWAP Port Statistics:

```
ID          :             34      TYPE      :              3
RX PKTS     :            3/0      TX PKTS    :         148850/148800
RX OCTETS   :          345/0      TX OCTETS  :       81851372/81840000
RX ERR      :            0/0      TX ERR     :              0/0
LAG Port Statistics:
ID          :             33      TYPE       :              1
RX PKTS     :          448/22     TX PKTS    :         111634/111609
RX OCTETS   :       55786/1856    TX OCTETS  :       44650157/44643600
RX ERR      :            0/0      TX ERR     :              0/0
```

Wired0 Exception Statistics:

```
UNKNOWN                         :               0/0
OUTER_MACSEC_MISSING            :               0/0
OUTER_MACSEC_BAD_SA             :               0/0
OUTER_MACSEC_FAILED             :               0/0
OUTER_VLAN_TAG_MISSING          :               0/0
OUTER_VLAN_PORT_BLOCK           :               0/0
OUTER_VLAN_ANY_BLOCK            :               0/0
OUTER_SANITY_FAILED             :               0/0
OUTER_DTLS_MISSING              :               0/0
OUTER_DTLS_UNEXPECTED           :               0/0
OUTER_DTLS_FAILED               :               0/0
INNER_SANITY_FAILED             :               0/0
OUTER_UCAST_DST_UKNOWN          :               0/0
OUTER_UCAST_BRIDGE_BLOCK        :               0/0
OUTER_UCAST_VLAN_BLOCK          :               0/0
OUTER_MCAST_TYPE_BLOCK          :               0/0
INNER_UCAST_DST_UKNOWN          :               0/0
INNER_UCAST_BLOCK               :               0/0
INNER_MGID_UNKNOWN              :               0/0
INNER_CAPWAP_ERROR              :               0/0
INNER_VLAN_TAG_BLOCK            :               0/0
INNER_UCAST_SRC_UNKNOWN         :               0/0
INNER_CAPWAP_REASM_FAILED       :               0/0
```

Wired1 Exception Statistics:

```
UNKNOWN                         :               0/0
OUTER_MACSEC_MISSING            :               0/0
OUTER_MACSEC_BAD_SA             :               0/0
OUTER_MACSEC_FAILED             :               0/0
OUTER_VLAN_TAG_MISSING          :               0/0
OUTER_VLAN_PORT_BLOCK           :               0/0
OUTER_VLAN_ANY_BLOCK            :               0/0
OUTER_SANITY_FAILED             :               0/0
OUTER_DTLS_MISSING              :               0/0
OUTER_DTLS_UNEXPECTED           :               0/0
OUTER_DTLS_FAILED               :               0/0
INNER_SANITY_FAILED             :               0/0
OUTER_UCAST_DST_UKNOWN          :               0/0
OUTER_UCAST_BRIDGE_BLOCK        :               0/0
OUTER_UCAST_VLAN_BLOCK          :               0/0
OUTER_MCAST_TYPE_BLOCK          :               0/0
INNER_UCAST_DST_UKNOWN          :               0/0
INNER_UCAST_BLOCK               :               0/0
INNER_MGID_UNKNOWN              :               0/0
INNER_CAPWAP_ERROR              :               0/0
INNER_VLAN_TAG_BLOCK            :               0/0
INNER_UCAST_SRC_UNKNOWN         :               0/0
INNER_CAPWAP_REASM_FAILED       :               0/0
```

Decap Statistics:

```
UC MGMT KEEPALIVE MC MC_OTHER FWD0 FWD1 FWD FAIL FALL_THROUGH DROP
 0    1         2  0        0  611  179   0    0            0    0
```

Encap Statistics:

```
DATA MGMT KEEPALIVE FWD0 FWD1 FAIL
39993    5         2  125   11    0
```

SNMP

The existing tables cLReapGroupConfigTable and cLReapGroupApConfigTable in CISCO-LWAPP-REAP_MIB would return the configuration of the default-flex-group and the joined APs respectively

Web Links

- Cisco WLAN Controller Information:
  http://www.cisco.com/c/en/us/products/wireless/4400-series-wireless-lan-controllers/index.html
  http://www.cisco.com/c/en/us/products/wireless/2000-series-wireless-lan-controllers/index.html
- Cisco NCS Management Software Information:
  http://www.cisco.com/c/en/us/products/wireless/prime-network-control-system-series-appliances/index.html
- Cisco MSE Information:
  http://www.cisco.com/c/en/us/products/wireless/mobility-services-engine/index.html
- Cisco LAP Documentation:
  http://www.cisco.com/c/en/us/products/wireless/aironet-3500-series/index.html

Terminology

- APM—AP Manager Interface
- Dyn—Dynamic Interface
- Management—Management Interface
- Port—Physical Gbps port
- WiSM-2—Wireless Service Module
- AP—Access Point
- LAG—Link Aggregation
- SPAN—Switch Port Analyzer
- RSPAN—Remote SPAN
- VACL—VLAN Access Control List
- DEC—Distributed Etherchannel
- DFC—Distributed Forwarding Card
- OIR—Online Insertion and Removal
- VSL—Virtual Switch Link
- ISSU—In Service Software Upgrade
- MEC—Multichassis Ether Channel
- VSS—Virtual Switch System
- WCS—Wireless Control System
- NAM—Network Analysis Module

- IDSM—Intrusion Detection Service Module
- FWSM—Firewall Service Module
- STP—Spanning Tree Protocol
- VLAN—Virtual LAN
- SSO—Stateful Switchover
- WCP—Wireless Control Protocol
- WiSM-2—Wireless Service Module-2

FAQ

Q. If I configure LAPs at a remote location as FlexConnect, can I give those LAPs a primary and secondary controller?

Example: There is a primary controller at site A and a secondary controller at site B. If the controller at site A fails, the LAP does failover to the controller at site B. If both controllers are unavailable does the LAP fall into FlexConnect standalone mode?

A. Yes. First the LAP fails over to its secondary. All WLANs that are locally switched have no changes, and all that are centrally switched just have the traffic go to the new controller. And, if the secondary fails, all WLANs that are marked for local switching (and open/pre-shared key authentication/you are doing AP authenticator) remain up.

Q. How do access points configured in Local mode deal with WLANs configured with FlexConnect Local Switching?

A. Local mode access points treat these WLANs as normal WLANs. Authentication and data traffic are tunneled back to the WLC. During a WAN link failure this WLAN is completely down and no clients are active on this WLAN until the connection to the WLC is restored.

Q. Can I do web authentication with Local switching?

A. Yes, you can have an SSID with web-authentication enabled and drop the traffic locally after web-authentication. Web-authentication with Local switching works fine.

Q. Can I use my Guest-Portal on the Controller for an SSID, which is handled locally by the H REAP? If yes, what happens if I lose connectivity to the controller? Do current clients drop immediately?

A. Yes. Since this WLAN is locally switched, the WLAN is available but no new clients are able to authenticate as the web page is not available. But, the existing clients are not dropped off.

Q. Can FlexConnect certify PCI compliance?

A. Yes. FlexConnect solution supports rogue detection to satisfy PCI compliance.

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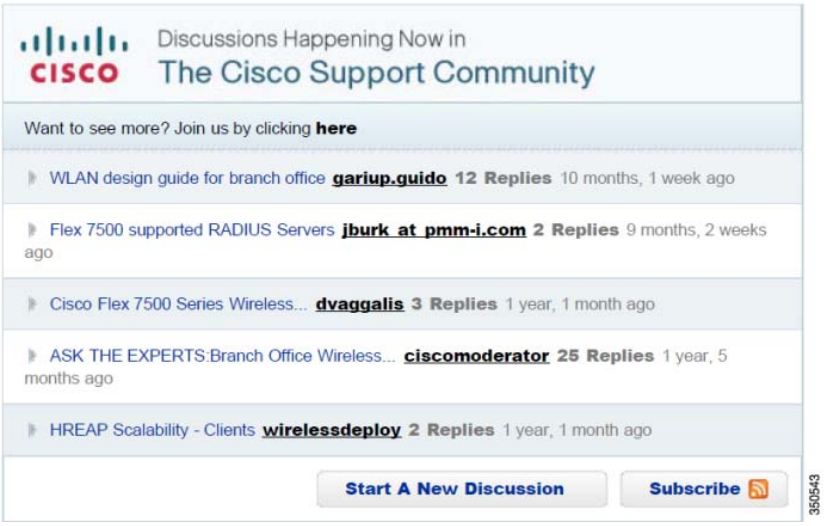

Related Information

- HREAP Design and Deployment Guide
- Cisco 4400 Series Wireless LAN Controllers
- Cisco 2000 Series Wireless LAN Controllers
- Cisco Wireless Control System
- Cisco 3300 Series Mobility Services Engine
- Cisco Aironet 3500 Series
- Cisco Secure Access Control System
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