Cisco Catalyst 3850 Switch

Services Guide

April 2013

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Contents

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Overview

The Cisco® Catalyst® 3850 Switch is built on a unified access data plane (UADP) application-specific integrated circuit (ASIC). This is a state-of-the-art ASIC that has all services fully integrated in the chip and thus requires no additional modules. The ASIC is programmable and is flexible to support future requirements. It also delivers services with flexibility and visibility across wired and wireless networks.

The access layer of the network has evolved from just pushing the traffic into the network to delivering a plethora of services. The convergence of wired and wireless networks adds another level to services being applied at the access layer. Service-rich and service-aware networking platforms allow organizations to achieve not only lower total cost of ownership (TCO), but also faster time to service delivery.

This document provides an overview of the Cisco Catalyst 3850 and the steps to deploy services with the Cisco Catalyst 3850. It broadly includes the following sections:

- Security
- Quality of service
- Flexible NetFlow
- Multicast
- Mobility

Cisco Catalyst 3850 Security Policy

In today's networking environment, it has become a challenge to manage security policies on wired and wireless networks. It is mainly due to the fact that wired and wireless users are being identified in different points on the network and are subject to different policies.

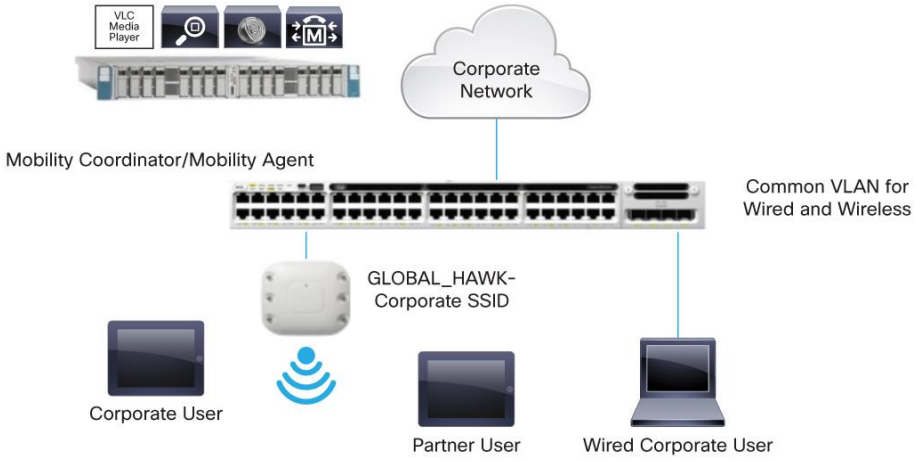
The Cisco Catalyst 3850 defines a major change in the architecture, because it brings wired and wireless networks together on an access switch. As we terminate the wireless users on the Cisco Catalyst 3850, we also get visibility to users who are getting onto the network at the access layer, similar to wired users. This change also moves the policy point to the access layer, and therefore it gets consistent with the wired endpoints.

Configuring 802.1X in Converged Access

In the topology diagram shown in Figure 1, a wired corporate user and access points are connected to the Cisco Catalyst 3850. Two wireless clients are connected to the service set identification (SSID) on the Cisco Catalyst 3850. One of the wireless users is a corporate user, and the other user is a partner. Corporate users and partner users have different security policies defined on Cisco's Identity Services Engine (ISE) server that is in the campus services block. There are other servers such as call manager, video streaming server, and the Cisco Prime™ Infrastructure server in the campus services block as well.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Figure 1. 802.1X with Converged Access



The authentication, authorization, and accounting (AAA) group and RADIUS server are set up on the Cisco Catalyst 3850. The authentication and authorization are redirected to the ISE server. The wireless clients are set up to get authenticated using dot1x.

```
aaa new-model
aaa authentication dot1x CLIENT_AUTH group radius
aaa authorization network CLIENT_AUTH group radius
!
```

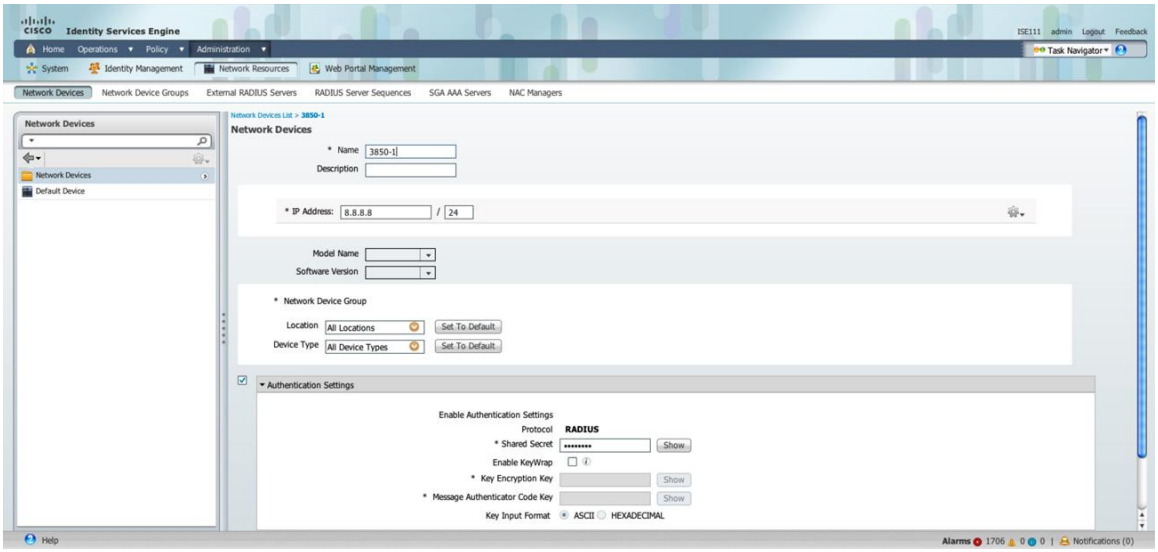
The ISE server is the RADIUS server, and the switch is defined on the ISE server as one of the network devices. The RADIUS server needs to be defined on the switch.

```
radius server ise
 address ipv4 9.9.9.9 auth-port 1812 acct-port 1813
 timeout 60
 retransmit 3
 key cisco123
!
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

To define the Cisco Catalyst 3850, on the ISE screen, navigate to Administration → Network Resources → Network Devices as in Figure 2.

Figure 2. Device Definition in ISE



The dot1x needs to be enabled on the switch globally for wired and wireless clients.

```
dot1x system-auth-control
!
```

802.1X Configuration for Wired Users

802.1X for wired users is configured per port. Here is the port configuration:

```
interface GigabitEthernet1/0/13
 switchport access vlan 12
 switchport mode access
 access-session port-control auto
 access-session host-mode single-host
 dot1x pae authenticator
 service-policy type control subscriber DOT1X
```

The Cisco Catalyst 3850 also introduces session-aware networking (SaNet), which is a replacement for Auth Manager that is present in current Cisco IOS® Software platforms.

The objective of having SaNet is to have no dependency between features applied to sessions or authentication method. Thus, with appropriate AAA interactions, any authentication method should derive authorization data for any feature, to be activated on a session. This can be accomplished by using a policy model similar to Modular Policy Framework (MPF), which is used in routing protocols, firewall rules, quality of service (QoS), and so on. For more details, see SaNet documentation at http://www.cisco.com/en/US/docs/ios-xml/ios/san/configuration/xe-3se/3850/san-overview.html. The following policy is an example for SaNet:

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
class-map type control subscriber match-all DOT1X_NO_RESP
 match method dot1x
!
policy-map type control subscriber DOT1X
 event session-started match-all
  1 class always do-until-failure
   2 authenticate using dot1x retries 3 retry-time 60
 event authentication-success match-all
 event authentication-failure match-all
  5 class DOT1X_NO_RESP do-until-failure
   1 authentication-restart 60
!
```

802.1X Configuration for Wireless Users

For wireless clients, 802.1x is configured under WLAN configuration mode. The AAA authentication method is similar to wired clients.

```
wlan Predator 1 Predator
security dot1x authentication-list CLIENT_AUTH
```

When a user provides credentials, the ISE server authenticates and authorizes the user. Upon successful authorization, the user is assigned a specific VLAN, which provides policies based on groups or device types in ISE. It also provides other policies such as QoS, downloadable access control list (dACL), and so on.

The client session is maintained on the Cisco Catalyst 3850 after authorization, until the session is terminated. The client states are controlled by the wireless control manager (WCM) process.

Any end station (wired or wireless) authenticating using dot1X is termed as a “client,” and all the policies such as dACL and QoS that are specific to this client are installed on the client entity in hardware, unlike ports in the existing 3K switches. This is one way that consistency between wired and wireless clients is achieved.

To look at the overall wired and wireless devices connected on the switch, the following command can be used:

```
Switch#sh access-session

Interface    MAC Address    Method  Domain  Status Fg Session ID
Gi1/0/13     0024.7eda.6440 dot1x   DATA    Auth      0A0101010000109927B3B90C
Ca1          b065.bdbf.77a3 dot1x   DATA    Auth      0a01010150f57a300000002e
Ca1          b065.bdb0.a1ad dot1x   DATA    Auth      0a01010150f57ac20000002f

Session count = 3

Key to Session Events Status Flags:

  A - Applying Policy (multi-line status for details)
  D - Awaiting Deletion
  F - Final Removal in progress
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
    I - Awaiting IIF ID allocation
    P - Pushed Session (non-transient state)
    R - Removing User Profile (multi-line status for details)
    U - Applying User Profile (multi-line status for details)
    X - Unknown Blocker
```

The following output shows the detailed view of the wireless client session:

```
Switch#sh access-session mac b065.bdb0.a1ad details
            Interface:  Capwap0
               IIF-ID:  0xE49A0000000008
          MAC Address:  b065.bdb0.a1ad
         IPv6 Address:  Unknown
         IPv4 Address:  12.0.0.2
            User-Name:  user1
               Status:  Authorized
               Domain:  DATA
       Oper host mode:  multi-auth
     Oper control dir:  both
      Session timeout:  N/A
    <snip….snip>

 Server Policies (priority 100)
              ACS ACL:  xACSACLx-IP-user1-46a243eb
Method status list:
       Method           State  dot1x            Authc Success
```

The following is the configuration on the wired port:

```
Switch#sh run int gig1/0/13
Building configuration...

Current configuration : 317 bytes
!
interface GigabitEthernet1/0/13
 description dot1X Wired Port in Vlan 30
 switchport access vlan 30
 switchport mode access
 load-interval 30
 access-session host-mode single-host
 access-session port-control auto
 dot1x pae authenticator
 spanning-tree portfast
 service-policy type control subscriber 802.1x
end
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The following is the detailed output of the wired client session:

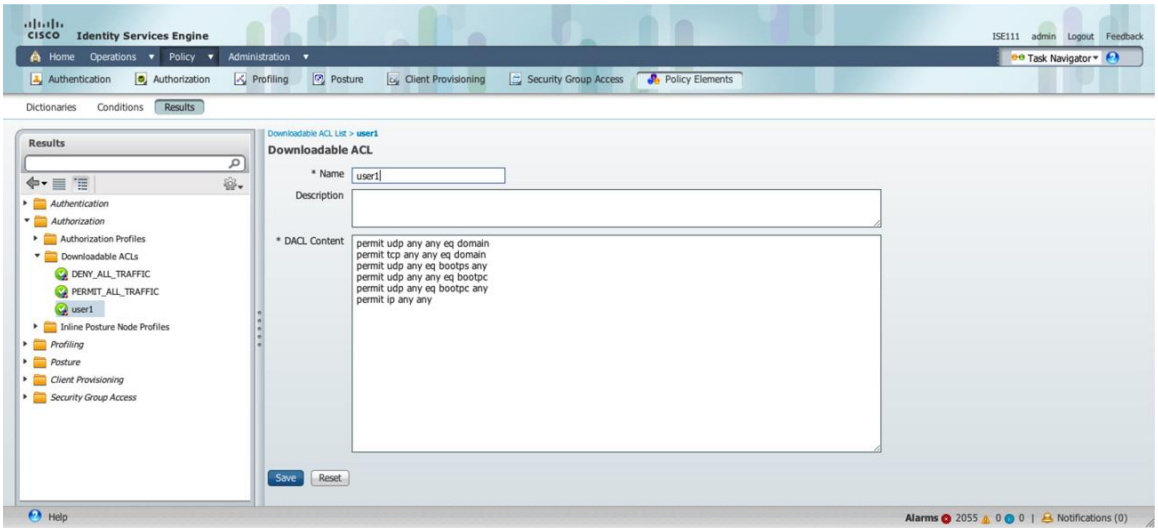
```
Switch#sh access-session mac 0024.7eda.6440 details
            Interface:  GigabitEthernet1/0/13
               IIF-ID:  0x1092DC000000107
          MAC Address:  0024.7eda.6440
         IPv6 Address:  Unknown
         IPv4 Address:  10.3.0.113
            User-Name:  corp1
               Status:  Authorized
               Domain:  DATA
       Oper host mode:  single-host
     Oper control dir:  both
      Session timeout:  N/A
    Common Session ID:  0A010101000011334A316CE0
      Acct Session ID:  Unknown
               Handle:  0x8B00039F
       Current Policy:  802.1x

Server Policies:
              ACS ACL:  xACSACLx-IP-Corp-506f07b4

Method status list:
       Method           State
       dot1x            Authc Success
```

Note: In the preceding output, the ACL is installed on the client entity and not on the port.

Downloadable Access Control List

The screenshot in Figure 3 shows the dACL definition in ISE.

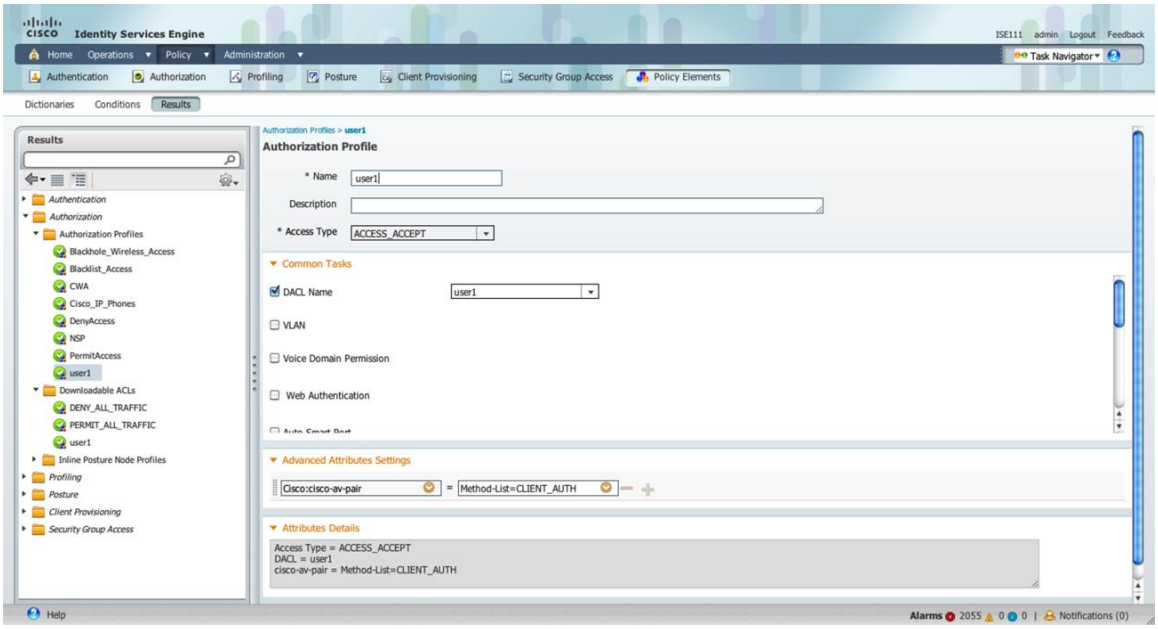
Figure 3. Downloadable ACL Screen



© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

After defining ACL in ISE, it can be associated with an authorization profile, as shown in Figure 4.

Figure 4. Authorization Profile



Note: If a named authentication **method-list** is in place for AAA, an attribute needs to be set from ISE, as shown in 4 **Method-List** in this example is CLIENT_AUTH.

After successful download of ACL, the client is authorized, and the following is the output of ACL:

```
Switch#sh access-lists
Extended IP access list xACSACLx-IP-user1-46a243eb (per-user)
    1 permit udp any any eq domain
    2 permit tcp any any eq domain
    3 permit udp any eq bootps any
    4 permit udp any any eq bootpc
    5 permit udp any eq bootpc any
    6 permit ip any any
```

Access Control List Deployment Considerations

With the Cisco Catalyst 3850 and converged access, ACLs can now be applied to wireless clients as they are applied on wired ports/clients. The Cisco Catalyst 3850 has more ternary content-addressable memory (TCAM) space assigned for ACLs than 3K-X switches. The following paragraphs describe some of the scalability numbers.

Table 1 summarizes the access control entries (ACEs) scalability.

Table 1. Scale Numbers

ACL Resources	Cisco Catalyst 3850
IPv4 ACE	3000 entries
IPv6 ACE	1500 entries
L4OPs/ACL	8 L4OPs

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The total capacity of the ACEs is an aggregate number that constitutes all types of ACEs. One type of ACE, however, can scale up to 1500. For example, the total number of Port ACL (PACL) **access control entries** cannot exceed 1500. But a combination of PACL and Router ACL (RACL) **access control entries** can scale up to 3000.

Cisco Catalyst 3850 Quality of Service

One of the primary advantages of the Cisco Catalyst 3850 is the visibility into wireless packets at the access layer. This visibility is a powerful feature and enables network administrators to apply the rich intelligent services of wired traffic and extend these services to wireless traffic as well. QoS is one of the features that can be applied on wireless traffic similar to that of being applied on wired network.

Significant QoS features have been introduced for wired as well as wireless on the Cisco Catalyst 3850. Some of them are the following and are discussed in detail later in the document:

- Modular QoS CLI (MQC)
- Approximate Fair-Drop (AFD) algorithm for bandwidth management across wireless users, providing hierarchical support across access points, radios, Basic Service Set Identifier (BSSID), and clients.
- Eight queues per port (wired) and 4 queues per port (wireless)
- Bidirectional policing support in hardware for wireless clients
- Two-level hierarchical QoS on wired ports
- Per-SSID bandwidth management; differentiated bandwidth management across SSIDs

Because of the inherent differences of wired and wireless media and transmission methods, there are differences between wired and wireless QoS.

Wired QoS on the Cisco Catalyst 3850 is explained later, followed by wireless QoS in the following section.

Wired Quality of Service

Cisco Catalyst 3850 Trust Behavior

The trust behavior on the Cisco Catalyst 3850 has changed from the that of Cisco Catalyst 3K Series switches. By default, the Cisco Catalyst 3850 trusts markings on the wired ports. For wired ports, differentiated services code point (DSCP) markings in IP packets from endpoints such as IP phones, telepresence units, cameras, and laptops are trusted and retained.

Retained markings are summarized in Table 2.

Table 2. Trust Behavior

Incoming Packet	Outgoing Packet	Trust Behavior
L3	L3	Preserve DSCP/precedence
L2	L2	Not applicable
Tagged	Tagged	Preserve DSCP and class of service (CoS)
L3	Tagged	Preserve DSCP; CoS is set to 0

With the introduction of MQC, the “trust cos/dscp” CLI has been deprecated on the Cisco Catalyst 3850. However, “trust device” on the interface level is still supported. The default mode on the interface is **trusted** and changes to **untrusted** only when an untrusted device is detected. In the untrusted mode, the DSCP/precedence/CoS will be reset to 0.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Unlike wired, wireless is considered untrusted on the Cisco Catalyst 3850. The default trust setting for wireless target is **untrust**: that is, the packets are marked down to 0 in the absence of SSID-based policy.

The startup configuration on the Cisco Catalyst 3850 always has the following CLI:

```
qos wireless-default-untrust
```

This CLI is part of the default configuration (automatically created) and cannot be modified in the current release. That means the wireless will always be untrusted.

If trust behavior (similar to wired) is desired on wireless, table-maps need to be defined. The option of default copy can be used to protect the markings in the table-maps.

Marking on the downstream traffic is not being preserved on wireless targets. Therefore, a table-map is required in the downstream direction to retain the markings.

The following is a sample table-map that will retain the markings:

```
table-map dscp2dscp
 default copy
!
```

Configuring Ingress Quality of Service

Ingress Classification

When creating QoS classification policies, the network administrator must consider applications that are to be present at the access layer of the network (in the ingress direction). The applications present at the access edge need to be classified to mark them with appropriate marking and/or policing.

MQC offers scalability and flexibility in configuring QoS and provides consistent configuration across various Cisco switches and routers. The following sample configuration creates an extended access list for each application and then applies it under class-map configuration mode:

```
ip access-list extended BULK-DATA
 remark FTP
 permit tcp any any eq ftp
 permit tcp any any eq ftp-data
..
..
..
ip access-list extended DEFAULT
 remark EXPLICIT CLASS-DEFAULT
 permit ip any any
ip access-list extended MULTIMEDIA-CONFERENCING
 remark RTP
 permit udp any any range 16384 32767
ip access-list extended SCAVENGER
 remark KAZAA
 permit tcp any any eq 1214
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
 permit udp any any eq 1214
ip access-list extended SIGNALING
 remark SCCP
 permit tcp any any range 2000 2002
 remark SIP
 permit tcp any any range 5060 5061
 permit udp any any range 5060 5061
ip access-list extended TRANSACTIONAL-DATA
 remark HTTPS
 permit tcp any any eq 443
```

```
remark ORACLE-SQL*NET

permit tcp any any eq 1521
 permit udp any any eq 1521
```

The following is the configuration for creating a class-map for each application service and applying match statements:

```
class-map match-any BULK-DATA
  match access-group name BULK-DATA
class-map match-any VVLAN-SIGNALING
  match ip dscp cs3
class-map match-any MULTIMEDIA-CONFERENCING
  match access-group name MULTIMEDIA-CONFERENCING
class-map match-any DEFAULT
  match access-group name DEFAULT
class-map match-any SCAVENGER
  match access-group name SCAVENGER
class-map match-any SIGNALING
  match access-group name SIGNALING
class-map match-any VVLAN-VOIP
  match ip dscp ef
class-map match-any TRANSACTIONAL-DATA
  match access-group name TRANSACTIONAL-DATA
```

Ingress Marking and Policing

It is important to limit the bandwidth that each class may use at the access layer in the ingress direction. To achieve proper policing, accurate DSCP marking on ingress traffic at the access-layer switch is critical. It is best to use an explicit marking command for all trusted application classes.

There are two methods for ingress marking. These are “table-map” and “set” commands. For marking down, however, table-map is the only option that can be used.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

With table-maps, one can create a map of values that can be used between the same or different markings such as DSCP, CoS, and so on. The values that can be mapped are from 0 through 99 in decimal. Table-map also has a default mode of operation for values that do not have a mapping explicitly configured. If it is set to ignore, there will not be any change to the marking, unless an explicit mapping is configured. It can be configured to copy or to set a specific value.

The following is a sample table-map configuration:

```
table-map cos2cos
     default copy

policy-map cos-trust-policy
   class class-default
        set cos cos table cos2cos
```

The following sample configuration shows how to configure policing for multiple classes on ingress ports in access-layer switches:

```
policy-map Phone+PC-Policy
 class VVLAN-VOIP
  police 128000 8000 conform-action transmit exceed-action drop
  set dscp ef
 class VVLAN-SIGNALING
  police 32000 8000 conform-action transmit exceed-action drop
  set dscp cs3
 class MULTIMEDIA-CONFERENCING
  police 5000000 8000 conform-action transmit exceed-action drop
  set dscp af41
 class SIGNALING
  police 32000 8000 conform-action transmit exceed-action drop
  set dscp cs3
 class TRANSACTIONAL-DATA
  police 10000000 8000 conform-action transmit exceed-action set-dscp-transmit
  dscp table markdown
  set dscp af21
 class BULK-DATA
  police 10000000 8000 conform-action transmit exceed-action set-dscp-transmit
  dscp table markdown
  set dscp af11
 class SCAVENGER
  police 10000000 8000 conform-action transmit exceed-action drop
  set dscp cs1
 class DEFAULT
  police 10000000 8000 conform-action transmit exceed-action set-dscp-transmit
  dscp table markdown
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Applying Ingress Policies

Like other Cisco Catalyst platforms, Cisco Catalyst 3850 Switches offer two simplified methods to apply service policies. Depending on the deployment model, either of the following methods may be used:

- **Port-based QoS**: Applying service policy on a per-physical port basis will force traffic to pass through QoS policies before entering the network.
- **VLAN-based QoS**: Applying service policy on per-VLAN basis requires the policy map to be attached to a logical Layer 3 interface or Switch Virtual Interface (SVI).

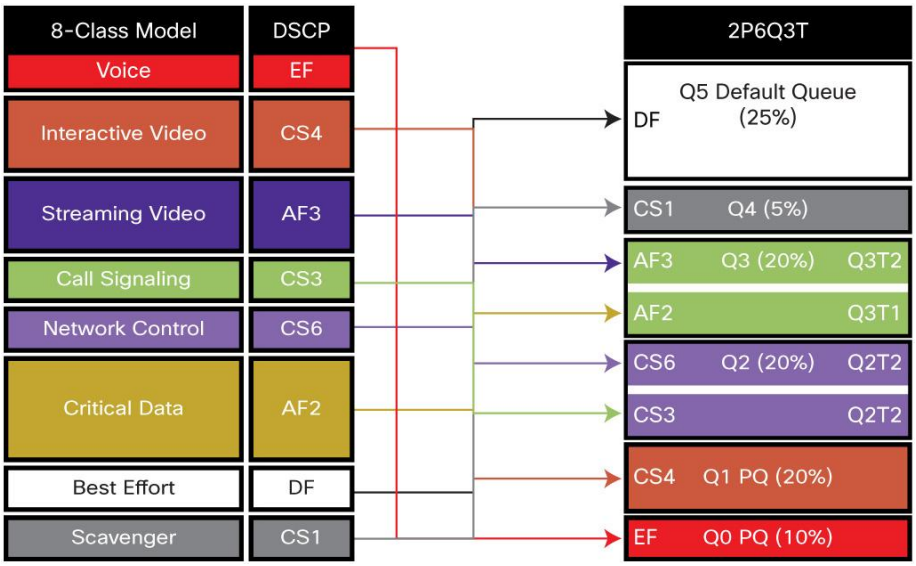
The following sample configuration shows how to deploy port-based QoS on the access-layer switches:

```
interface fastethernet0/4
 description CONNECTED TO PHONE+PC
  service-policy input Phone+PC-Policy
```

Egress Quality of Service

The Cisco Catalyst 3850 has eight queues per wired port. The switch can be configured to work in 2P6Q3T mode. Voice over IP (VoIP) Expedited Forwarding (EF) and broadcast video Class Selector 5 (CS5) can be assigned to the priority queues. Figure 5 illustrates 2P6Q3T mode.

Figure 5. 2P6Q3T Mode




```
class-map VOICEQ
match dscp ef

class-map match-any VIDEOQ
match dscp cs4

class-map NETWORK-MGMT
match dscp cs6
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
class-map CALL-SIG
match dscp cs3

class-map CRITICAL-DATA
match dscp af21 af22 af23

class-map VIDEO-STREAM
match dscp af31 af32 af33

class-map Scavenger-Q
match dscp cs1
```

After traffic is identified using DSCP, policy bases can be applied on classifications.

```
policy-map 2P6Q3T
 class VOICEQ
  priority level 1
 class VIDEOQ
  priority level 2
class NETWORK-MGMT
 bandwidth remaining percent 10
 class CALL-SIG
  bandwidth remaining percent 10
 class CRITICAL-DATA
  bandwidth remaining percent 10
 class VIDEO-STREAM
  bandwidth remaining percent 10
 class SCAVENGER
  bandwidth remaining percent 1
 class class-default
  bandwidth remaining percent 25
```

The egress policy can be applied to the port or L3 interface similar to the ingress policy.

Wireless Quality of Service

Wireless Targets

In wireless QoS, there are two terms: upstream and downstream. Upstream means ingressing from the access point and egressing from the wired network. Downstream means ingressing from the wired network and egressing out to the access point. The following table summarizes the QoS marking/policing and queuing capabilities on each type of target interface: access point, radio, SSID, and client.

In wireless targets, QoS policies can be applied on multiple levels. Each of these targets is discussed in the following sections.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Interface	Upstream (Ingress)		Downstream (Egress)	
	Mark/Police	Queuing	Mark/Police	Queuing
Port	No	No	No	YES
Radio	*No*	*No*	*No*	*YES*
SSID	YES	No	YES	YES
Client	YES	No	YES	AFD Rate-Limit

Wireless: Ingress Quality of Service

Ingress Marking and Policing on Wireless Client

In the ingress direction, traffic can be marked and policed at client level. The following example provides differentiated marking and policing for the different class of application sourced from the client:

```
policy-map PER-CLIENT
 class VOICE
   set dscp ef
    police 128k 8000 exceed-action drop
 class SIGNALING
  set dscp cs3
    police 32k 8000 exceed-action drop
 class MULTIMEDIA-CONFERENCING
   set dscp af41
    police 5m 8000 exceed-action drop
 class TRANSACTIONAL
   set dscp af21
 class CLASS-DEFAULT
   set dscp default
```

The client policy can be applied directly under the SSID interface (as in the following), or it can be pushed from the policy server (ISE).

```
wlan open 1 Employees
service-policy client input PER-CLIENT
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The applied policy can be shown with the following CLI:

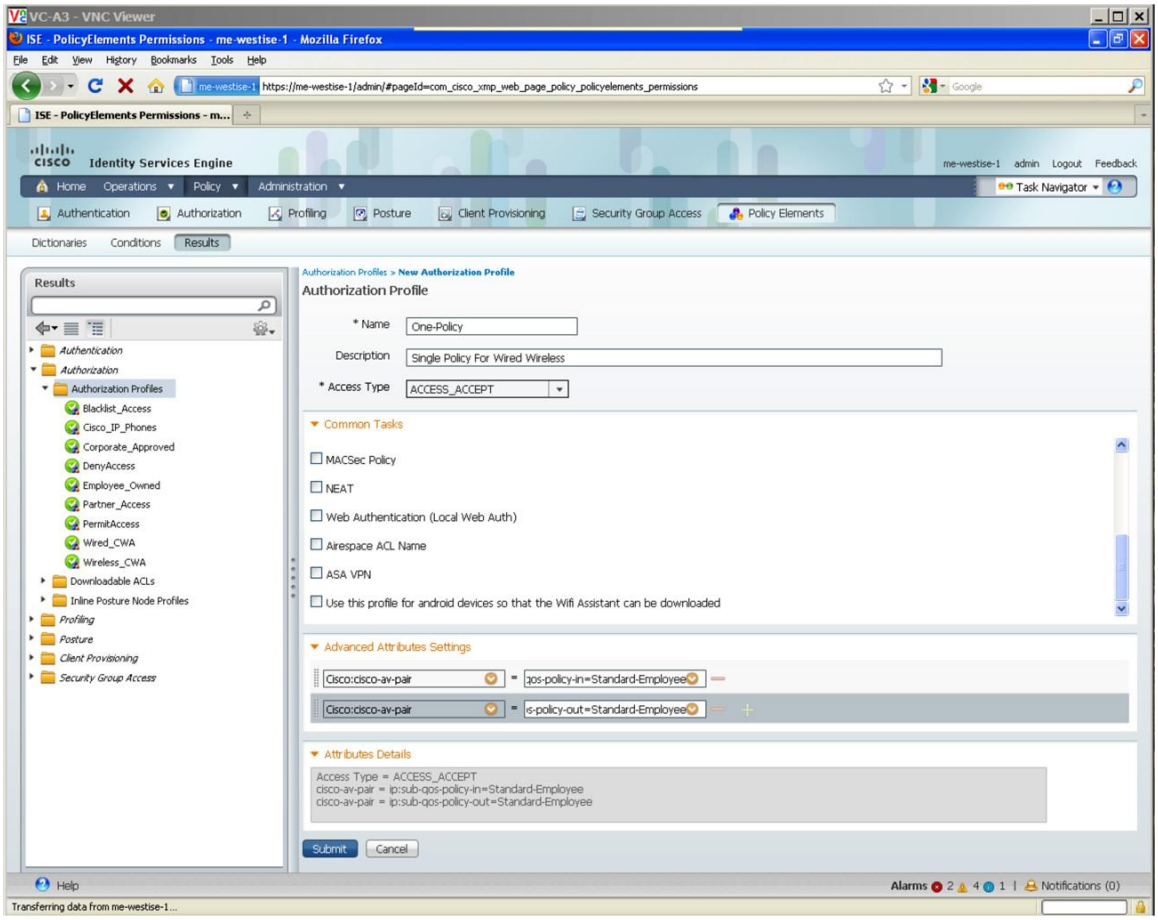
```
Switch# sh policy-map interface wireless client
Client 000A.CC10.0001
  Service-policy input: Standard-Employee
    Class-map: Voice (match-all)
      Match: access-group name Voice
      police:
          cir 128000 bps, bc 4000 bytes
        conformed 0 bytes; actions:
          transmit
…
      QoS Set
        dscp ef
…
    Class-map: TRANSACTIONAL-DATA (match-all)
      Match: access-group name TRANSACTIONAL-DATA
      QoS Set
        dscp af21
    Class-map: class-default (match-any)
      Match: any
      QoS Set
        dscp default
```

The preceding configuration enforces the policer per wireless client that joined on the SSID. In this case the Cisco Catalyst 3850 uses microflow policers that act per client.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

If the policy name is downloaded from the ISE server, the server needs to be configured as shown in Figure 6, with the AV pair ip:sub-qos-policy-in=Standard-Employee.

Figure 6. Authentication Profile



The same policy can be applied for open wired ports as well. The policy needs to be attached to the port and not to the clients. Currently QoS policies cannot be attached to wired “clients.”

Note: Wired port application is described earlier in the wired section.

Ingress Policies on WLAN/SSID

Although the policy application happens at the WLAN level from a CLI standpoint, the policies are actually applied to every instance of the SSID in each of the <access point, radio> pairs in the system. This is internally referred to as the BSSID. SSID is used synonymously with BSSID in this document. At SSID level we can police and mark. However, at SSID level, marking is only possible with a table-map. In the following example only table-map with a default action of copy is defined. It retains the incoming DSCP in the IP packet.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
table-map dscp2dscp
   default copy

Policy-map TRUST
Table Map dscp2dscp
   default copy
```

The QoS policy is applied under the WLAN configuration. The SSID policy is applied as shown in the following example. This results in “trusted” behavior for traffic ingressing from wireless, similar to wired.

```
wlan open 1 Employees
service-policy input TRUST
```

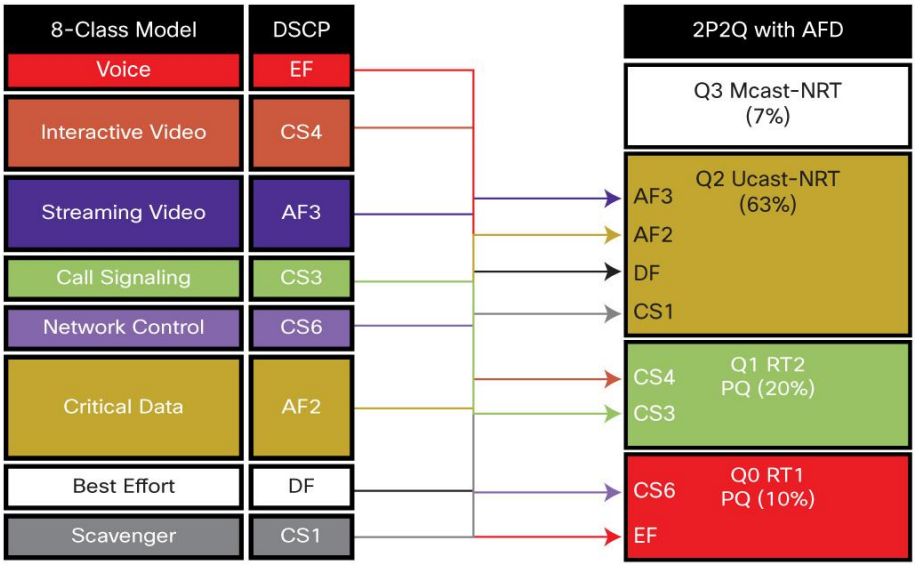
Wireless: Egress Quality of Service

This explains the capabilities of QoS that are available on the Cisco Catalyst 3850. On the egress (downstream), QoS capabilities exist per access point, radio, SSID, and client.

Policy on Access Point/Port

The ports that are connected to access points are termed wireless ports throughout this document. There are four queues on the wireless ports to match the four queues on the access point. The queue structure is 2P2Q3T: two priority queues, and two SRR queues, with three thresholds each. The recommended queuing configuration in a 2P2Q3T structure is shown in Figure 7.

Figure 7. 2P2Q3T Queue Model for Queuing Application Traffic



Four queues are created at the port level when a port is configured as a wireless port: real time 1 (RT1), RT2, unicast non real time (NRT), and multicast nonclient NRT.

The multicast nonclient is classified as any traffic that has a destination IP address of multicast or broadcast.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The following is the default behavior of the four queues:

Q0 (RT1): Control traffic

Q1 (RT2): None

Q2 (NRT): Everything other than multicast NRT and control traffic

Q3 (multicast NRT): Multicast and nonclient traffic

Default QoS policy is applied to the wireless port in the downstream (egress) direction. On port level no policy is supported in upstream (ingress) direction. The policy on the port is applied to the CAPWAP encapsulated packets egressing out to the access point.

The default wireless port policy includes a port shaper and a child policy. The parent policy cannot be modified by user and is controlled by the WCM. This parent policy has a port shaper that is the sum of the radio rates on the access point. The child policy on the wireless port is user configurable.

The following describes default child policy configuration:

```
policy-map port_child_policy
 class non-client-nrt-class
    bandwidth remaining ratio 10
```

The following is the overall wireless port policy:

```
Switch#sh policy-map in gig1/0/3
 GigabitEthernet1/0/3

  Service-policy output: defportangn

    Class-map: class-default (match-any)
      Match: any
      Queueing

      (total drops) 0
      (bytes output) 17633136
      shape (average) cir 600000000, bc 2400000, be 2400000
      target shape rate 600000000

      Service-policy : port_child_policy

        Class-map: non-client-nrt-class (match-any)
          Match: non-client-nrt
          Queueing

          (total drops) 0
          (bytes output) 17633136
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
            bandwidth remaining ratio 10

          Class-map: class-default (match-any)
            Match: any

            (total drops) 0
            (bytes output) 0
```

The “port_child_policy” can be modified by the user to queue different application traffic at the SSID level. This traffic is queued toward the appropriate queues at the port level. The following is the “port_child_policy” configuration example:

```
Switch#sh run policy-map port_child_policy
Building configuration...
Current configuration : 227 bytes
!
 class non-client-nrt-class
    bandwidth remaining ratio 10
 class voice
    priority level 1
    police 20000
 class video
    priority level 2
    police 20000
 class class-default
    bandwidth remaining ratio 25
```

The “police 20000” statement in the “class voice” and “class video” polices aggregates multicast traffic for each class at the port/access point level. It does not police unicast traffic that is classified using the “voice” and “video” class-maps.

Policy on Radio

Radio-level policy is not user configurable. This is a rate limiter that limits all traffic going to the radio. Currently only two radios are supported per access point, and hence two rate limiters supported per access point. The Cisco Catalyst 3850 polls the access point to discover the maximum rate of the radio, and a shaper is placed in order to limit the oversubscription of the radio. Based on the discovery of maximum rate, the rate limiter can limit at 200 or 400 Mbps for 2.4G and 5G bands, respectively.

The following is the policy at radio level:

```
Switch#sh policy-map interface wireless radio

Radio dot11b iifid: 0x104F10000000011.0xC9CA4000000004

  Service-policy output: def-11gn

    Class-map: class-default (match-any)
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
        Match: any
        shape (average) cir 200000000, bc 800000, be 800000
        target shape rate 200000000

  Radio dot11a iifid: 0x104F10000000011.0xCF8F4000000005

    Service-policy output: def-11an

      Class-map: class-default (match-any)
        Match: any
        shape (average) cir 400000000, bc 1600000, be 1600000
        target shape rate 400000000
```

Although the preceding policy shows its shaping, it does not buffer or smooth out the rate. Essentially this is a rate limiter at radio level.

Policy on Service Set Identification

Policy at SSID level or at BSSID level is user configurable in both upstream and downstream directions. SSID-level policies are applied in the WLAN configuration mode.

In downstream direction, the recommended policy is a hierarchical queuing policy with table-map-based marking in the parent class default. In absence of a table-map configuration in the SSID, the packets are all remarked down to 0. The packets are sent through the NRT queue at the port level. This is because the WLAN is considered to be untrusted in the absence of a table-map.

If voice/video traffic needs to be prioritized, the child policy-maps on both the port/access point and SSID should be configured with class-maps and appropriate actions. If the child policy for voice/video differentiation is missing on either one of the targets (port/access point and/or SSID), the voice and video traffic will not be prioritized on the wireless network.

The following is an example of two SSIDs: enterprise and guest. The voice/video traffic is prioritized on the enterprise, while the guest traffic is classified as default and given the appropriate queuing treatment.

```
Policy-map enterprise-ssid-child
     Class  voice
          Priority level 1
         Police  20000
Class video
        Priority level 2
        Police  20000
Policy-map enterprise-ssid
Class class-default
        bandwidth remaining percent 70
     set wlan-user-priority dscp dscp2up1
        set dscp dscp dscp2dscp1
        service-policy enterprise-ssid-child
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
Policy-map guest-ssid
Class class-default
      Shape average percent 20
```

On the enterprise SSID class-map voice and video, the policer enforces the aggregate unicast traffic at the BSSID level. The class default is configured to provide a minimum bandwidth allocation to the enterprise SSID, which is able to utilize the additional unused bandwidth in the absence of congestion.

The class default on the guest SSID, however, is shaped to 20 percent of the available bandwidth irrespective of the bandwidth utilization and congestion.

Client

Client policies can be applied in both upstream and downstream directions. Client policies are user configurable and can be applied under the WLAN configuration mode. When applied in WLAN configuration mode, all clients under SSID receive the same policy, but the policy enforcement is done on a per-user basis using microflow policing.

The client-level policy can also be applied from the AAA server. The policy is defined locally on the switch, and the name of the policy is downloaded from the AAA server at the time of client authorization. With the help of downloadable policies, any differentiated policy can be applied for clients or client groups.

After the client policy is associated with a client, the client policy can be looked up using the client MAC address.

The following is the output of a client policy-map applied in the egress (downstream) direction:

```
Switch#sh policy-map interface wireless client mac b065.bdbf.77a3

Client B065.BDBF.77A3 iifid:
0x1047D4000000011.0xD7E4C000000076.0xDD94000000028D.0xFCEBC000000373

  Service-policy output: egress-client

    Class-map: class-default (match-any)
      Match: any
      police:
          cir 500000 bps, bc 15625 bytes
        conformed 404432 bytes; actions:
          transmit
        exceeded 0 bytes; actions:
          drop
        conformed 0000 bps, exceed 0000 bps
```

Flexible NetFlow

Flexible NetFlow (FnF) is an integral part of Cisco IOS Software that collects and measures data, allowing all routers or switches in the network to become a source of telemetry and a monitoring device. FnF allows extremely granular and accurate traffic measurements and high-level aggregated traffic collection. FnF provides real-time network monitoring, security incident detection, and classification of flow of network traffic.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Cisco Catalyst 3850 NetFlow Architecture (Wired and Wireless)

NetFlow Cisco Catalyst 3850 Overview

The Cisco Catalyst 3850 supports both ingress and egress FnF on all ports of the switch at line rate. Switch raw scalability is up to 24K cached flows, whereas it is 8K for ingress and 16K for egress per UADP ASIC. The Cisco Catalyst 3850 supports NetFlow Version 9, with IPv4, IPv6, Layer 2 flows, and sampled NetFlow. TCP flags are also exported as part of the flow information. When Cisco Catalyst 3850 switches are stacked together, each individual stack member exports its own flows to the collector. The Cisco Catalyst 3850 supports up to 16 flow monitors with eight different collectors simultaneously per flow monitor. Microflow policing is supported only for wireless clients.

The FnF feature on the Cisco Catalyst 3850 is enabled on the IP base version and earlier. The Cisco Catalyst 3850 48-port switch has two UADP ASICs per switch, and the Cisco Catalyst 3850 24-port switch has one UADP ASIC.

NetFlow Configuration on Cisco Catalyst 3850 Switch

There are three components of FnF configuration: flow record, flow exporter, and flow monitor.

Flow Record

The NetFlow flow record is made up of primary fields and nonprimary fields. Primary fields are the fields from packet headers that are used for classifying and characterizing the flow. Additional information can be added to the flow record, and this information is contained in nonprimary fields. Match commands as seen in the following are used to define primary fields, while collect commands are used to define the nonprimary fields.

Configuring a Flow Record (Ingress)

```
flow record v4
 match ipv4 tos
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 collect interface output
 collect transport tcp flags
 collect counter bytes long
 collect counter packets long
 collect timestamp absolute first
 collect timestamp absolute last
 collect counter bytes layer2 long
```

Note: “match interface output” cannot be configured in the ingress flow monitor. In order to get the egress interface information, use the “collect interface output” command in an ingress flow record.

Similarly, “match interface input” is not supported on an egress flow record; use “collect interface input” as shown in the following:

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Configuring a Flow Record (Egress)

```
flow record v4out
 match ipv4 protocol
 match ipv4 tos
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface output
 collect interface input
 collect transport tcp flags
 collect counter bytes long
 collect counter packets long
 collect timestamp absolute first
 collect timestamp absolute last
 collect counter bytes layer2 long
```

Exporter/Collector Information

There are two primary methods to access NetFlow data: using a CLI with show commands or using an application that receives exported NetFlow information sent periodically by the switch.

```
flow exporter Collector
destination 10.1.1.28
dscp 48
transport udp 2055
template data timeout 30
option exporter-stats timeout 30
```

Flow exporter commands specify the destination IP address of the exporter/collector. DSCP specifies the DSCP value for datagrams sent to the exporter/collector. The next command specifies the L4 port on which the exporter/collector application listens for the NetFlow export packets from the switch. Template commands enable the switch to send the NetFlow template after specified number of seconds to the exporter/collector. The Cisco Catalyst 3850 supports up to eight different exporters/collectors simultaneously per flow monitor.

Flow Monitor

Flow monitors are the FnF component that is applied to interfaces. Flow monitors consist of a record, cache parameters, and the exporter/collector. The flow monitor cache is automatically created at the time the flow monitor is configured on the first interface.

Flow monitor is the container for the following information:

- Flow record
- Flow cache parameters
- Exporter/collector information

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
flow monitor v4
   exporter Collector
   exporter Collector 1
   cache timeout active 60
   cache timeout inactive 20
record v4
```

Attaching a Flow Monitor to Supported Port Types

Wired Port

```
interface GigabitEthernet1/0/1
   description Interface for WIRED CLIENT in CONVERGED VLAN
   switchport access vlan 10
   switchport mode access
   ip flow monitor v4 input
   ip flow monitor v4out output
   load-interval 30
  no shutdown
!
```

Wireless WLAN Port

```
wlan SSID 1 SSID
 client vlan 12
 ip flow monitor v4 input
 ip flow monitor v4out output
no shutdown
!
```

VLAN Interface

```
Vlan configuration 500
 ip flow monitor v4 input
 ip flow monitor v4out output
!
```

Configure Simple Network Management Protocol for Exporter

```
snmp-server community public RO
snmp-server community private RO
```

Simple Network Management Protocol (SNMP) configurations enable the external collectors to read the configuration related to NetFlow on the switch and collect flows.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Flexible NetFlow Outputs

```
To display the status and statistics for a flexible NetFlow flow monitor, use the
"Show Flow monitor" command in privileged EXEC mode.
Switch# show flow monitor
Flow Monitor v4:
  Description:       User defined
  Flow Record:       v4
  Flow Exporter:     Collector
  Cache:
    Type:              normal (Platform cache)
    Status:            allocated
    Size:              Unknown
    Inactive Timeout:  15 secs
    Active Timeout:    60 secs
    Update Timeout:    1800 secs
```

To display the flexible NetFlow configuration status for an interface, use the "Show Flow Interface" commands in privileged EXEC mode.

```
Switch# show flow interface
Interface GigabitEthernet2/0/26
  FNF:  monitor:            v4
        direction:          Input
        traffic(ip):        on
  FNF:  monitor:            v4out
        direction:          Output
        traffic(ip):        on
```

To display aggregated flow statistics from a flow monitor cache, use the "Show flow monitor cache format table" command.

```
Switch# Show flow monitor v4 cache format table
Cache type:                               Normal (Platform cache)
  Cache size:                              Unknown
  Current entries:                                2

  Flows added:                                26492
  Flows aged:                                 26490
    - Active timeout      (  1800 secs)           4
    - Inactive timeout    (    15 secs)       26486
IPV4-SRC-ADDR DST-ADDR SRC-PORT DST-PORT INTF-INPUT intf-output bytes-long pkts-
long time-abs-first time-abs-last
===============  ===============  =============  =============
====================
10.1.22.102 10.1.1.22  52226  5060  Gi1/0/4 LIIN0  1038  3    19:52:12.755
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
19:52:12.755
10.1.22.101 10.1.1.22  51524  5060  Gi1/0/3 LIIN0  1038  3    19:52:10.755
19:52:10.755
```

To display top N destination aggregated flow statistics from a flow monitor cache, use the following command.

```
Switch# show flow monitor v4 cache aggregate ipv4 destination add sort counter
bytes long top 4
Processed 4 flow
Aggregated to 4 flow
Showing the top 4 flow

IPV4 DST ADDR         flows            bytes long             pkts long
===============  ==========  ====================  ====================
10.1.1.22                1                  1038                     3
10.1.1.92                2                  1038                     3
10.1.1.82                4                  1038                     3
10.1.1.52                9                  1038                     3
```

To display top N source address aggregated flow statistics from a flow monitor cache, use the following command.

```
Switch# sh flow monitor v4 cache aggregate ipv4 source address sort highest ipv4
source address top 2
Processed 2 flows
Aggregated to 2 flows
Showing the top 2 flows


IPV4 SRC ADDR         flows            bytes long             pkts long
===============  ==========  ====================  ====================
10.1.22.102              1                  1038                     3
10.1.22.101              1                  1038                     3
```

To display the status and statistics for IPv6 flexible NetFlow flow monitor, use the “Show Flow monitor” command in privileged EXEC mode.

```
Switch# show flow moni v6_m1 cache format table
  Cache type:                               Normal (Platform cache)
  Cache size:                              Unknown
  Current entries:                              12

  Flows added:                                  30
  Flows aged:                                   18
    - Inactive timeout     (    15 secs)        18
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
IPV6 SRC ADDR  IPV6 DST ADDR   TRNS  SRC PORT  TRNS DST PROT  bytes long pkts
long
=========================================  ==================
2322::2   FF02::1:FF00:1   0   34560   58    72           1
2322::2   2201::2          1024 1026   17    9166290      43649
2322::2   2201::2          1024 1027   17    9166290      43649
2322::2   2201::2          1024 1024   17    9166500      43650
```

To display top N IPv6 destination address aggregated flow statistics from a flow monitor cache, use the following command:

```
Switch# show flow monitor v6_m1 cache aggregate ipv6 destination address sort
counter bytes long top 2
Processed 10 flows
Aggregated to 2 flows
Showing the top 2 flows

IPV6 DESTINATION ADDRESS:  2322::2
counter flows:             5
counter bytes long:        3278889600
counter packets long:      15613760

IPV6 DESTINATION ADDRESS:  2201::2
counter flows:             5
counter bytes long:        3221137920
counter packets long:      15338752
```

To display top N source address aggregated flow statistics from a flow monitor cache, use the following command:

```
Switch# show flow monitor v6_m1 cache aggregate ipv6 source address sort highest
ipv6 source address top 2
Showing the top 2 flows

IPV6 SOURCE ADDRESS:   2322::2
counter flows:         5
counter bytes long:    3919704180
counter packets long:  18665258

IPV6 SOURCE ADDRESS:   2201::2
counter flows:         5
counter bytes long:    3913954800
counter packets long:  18637880
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Multicast Overview (Traditional and Converged Multicast)

Efficient and intelligent use of bandwidth is paramount, particularly with the advent of video, mobility, and cloud technologies. It is also critical considering the surge in related one-to-many or many-to-many communication-based applications. Multicast helps to fulfill the requirement of such bandwidth-intensive applications with its inherent ability to replicate a single stream when and where necessary.

In today's network, replication for wired clients is performed at the network switches. There are two methods that multicast works in wireless. Either the controller replicates to the access points that have interested clients, or the controller replicates one packet to the multicast group address to which all access points are joined, offloading the replication to the multicast-enabled network infrastructure. Hence there is a duplication of one multicast source stream: one for wired, one for wireless.

With the Cisco Catalyst 3850 and the wired/wireless convergence, there is only one multicast source stream in the network. The Cisco Catalyst 3850 replicates this stream to both wired and wireless clients. This helps in reducing the number of streams from the same source, thus conserving bandwidth and enhancing overall network performance.

The wired multicast configuration is the same as that of existing Cisco Catalyst 3K Series switches. Refer to the IP Multicast Configuration Guide for configuring IP multicast on the wired network.

Restrictions of IP Multicast Routing Configuration

The following are the restrictions for configuring IP multicast routing:

- IP multicast routing is not supported on switches running the LAN Base feature set.
- Multicast Flexlink is not supported on the switch.
- Layer 3 IPv6 multicast routing is not supported on the switch.

Configuring Wireless IP Multicast on Cisco Catalyst 3850

There are two modes in which wireless multicast works on the Cisco Catalyst 3850. In the basic mode, the switch replicates individual packets to only those ports where the access point has interested clients. In this mode, the replication of packets occurs before the CAPWAP encapsulation is added to the packet, destined to each interested access point. This increases the recirculation on the switch since each packet to each access point is passed through the recirculation block. However, this leads to efficient use of bandwidth in the switch since the replicated packets are only sent to those access points that have interested clients.

In multicast-multicast mode, the switch and all the access points connected to it join one unique multicast group that is not used anywhere else in the network. The ingress source stream from the campus network is replicated once and encapsulated in CAPWAP with the destination address of this multicast group (formed between the switch and all access points). In this mode, the replication happens only once for the group - hence only one recirculation for CAPWAP encapsulation - and this packet is transmitted to all the connected access points. In this mode, number of packets being switched by the UADP ASIC is optimized over the cost of switch bandwidth. The switch always uses the management interface IP address as the source for sending these CAPWAP-encapsulated multicast packets. The access point decapsulates the outer CAPWAP header and sends the original multicast packets as broadcast at the lowest data rate on all BSSID and radio.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The videostream mode is a further enhancement of the preceding. Instead of sending the multicast as broadcast at the lowest data rate, the access point converts the original multicast packet as unicast and sends it only to the interested client at the highest available data rate. This works the same way as it works in today's Cisco Unified Wireless Network as the function is performed at the access point level.

The following commands enable wireless multicast on the Cisco Catalyst 3850 Switch:

```
Switch#conf t
Switch(config)#ip multicast-routing
Switch(config)#wireless multicast
Switch(config)#wireless broadcast
Switch(config)#Wireless multicast non-ip
Switch(config)#interface interface-id
Switch(config-if)# ip pim {dense-mode | Sparse-Mode | Sparse-dense-mode}
Switch(config)#vlan configuration <id>
Switch(config-vlan)#ipv6 nd suppress
Switch(config-vlan)#ipv6 snooping
Switch(config-vlan)#end
Switch#copy running-config startup-config
```

Irrespective of multicast routing being enabled, Internet Group Management Protocol (IGMP) snooping must be enabled on the client VLAN for wireless clients to receive IP multicast traffic.

To enable multicast routing on a Cisco Catalyst 3850 Switch, the "ip multicast-routing" command is used. To send multicast on wireless to all clients (interested in multicast or not), the "wireless-multicast" command is used. "Wireless-broadcast" command enables broadcasting of packets on wireless data plane of switch.

To enable multicast flooding on wireless, the "wireless multicast non-ip" command can be used.

Multicast Mode Configuration

Wireless multicast packets are required to be sent to the access point as CAPWAP encapped packet in a unicast tunnel or a multicast tunnel. When multicast mode is enabled, WCM creates a multicast CAPWAP tunnel in Cisco IOS Software and converts the access point tunnels to multicast mode pointing to the multicast tunnel.

When an access point is in multicast mode, the multicast/broadcast packets to the client behind this access point are sent to this access point in an outer multicast tunnel.

All the access points in the multicast mode must watch for the multicast group, which is specified while creating the multicast tunnel. Following is a multicast mode configuration:

```
Switch# conf t
Switch(config)# ap capwap multicast <Multicast IP Address>
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Following is the basic configuration of wireless multicast:

- Configure IGMP snooping and querier:

```
Switch(config)#ip igmp snooping
Switch(config)#ip igmp snooping querier
```

- Configure wireless multicast and access point CAPWAP mode:

```
Switch(config)#wireless multicast
Switch(config)#ap capwap multicast 234.5.6.7
```

- Configure multicast routing (3850 only):

```
Switch(config)#ip multicast-routing
Switch(config)#interface vlan 100
Switch(config)# ip pim sparse-dense-mode
```

Multicast Show Commands

You can display information to learn resource usage and solve network problems. You can also display information about node reachability and discover the routing path that packets of your device are taking through the network.

You can use any of the privileged EXEC commands in the following table to display various routing statistics.

To display wireless multicast status on switch and access point multicast mode and each VLAN's broadcast and non-IP multicast status, use the "Show Wireless Multicast" command in privileged EXEC mode.

```
Switch#show wireless multicast
show wireless multicast

Multicast                               : Enabled
AP Capwap Multicast                     : Unicast
Wireless Broadcast                      : Disabled
Wireless Multicast non-ip-mcast         : Disabled

Vlan        Non-ip-mcast     Broadcast        MGID
------------------------------------------------------
1           Enabled          Enabled          Disabled
410         Enabled          Enabled          Disabled
411         Enabled          Enabled          Enabled
412         Disabled         Disabled         Enabled
413         Disabled         Disabled         Enabled
414         Enabled          Enabled          Disabled
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

To display all (S,V,G) list and the corresponding MGID value, use the “Show wireless multicast group summary” command in privileged EXEC mode.

```
Switch#show wireless multicast group summary
IPv4 groups
-------------
MGID        Source             Group              Vlan
-------------------------------------------------------------
4160        0.0.0.0            239.255.67.250     412
4162        0.0.0.0            239.255.255.250    412
4163        0.0.0.0            224.0.1.60         412

Switch#show ip igmp snooping wireless mgid
Total number of L2-MGIDs    = 3

Total number of MCAST MGIDs = 3

 Wireless multicast is Enabled in the system
 Vlan     bcast    nonip-mcast   mcast    mgid    Stdby Flags
 1      Disabled   Disabled   Enabled    Disabled  0:0:1:0
 410    Disabled   Disabled   Enabled    Disabled  0:0:1:0
 411    Disabled   Disabled   Enabled    Enabled   0:0:1:0
 412    Disabled   Disabled   Enabled    Enabled   0:0:1:0
 413    Disabled   Disabled   Enabled    Enabled   0:0:1:0

Index  MGID                  (S, G, V)
-----------------------------------------------------------
160 4163   (0.0.0.0, 224.0.1.60, 412)
409 4162   (0.0.0.0, 239.255.255.250, 412)
409 4160   (0.0.0.0, 239.255.67.250, 412)
```

To display IP IGMP snooping tracking by VLAN on a switch with SVG to client mapping, use the “Show ip igmp snooping igmpv2-tracking” command in privileged EXEC mode.

```
Switch#show ip igmp snooping igmpv2-tracking
Client to SGV mappings
----------------------
Client: 10.33.170.4 Port: Ca1
   Group: 239.255.255.250 Vlan: 412 Source: 0.0.0.0 blacklisted: no

Client: 10.33.170.33 Port: Ca7
   Group: 239.255.255.250 Vlan: 412 Source: 0.0.0.0 blacklisted: no

Client: 10.33.170.75 Port: Ca1
   Group: 239.255.255.250 Vlan: 412 Source: 0.0.0.0 blacklisted: no
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
    Group: 239.255.67.250 Vlan: 412 Source: 0.0.0.0 blacklisted: no

SGV to Client mappings
----------------------
Group: 224.0.1.60 Source: 0.0.0.0 Vlan: 412
    Client: 10.33.170.101 Port: Ca10 Blacklisted: no

Group: 239.255.67.250 Source: 0.0.0.0 Vlan: 412
    Client: 10.33.170.75 Port: Ca1 Blacklisted: no

Group: 239.255.255.250 Source: 0.0.0.0 Vlan: 412
    Client: 10.33.170.75 Port: Ca1 Blacklisted: no
    Client: 10.155.156.71 Port: Ca1 Blacklisted: no
```

To display the detailed information on a particular multicast group with client association, use the “show wireless multicast group vlan” command in privileged EXEC mode.

```
Switch#show wireless multicast group 239.255.255.250 vlan 412
 Source : 0.0.0.0
 Group  : 239.255.255.250
 Vlan   : 412
 MGID   : 4162

 Number of Active Clients : 4
  Client List
 -------------
Client MAC         Client IP         Status
-------------------------------------------------------------
2477.0336.e574     10.33.170.4       MC_ONLY
2477.035e.d848     10.33.170.109     MC_ONLY
6033.4b24.fa89     10.33.170.33      MC_ONLY
7cd1.c391.c674     10.33.170.75      MC_ONLY
```

To display the IP IGMP snooping groups on a switch, use the “show ip igmp snooping groups” command in privileged EXEC mode.

```
Switch#show ip igmp snooping groups
Vlan      Group                   Type        Version     Port List
------------------------------------------------------------------------
412       224.0.1.60              igmp        v2          Ca10
412       239.255.67.250          igmp        v3          Ca1
412       239.255.255.250         igmp        v2,v3       Ca1, Ca7
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

To display the multicast groups that are directly connected to the switch and that were learned through IGMP, use the “show ip igmp groups” command in privileged EXEC mode.

```
Switch#show ip igmp groups
IGMP Connected Group Membership
Group Address    Interface   Uptime    Expires   Last Reporter
239.255.255.255  Vlan413     4d18h     00:02:42  10.32.104.1
239.255.255.255  Vlan412     4d18h     00:01:39  10.33.170.1
239.255.255.250  Vlan412     01:27:18  00:02:45  10.33.170.75
```

To display the reachability to the multicast group with ICMP echo request, use the “Ping” command in privileged EXEC mode.

```
Switch#ping 239.255.255.255
Type escape sequence to abort.
Sending 1, 100-byte ICMP Echos to 239.255.255.255, timeout is 2 seconds:

Reply to request 0 from 10.32.104.1, 20 ms
Reply to request 0 from 10.33.170.1, 20 ms
Reply to request 0 from 10.32.104.1, 20 ms
```

To display multicast-related information of an interface, use the “Show ip igmp interface vlan” command in privileged EXEC mode.

```
Switch#show ip igmp interface vlan412
Vlan412 is up, line protocol is up
  Internet address is 10.33.170.1/24
  IGMP is enabled on interface
  Current IGMP host version is 3
  Current IGMP router version is 3
  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: 43 joins, 38 leaves
  Multicast routing is enabled on interface
  Multicast TTL threshold is 0
  Multicast designated router (DR) is 10.33.170.1 (this system)
  IGMP querying router is 10.33.170.1 (this system)
  Multicast groups joined by this system (number of users):
      224.2.127.254(1)  239.255.255.255(1)
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

To display the IP IGMP membership status of all multicast groups on a switch, use the “show ip igmp membership all” command in privileged EXEC mode.

```
Switch#show ip igmp membership all
Flags: A  - aggregate, T - tracked
       L  - Local, S - static, V - virtual, R - Reported through v3
       I - v3lite, U - Urd, M - SSM (S,G) channel
       1,2,3 - The version of IGMP, the group is in
Channel/Group-Flags:
       / - Filtering entry (Exclude mode (S,G), Include mode (G))
Reporter:
       <mac-or-ip-address> - last reporter if group is not explicitly tracked
       <n>/<m>      - <n> reporter in include mode, <m> reporter in exclude

 Channel/Group         Reporter        Uptime   Exp.  Flags  Interface
 *,239.255.255.255     10.32.104.1     4d18h    02:05 3LA    Vl413
 *,239.255.255.255     10.33.170.1     4d18h    02:59 3LA    Vl412
 *,239.255.255.250     10.33.170.33    01:32:53 02:59 2A     Vl412
```

To display the statistics of a particular multicast group, use the “show ip igmp membership” in privileged EXEC mode.

```
Switch#show ip igmp membership 239.255.255.255
Flags: A  - aggregate, T - tracked
       L  - Local, S - static, V - virtual, R - Reported through v3
       I - v3lite, U - Urd, M - SSM (S,G) channel
       1,2,3 - The version of IGMP, the group is in
Channel/Group-Flags:
       / - Filtering entry (Exclude mode (S,G), Include mode (G))
Reporter:
       <mac-or-ip-address> - last reporter if group is not explicitly tracked
       <n>/<m>      - <n> reporter in include mode, <m> reporter in exclude

 Channel/Group        Reporter        Uptime   Exp.  Flags  Interface
 *,239.255.255.255    10.32.104.1     4d18h    00:39 3LA    Vl413
 *,239.255.255.255    10.33.170.1     4d18h    01:34 3LA    Vl412
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Converged Access with the Cisco Catalyst 3850

The Cisco Catalyst 3850 Switch offers scalable, resilient, and future-proofed wired and wireless services. It serves as an integrated wireless LAN controller for up to 50 Cisco access points and 2000 clients per stack. The Cisco Catalyst 3850 can form the basis of a deployment in which the access points and clients can scale up to 250 Cisco access points and 16,000 clients, respectively. The converged access deployment mode builds on an existing Cisco Unified Wireless Network. For deployments scaling beyond 250 access points and 16k clients, the Cisco Catalyst 3850 can be used with the Cisco 5760 Wireless LAN Controller and can scale up to 72k access points and 864k clients.

The converged access deployment is achieved by distributing some of the functions from the wireless LAN controllers (WLCs) down to the Cisco Catalyst 3850 Switches in the access. The access switches terminate the CAPWAP encapsulated wireless traffic locally, converting the wireless traffic into Ethernet frames. This includes the added advantage of unifying wired and wireless traffic on the switch and makes it possible to apply the rich and intelligent wired services on wireless traffic.

This section explains the converged access deployment with the Cisco Catalyst 3850 Switches.

Before the details are explored, it is important to understand the functions that are distributed down to the access switches.

Distributed Functions Enabling Converged Access

There are two important software functions among others that enable wireless services on WLC.

Mobility Agent

This software function manages CAPWAP tunnel terminations from access points and builds a database of client stations (endpoints) that are served locally as well as roamed from an anchor WLC. The mobility agent also serves the function of 802.1x authenticator, proxy IGMP, and proxy ARP for locally served clients.

Mobility Controller

This complements software functions of the mobility agent and manages mobility (roaming) for client stations from one WLC to another, and provides guest access functionality by building a CAPWAP tunnel with the guest anchor controller in the DMZ. The mobility controller manages the access point licenses as well. It also provides a central way of managing the RF spectrum residing outbound of the access points. This is called radio resource management (RRM) and includes rogue detection, dynamic channel assignment, transmit power on the access points, coverage hole detection, and CleanAir®. In addition, the mobility controller builds a database of client stations across all the mobility agents. The mobility controller is also responsible for caching the pairwise master key (PMK) of all clients on all the mobility agents, enabling fast roaming of the clients within its subdomain and mobility group.

Because of the preceding important functions, a mobility controller is a mandatory element in the converged access deployment. The mobility controller software function runs in the active member of a Cisco Catalyst 3850 Switch stack and can be failed over to the standby member in the stack in the event of an active failover. A switch stack hosting the mobility controller function can also run the mobility agent function on the active member for all the locally connected Cisco access points.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The mobility controller's area of responsibility lies in the mobility subdomain it controls. All the mobility agents in the subdomain form CAPWAP mobility tunnels to the mobility controller and report local and roamed client states to the mobility controller. The mobility controller builds a database of client stations across all the mobility agents.

By distributing these functions in the Cisco Catalyst 3850 Switches in the access, converged access provides scalable, resilient, feature-rich wireless services in conjunction with wired services and features.

Mobility Oracle

This is a software function that is responsible for client station visibility across the mobility controllers (mobility subdomains) in its mobility domain. The mobility oracle is an optional entity in the hierarchy of mobility agent-mobility controller-mobility oracle. The advantage of configuring a mobility oracle for a converged access deployment is that it scales and reduces control events that occur for initial client joins and client roams, especially in a multi-mobility controller environment. This function cannot be hosted on the Cisco Catalyst 3850, and can only be hosted on software-upgraded Cisco 5508 WLC, WiSM2, or Cisco 5760 WLC. Typically the mobility oracle is hosted on a controller appliance running the mobility controller function.

Logical Hierarchical Groupings of Roles

Mobility Group

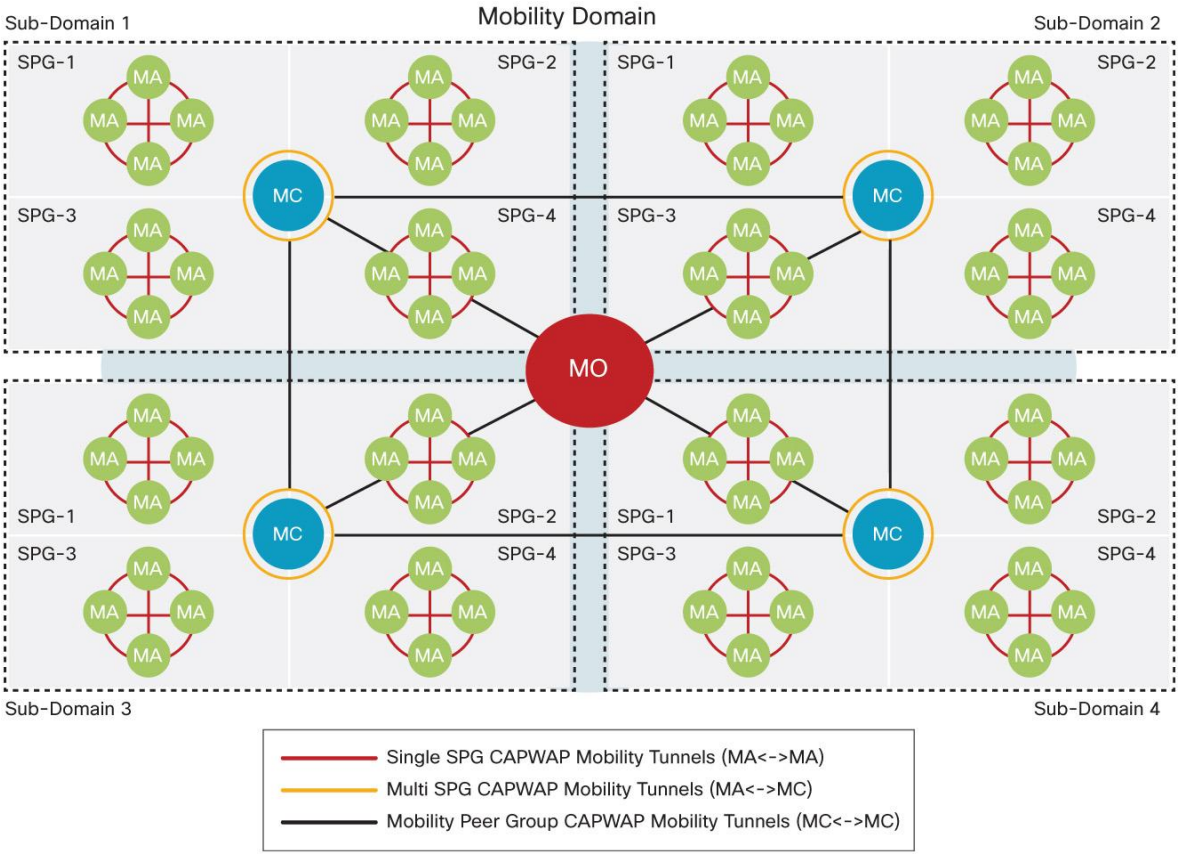
Today's Cisco Unified Wireless Network defines mobility group as a logical group of mobility controllers to enable fast roaming of clients within the mobility controllers of a mobility group.

Switch Peer Group (SPG)

The converged access deployment defines a switch peer group (SPG) as a logical group of mobility agents within one mobility controller (or mobility subdomain). The main advantage of configuring SPGs is to constrain the roaming traffic to switches that form the SPG. When the mobility agents are configured in one SPG on the mobility controller, the software automatically forms full mesh CAPWAP tunnels between the mobility agent switches These CAPWAP tunnels can be formed in a multilayer network design (where the mobility agent switches are L2 adjacent on a VLAN spanned across) or a routed access design (where the mobility agent switches are L3 adjacent). (See Figure 8.)

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Figure 8. Hierarchical Roles in Converged Access



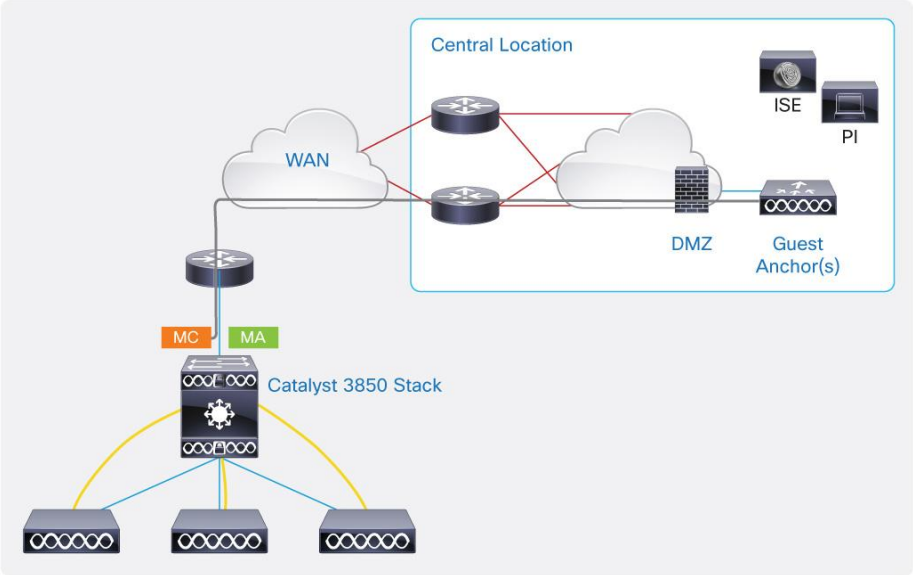
The SPGs are designed as a group of mobility agent switches to where the users frequently roam. It is important that roams within an SPG are local to the SPG and need not involve the mobility controller, whereas roams across an SPG require traffic to traverse the mobility controller.

Converged Access Network Design with Cisco Catalyst 3850

If the wireless deployment consists of one Cisco Catalyst 3850 Switch operating as mobility controller as well as mobility agent, which might be suited for a small branch type deployment, 50 Cisco access points and 2000 clients are supported, as seen in Figure 9.

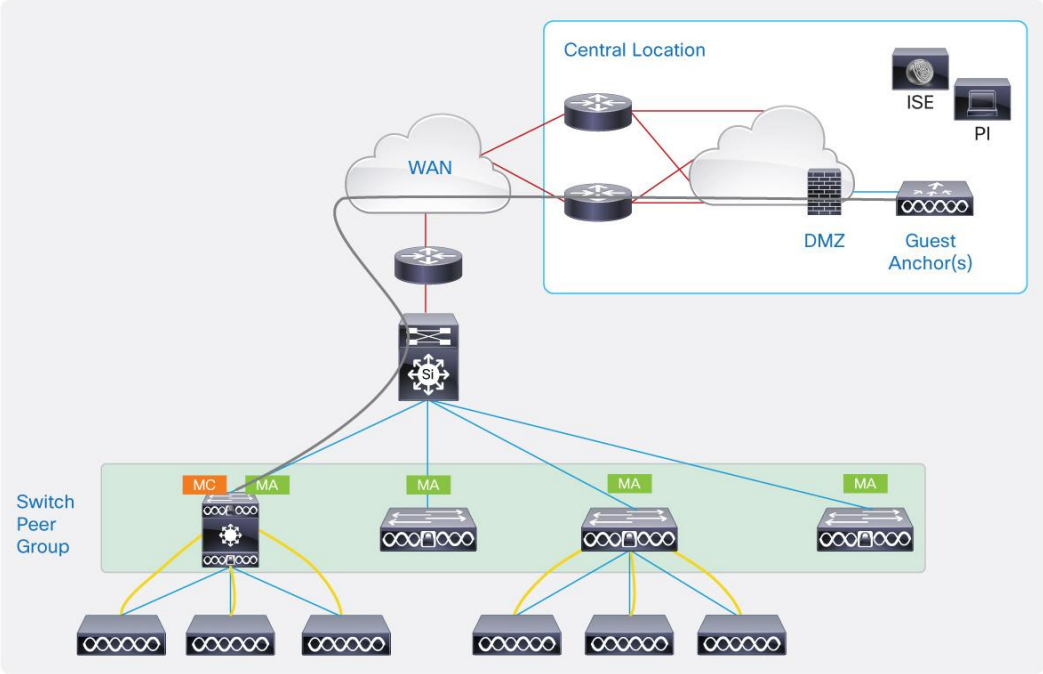
© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Figure 9. Single Cisco Catalyst 3850 Stack for Wired/Wireless in Small Branch



If the wireless deployment consists of only a Cisco Catalyst 3850 Switch running as a mobility controller with several other switches operating as mobility agents, 16 mobility agents can be grouped together in one SPG under one mobility controller. The access point and client scale remain at 50 Cisco access points and 2000 clients, as seen in Figure 10. Only the Cisco 5508, 5760 controller appliances, or the WiSM2 service module supports the guest access controller functionality in the DMZ. The guest access controller functionality is not supported on the Cisco Catalyst 3850.

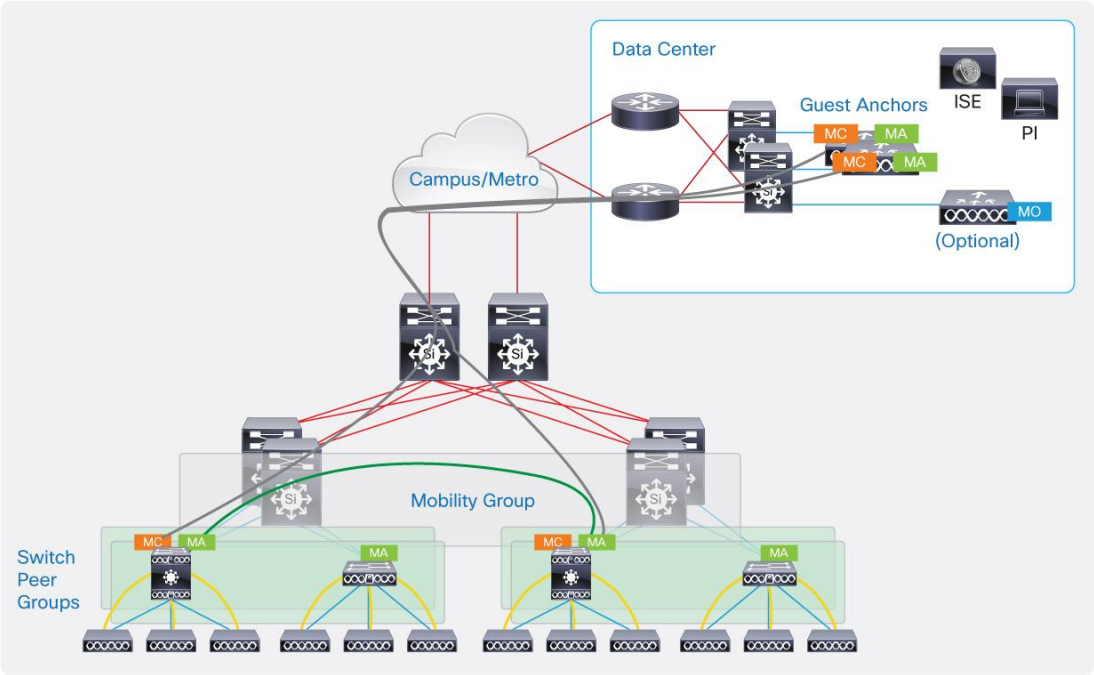
Figure 10. Single Mobility Controller with Cisco Catalyst 3850 Switches for Wired/Wireless in Medium/Large Branch



© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

For medium campus wireless deployments scaling up to 250 Cisco access points and 16,000 clients, 7 mobility controller switches (with other mobility agent switches operating as mobility agents in their SPG) can be grouped together in a mobility group with guest access provided by guest anchor controller in the DMZ, as seen in Figure 11. If there is no guest access operational, 8 mobility controller switches can be grouped together in a mobility group.

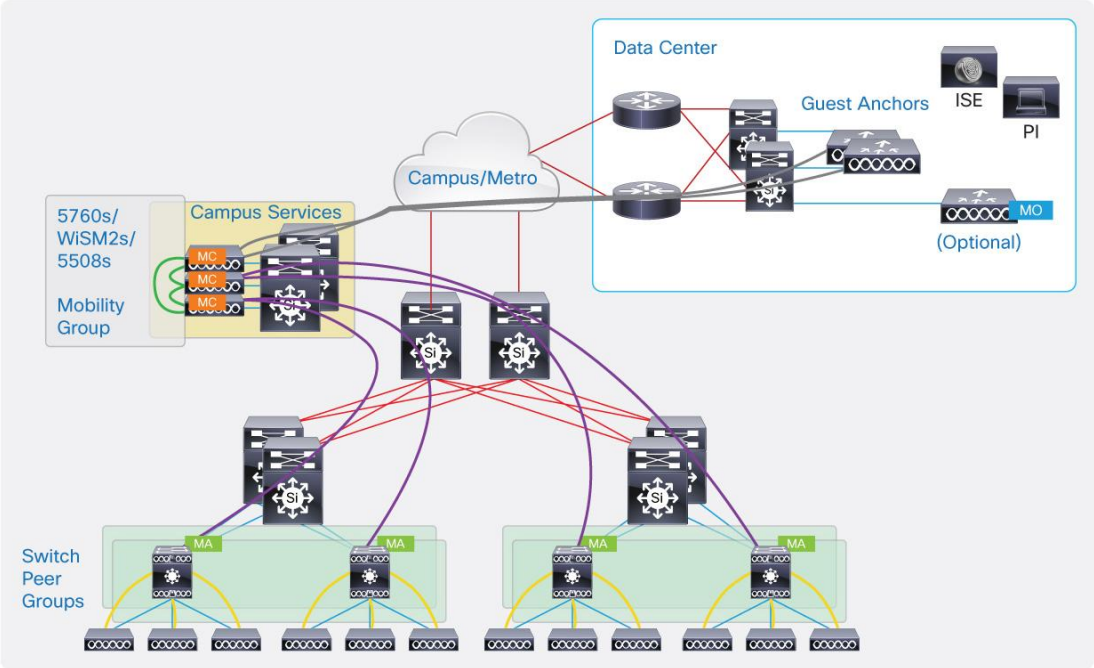
Figure 11. Multiple Mobility Controllers with Cisco Catalyst 3850 Switches for Wired/Wireless in Medium/Large Campus



For typical large campus wireless deployments scaling beyond 250 Cisco access points and 16,000 clients, the converged access allows the option of operating the Cisco Catalyst 3850 Switches as mobility agents, peering with a software upgraded Cisco 5508 or WiSM2 Wireless LAN Controller, or a Cisco 5760 WLC operating as mobility controller, as seen in Figure 12.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

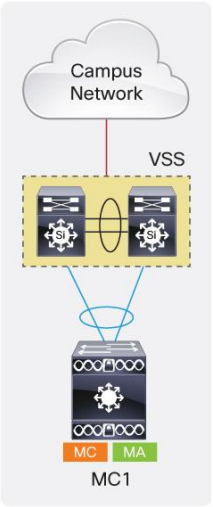
Figure 12. 5508/WiSM2/5760 Controller Appliances with Cisco Catalyst 3850 Switches for Large Campus



Configuring Converged Access with Cisco Catalyst 3850

This section explains how to configure the wireless services on the Cisco Catalyst 3850. Consider a large branch or a small campus that has a deployment scale of up to 250 access points and 16,000 clients that can be implemented only using Cisco Catalyst 3850 Switches. The converged access deployment will be explained using a case study starting from a small branch in the initial phase growing to a large branch/medium campus deployment. (See Figure 13.)

Figure 13. Configuring Mobility Controller on Cisco Catalyst 3850



© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The Cisco access points must be connected directly to the Cisco Catalyst 3850 Switch. One Cisco Catalyst 3850 Switch forms the access layer. The distribution in this example is made of the Cisco Catalyst 4500E Supervisor 7-E systems in virtual switching system (VSS) configuration. It is a multilayer network design in which the L3 SVI for L2 VLANs on the access is defined on the VSS system. The Cisco Catalyst 3850 connects to the VSS through a L2 port channel configured as an 802.1Q trunk carrying all the VLANs. Three VLANs are used: Vlan 501 for wired clients, Vlan 500 for wireless clients, and Vlan 601 for switch/wireless management. The access points must be configured in the wireless VLAN for them to be controlled by the Cisco Catalyst 3850, in this case Vlan 601.

The configuration to enable wireless termination on the Cisco Catalyst 3850 Switch is as shown in the following:

```
ap cdp
ap country US
wireless management interface Vlan601
wireless mobility controller
```

The “ap cdp” enables CDP process on the Cisco access points connected to the Cisco Catalyst 3850 Switch. “ap country US” defines the country code for that access point The wireless management interface command is used to source the access point CAPWAP and other CAPWAP mobility tunnels. The next command enables the switch to act as the mobility controller role for the converged access deployment. This previous command requires a reboot of the switch. Save the configuration and reload the switch.

The Cisco Catalyst 3850 downloads the software to the access point when it joins the switch for the very first time. This process takes a longer time since the access point needs to download the code and reboot in order to join the switch. Again, this happens the very first time the access point connects to the switch; all subsequent reloads include the access point booting with this code and joining the switch.

The next step is to configure SSIDs, define wireless LAN (WLAN) on the switch, with corresponding VLAN used for wireless clients, the authentication and ciphers method, and the AAA server profile to use for this WLAN. In the following example, the name of the SSID is Predator, using the client VLAN 500 we defined for wireless clients, and enabling WPA, WPA2 with TKIP, using 802.1X authentication with the AAA server defined elsewhere in the configuration.

For an open SSID, configure “no security wpa” following the WLAN configuration. For preshared key (PSK) security, configure under WLAN configuration.

```
wlan Predator 1 Predator
 aaa-override
 client association limit 2000
 client vlan 500
 security wpa wpa2 ciphers tkip
 security dot1x authentication-list ise
 no shutdown
 no security wpa akm dot1x
 security wpa akm psk set-key ascii 0 skunkworks
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Relevant excerpts from outputs regarding wireless configuration on the Cisco Catalyst 3850 are shown in the following:

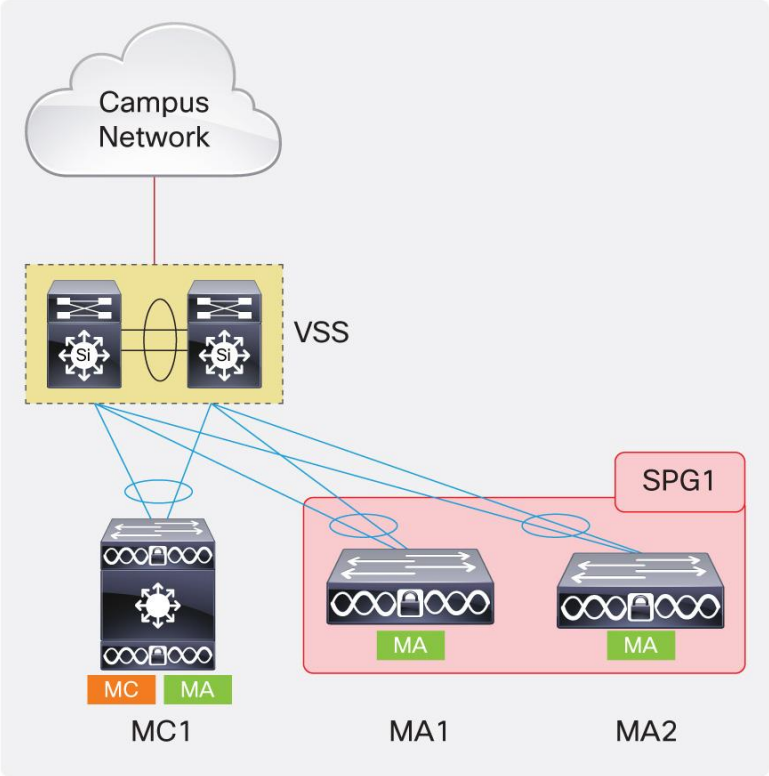
```
MC1#show wireless mobility summary
Mobility Controller Summary:
Mobility Role                                   : Mobility Controller
Mobility Protocol Port                          : 16666
Mobility Group Name                             : default
Controllers configured in the Mobility Domain:
IP              Public IP        Group Name       Multicast IP
Link Status
------------------------------------------------------------------------------
20.1.3.2        -                default              -          UP   : UP

MC1#show wlan summary
Number of WLANs: 1
WLAN Profile Name                SSID                         VLAN    Status
------------------------------------------------------------------------------
1    Predator                    Predator                      500      UP
MC1#show capwap summary
CAPWAP Tunnels General Statistics:
  Number of Capwap Data Tunnels       = 2
  Number of Capwap Mobility Tunnels   = 0
  Number of Capwap Multicast Tunnels  = 0
Name   APName                           Type PhyPortIf Mode      McastIf
------ -------------------------------- ---- --------- --------- -------
Ca5    3502E_G2/0/25_83A9               data Gi2/0/25  unicast   -
Ca4    3602I_G2/0/1_3A04                data Gi2/0/1   unicast   -
Name   SrcIP           SrcPort DestIP          DstPort DtlsEn MTU
------ --------------- ------- --------------- ------- ------ -----
Ca5    20.1.3.2        5247    20.1.3.54       63548   No     1657
Ca4    20.1.3.2        5247    20.1.3.53       58274   No     1657
```

The preceding output shows that two data CAPWAP tunnels are formed with the Cisco access points, 3502E off of GigabitEthernet 2/0/25 (second switch in the stack) and 3602I off of GigabitEthernet 2/0/1. 20.1.3.2 is the switch/wireless management IP address of this switch. The last section in the output of "show capwap summary" displays the source IP address with which the switch forms the data CAPWAP tunnels with the access points with their IP addresses listed, as 20.1.3.54 on destination port 63584 and 20.1.3.53 on destination port 58274.

Consider the one-switch stack network experiences growth, and now the network administrator needs to add more Cisco Catalyst 3850 Switches and expand wireless coverage to more endpoints and devices. (See Figure 14.)

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Figure 14. Configuring Mobility Agents and Switch Peer Group on Cisco Catalyst 3850



In this case the additional Cisco Catalyst 3850 Switches can be added and configured as mobility agents with the previously configured switch acting as mobility controller. The mobility agents can be configured in one SPG.

Relevant configurations to be done on the mobility controller are given in the following:

```
wireless mobility controller peer-group SPG1
wireless mobility controller peer-group SPG1 member ip 20.1.5.2 public-ip
20.1.5.2
wireless mobility controller peer-group SPG1 member ip 20.1.7.2 public-ip
20.1.7.2
```

where an SPG, SPG1, is defined on the mobility controller, with 20.1.5.2 and 20.1.7.2 as the switch/wireless management IP addresses of the mobility agent switches configured as members of SPG1.

On the mobility agent switches, one needs to configure the mobility controller, SSID, WLAN, and authentication methods. The following is the configuration shown on the MA1 switch as seen in the preceding network diagram.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
wireless mobility controller ip 20.1.3.2 public-ip 20.1.3.2
wireless management interface Vlan602
wlan Predator 1 Predator
 aaa-override
 client association limit 2000
 client vlan 500
 security wpa wpa2 ciphers tkip
 security dot1x authentication-list ise
 no shutdown
ap cdp
```

where 20.1.3.2 is the switch/wireless management IP address of the mobility controller switch, Vlan 602 is the switch/wireless management interface, and Vlan 500 is the client VLAN that is spanned across from the mobility controller switch.

Relevant similar configuration is done on the other member of the SPG1 on the MA2 switch, as seen in the following:

```
wireless mobility controller ip 20.1.3.2 public-ip 20.1.3.2
wireless management interface Vlan603
wlan Predator 1 Predator
 client vlan 500
 security wpa wpa2 ciphers tkip
 security dot1x authentication-list ise
 no shutdown
ap cdp
```

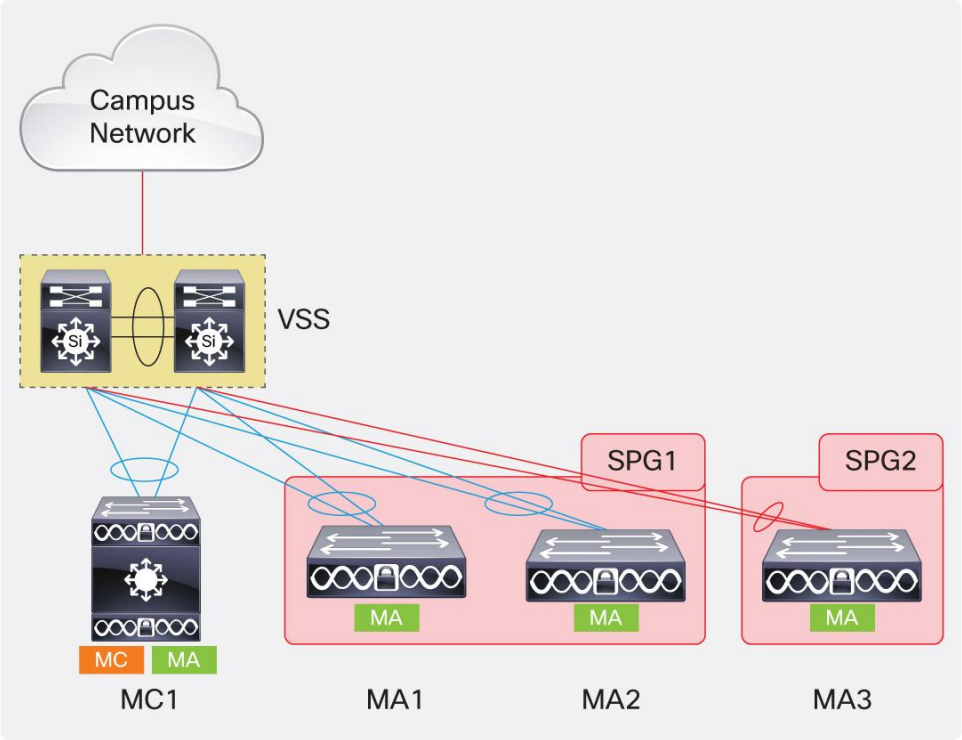
where 20.1.3.2 is the switch/wireless management IP address of the mobility controller switch, VLAN 603 is the wireless management interface, and VLAN 500 is the client VLAN that is spanned across from the mobility controller switch.

Notice that the SPG definitions and the SPG membership are configured only on the mobility controller switch. Only the mobility controller definition is configured on the actual mobility agent switches.

The SPG membership defined on the mobility controller is irrespective of the connectivity between the mobility controller and mobility agent switches. The access network might be Layer 2 connected to the distribution and/or operating in routed access design to the distribution. (See Figure 15.)

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Figure 15. Configuring Mobility Group on Multiple Mobility Controllers on Cisco Catalyst 3850



Assume that there was an acquisition of the company next door, and now the two networks have to be integrated in the current network. The network in the acquired company operates in routed access design mode, as shown by the diagram. The new switch can be configured to operate as a mobility agent under the previously defined mobility controller switch in the network.

As far as the SPG membership is concerned, there is a choice. If the two user groups are going to be integrated, OR in terms of keeping the roams simple, the customer can configure just one SPG under a Cisco Catalyst 3850-based mobility controller. One SPG defined on a Cisco Catalyst 3850 mobility controller switch can contain up to 16 member mobility agents in the SPG.

The other choice is to create a different SPG on the mobility controller switch and insert the new mobility agent switches in this new SPG. If the user groups from the present company and the acquired company are not going to roam across the respective workspaces, then a new SPG can be created in such a case. In the example network preceding, the administrator chooses to create a second SPG, an assumption convenient in order to better explain the roaming effect on clients.

Relevant configuration that needs to be done on the mobility controller in this case is as in the following:

```
wireless mobility controller peer-group SPG2
wireless mobility controller peer-group SPG2 member ip 20.1.8.2 public-ip
20.1.8.2
```

where an SPG, SPG2, is defined on the mobility controller, with 20.1.8.2 as the switch/wireless management IP addresses of the mobility agent switch configured as member of SPG2.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

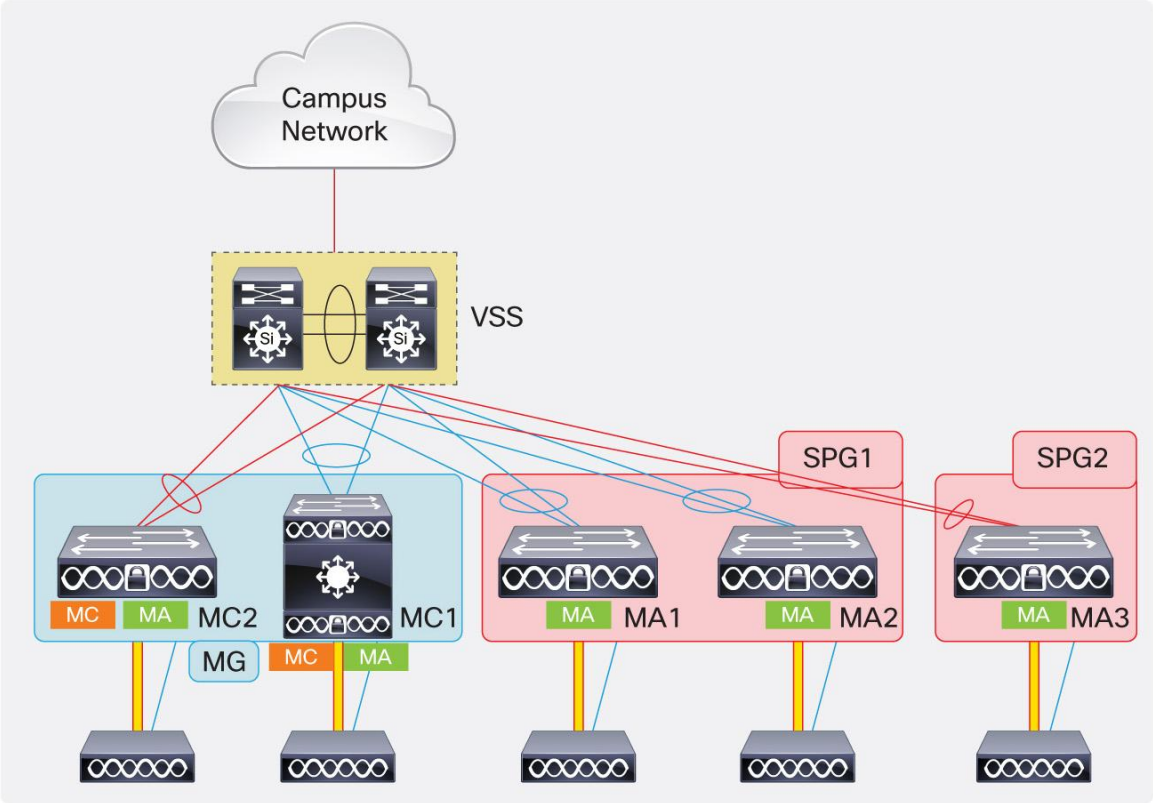
Relevant configurations done on the MA3 switch in this case are given in the following:

```
wireless mobility controller ip 20.1.3.2 public-ip 20.1.3.2
wireless management interface Vlan604
wlan Predator 1 Predator
 aaa-override
 client vlan 701
 security wpa wpa2 ciphers tkip
 security dot1x authentication-list ise
 no shutdown
ap cdp
```

where 20.1.3.2 is the switch/wireless management IP address of the mobility controller switch, VLAN 604 is the wireless management interface, and VLAN 701 is the client VLAN on the mobility agent switch operating in routed access mode.

Now assume that business is good and the company experiences growth more than ever. What started as a small branch has evolved to be a larger branch with a deployment need of scaling to more than 50 access points. With just one mobility controller switch in the branch, the deployment is limited to 50 access points. The network administrator can configure another Cisco Catalyst 3850 Switch to operate as an mobility controller to support a similar deployment of 50 access points. (See Figure 16.)

Figure 16. Multiple Mobility Controller Configuration on Cisco Catalyst 3850



© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

These two mobility controller switches can be grouped together in one mobility group to enable fast roaming between clients of each respective subdomain.

Relevant configuration that needs to be done on the existing mobility controller switch is as given in the following:

```
wireless mobility group member ip 20.1.9.2 public-ip 20.1.9.2 group MG
wireless mobility group name MG
```

where MG is the mobility group name that is created, and 20.1.9.2 is the switch/wireless management IP address of the new mobility controller added in the mobility group.

Configuration that needs to be done on the new mobility controller switch that was brought online is given in the following:

```
wireless mobility controller
wireless mobility group member ip 20.1.3.2 public-ip 20.1.3.2 group MG
wireless mobility group name MG
wireless management interface Vlan605
wlan Predator 1 Predator
 aaa-override
 client vlan 702
 security wpa wpa2 ciphers tkip
 security dot1x authentication-list ise
 no shutdown
ap cdp
```

where 20.1.3.2 is the switch/wireless management IP address of the existing mobility controller switch, MG is the name of the mobility group that was created, VLAN605 is the wireless management interface on this mobility controller switch, SSID named Predator is created, VLAN702 is the client VLAN for wireless endpoints on this switch, authentication and encryption parameters are defined for this WLAN, and CDP is being enabled on all the access points connecting to this switch.

This is a scalable method of deploying converged access with Cisco Catalyst 3850 Switches since each switch has the capability to do 40 Gbps of wireless traffic termination. The preceding network can collectively terminate up to 320 Gbps of wireless traffic: 8 switches (4 in stack, and 4 acting as standalone). This sufficiently demonstrates the capability of the Cisco Catalyst 3850 Switch to be future proofed for 802.11ac when that standard comes around.

Roaming in Cisco Unified Wireless Network

Before roaming is explained in this section, it is essential to understand some terminologies that are used while explaining roams in converged access deployment, starting with point of presence (PoP) and point of attachment (PoA).

Point of presence (PoP) is defined as the point in the network where the wired infrastructure first sees the wireless traffic. Packet conversions from 802.11 (wireless) to 802.3 (Ethernet) and vice versa take place at this point. PoP serves several functionalities. It serves as a point for symmetrical routing and also serves where network security policy is applied to the wireless traffic. In the Cisco Unified Wireless Network, the controller is where the PoP is defined, since wireless traffic is terminated and converted to Ethernet frames at the controller, and it is at this point that the wired infrastructure sees the frames from wireless endpoints.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Point of attachment (PoA) moves with user mobility and is defined as the access point to which the user joins or roams.

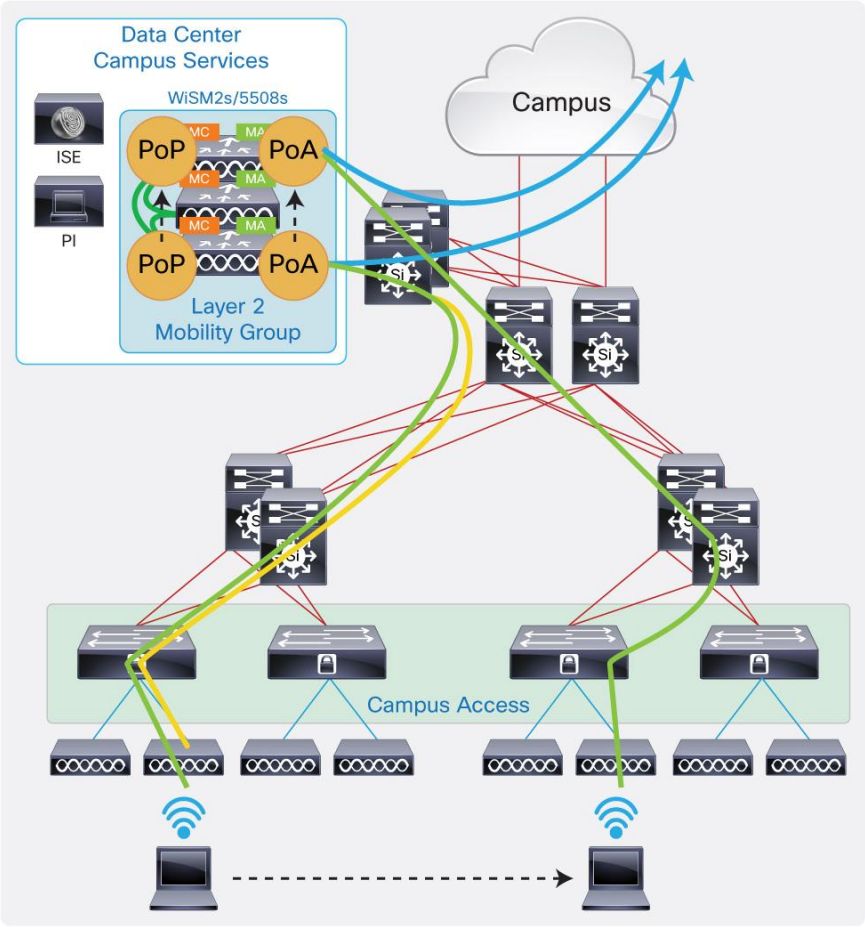
There are two types of roams within the wireless network: intracontroller roams and intercontroller roams:

- **Intracontroller roams** occur when a user roams from one access point to another access point connected to the same controller.
- **Intercontroller roams** occur when a user roams from an access point connected to one controller to another access point connected to a different controller.

There are two types of roams that can occur within intercontroller roams: L2 roams and L3 roams:

- **L2 roam** occurs when the user roams from an access point connected to its controller to a different access point connected to another controller, where the two controllers are L2 adjacent to each other. This is typically the case in most deployments where the WLCs are centrally deployed in either the data center or a campus services block, with the client VLANs spanned between the controllers. In the Cisco Unified Wireless Network, in an L2 roam, both the PoP and the PoA move to the controller where the user has roamed. The previous controller transfers the entire client context (MAC address, IP address, ACL policy, QoS policy, IGMP group membership, and so on) to the new controller to which the client roamed. (See Figure 17.)

Figure 17. L2 Roam in Cisco Unified Wireless Network

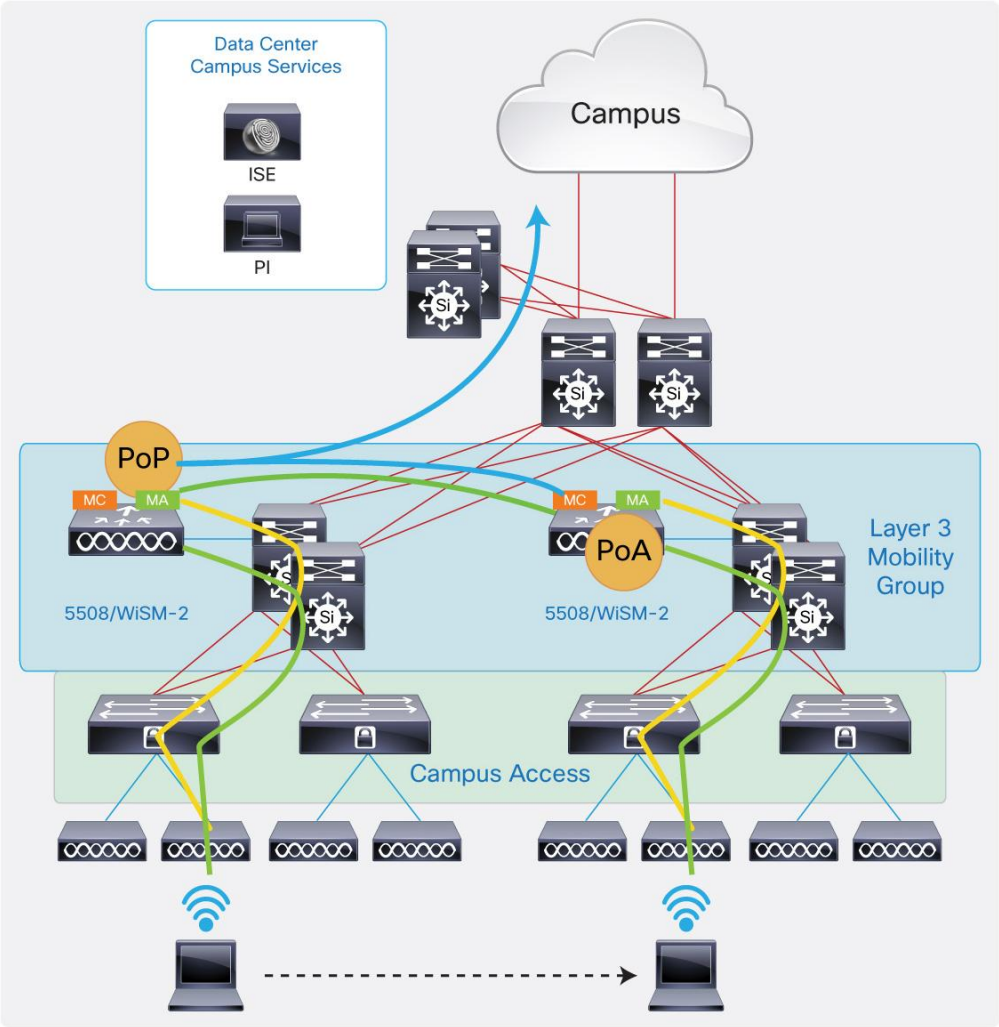


© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The previous controller does not hold any state of the client that has roamed to another controller. In this case the client traffic is CAPWAP encapsulated by the access point and terminated at the new controller with which access point has associated.

- **L3 roam** occurs when the user roams from an access point connected to its controller to a different access point connected to another controller, where the two controllers are L3 adjacent to each other. (See Figure 18.)

Figure 18. L3 Roam in Cisco Unified Wireless Network



This is the case when individual controllers are deployed at each distribution block in the campus network, where the client VLANs are not spanned across. In an existing Cisco Unified Wireless Network, only the PoA moves with the user mobility, and PoP remains with the initial controller the client first joined. In this case the PoP is also called the anchor controller, and the PoA is called the foreign controller. The anchor and the foreign controllers hold the client state since even though the client physically moves to another controller, its traffic is still back-hauled at the anchor for symmetric routing and policy application.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Understanding Roams in Converged Access

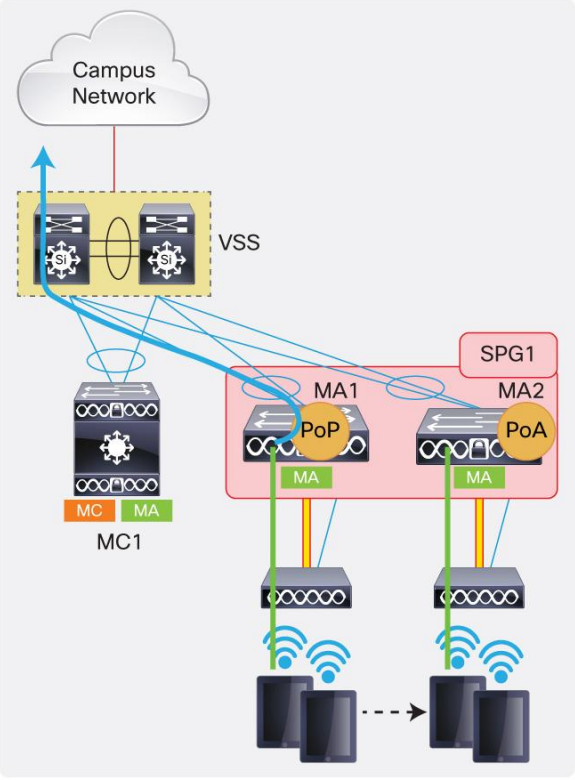
Since roams in Cisco Unified Wireless Network are explained earlier, this section explains the roams as they occur in converged access mode. It will be clear that the roams in converged access deployment are no different than those that occur in an existing Cisco Unified Wireless Network. In converged access deployment, QoS policies are applied at the foreign or PoA switch, and ACL policies are applied at the anchor or PoP switch.

In converged access mode, there are two methods of supporting roams: tunneled (sticky) mode and nontunneled (nonsticky) mode.

Tunneled mode is the default method of supporting L2 roams and the only method of supporting L3 roams in converged access deployment. This means that even for L2 roams, by default, only the PoA moves with the user mobility, and PoP is maintained at the anchor switch for stateful policy application.

Figure 19 shows the switches are trunked to the distribution VSS, and the client wireless VLAN 500 is spanned across the access switches. The initial client join occurs on the MA1 switch. The initial client traffic profile is CAPWAP encapsulated to the switch. The switch terminates the wireless traffic and sends out a converted Ethernet frame. Hence PoP and PoA both are on MA1 for the initial client join. After clients roam to MA2, the PoP stays at MA1, and the PoA moves to MA2, as seen earlier. Hence, the roamed traffic is CAPWAP encapsulated to the new mobility agent. The new mobility agent encapsulates this traffic on the full mesh SPG1 tunnel to PoP switch. After arriving on the PoP switch, the traffic is terminated and converted and shipped off into the wired world by MA1. Since the client roams within the SPG, the roamed traffic does not need to traverse the mobility controller switch. Typically the SPG will be formed around switches within a distribution block inside a building, or a floor: areas to which most users roam.

Figure 19. L2 Roam in Tunneled Mode in Converged Access



© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

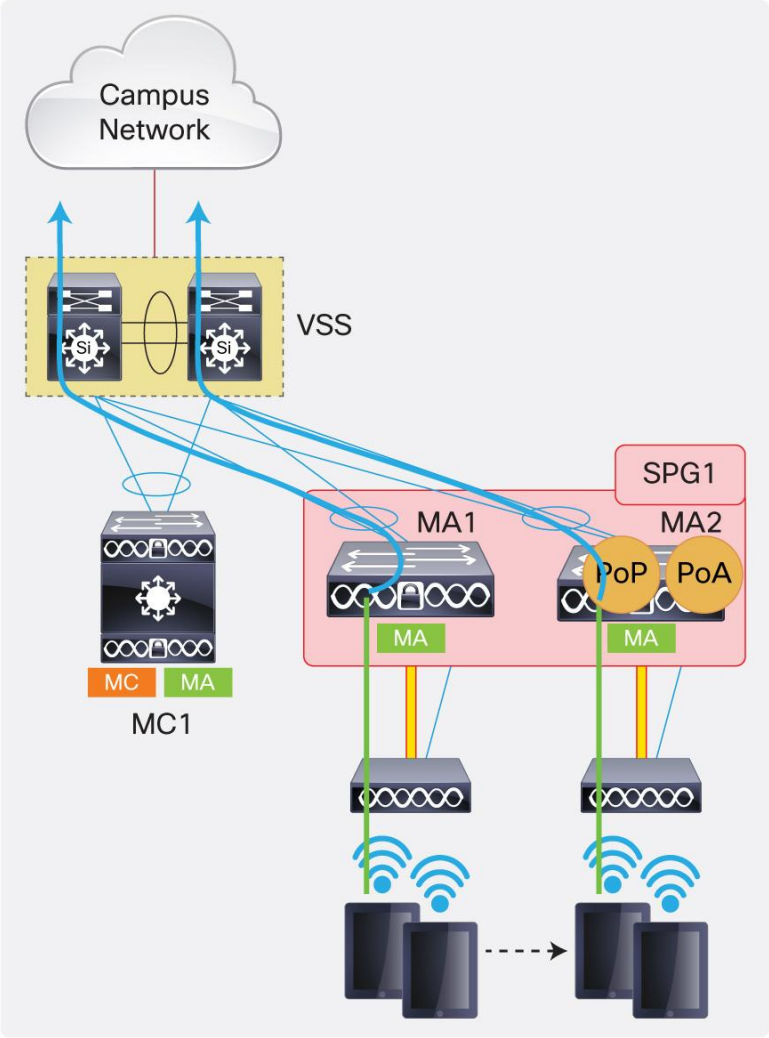
There is a provision per WLAN that the administrator can configure, if they want a L2 roam like the Cisco Unified Wireless Network, where both the PoP and PoA of the user moves. This is the nontunneled (nonsticky) L2 roam.

The advantage of this roam is that the roamed traffic does not need to be back-hauled to the PoP switch, since the PoP moves along with the user mobility. The roamed traffic is terminated locally at the new mobility agent and delivered to the wired world, decreasing latency for application traffic. This type of roam, though decreasing application latency, might increase client roam times.

As Figure 20 shows, initial client join is on MA1. This wireless traffic is terminated locally and switched to the wired world. When the clients roam to an access point connected to MA2, both PoP and PoA move to the new mobility agent switch. No client state is retained by MA1, where the clients initially joined.

This roam is exactly like the existing Cisco Unified Wireless Network L2 roam.

Figure 20. L2 Roam in Nontunneled Mode in Converged Access



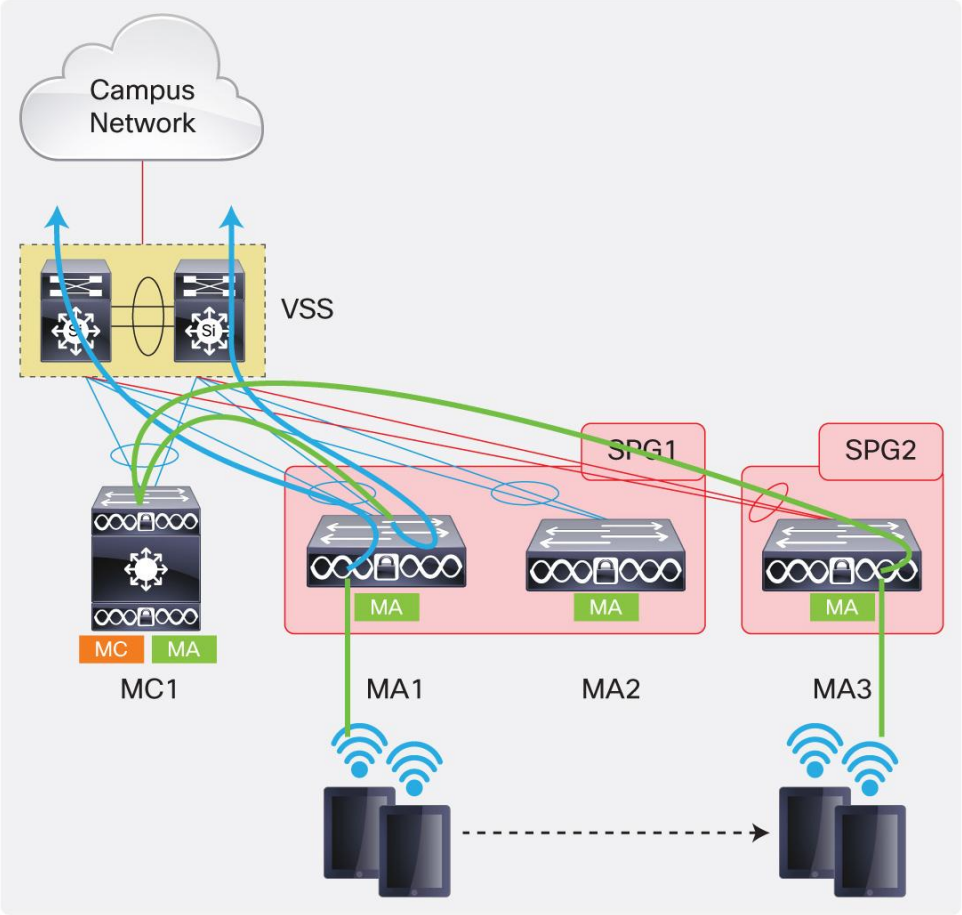
The L3 roams are supported by the tunneled (sticky) method, as explained earlier.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Traffic Paths in Converged Access

This section explains the traffic path (profile) for local and roamed wireless clients across the different SPGs and mobility controllers. (See Figure 21.)

Figure 21. Client Roams Within an SPG in Converged Access

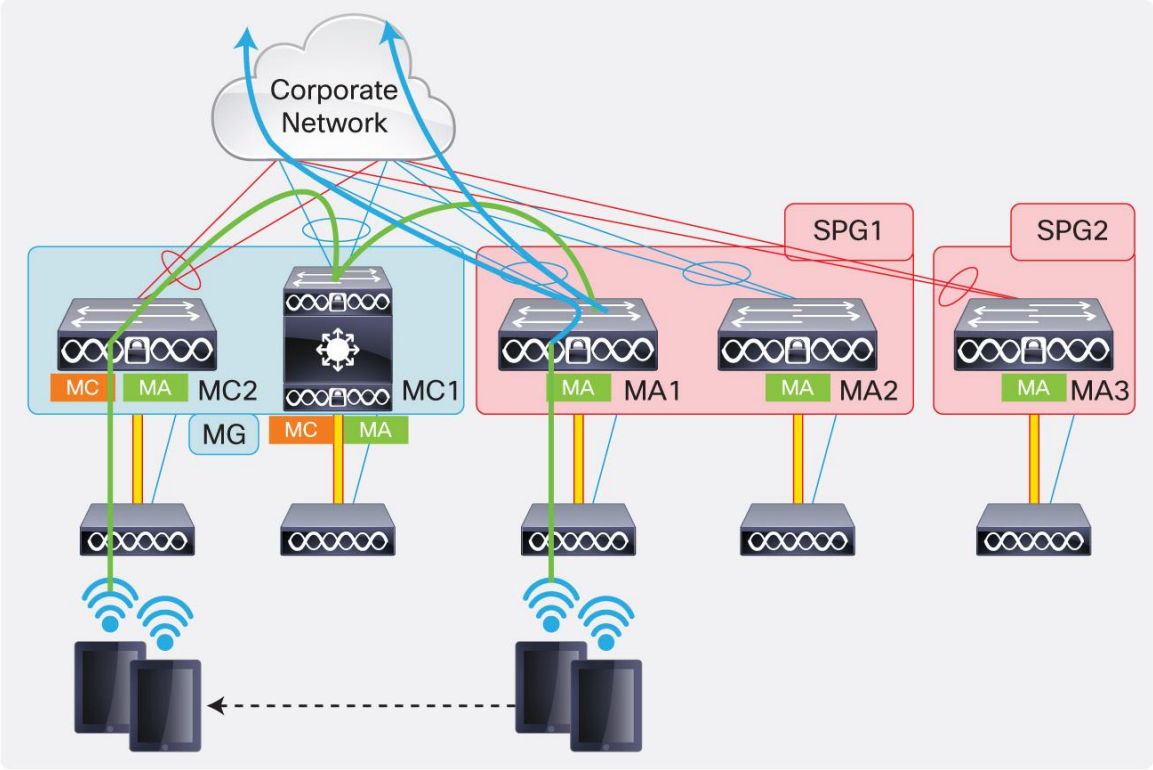


As seen earlier, roams within an SPG are constrained within the anchor and foreign switches of the SPG.

As mentioned before, traffic for wireless clients that roam across an SPG has to traverse a mobility controller. Assume that the mobility controller does the routing for the traffic that is roamed across an SPG. In Figure 21, the client roams from initial MA1 in SPG1 to MA3 in SPG2. In this case the roamed traffic is terminated and encapsulated at the new mobility agent, in the mobility agent-to-mobility controller CAPWAP tunnel and switched to MC1. The mobility controller knows the anchor (PoP) switch for this client and encapsulates the traffic and switches it to the anchor, MA1. The anchor switch applies ACLs to this traffic and also serves symmetrical routing in case the roam is an L3 roam. (See Figure 22.)

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Figure 22. Client Roams Across Mobility Controller in Converged Access



In the preceding scenario, an intersubdomain (intermobility controller) roam is explained. The initial client join happens at MA1 in SPG1. The wireless traffic is terminated locally at MA1 and delivered to the wired side when the client is static. When the client roams to an access point connected to MC2, it roams from the subdomain whose master is MC1. In this case, the traffic path for the roamed client is terminated at the foreign (PoA) MC2 switch. The foreign (PoA) MC2 switch encapsulates this traffic in the mobility controller-to-mobility controller CAPWAP tunnel and switches the traffic to MC1. This switch encapsulates this traffic in the mobility controller-to-mobility agent CAPWAP tunnel and lands it back to the anchor (PoP) MA1 switch. The ACL policy is applied at the anchor switch (MA1), and this switch forwards this traffic into the wired portion of the network.

Relevant Outputs for Tracking Client Roams in Converged Access

This section explains how all the preceding theory does look in practice. This section will cover relevant outputs for wireless clients as they initially join the wireless network and follow them as they roam through the wireless network.

The client wireless VLAN is spanned across three switches (MC1, MA1, and MA2). The fourth mobility agent switch, MA3, is in a routed access design across which the client wireless VLAN cannot be spanned.

The second mobility controller switch, MC2, is also a routed access design across which the client wireless VLAN cannot be spanned.

The L2 roam by default in converged access is tunneled. The example network covers the scenarios in which L2 tunneled roam, followed by L3 roam, and lastly L2 nontunneled roams occur.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

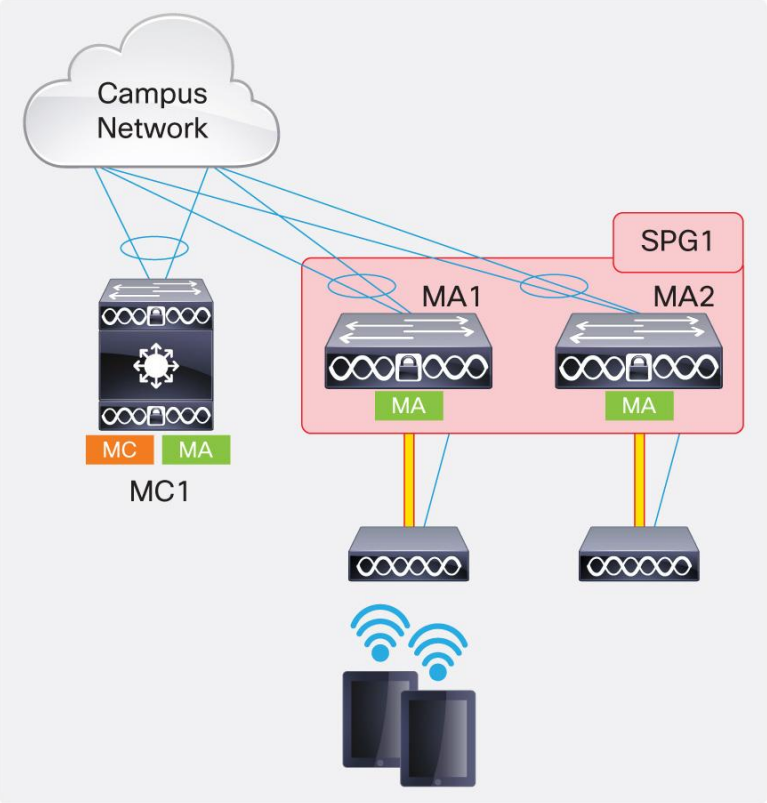
Table 3 is a list of switch names, IP addresses, their roles in SPG, and mobility group that form part of the example network. Understanding this will help explain the client roams as they roam from one switch to another.

Table 3. Switch Roles and Other Details in Example Topology

Switch Name	IP Address	Mobility Role	Switch Peer Group	Mobility Group
MC1	20.1.3.2	Mobility controller	-	MG
MA1	20.1.5.2	Mobility agent	SPG1	MG
MA2	20.1.7.2	Mobility agent	SPG1	MG
MA3	20.1.8.2	Mobility agent	SPG2	MG
MC2	20.1.9.2	Mobility controller	-	MG

Figure 23 shows initial client join on MA1

Figure 23. Initial Client Join on MA1




```
MA1#show wireless client summary
Number of Local Clients : 2

MAC Address    AP Name                                WLAN State                 Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad 3602I_G1/0/1_66BC                      1    UP                    11n(5)
b065.bdbf.77a3 3602I_G1/0/1_66BC                      1    UP                    11n(5)
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Initial client join on MA1, as seen in CLI on the switch, where it shows the client MAC address, to which access point it is connected, and the WLAN and 11n on 5GHz:

```
MA1#show wcdb database all
   Total Number of Wireless Clients = 2
          Clients Waiting to Join   = 0
          Local Clients             = 2
          Anchor Clients            = 0
          Foreign Clients           = 0
          MTE Clients               = 0

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    500 20.1.1.53       0x00DC7DC000000005 RUN      LOCAL
b065.bdb0.a1ad    500 20.1.1.52       0x00DC7DC000000005 RUN      LOCAL

MA1#show wireless client mac b065.bdbf.77a3 detail
Client MAC Address : b065.bdbf.77a3
Client Username : blackbird
AP MAC Address : 203a.076f.abe0
AP Name: 3602I_G1/0/1_66BC
Client State : Associated
Wireless LAN Id : 1
Wireless LAN Name: Predator
Protocol : 802.11n - 5 GHz
Channel : 157
IPv4 Address : 20.1.1.53
Mobility State : Local
EAP Type : PEAP
Interface : WIRELESS_VLAN
VLAN : 500
Access VLAN : 500

MA1#show mac address dynamic | include Ca1
 Vlan    MAC Address           Type        Ports
-----    -----------       -------     -----
 500     b065.bdb0.a1ad    DYNAMIC     Ca1
 500     b065.bdbf.77a3    DYNAMIC     Ca1
```

where “Ca1” is the access point CAPWAP data tunnel and it shows that the client MAC addresses are seen behind the Ca1 interface.

As mentioned earlier that the mobility controller has visibility of all clients across all mobility agents, the following is the client visibility CLI on the mobility controller for clients local on the mobility agent.

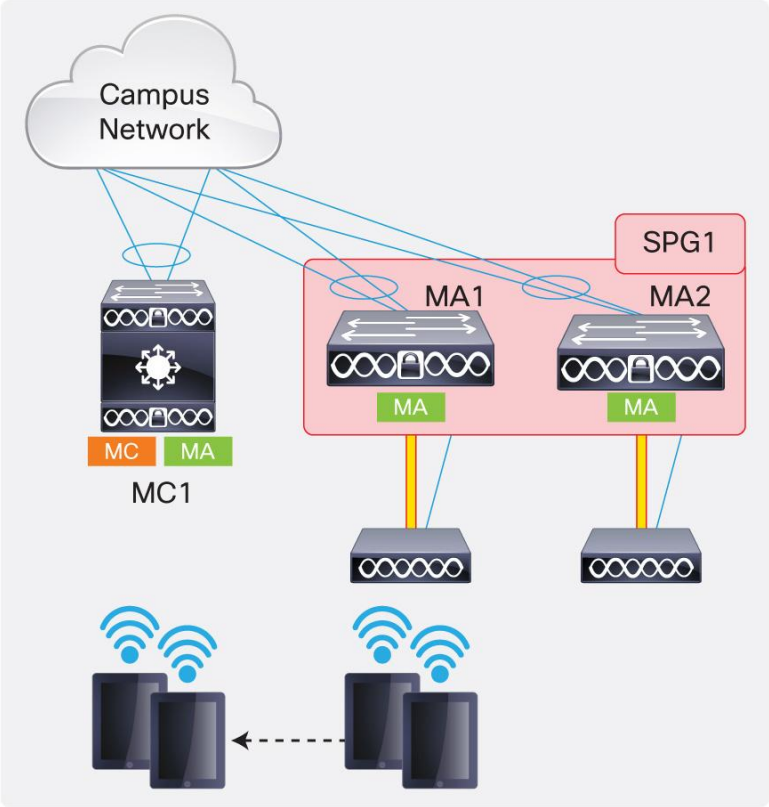
© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
MC1#sh wireless mobility controller client summary
Number of Clients : 2
State is the Sub-Domain state of the client.
* indicates IP of the associated Sub-domain
Associated Time in hours:minutes:seconds
MAC Address     State       Anchor IP          Associated IP    Associated Time
-------------------------------------------------------------------------------
b065.bdb0.a1ad  Local       0.0.0.0            20.1.5.2         00:00:23
b065.bdbf.77a3  Local       0.0.0.0            20.1.5.2         00:00:35
```

Notice the anchor IP 0.0.0.0 indicating that these clients are locally connected on the mobility agent switch whose IP address is 20.1.5.2 (MA1).

Consider when the clients roam from mobility agent to mobility controller switch (Figure 24).

Figure 24. Client Roams Within an SPG in Converged Access



© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

The following are the relevant outputs displaying the client roam. In this case, MA1 becomes the anchor switch, while MC1 becomes the foreign switch.

```
MC1#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State                Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad 3602I_G2/0/1_3A04                    1    UP                   11n(5)
b065.bdbf.77a3 3602I_G2/0/1_3A04                    1    UP                   11n(5)

MC1#show wcdb database all
   Total Number of Wireless Clients = 2
          Foreign Clients           = 2
          MTE Clients               = 0

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    500 20.1.1.53       0x00E685C000000006 RUN      FOREIGN
b065.bdb0.a1ad    500 20.1.1.52       0x00E685C000000006 RUN      FOREIGN
MC1#show wireless client mac b065.bdbf.77a3 detail
Client MAC Address : b065.bdbf.77a3
Client Username : blackbird
AP MAC Address : 8875.5687.b830
AP Name: 3602I_G2/0/1_3A04
Wireless LAN Name: Predator
Protocol : 802.11n - 5 GHz
IPv4 Address : 20.1.1.53
Mobility State : Foreign
Mobility Anchor IP Address : 20.1.5.2
Mobility Move Count : 1
Interface : WIRELESS_VLAN
VLAN : 500
```

Notice that the mobility state is “foreign” in the client database on the switch to which client roams. Also notice that the client detail on the roamed-to switch shows local access point name, mobility state, and the mobility anchor IP address (20.1.5.2). 20.1.5.2 is the switch/wireless management switch of the switch the client initially joined, MA1.

Relevant outputs on the anchor switch (MA1 in this case) are as in the following:

```
MA1#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State                Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad 20.1.3.2                             1    UP                   Mobile
b065.bdbf.77a3 20.1.3.2                             1    UP                   Mobile
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Comparing the preceding output with the one in the initial client join, notice that the access point name changes to the switch IP address to where the clients roamed (switch/wireless management IP address of MC1 in this case), and the protocol state becomes “Mobile.”

```
MA1#sh wcdb data all
   Total Number of Wireless Clients = 2
          Clients Waiting to Join   = 0
          Local Clients             = 0
          Anchor Clients            = 2
          Foreign Clients           = 0
          MTE Clients               = 0
Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    500 20.1.1.53       0x00D03BC000000002 RUN      ANCHOR
b065.bdb0.a1ad    500 20.1.1.52       0x00D03BC000000002 RUN      ANCHOR
```

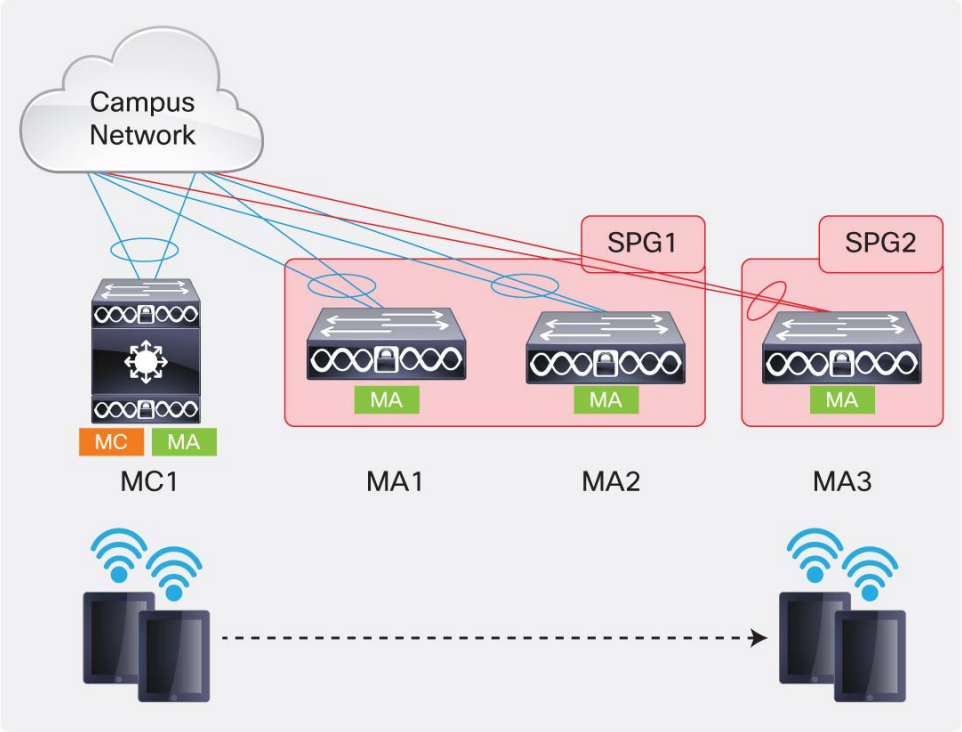
Relevant outputs displaying the client detail on the anchor switch, MA1, as in the following:

```
MA1#sh wireless client mac b065.bdbf.77a3 detail
Client MAC Address : b065.bdbf.77a3
Client Username : blackbird
AP MAC Address : 0000.0000.0000
AP Name: 20.1.3.2
Client State : Associated
Wireless LAN Id : 1
Wireless LAN Name: Predator
Protocol : Mobile
Channel :
IPv4 Address : 20.1.1.53
Mobility State : Anchor
Mobility Foreign IP Address : 20.1.3.2
Interface : WIRELESS_VLAN
VLAN : 500
Access VLAN : 500
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

where the mobility state is “anchor,” and the access point name is the switch/wireless management IP address of the foreign switch (MC1): 20.1.3.2. (See Figure 25.)

Figure 25. Client Roams Across SPG in Converged Access



In the preceding scenario the endpoints roam from the mobility controller to another mobility agent in SPG2. The thing to note here is that this is an L3 roam, since the client wireless VLAN 500 is not spanned across to this mobility agent. The client retains the IP address it received at initial client join at MA1. Its traffic is back-hauled from the new mobility agent (MA3), to its mobility controller (MC1), to the anchor mobility agent switch (MA1), where it is forwarded into the wired portion of the network as an Ethernet frame.

Starting off with the relevant outputs on the switch to which the clients roamed:

```
MA3#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State              Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad 3602I_G1/0/1_3A2A                    1    UP                 11n(5)
b065.bdbf.77a3 3602I_G1/0/1_3A2A                    1    UP                 11n(5)

MA3#show wcdb database all
   Total Number of Wireless Clients = 2
          Foreign Clients           = 2
          MTE Clients               = 0
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    701 20.1.1.53       0x00C9D9C000000004 RUN      FOREIGN
b065.bdb0.a1ad    701 20.1.1.52       0x00C9D9C000000004 RUN      FOREIGN
```

Since the roam is across an SPG, the mobility controller gets involved in the mobility in this case. Relevant outputs from the mobility controller for the client visibility are displayed in the following:

```
MC1#show wcdb database all
   Total Number of Wireless Clients = 2
         MTE Clients                = 2

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3      0 0.0.0.0         0x00CB4E4000000004 RUN      MTE
b065.bdb0.a1ad      0 0.0.0.0         0x00CB4E4000000004 RUN      MTE

MC1#
MC1#show wireless mobility controller summary
Number of Clients : 2
State is the Sub-Domain state of the client.
* indicates IP of the associated Sub-domain
Associated Time in hours:minutes:seconds
MAC Address     State       Anchor IP          Associated IP    Associated Time
-------------------------------------------------------------------------------
b065.bdb0.a1ad  Local       20.1.5.2           20.1.8.2         00:01:24
b065.bdbf.77a3  Local       20.1.5.2           20.1.8.2         00:01:29
```

The preceding output displays a new option: MTE. It is defined as mobility tunnel endpoint and points to the fact that the mobility controller has to switch the packets for these clients ingressing over the mobility agent-to-mobility controller tunnel from foreign, and egressing out the mobility agent-to-mobility controller tunnel to anchor.

Relevant outputs at the anchor switch are the following:

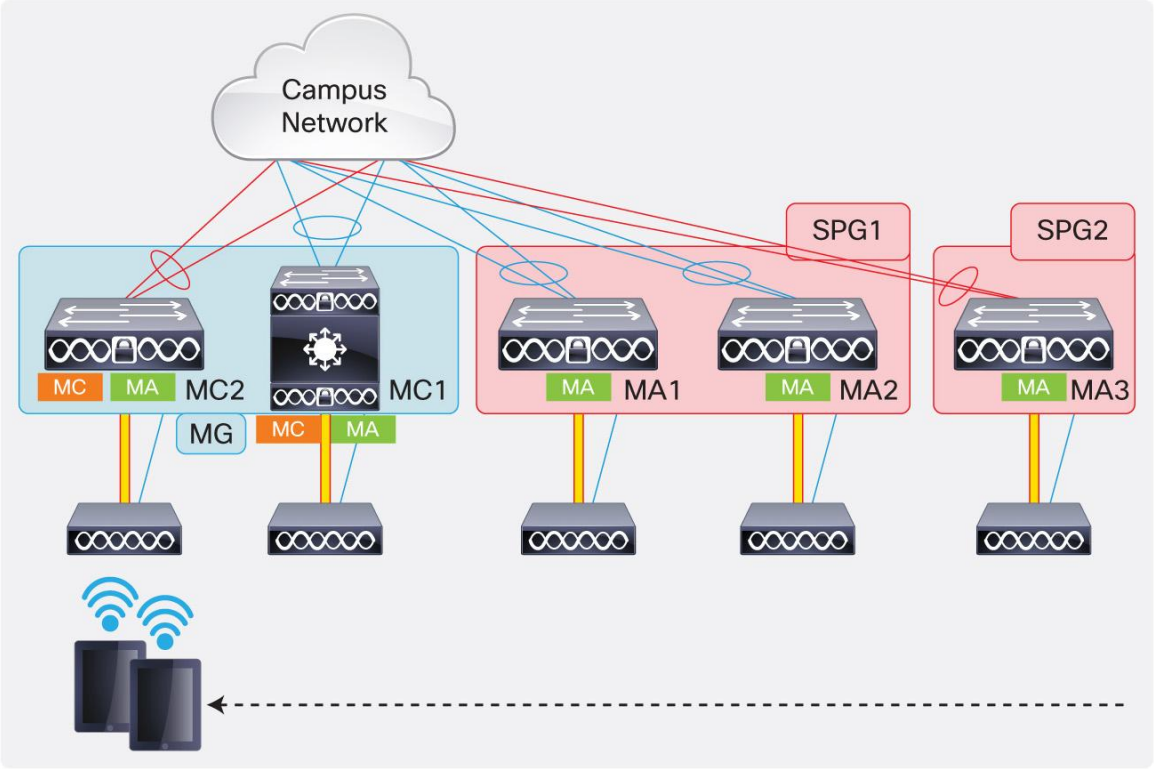
```
MA1#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State              Protocol
-------------------------------------------------------------------------------
b065.bdb0.a1ad 20.1.8.2                             1    UP                 Mobile
b065.bdbf.77a3 20.1.8.2                             1    UP                 Mobile

MA1#
MA1#show wcdb database all
   Total Number of Wireless Clients = 2
         Anchor Clients             = 2
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
Mac Address     VlanId IP Address       Src If              Auth      Mob
--------------  ------ ---------------  ------------------  --------  -------
b065.bdbf.77a3     500 20.1.1.53        0x00D03BC000000002  RUN       ANCHOR
b065.bdb0.a1ad     500 20.1.1.52        0x00D03BC000000002  RUN       ANCHOR
```

Figure 26 shows client roam across MCs

Figure 26. Client Roams Across Mobility Controllers (Intersubdomain) in Converged Access



In the preceding scenario, the wireless clients roam from the mobility agent in SPG2 across the subdomain to an access point connected to another mobility controller (MC2) in the same mobility group.

This roam again has to be back-hauled using the mobility controllers through the mobility controller-to-mobility controller CAPWAP mobility tunnel, and then from mobility controller-to-mobility agent CAPWAP mobility tunnel to the anchor mobility agent. Relevant outputs start from the foreign switch, which in this case is the new mobility controller switch (MC2).

```
MC2#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State                 Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad 1042_G1/0/1_BD0C                     1    UP                    11n(5)
b065.bdbf.77a3 1042_G1/0/1_BD0C                     1    UP                    11n(5)

MC2#show wcdb database all
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
    Total Number of Wireless Clients = 2
           Clients Waiting to Join    = 0
           Foreign Clients            = 2
           MTE Clients                = 0

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    702 20.1.1.53       0x00C33C0000000004 RUN      FOREIGN
b065.bdb0.a1ad    702 20.1.1.52       0x00C33C0000000004 RUN      FOREIGN

MC2#show wireless client mac b065.bdbf.77a3 detail
Client MAC Address : b065.bdbf.77a3
Client Username : blackbird
AP MAC Address : 8875.56da.2010
AP Name: 1042_G1/0/1_BD0C
Wireless LAN Id : 1
Wireless LAN Name: Predator
IPv4 Address : 20.1.1.53
Mobility State : Foreign
Mobility Anchor IP Address : 20.1.5.2
Mobility Move Count : 2
Interface : WIRELESS_VLAN_GRAIL
VLAN : 702
```

The next series of outputs are from the mobility controller of SPG1, MC1.

```
MC1#show wcdb database all
   Total Number of Wireless Clients = 2
          Clients Waiting to Join    = 0
          MTE Clients                = 2

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3      0 0.0.0.0         0x00DAC94000000001 RUN      MTE
b065.bdb0.a1ad      0 0.0.0.0         0x00DAC94000000001 RUN      MTE
```

Nontunneled Roam in Converged Access

The L2 roam that behaves in a manner similar to the one in existing Cisco Unified Wireless Networks is explained in this section. The administrator can span the client wireless VLAN across the access switches, where the administrator wants to configure the nontunneled (nonsticky) mode. As explained earlier, in this mode, the L2 roam also moves the PoP over to the PoA, and there is no client state held at the old switch where the client initially joined. There is no back-haul of roamed traffic in this case. There is no concept of anchor and foreign in this case, and both ACL and QoS are applied at the switch to where the client roamed.

To enable the nontunneled mode on the two mobility agent switches and one mobility controller switch, configure terminal:

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
wlan Predator
shutdown
no mobility anchor sticky

no shutdown
```

Tracking the initial client join on MA1:

```
MA1#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State              Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad 3602I_G1/0/1_66BC                    1    UP                 11n(5)
b065.bdbf.77a3 3602I_G1/0/1_66BC                    1    UP                 11n(5)

MA1#show wcdb database all
   Total Number of Wireless Clients = 2
         Clients Waiting to Join   = 0
         Local Clients             = 2
         Anchor Clients            = 0
         Foreign Clients           = 0
         MTE Clients               = 0

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    500 20.1.1.54       0x00DC7DC000000005 RUN      LOCAL
b065.bdb0.a1ad    500 20.1.1.55       0x00DC7DC000000005 RUN      LOCAL
```

The mobility controller (MC1) has the client visibility at this time and looks like the following:

```
MC1#show wireless mobility controller client summary
Number of Clients : 2

State is the Sub-Domain state of the client.
* indicates IP of the associated Sub-domain
Associated Time in hours:minutes:seconds

MAC Address     State       Anchor IP          Associated IP    Associated Time
-------------------------------------------------------------------------------
b065.bdb0.a1ad  Local       0.0.0.0            20.1.5.2         00:01:04
b065.bdbf.77a3  Local       0.0.0.0            20.1.5.2         00:02:40
```

Note that the anchor IP is 0.0.0.0 since it is a initial client join on 20.1.5.2.

Consider the client roams from MA1 to an access point connected to MA2, and notice the change that happens in this type of nontunneled L2 roam.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
MA1#show wcdb database all
   Total Number of Wireless Clients = 0

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
```

The switch where the clients initially joined has 0 clients after the roam, as seen earlier.

```
MA2#show wireless client summary
Number of Local Clients : 2
MAC Address    AP Name                              WLAN State              Protocol
-------------------------------------------------------------------------------------
b065.bdb0.a1ad AP6073.5c90.4e87                     1    UP                 11n(5)
b065.bdbf.77a3 AP6073.5c90.4e87                     1    UP                 11n(5)

MA2#show wcdb database all
   Total Number of Wireless Clients = 2
          Clients Waiting to Join   = 0
          Local Clients             = 2
          Anchor Clients            = 0
          Foreign Clients           = 0
          MTE Clients               = 0

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
b065.bdbf.77a3    500 20.1.1.54       0x00EC328000000005 RUN      LOCAL
b065.bdb0.a1ad    500 20.1.1.55       0x00EC328000000005 RUN      LOCAL
```

The new mobility agent switch to where the client roamed displays mobility state as “LOCAL” for the two clients, as seen earlier.

```
MC1#show wireless mobility controller client summary
Number of Clients : 2

State is the Sub-Domain state of the client.
* indicates IP of the associated Sub-domain
Associated Time in hours:minutes:seconds

MAC Address     State       Anchor IP          Associated IP    Associated Time
-------------------------------------------------------------------------------
b065.bdb0.a1ad  Local       0.0.0.0            20.1.7.2         00:00:50
b065.bdbf.77a3  Local       0.0.0.0            20.1.7.2         00:00:50
```

The mobility controller switch reflects the change of switch to where the clients roamed as well as their mobility state as “Local” on 20.1.7.2 (switch/management IP of MA2); the anchor column still displays 0.0.0.0.

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Tunnel Roles in Converged Access

This section explains what function each CAPWAP tunnel plays in the converged access deployment.

The following outputs are from an MA1:

```
MA1#show capwap summary

CAPWAP Tunnels General Statistics:
  Number of Capwap Data Tunnels       = 1
  Number of Capwap Mobility Tunnels   = 2
  Number of Capwap Multicast Tunnels  = 0
Name   APName                           Type PhyPortIf Mode      McastIf
------ -------------------------------- ---- --------- --------- -------
Ca1    3602I_G1/0/1_66BC                data Gi1/0/1   unicast   -
Ca0    -                                mob  -         unicast   -
Ca2    -                                mob  -         unicast   -

Name   SrcIP           SrcPort DestIP          DstPort DtlsEn MTU
------ --------------- ------- --------------- ------- ------ -----
Ca1    20.1.5.2        5247    20.1.5.52       38508   No     1449
Ca0    20.1.5.2        16667   20.1.3.2        16667   No     1464
Ca2    20.1.5.2        16667   20.1.7.2        16667   No     1464
```

where:

Ca1, or CAPWAP tunnel 1, is the data tunnel formed with the Cisco Access Point 3602I (20.1.5.52) connected to Gi1/0/1.

Ca0 is the mobility agent-to-mobility controller CAPWAP mobility tunnel formed with the mobility controller switch (20.1.3.2).

Ca2 is the mobility agent-to-mobility agent CAPWAP mobility tunnel formed with another mobility agent switch (20.1.7.2) in the same SPG, SPG1.

The following outputs are from the mobility controller switch:

```
MC1#show capwap summary
CAPWAP Tunnels General Statistics:
  Number of Capwap Data Tunnels       = 2
  Number of Capwap Mobility Tunnels   = 4
  Number of Capwap Multicast Tunnels  = 0
Name   APName                           Type PhyPortIf Mode      McastIf
------ -------------------------------- ---- --------- --------- -------
Ca1    -                                mob  -         unicast   -
Ca2    -                                mob  -         unicast   -
Ca3    -                                mob  -         unicast   -
Ca0    -                                mob  -         unicast   -
```

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

```
Ca5     3502E_G2/0/25_83A9                data Gi2/0/25   unicast    -
Ca4     3602I_G2/0/1_3A04                 data Gi2/0/1    unicast    -

Name    SrcIP           SrcPort DestIP          DstPort DtlsEn MTU
------ --------------- ------- --------------- ------- ------ -----
Ca1     20.1.3.2        16667   20.1.5.2        16667   No     1464
Ca2     20.1.3.2        16667   20.1.7.2        16667   No     1464
Ca3     20.1.3.2        16667   20.1.8.2        16667   No     1464
Ca0     20.1.3.2        16667   20.1.9.2        16667   No     1464
Ca5     20.1.3.2        5247    20.1.3.54       63548   No     1657
Ca4     20.1.3.2        5247    20.1.3.53       58274   No     1657
```

where:

Ca4 and Ca5 are the data tunnels formed with Cisco Access Point 3602I (20.1.3.53) and 3502E (20.1.3.54) connected to Gi2/0/1 and Gi2/0/25, respectively.

Ca0 is the mobility controller-to-mobility controller CAPWAP mobility tunnel formed with the mobility controller switch (20.1.9.2).

Ca1 is the mobility controller-to-mobility agent CAPWAP mobility tunnel formed with the mobility agent switch (20.1.5.2).

Ca2 is the mobility controller-to-mobility agent CAPWAP mobility tunnel formed with the mobility agent switch (20.1.7.2).

Ca3 is the mobility controller-to-mobility agent CAPWAP mobility tunnel formed with the mobility agent switch (20.1.8.2).

The mobility controller switch also builds a similar CAPWAP mobility tunnel with the guest anchor controller (which can be a WiSM2, 5508 upgraded to 7.3 release, or a 5760 controller) if guest access is configured.

Note: These CAPWAP mobility tunnels are automatically created by software under the covers based on the configuration that is done for mobility.

Appendix A: Detailed FnF Field Support

Field	L2 In	L2 Out	IPv4 In	IPV4 Out	IPv6 In	IPv6 Out	Notes
interface input	Yes	-	Yes	-	Yes	-	
interface output	-	Yes	-	Yes	-	Yes	
flow direction	Yes	Yes	Yes	Yes	Yes	Yes	
Ethertype	Yes	Yes	-	-	-	-	
vlan input	Yes	-	Yes	-	Yes	-	Supported only for switchport
vlan output	-	Yes	-	Yes	-	Yes	Supported only for switchport
dot1q vlan input	Yes	-	Yes	-	Yes	-	Supported only for switchport
dot1q vlan output	-	Yes	-	Yes	-	Yes	Supported only for switchport
dot1q priority	Yes	Yes	Yes	Yes	Yes	Yes	Supported only for switchport
mac source address input	Yes	Yes	Yes	Yes	Yes	Yes	

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Field	L2 In	L2 Out	IPv4 In	IPV4 Out	IPv6 In	IPv6 Out	Notes
mac source address output	-	-	-	-	-	-	
mac destination address input	Yes	-	Yes	-	Yes	-	
mac destination address output	-	Yes	-	Yes	-	Yes	
ipv4 version	-	-	Yes	Yes	Yes	Yes	
ipv4 tos	-	-	Yes	Yes	Yes	Yes	
ipv4 protocol	-	-	Yes	Yes	Yes	Yes	Must use if any of src/dest port, ICMP code/type, IGMP type, or TCP flags is used.
ipv4 ttl	-	-	Yes	Yes	Yes	Yes	
ipv4 version	-	-	Yes	Yes	Yes	Yes	Same as IP_VERSION
ipv4 tos	-	-	Yes	Yes	Yes	Yes	Same as IP_TOS
ipv4 ttl	-	-	Yes	Yes	Yes	Yes	Same as IP_TTL
ipv4 protocol	-	-	Yes	Yes	Yes	Yes	Same as IP_PROT. Must use if any of src/dest port, ICMP code/type, IGMP type, or TCP flags is used.
ipv4 source address	-	-	Yes	Yes	-	-	
ipv4 destination address	-	-	Yes	Yes	-	-	
icmp ipv4 type	-	-	Yes	Yes	-	-	
icmp ipv4 code	-	-	Yes	Yes	-	-	
igmp type	-	-	Yes	Yes	-	-	
ipv6 version	-	-	Yes	Yes	Yes	Yes	Same as IP_VERSION
ipv6 protocol	-	-	Yes	Yes	Yes	Yes	Same as IP_PROT. Must use if any of src/dest port, ICMP code/type, IGMP type, or TCP flags is used.
ipv6 source address	-	-	-	-	Yes	Yes	
ipv6 destination address	-	-	-	-	Yes	Yes	
ipv6 traffic-class	-	-	Yes	Yes	Yes	Yes	Same as IP_TOS
ipv6 hop-limit	-	-	Yes	Yes	Yes	Yes	Same as IP_TTL
icmp ipv6 type	-	-	-	-	Yes	Yes	
icmp ipv6 code	-	-	-	-	Yes	Yes	
source-port	-	-	Yes	Yes	Yes	Yes	
destination-port	-	-	Yes	Yes	Yes	Yes	
bytes long	Yes	Yes	Yes	Yes	Yes	Yes	Packet size = (Ethernet frame size including FCS - 18 bytes) Recommended: Avoid this field and use CNT_BYTES_LAYER2_LONG
packets long	Yes	Yes	Yes	Yes	Yes	Yes	
timestamp absolute first	Yes	Yes	Yes	Yes	Yes	Yes	
timestamp absolute last	Yes	Yes	Yes	Yes	Yes	Yes	
tcp flags	Yes	Yes	Yes	Yes	Yes	Yes	Collects all flags
bytes layer2 long	Yes	Yes	Yes	Yes	Yes	Yes	

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV Amsterdam,
The Netherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at www.cisco.com/go/offices.

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: www.cisco.com/go/trademarks. Third party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1110R)

Printed in USA C07-727066-00 04/13

© 2013 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public Information.