Parallel Redundancy Protocol Over Wireless Deployment Guide

Revised: February 19, 2021

Parallel Redundancy Protocol Over Wireless Deployment Guide

This document provides details about configuring Parallel Redundancy Protocol (PRP) over wireless on the Cisco IW3702 access points.

Note The documentation set for this product strives to use bias-free language. For purposes of this documentation set, bias-free is defined as language that does not imply discrimination based on age, disability, gender, racial identity, ethnic identity, sexual orientation, socioeconomic status, and intersectionality. Exceptions may be present in the documentation due to language that is hardcoded in the user interfaces of the product software, language used based on RFP documentation, or language that is used by a referenced third-party product.

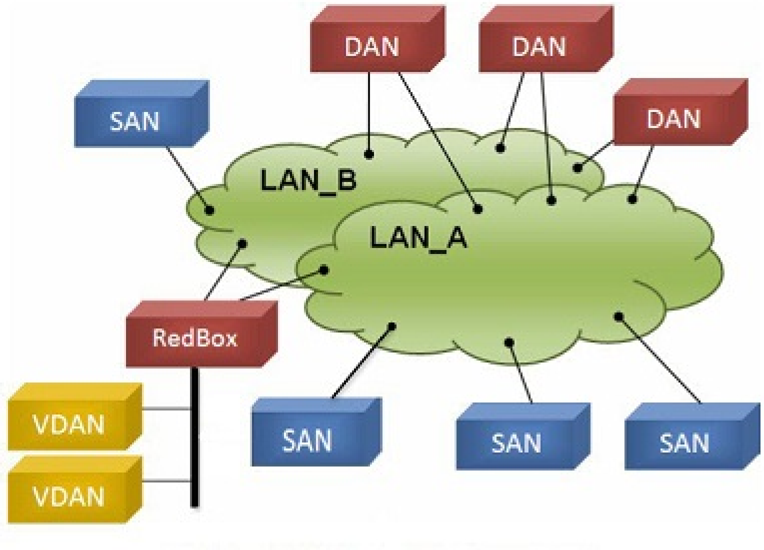
Information About Parallel Redundancy Protocol (PRP) over Wireless

Parallel Redundancy Protocol (PRP) is defined in the International Standard IEC 62439-3. PRP is designed to provide hitless redundancy (zero recovery time after failures) in Ethernet networks.

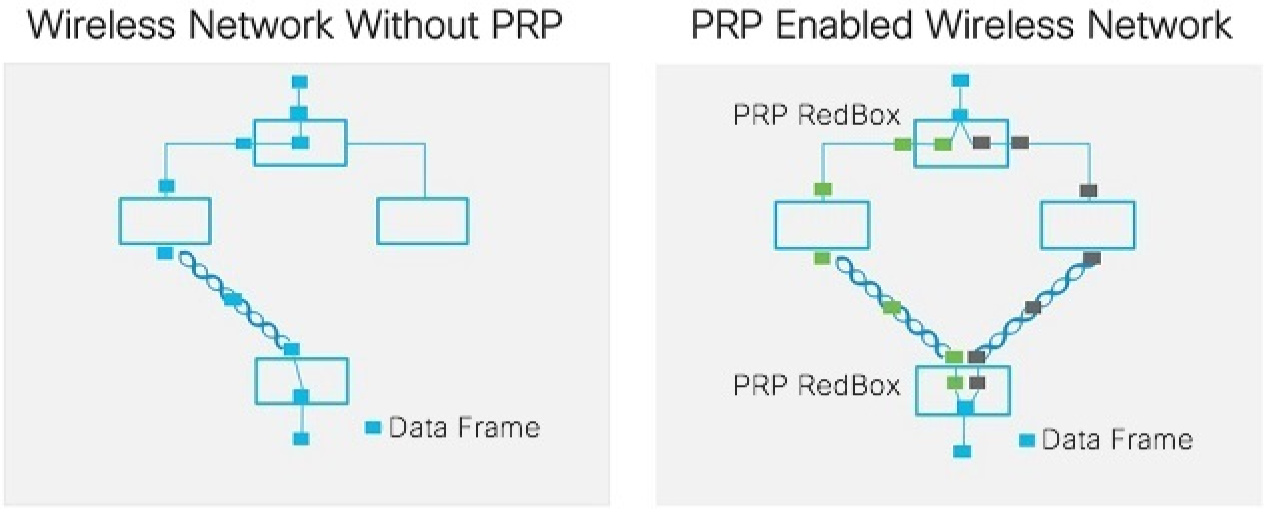
PRP allows a data communication network to prevent data transmission failures by providing two alternate paths for the traffic to reach its destination. Two Ethernet networks (LANs) with similar topology are separated.

A device that requires protection for data across the network connects to the two independent networks (LAN-A and LAN-B) is called a Dual Attached Node implementing PRP (DANP). A DANP source sends two frames simultaneously on both LANs. A DANP destination receives both frames and discards the duplicating. If one LAN fails, a DANP destination can still receive a frame from the other LAN.

Nonredundant endpoints in the network that attach only to either LAN-A or LAN-B are known as Singly Attached Nodes (SANs). A Redundancy Box (RedBox) is used when a single interface node must be attached to both networks. Such a node can communicate with all other nodes.



The PRP functionality is available on wireless since Cisco Wireless Controller Release 8.4. The feature is designed to bridge wired client traffic (behind the WGB) using dual radio links to provide reliable wireless transmission. As shown in the following figure, the typical wireless data transmission goes over a single radio path and is susceptible to RF interference and packet loss during handoff. The PRP over Wireless feature creates a redundant radio path for data transmission and enables consistent and reliable data connectivity over the wireless network. It allows the distribution of traffic over two parallel wireless connections to achieve the highest level of resilience and reduction in delay variation.



The PRP over Wireless feature is supported on IW3702 WGB with two redundancy options. Wired client traffic is duplicated and transmitted on dual radio links either by two WGBs (dual WGB, dual radio), or by a single WGB with dual radio links (single WGB, dual radio). Each redundancy option is discussed in detail in the following sections with sample configurations provided.

Prerequisites and Components Used

The PRP over wireless feature is supported for the following software releases, platforms, and AP Modes.

- Dual WGB dual radio redundancy option – Wireless Controller Software Release 8.4
- Single WGB dual radio redundancy option – Wireless Controller Software Release 8.5
- APs on the infrastructure side – FlexConnect mode (central authentication, local switching). The following IOS-based platforms are supported: IW3702, 2700, 3700, and 1570 series.
- WGB on the mobile client side – IW3702

The configuration example that is given in this document involves the following components:

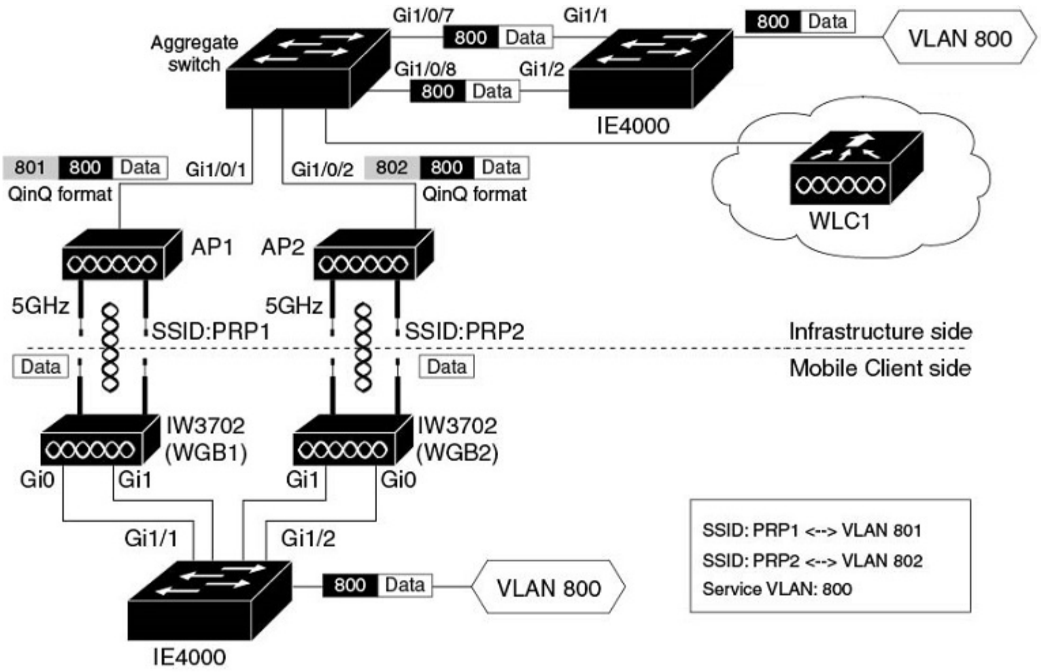
- Wireless LAN Controller (WLC) – Release 8.5.120.0
- Infrastructure APs – IW3702 APs in FlexConnect mode (central authentication, local switching)
- WGB – IW3702 AP running autonomous image of Release 15.3(3)JF
- PRP switch – IE 4000 with image version ie4000-universal-mz.152-4.EA5
- Aggregate switch with Dot1q tunneling function – Catalyst 3750

Dual WGB Dual Radio PRP Redundancy Option

These sections contain configurations of the infrastructure side and mobile client side for dual WGB dual radio PRP redundancy.

Example Network Topology

The following figure shows an example of dual WGB dual radio PRP redundancy topology.



In this topology, the redundant path is provided by two 5GHz radios on two WGBs. The two PRP switches (in this example, the Cisco IE4000) work as RedBox (redundancy box) on both the mobile client side and network infrastructure side, performing packet duplication and duplication discard.

Detailed functions of each network component are described as following:

Infrastructure side:

- The PRP capable switch (in this example, the Cisco IE4000) on the infrastructure side serves as the RedBox, performing packet duplication and duplication discard.
- APs on the infrastructure side transmit and receive redundant data traffic over different SSIDs (in this example, PRP1 and PRP2), and tag the data with different VLANs (QinQ Tunnel encapsulation or decapsulation).
- The traffic between aggregate switch and APs is in QinQ format to identify the path where they come from. The QinQ function is enabled on the aggregate switch Ethernet interfaces (Gi1/0/7 and Gi1/0/8), which connect to the IE switch PRP ports. These two interfaces perform QinQ Tunnel encapsulation for downstream traffic and decapsulation for upstream traffic, so that the duplicated traffic can be carried over different VLANs.

Mobile client side:

- The Gig port 0 (PoE IN) of each IW3702 is connected to the two PRP ports of the PRP switch. Since the IE4000 PRP port is not a PoE port, IW3702 should connect to a power injector.
- PRP-capable switch IE4000 is used to perform packet duplication and duplication discard function for the client VLAN traffic (VLAN 800).
- Each IW3702 works as a WGB, which associates to different SSIDs (in this example, PRP1 and PRP2) and locates in different VLANs (in this example, VLAN 801 and VLAN 802). The redundant wireless paths are provided for wired clients behind the WGB by two 5GHz radios on two WGBs.

Roaming Coordination:

- Gig port 1 (PoE OUT) of the two IW3702s can be connected through the IE switch Ethernet interface to provide roaming coordination function, which prevents both WGBs from roaming at the same time.

Note When powered by the PoE IN port with 802.3at power input, the IW3072 Gig port 1 can still forward traffic. But the PoE OUT functionality is not supported.

Infrastructure Side Configuration

This section contains the following infrastructure side configurations.

Wireless LAN Controller Configuration

This section contains the following Wireless LAN Controller configurations.

- WLAN Creation, on page 6
- Enabling PRP Under WLAN, on page 10
- Configuring WGB Multiple Client VLAN, on page 11

WLAN Creation

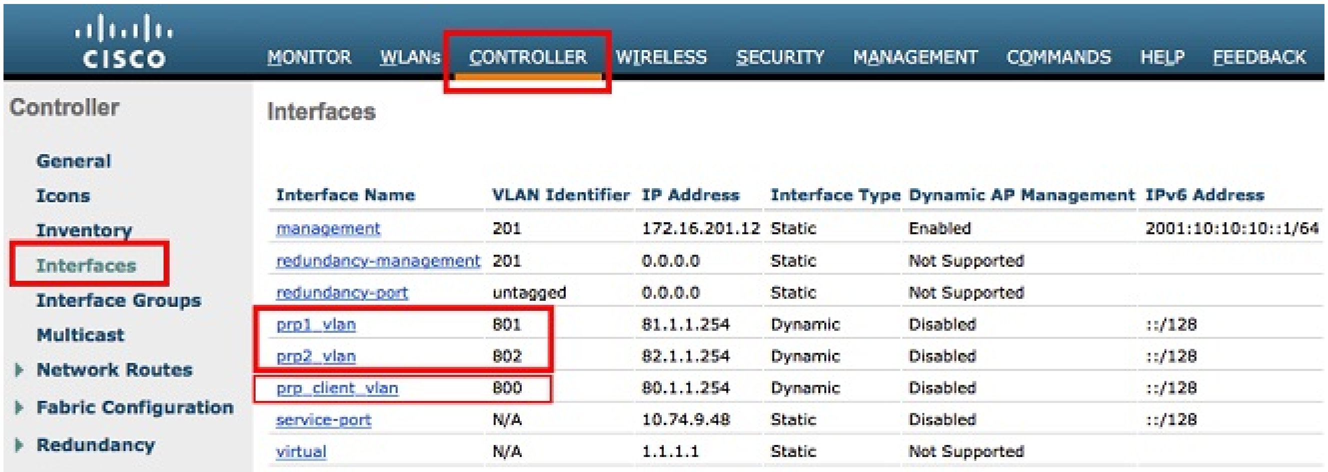
For the PRP over wireless to function, two WLANs (SSIDs) in two different interfaces (VLANs) are required to carry redundant wireless traffic. Configure the WLANs across all the infrastructure side APs.

Procedure

Step 1 Create dynamic interfaces.

For the PRP and QinQ to work under Flexconnect and local switch mode, you should configure the following dynamic interfaces:

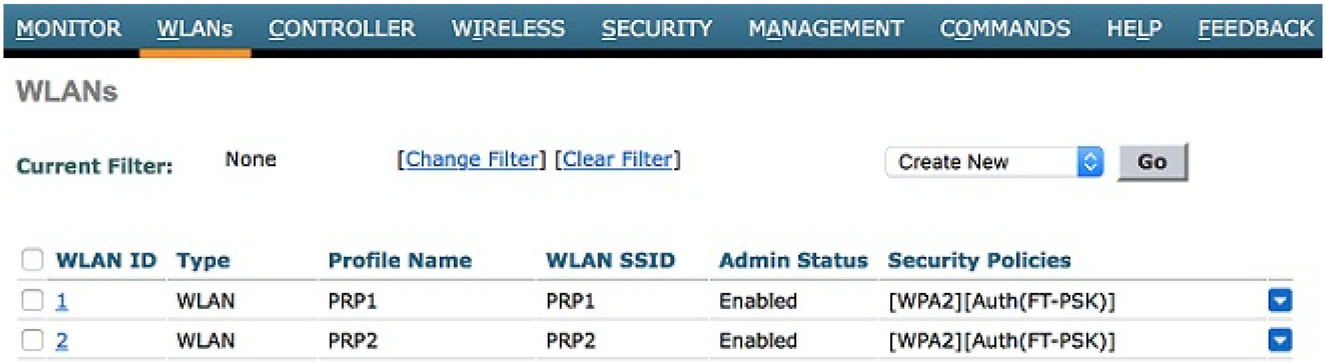
- WLAN VLAN interface, which maps to the WGB (wireless client) VLAN. In this example, VLAN 801 and VLAN 802 are VLANs for SSID PRP1 and SSID PRP2 respectively. This VLAN is expected to be used as the outer tag of QinQ packet.
- Wired client VLAN, which is used by the Flexconnect AP as the inner tag of QinQ packet. In this example, VLAN 800 is configured as the wired client VLAN.



Interfaces

Interface Name	VLAN Identifier	IP Address	Interface Type	Dynamic AP Management	IPv6 Address
management	201	172.16.201.12	Static	Enabled	2001:10:10:10::1/64
redundancy-management	201	0.0.0.0	Static	Not Supported	
redundancy-port	untagged	0.0.0.0	Static	Not Supported	
prp1_vlan	801	81.1.1.254	Dynamic	Disabled	::/128
prp2_vlan	802	82.1.1.254	Dynamic	Disabled	::/128
prp_client_vlan	800	80.1.1.254	Dynamic	Disabled	::/128
service-port	N/A	10.74.9.48	Static	Disabled	::/128
virtual	N/A	1.1.1.1	Static	Not Supported	

Step 2 Create WLAN with SSID (PRP1/PRP2).

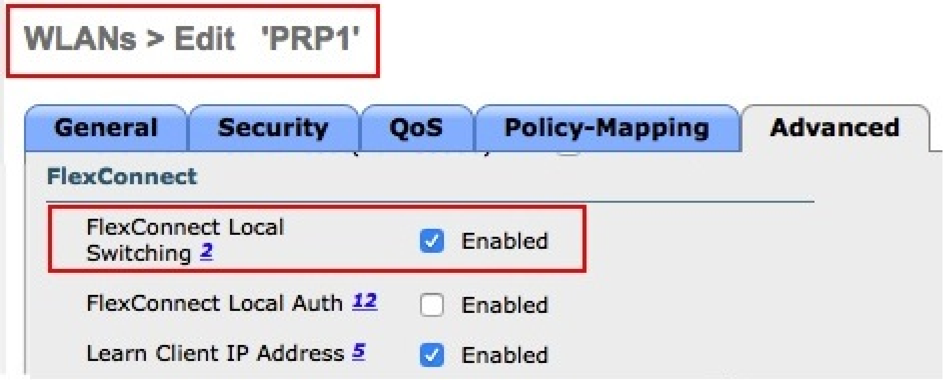


WLANs

Current Filter: None

□ WLAN ID	Type	Profile Name	WLAN SSID	Admin Status	Security Policies
□ 1	WLAN	PRP1	PRP1	Enabled	[WPA2][Auth(FT-PSK)]
□ 2	WLAN	PRP2	PRP2	Enabled	[WPA2][Auth(FT-PSK)]

Step 3 The PRP over wireless feature works only in Flexconnect mode. Enable FlexConnect Local Switching mode on the WLANs that have been created.



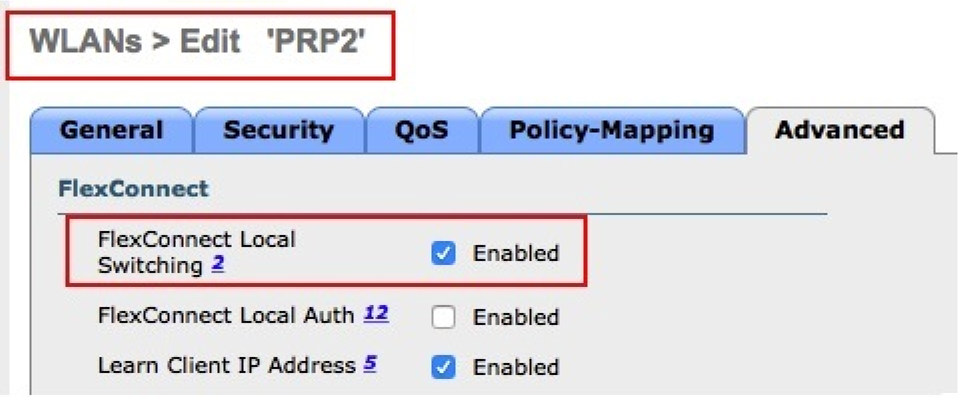
WLANs > Edit 'PRP1'

FlexConnect

FlexConnect Local Switching 2 ☑ Enabled

FlexConnect Local Auth 12 □ Enabled

Learn Client IP Address 5 ☑ Enabled

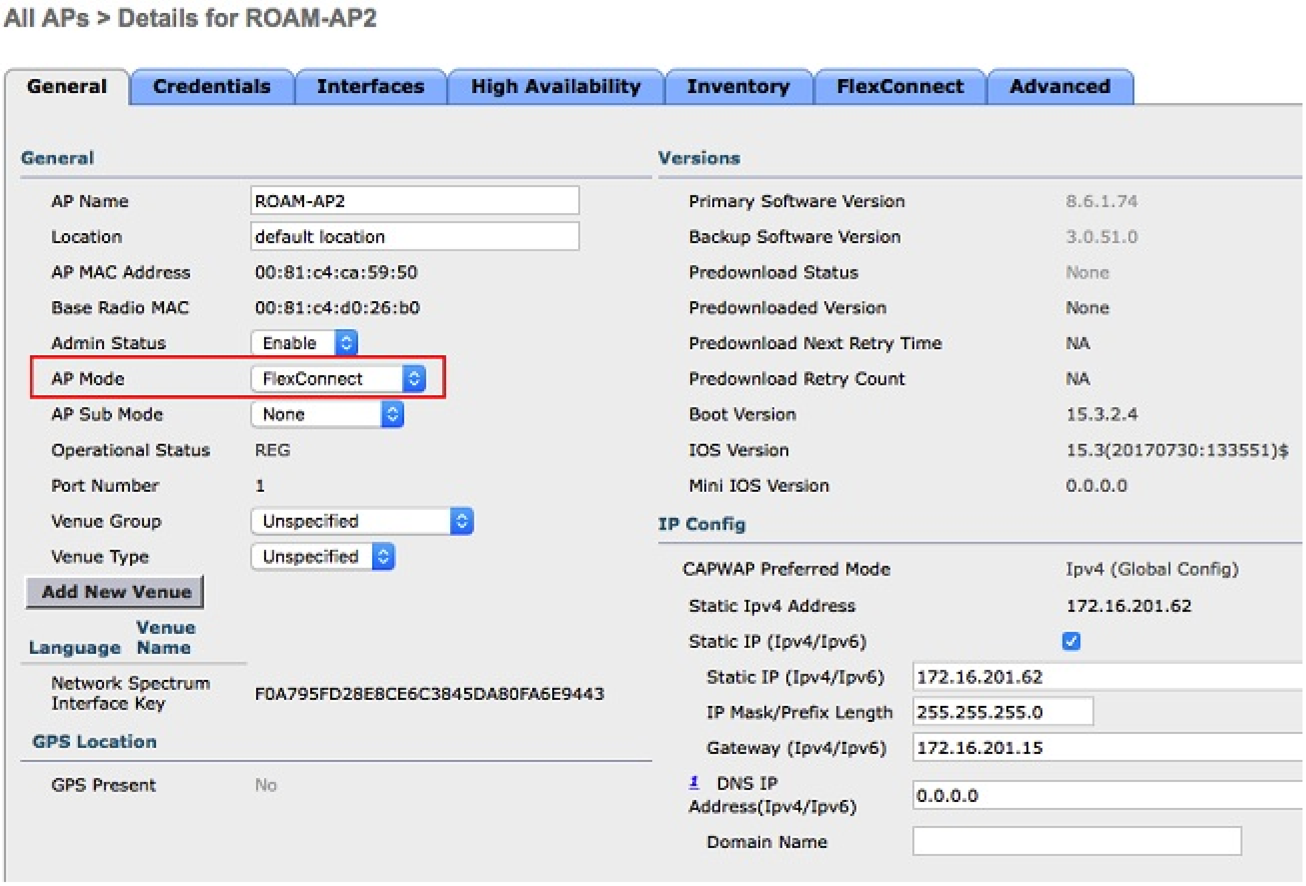


WLANs > Edit 'PRP2'

FlexConnect

FlexConnect Local Switching 2	☑ Enabled
FlexConnect Local Auth 12	□ Enabled
Learn Client IP Address 5	☑ Enabled

Step 4 Connect the APs to the infrastructure and make them join the WLC in Flexconnect mode.



All APs > Details for ROAM-AP2

General

AP Name	ROAM-AP2
Location	default location
AP MAC Address	00:81:c4:ca:59:50
Base Radio MAC	00:81:c4:d0:26:b0
Admin Status	Enable
AP Mode	FlexConnect
AP Sub Mode	None
Operational Status	REG
Port Number	1
Venue Group	Unspecified
Venue Type	Unspecified

Language	Venue Name

Network Spectrum Interface Key	F0A795FD28E8CE6C3845DA80FA6E9443

GPS Location

GPS Present	No

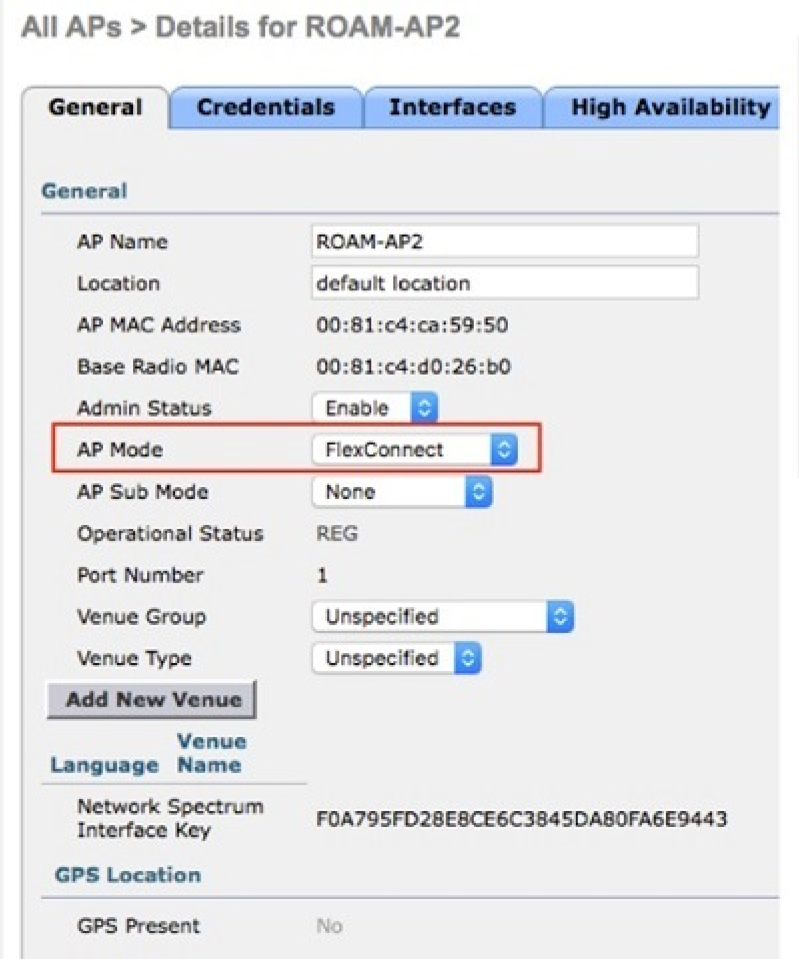
Versions

Primary Software Version	8.6.1.74
Backup Software Version	3.0.51.0
Predownload Status	None
Predownloaded Version	None
Predownload Next Retry Time	NA
Predownload Retry Count	NA
Boot Version	15.3.2.4
IOS Version	15.3(20170730:133551)$
Mini IOS Version	0.0.0.0

IP Config

CAPWAP Preferred Mode	Ipv4 (Global Config)
Static Ipv4 Address	172.16.201.62
Static IP (Ipv4/Ipv6)	☑
Static IP (Ipv4/Ipv6)	172.16.201.62
IP Mask/Prefix Length	255.255.255.0
Gateway (Ipv4/Ipv6)	172.16.201.15
1 DNS IP Address(Ipv4/Ipv6)	0.0.0.0
Domain Name	

Step 5 Enable VLAN mappings on all APs and make sure that WLANs created for PRP are included for the VLANs.



All APs > Details for ROAM-AP2

General

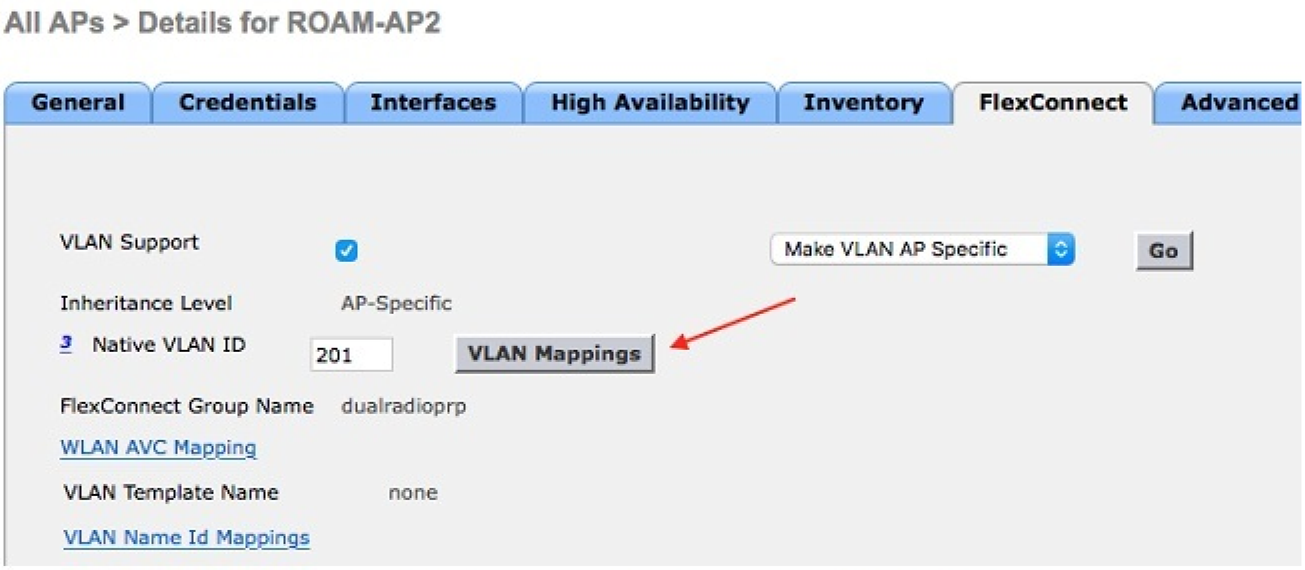
AP Name	ROAM-AP2
Location	default location
AP MAC Address	00:81:c4:ca:59:50
Base Radio MAC	00:81:c4:d0:26:b0
Admin Status	Enable
AP Mode	FlexConnect
AP Sub Mode	None
Operational Status	REG
Port Number	1
Venue Group	Unspecified
Venue Type	Unspecified

Language	Venue Name

Network Spectrum Interface Key	F0A795FD28E8CE6C3845DA80FA6E9443

GPS Location

GPS Present	No



All APs > Details for ROAM-AP2

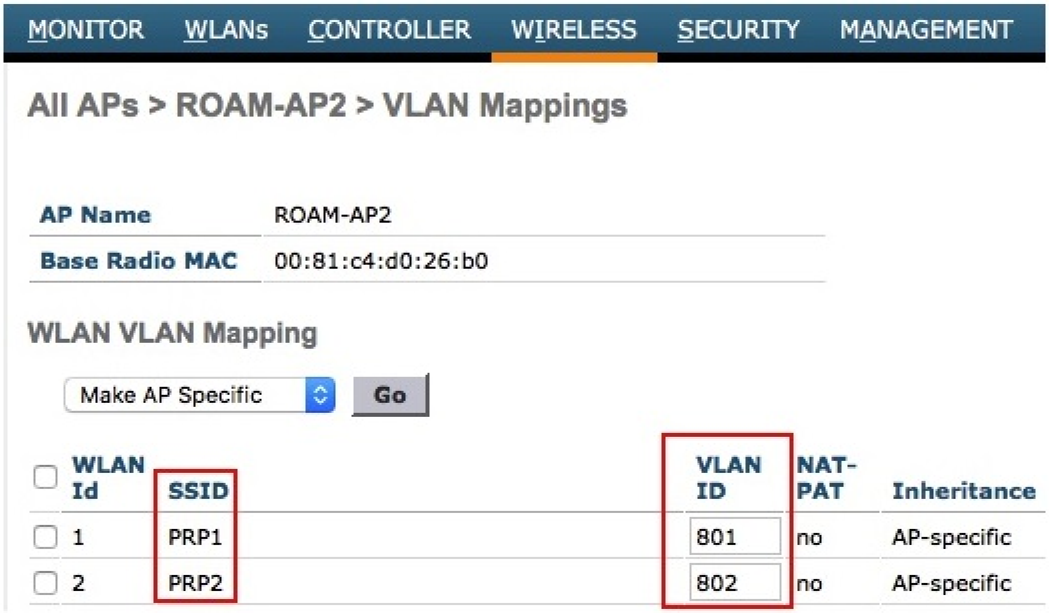
VLAN Support ☑

Inheritance Level AP-Specific

Native VLAN ID 201

FlexConnect Group Name dualradioprp

VLAN Template Name none



All APs > ROAM-AP2 > VLAN Mappings

AP Name	ROAM-AP2
Base Radio MAC	00:81:c4:d0:26:b0

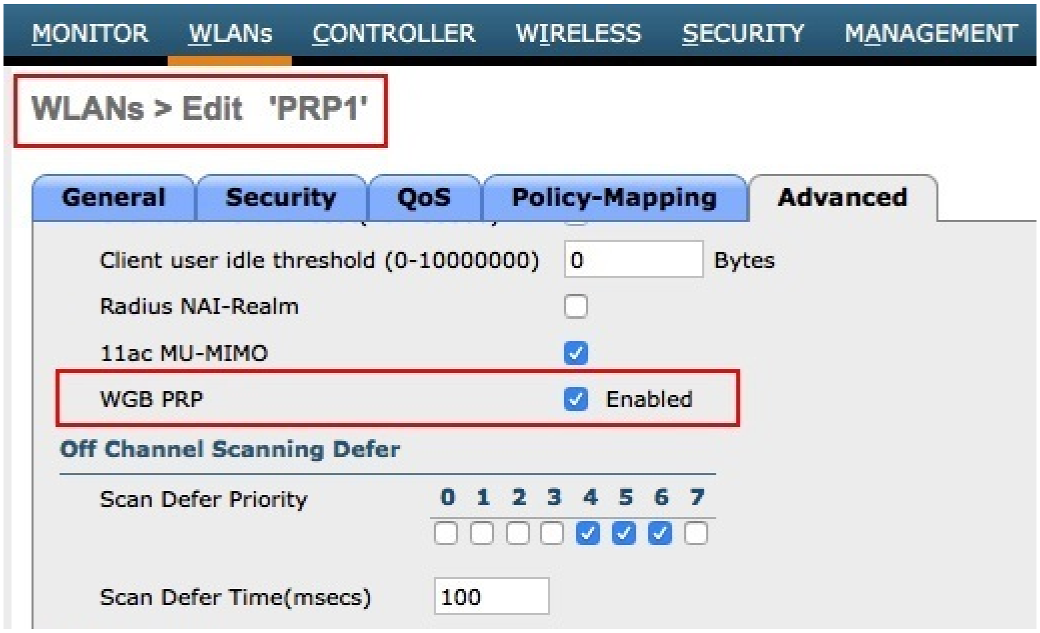
WLAN VLAN Mapping

□	WLAN Id	SSID	VLAN ID	NAT-PAT	Inheritance
□	1	PRP1	801	no	AP-specific
□	2	PRP2	802	no	AP-specific

Note When using fast secure roaming method CCKM, you need to create FlexConnect Groups for CCKM to work. The group name must be the same between APs for a fast roaming to happen for CCKM.

Enabling PRP Under WLAN

Make sure to enable the PRP feature only for the WLANs that require PRP functionality. In this example, PRP feature should be enabled for WLAN PRP1 and WLAN PRP2.



WLANs > Edit 'PRP1'

Client user idle threshold (0-10000000) 0 Bytes

Radius NAI-Realm □

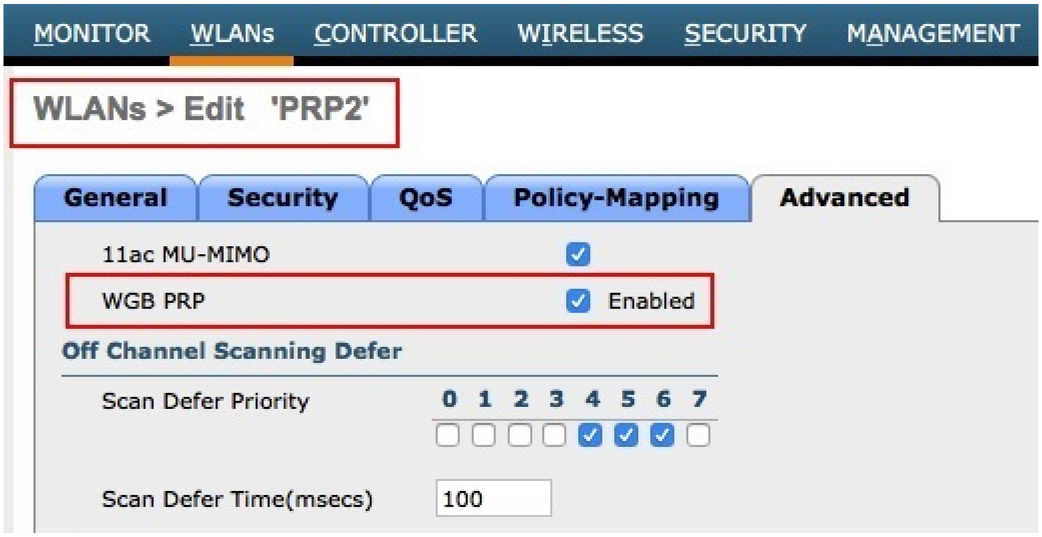
11ac MU-MIMO ☑

WGB PRP ☑ Enabled

Off Channel Scanning Defer

	0	1	2	3	4	5	6	7
Scan Defer Priority	□	□	□	□	☑	☑	☑	□

Scan Defer Time(msecs) 100



WLANs > Edit 'PRP2'

11ac MU-MIMO ☑

WGB PRP ☑ Enabled

Off Channel Scanning Defer

	0	1	2	3	4	5	6	7
Scan Defer Priority	□	□	□	□	☑	☑	☑	□

Scan Defer Time(msecs) 100

Configuring WGB Multiple Client VLAN

To enable WGB client multiple VLAN support, both WLC and WGB need to be configured.

On WLC, navigate to the **Controller** > **General** tab, and choose **Enable** for WGB VL AN client.

On WGB, use the following command to enable WGB VLAN tagging:

```
WGB(config)#workgroup-bridge unified-vlan-client
WGB(config)#workgroup-bridge unified-vlan-client broadcast-tagging
```

Note When you have multiple VLAN configurations on WGB, you need to configure the encryption cipher mode and keys for a particular VLAN, for example, **encryption vlan 801 mode ciphers aes-ccm**. Then, you need to configure the encryption cipher mode globally on the multicast/broadcast interface by entering the following command: **encryption mode ciphers aes-ccm**.

PRP Switch Configuration

Several Cisco Industrial Ethernet switches support PRP feature.

PRP channel or channel group is a logical interface that aggregates two Gigabit Ethernet interfaces (access, trunk, or routed) into a single link. In the channel group, the lower numbered Gigabit Ethernet member port is the primary port and connects to LAN_A. The higher numbered port is the secondary port and connects to LAN_B. The PRP channel remains up as long as at least one of these member ports remains up and sends traffic. When both member ports are down, the channel is down. The total number of supported PRP channel groups is 2 per switch, and the interfaces that can be utilized for each group on each switch series are fixed.

On the IE 4000:

- PRP channel group 1 always uses Gi1/1 for LAN_A and Gi1/2 for LAN_B
- PRP channel group 2 always uses Gi1/3 for LAN_A and Gi1/4 for LAN_B

The following example shows how to create a PRP channel on the IE 4000 switch.

```
switch#configure terminal
switch(config)#interface range GigabitEthernet1/1-2
switch(config-if)#switch port mode trunk
switch(config-if)#no keepalive
switch(config-if)#no cdp enable
switch(config-if)#udld port disable
switch(config-if)#prp-channel-group 1
switch(config-if)#no shutdown
switch(config-if)#spanning-tree bpdufilter enable
```

Note The **spanning-tree portfast edge trunk** command is optional on the prp-channel interface but highly recommended. It improves the spanning tree converge time in PRP LAN-A and LAN-B.

For more information about configuring the PRP channel group, see Parallel Redundancy Protocol (PRP) for IE 4000, IE 4010, and IE 5000 Switches.

Aggregate Switch Configuration

Following is a sample configuration of aggregation Switch. VLAN 201 is the WLC management interface.

```
interface GigabitEthernet1/0/1
 description ***Port to AP1***
 switchport trunk encapsulation dot1q
 switchport trunk native vlan 201
 switchport trunk allowed vlan 201,801,802
 switchport mode trunk

interface GigabitEthernet1/0/2
 description ***Port to AP2***
 switchport trunk encapsulation dot1q
 switchport trunk native vlan 201
 switchport trunk allowed vlan 201,801,802
 switchport mode trunk

interface GigabitEthernet1/0/7
 description ***Port to IE switch PRP port***
 switchport access vlan 801
 switchport mode dot1q-tunnel
 spanning-tree portfast trunk

interface GigabitEthernet1/0/8
 description ***Port to IE switch PRP port***
 switchport access vlan 802
 switchport mode dot1q-tunnel
 spanning-tree portfast trunk
```

Mobile Client Side Configuration

This section contains the following mobile client side configurations.

Workgroup Bridge Configuration

Two IW3702 APs on the mobile client side should be configured as WGBs to associate to SSID PRP1 and SSID PRP2 respectively, with their GigabitEthernet0 ports connect to the IE4000 PRP ports.

- The following is a sample configuration on WGB1. It is configured to associates to SSID PRP1 with VLAN 801, and with wired client VLAN 800.

> **Note** Open security method is used in WGB configuration. In the following example, the parameters configured by the **mobile station scan xx xx xx** and **mobile station period x threshold x** command should be adjusted based on your own deployment. For more WGB configuration guidelines on roaming and security, see https://www.cisco.com/c/en/us/support/docs/wireless/aironet-1130-ag-series/113198-wgb-roam-config.html.

```
hostname WGB1
dot11 ssid PRP1
 vlan 801
 authentication open
interface Dot11Radio1
no ip address
ssid PRP1
station-role workgroup-bridge
mobile station scan 5745 5765 5785
mobile station period 1 threshold 70
!
interface Dot11Radio1.800
encapsulation dot1Q 800
bridge-group 2
bridge-group 2 spanning-disabled
!
interface Dot11Radio1.801
encapsulation dot1Q 801 native
bridge-group 1
bridge-group 1 spanning-disabled
!
interface GigabitEthernet0.800
```

```
encapsulation dot1Q 800
bridge-group 2
!
interface GigabitEthernet0.801
encapsulation dot1Q 801 native
bridge-group 1
!
workgroup-bridge unified-vlan-client
workgroup-bridge unified-vlan-client broadcast-tagging
```

- Similarly, WGB2 is configured to associates to SSID PRP2 with VLAN 802, and with the wired client VLAN 800, as the following example shows.

Note Open security method is used in WGB configuration. In the following example, the parameters configured by the **mobile station scan xx xx xx** and **mobile station period x threshold x** command should be adjusted based on your own deployment. For more WGB configuration guidelines on roaming and security, see https://www.cisco.com/c/en/us/support/docs/wireless/aironet-1130-ag-series/113198-wgb-roam-config.html.

```
hostname WGB2
dot11 ssid PRP2
 vlan 802
 authentication open
interface Dot11Radio1
no ip address
ssid PRP2
station-role workgroup-bridge
mobile station scan 5745 5765 5785
mobile station period 1 threshold 70
!
interface Dot11Radio1.800
encapsulation dot1Q 800
bridge-group 2
bridge-group 2 spanning-disabled
!
interface Dot11Radio1.802
encapsulation dot1Q 802 native
bridge-group 1
bridge-group 1 spanning-disabled
!
interface GigabitEthernet0.800
encapsulation dot1Q 800
bridge-group 2
!
interface GigabitEthernet0.802
encapsulation dot1Q 802 native
bridge-group 1
!
workgroup-bridge unified-vlan-client
workgroup-bridge unified-vlan-client broadcast-tagging
```

WGB Roaming Coordination

A pair of WGBs can support roaming coordination function by communicating via their second Gigabit Ethernet interface. The Gig1 ports of the two IW3702 WGBs can be connected via the IE Switch Ethernet ports to provide roaming coordination function between the two WGBs. The following example contains the configuration needed to enable this function, where VLAN 51 is used as a communication channel between the two WGBs for the roaming coordination.

- WGB1 Configuration

  ```
  dot11 coordinator uplink single Dot11Radio1
  dot11 coordinator timeout roam-wait 150

  interface GigabitEthernet1
   no ip address
   duplex auto
   speed auto

  interface GigabitEthernet1.51
   encapsulation dot1Q 51
   ip address 51.0.0.1 255.255.255.0
   ip coordinator peer-addr 51.0.0.2

  workgroup-bridge service-vlan 51
  ```

- WGB2 Configuration

  ```
  dot11 coordinator uplink single Dot11Radio1
  dot11 coordinator timeout roam-wait 150

  interface GigabitEthernet1
   no ip address
   duplex auto
   speed auto

  interface GigabitEthernet1.51
   encapsulation dot1Q 51
   ip address 51.0.0.2 255.255.255.0
   ip coordinator peer-addr 51.0.0.1

  workgroup-bridge service-vlan 51
  ```

- Configuration to Avoid Bridge Loop

  Wired network on WGB side can introduce a bridge loop if you connect the Gig1 port of WGBs directly or via a switch. The following sample configurations can avoid the bridge loop.

  Note The coordination traffic is forwarded on service VLAN and will not be blocked.

  - To avoid bridge loop when connecting the Gig1 port of WGBs directly, configure the following on both WGBs:

    ```
    WGB(config)# access-list 700 deny 0000.0000.0000 ffff.ffff.ffff
    WGB(config)# interface gigabitEthernet 1
    WGB(config-if)# l2-filter bridge-group-acl
    WGB(config-if)# bridge-group 1
    WGB(config-if)# bridge-group 1 output-address-list 700
    ```

  - To avoid traffic loop when connecting two WGBs via a switch, configure the following on the switch ports:

    ```
    interface GigabitEthernet0/3
     switchport trunk allowed vlan 51
     switchport mode trunk

    interface GigabitEthernet0/4
    ```

```
      switchport trunk allowed vlan 51
      switchport mode trunk
```

PRP Switch Configuration

- Create PRP channel group.

  The following configurations are required to configure PRP channel group on the PRP switch of the mobile client side.

```
switch#configure terminal
switch(config)#interface range GigabitEthernet1/1-2
switch(config-if)#switch port mode trunk
switch(config-if)#no keepalive
switch(config-if)#no cdp enable
switch(config-if)#udld port disable
switch(config-if)#prp-channel-group 1
switch(config-if)#no shutdown
switch(config-if)#spanning-tree bpdufilter enable
```

Note The **spanning-tree portfast edge trunk** command is optional on the prp-channel interface but highly recommended. It improves the spanning tree converge time in PRP LAN-A and LAN-B.

- Create communication channel for roaming coordination.

```
interface GigabitEthernet1/7
 description ***To Gig1 of WGB1***
 switchport trunk allowed vlan 51
 switchport mode trunk
end

interface GigabitEthernet 1/8
 description ***To Gig1 of WGB2***
 switchport trunk allowed vlan 51
 switchport mode trunk
```

Verification

After the configurations are all set, use the following commands to verify the setup.

- On the infrastructure side PRP switch, create the SVI interface with service VLAN 800, and create a DHCP pool for VLAN 800.
- On the mobile client side PRP switch, simulate wired client by creating SVI interface with VLAN 800 as a DHCP client. The DHCP address should be assigned from the DHCP pool VLAN 800.

```
IE-SW#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Vlan1                  unassigned      YES NVRAM  administratively down down
Vlan800                10.10.80.93     YES DHCP   up                    up
```

- Verify the wired client status.

```
(WLC) >show client summary
Number of Clients................................ 4
Number of PMIPV6 Clients......................... 0
Number of EoGRE Clients.......................... 0
GLAN/
 RLAN/
MAC Address AP Name Slot Status WLAN Auth Protocol Port Wired Tunnel Role
----------------- ----------------- ---- ------------- ----- ---- ---------------- ---- ----- -------
----------------
00:10:94:00:00:07 AP1 1 Associated 8 Yes N/A 1 No No Local
4c:00:82:1a:c0:b0 AP1 1 Associated 7 Yes 802.11n(5 GHz) 1 No No Local
f4:0f:1b:f8:3b:c1 AP1 1 Associated 8 Yes N/A 1 No No Local
f8:72:ea:e4:a4:d8 AP1 1 Associated 8 Yes 802.11n(5 GHz) 1 No No Local

(WLC) >show client detail f4:0f:1b:f8:3b:c1
Client MAC Address............................... f4:0f:1b:f8:3b:c1
Client Username ................................. N/A
AP MAC Address................................... d4:a0:2a:98:88:00
AP Name.......................................... AP1
AP radio slot Id................................. 1
2nd AP MAC Address............................... d4:a0:2a:98:88:00
2nd AP Name...................................... AP1
2nd AP radio slot Id............................. 1
Client State..................................... Associated
Client User Group................................
Client NAC OOB State............................. Access
Workgroup Bridge Client.......................... WGB: f8:72:ea:e4:a4:d8
Workgroup Bridge Client.......................... 2nd WGB: 4c:00:82:1a:c0:b0
Wireless LAN Id.................................. 8
Wireless LAN Network Name (SSID)................. PRP2
Wireless LAN Profile Name........................ PRP2
2nd Wireless LAN Id.............................. 7
2nd Wireless LAN Network Name (SSID)............. PRP1
2nd Wireless LAN Profile Name.................... PRP1
```

- Verify data path.

  Ping the infrastructure side from the mobile client side.

```
PRP-SW#ping 10.10.80.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.80.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/5/9 ms
```

Output from the infrastructure PRP switch:

```
PRP-SW#show prp statistics ingressPacketStatistics

GE ports PRP INGRESS STATS:
   ingress pkt lan a: 6   <= LAN A receives 6 pkts
   ingress pkt lan b: 6   <= LAN B receives 6 pkts
   ingress crc lan a: 0
   ingress crc lan b: 0
   ingress danp pkt acpt: 5
   ingress danp pkt dscrd: 5  <= discard 5 duplicate pkts
   ingress supfrm rcv a: 0
   ingress supfrm rcv b: 0
   ingress over pkt a: 0
   ingress over pkt b: 0
```

```
    ingress pri over pkt_a: 0
    ingress pri over pkt_b: 0
```

- Verify the roaming coordination status.

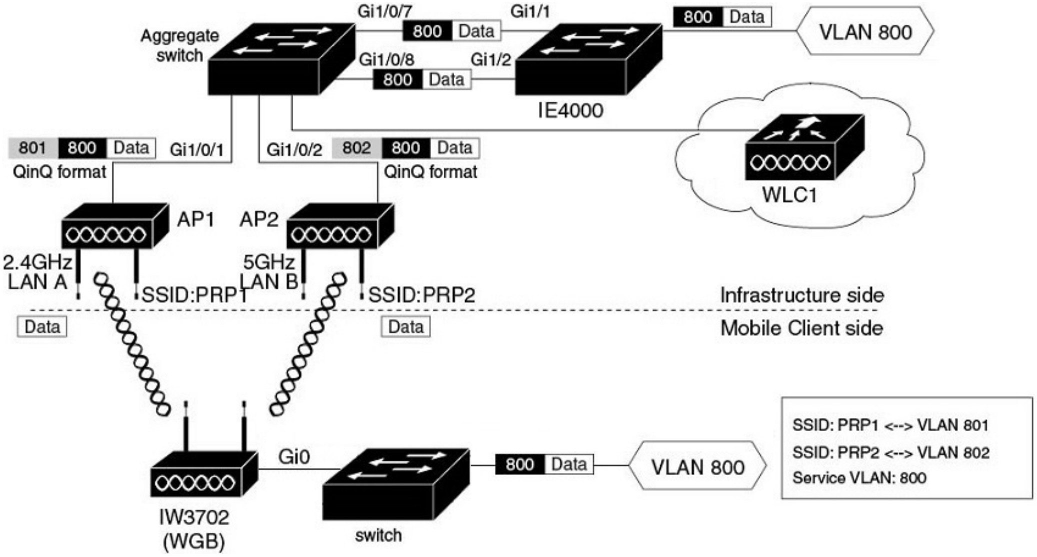
```
WGB1#show coordinator status

WGB1#show dot11 coordinator statistics
```

Single WGB Dual Radio PRP Redundancy Option

These sections contain configurations of the infrastructure side and mobile client side for single WGB dual radio PRP redundancy.

Example Network Topology

The following figure shows a sample topology of the single WGB dual radio PRP redundancy.



For the single WGB dual radio PRP redundancy option, the redundant path is available via 2.4GHz and 5GHz radios on a single WGB. The single WGB works as a RedBox (redundancy box) on the mobile client side, performing packet duplication and duplication discard. On the network infrastructure side, the PRP switch works as the RedBox. Detailed functions of each network components are illustrated as below.

Infrastructure side:

- The PRP capable switch (in this example, the Cisco IE4000) on the infrastructure side serves as the RedBox, performing packet duplication and duplication discard function.
- The APs on the infrastructure side transmit and receive the redundant data traffic over different SSIDs (in this example, PRP1 and PRP2), and tag the traffic with different VLANs (QinQ Tunnel encapsulation or decapsulation).
- The traffic between the aggregate switch and APs is in QinQ format to identify the path of where it is from. The QinQ function is enabled on the Ethernet interfaces (Gi1/0/7 and Gi1/0/8) of the aggregate switch. These two interfaces connect to the PRP

ports of the IE switch, performing QinQ Tunnel encapsulation for the downstream traffic and decapsulation for the upstream traffic, so that the duplicated traffic can be carried over different VLANs.

Mobile client side:

- The IW3702 Gig0 port connects to the switch Ethernet port. The IW3702 serves as the PRP Redbox, performing packet duplication and duplication discard function for the client VLAN traffic (VLAN800).
- The IW3702 works as a WGB, with 2.4GHz and 5GHz radios associate to different SSIDs (in this example, PRP1 and PRP2) and locate in different VLANs (in this example, VLAN 801 and VLAN 802). The redundant wireless paths are provided for the wired clients behind the WGB via 2.4GHz and 5GHz radios on the single WGB.

Roaming Coordination:

- Roaming coordination between 2.4GHz and 5GHz radios is provided via internal communication to prevent two radios from roaming at the same time.

Infrastructure Side Configuration

For the PRP over wireless on single WGB dual radio redundancy option, the network topology and configurations of the infrastructure side are identical to the dual WGB dual radio redundancy option. For details, see Infrastructure Side Configuration, on page 6.

Mobile Client Side Configuration

This section contains the following mobile client side configurations.

Workgroup Bridge Configuration

Both 2.4GHz and 5GHz radios of the IW3702 on the mobile client side are configured as WGB and associate to SSID PRP1 and SSID PRP2 respectively. The IW3702 GigabitEthernet0 port connects to a normal switch port to bridge wired client traffic.

Use the following commands to enable the PRP sub mode on WGB.

```
iw3702(config)# dot11 wgb prp
iw3702(config-prp)# no shutdown
```

In the following WGB configuration example, the wired client vlan 800 traffic is bridged over parallel paths - SSID PRP1 (VLAN 801) on 2.4GHz radio and SSID PRP2 (VLAN 802) on 5GHz radio. Bvi-vlanid is used to configure the VLAN ID of the BVI interface, which should be different from the wired client's VLAN. In this example, VLAN ID 900 is configured. A dynamic interface with VLAN ID 900 is created on WLC on the infrastructure side.

Note Open security method is used in WGB configuration. In the following example, the parameters configured by the **mobile station scan xx xx xx** and **mobile station period x threshold x** command should be adjusted based on your own deployment. For more WGB configuration guidelines on roaming and security, see https://www.cisco.com/c/en/us/support/docs/wireless/aironet-1130-ag-series/113198-wgb-roam-config.html.

```
dot11 wgb prp
 no shutdown
 bvi-vlanid 900
!
dot11 ssid PRP1
```

```
 vlan 801
 authentication open
 no ids mfp client
!
dot11 ssid PRP2
 vlan 802
 authentication open
 no ids mfp client
!
interface Dot11Radio0
ssid PRP1
packet retries 32 drop-packet
station-role workgroup-bridge
mobile station scan 2412 2437 2462
mobile station period 1 threshold 70
rts retries 32
bridge-group 1
bridge-group 1 spanning-disabled
!
interface Dot11Radio0.800
encapsulation dot1Q 800
bridge-group 50
bridge-group 50 spanning-disabled
!
interface Dot11Radio0.801
encapsulation dot1Q 801
bridge-group 100
bridge-group 100 spanning-disabled
!
interface Dot11Radio1
ssid PRP2
packet retries 32 drop-packet
station-role workgroup-bridge
mobile station scan 5745 5765 5785
mobile station period 1 threshold 70
rts retries 32
bridge-group 1
bridge-group 1 spanning-disabled
!
interface Dot11Radio1.800
encapsulation dot1Q 800
bridge-group 50
bridge-group 50 spanning-disabled
!
interface Dot11Radio1.802
encapsulation dot1Q 802
bridge-group 200
bridge-group 200 spanning-disabled

interface GigabitEthernet0
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface GigabitEthernet0.800
 encapsulation dot1Q 800
 bridge-group 50
 bridge-group 50 spanning-disabled
!
workgroup-bridge unified-vlan-client
workgroup-bridge unified-vlan-client broadcast-tagging
```

Roaming coordination function on single WGB works by internal communication of the 2.4GHz and 5GHz radios to avoid both radios roam at the same time. It can be enabled by using the following commands:

```
dot11 coordinator uplink both
dot11 coordinator timeout roam-wait 100
```

Switch Configuration

Following is a sample configuration of switch.

```
interface GigabitEthernet1/0/1
description ***Port to WGB***
switchport trunk encapsulation dot1q
switchport mode trunk
interface GigabitEthernet1/0/2
description ***Port to wired client ***
switchport access vlan 800
switchport mode access
```

Verification

After the configurations are all set, use the following commands to verify the setup.

- On the infrastructure side PRP switch, create the SVI interface with service VLAN 800, and create a DHCP pool for VLAN 800.
- On the mobile client side switch, simulate wired client by creating SVI interface with VLAN 800 as a DHCP client. The DHCP address should be assigned from the DHCP pool VLAN 800.

```
IE-SW#show ip interface brief

Interface              IP-Address      OK? Method Status                Protocol
Vlan1                  unassigned      YES NVRAM  administratively down down
Vlan800                10.10.80.92     YES DHCP   up                    up
```

- Verify the wired client status.

```
(WLC) >show client summary

Number of Clients................................ 4
Number of PMIPV6 Clients......................... 0
Number of EoGRE Clients.......................... 0
GLAN/
 RLAN/
MAC Address       AP Name           Slot Status        WLAN  Auth Protocol         Port Wired Tunnel  Role
----------------- ----------------- ---- ------------- ----- ---- ---------------- ---- ----- -------
----------------
00:81:c4:31:7d:90 AP2                1   Associated     8     Yes   802.11ac(5 GHz)  1     No     No
Local
00:81:c4:31:af:50 AP2                0   Associated     7     Yes   802.11n(2.4 GHz) 1     No     No
Local
00:82:c4:cc:cd:21 AP2                0   Associated     7     Yes   N/A              1     No     No
Local
```

```
(WLC) >show client detail 00:82:c4:cc:cd:21

Client MAC Address............................... 00:82:c4:cc:cd:21
Client Username ................................. N/A
AP MAC Address................................... 00:81:c4:d0:26:b0
AP Name.......................................... AP2
AP radio slot Id................................. 0
2nd AP MAC Address............................... 00:81:c4:d0:26:b0
2nd AP Name...................................... AP2
2nd AP radio slot Id............................. 1
Client State..................................... Associated
Client User Group................................
Client NAC OOB State............................. Access
Workgroup Bridge Client.......................... WGB: 00:81:c4:31:af:50
Workgroup Bridge Client.......................... 2nd WGB: 00:81:c4:31:7d:90
Wireless LAN Id.................................. 7
Wireless LAN Network Name (SSID)................. PRP1
Wireless LAN Profile Name........................ PRP1
2nd Wireless LAN Id.............................. 8
2nd Wireless LAN Network Name (SSID)............. PRP2
2nd Wireless LAN Profile Name.................... PRP2
```

- Verify the data path.

  Ping the infrastructure side from the mobile client side.

```
PRP-SW#ping 10.10.80.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.80.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/5/9 ms
```

  Output from WGB:

```
WGB#show dot11 wgb prp

available uplink count: 2
Index: 0 Status: UP Name: Dot11Radio0 Virtual-Dot11Radio0 AP: cc46.d616.ad84
Index: 1 Status: UP Name: Dot11Radio1 Virtual-Dot11Radio1 AP: cc46.d616.ad8a
======== Statistic counters ===========================
cnt_total_sent_A_:            249701        <= RADIO 0 REPLICATION
cnt_total_sent_B_:            249699        <= RADIO 1 REPLICATION
cnt_tx_difference:             2
cnt_total_received_A_:    2136458           <= RADIO 0 DISCARD
cnt_total_received_B_:    4123098           <= RADIO 1 DISCARD
cnt_rx_difference:             1986641
cnt_total_errors_A_:        0
cnt_total_errors_B_:        0
cnt_total_discard:              531303
cnt_discard_table_used_items:     1024
max_duplicate_delay_:    200
=======================================================
```

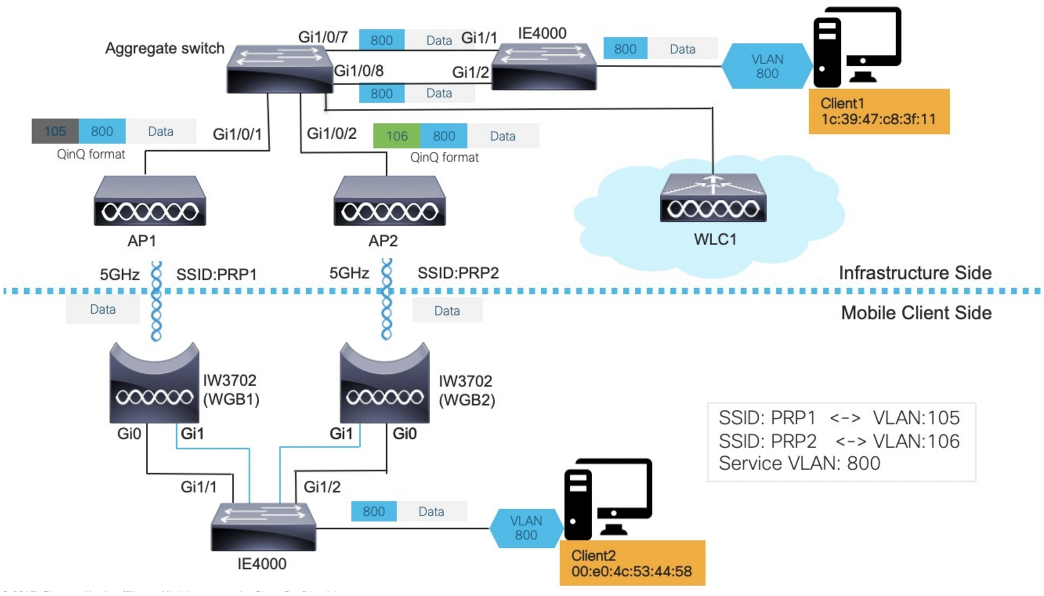
- Verify the roaming coordination status.

```
WGB1#show dot11 coordinator statistics
```

Troubleshooting

This section describes the good practice of tracking the issue of the wireless PRP solution.

Dual WGB Dual Radio PRP Redundancy Option



In above diagram, two wired clients communicate with each other. Client1 (1c39.47c8.3f11) resides on the infrastructure side while Client2 (00e0.4c53.4458) is on mobile client side.

Normally, wired Client2 will initialize the communication, using protocols such as DHCP, ARP, GARP, etc. But it is possible that wired Client2 is a passive client, which means it doesn't make any talk until it receives packets from the infrastructure side, for example, downstream ARP from wired Client1.

The troubleshooting procedures will be described in the following two sections.

Troubleshooting Upstream Traffic

To troubleshoot upstream traffic, use the following procedure to track the packet hop by hop.

Procedure

Step 1 On client side IE4000, execute **show mac address-table dynamic** to check if wired Client2 is learned in the MAC address table with correct VLAN ID.

Example:

```
IE4K-Switch1#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 800    00e0.4c53.4458    DYNAMIC     Gi1/24
 800    1c39.47c8.3f11    DYNAMIC     PR1
   1    00ee.ab49.b643    DYNAMIC     PR1
   1    706d.157c.1274    DYNAMIC     PR1
   1    d4c9.3ceb.3490    DYNAMIC     PR1
   1    f80f.6fc9.2a90    DYNAMIC     PR1
Total Mac Addresses for this criterion: 28
```

Step 2 On client side IE4000, execute **show prp channel 1 detail** to check if PRP ports are binding properly.

Example:

```
IE4K-Switch1#show prp channel 1 detail
PRP-channel: PR1
------------
 Layer type = L2
 Ports: 2 Maxports = 2
 Port state = prp-channel is Inuse
 Protocol = Enabled
Ports in the group:
  1) Port: Gi1/1
   Logical slot/port = 1/1 Port state = Inuse
 Protocol = Enabled
  2) Port: Gi1/2
   Logical slot/port = 1/2 Port state = Inuse
 Protocol = Enabled
```

Execute **show prp statistics egressPacketStatistics** to check LAN-A and LAN-B egress counter. If both PRP ports are in UP state, you should see below sent counters increase equally.

Example:

```
IE4K-Switch1#show prp statistics egressPacketStatistics
 PRP channel-group 1 EGRESS STATS:
   duplicate packet: 7383179
   supervision frame sent: 3113533
   packet sent on lan a: 4870442
   packet sent on lan b: 5431455
   byte sent on lan a: 1105813244
   byte sent on lan b: 1141294801
   egress packet receive from switch: 7581389
   overrun pkt: 0
   overrun pkt drop: 0
```

Step 3 On both WGBs, execute **show bridge** to check if the wired client MAC is learned in correct bridge group (bridge id).

Example:

```
WGB1#show bridge
Total of 300 station blocks, 291 free
Codes: P - permanent, S - self

Bridge Group 1:

    Address       Action   Interface       Age   RX count   TX count
1c39.47c8.3f11   forward   Vi0.106           0       5168          0
68a3.c4a0.2568   forward   Vi0.106           3          2          0
00ee.ab49.bc1a   forward   Gi0.106           0       2385          0
00ee.ab49.b619   forward   Vi0.106           0      20269          0
f80f.6fc9.2a90   forward   Vi0.106           0        158          0
00ee.ab49.b643   forward   Vi0.106           0         50          0

Bridge Group 2:

00e0.4c53.4458   forward   Gi0.800           0       3299          0
1c39.47c8.3f11   forward   Vi0.800           0          1        119
00ee.ab49.bc41   forward   Gi0.800           1          6          0

WGB2#show bridge
Total of 300 station blocks, 294 free
Codes: P - permanent, S - self

Bridge Group 1:
    Address       Action   Interface       Age   RX count   TX count
1c39.47c8.3f11   forward   Vi0.105           0       5381          0
00ee.ab49.bc1a   forward   Gi0.105           0       1908          0
00ee.ab49.b619   forward   Vi0.105           0       3226          0

Bridge Group 2:

00e0.4c53.4458   forward   Gi0.800           0       2656          0
1c39.47c8.3f11   forward   Vi0.800           0          1         81
00ee.ab49.bc41   forward   Gi0.800           0          6          0
```

Step 4 On WLC, execute **show client detail** <*mac_of_client*> to check if the client is learned and both WGBs details are learned on WLC.

Example:

```
(Cisco Controller) >show client detail 00:e0:4c:53:44:58
Client MAC Address............................... 00:e0:4c:53:44:58
Client Username ................................. N/A
Client Webauth Username ......................... N/A
Hostname: .......................................
Device Type: .................................... Unclassified
AP MAC Address................................... 70:ea:1a:29:90:80
AP Name.......................................... PRP_Root2_E984
AP radio slot Id................................. 1
2nd AP MAC Address............................... f8:0f:6f:c9:2a:90
2nd AP Name...................................... PRP_Root1_B89C
2nd AP radio slot Id............................. 1
Client State..................................... Associated
User Authenticated by ........................... None
Client User Group................................
Client NAC OOB State............................. Access
Workgroup Bridge Client.......................... WGB: 70:6d:15:7c:12:74
Workgroup Bridge Client.......................... 2nd WGB: d4:c9:3c:eb:34:90
Wireless LAN Id.................................. 3
Wireless LAN Network Name (SSID)................. PRP2
Wireless LAN Profile Name........................ PRP2
WLAN Profile check for roaming................... Disabled
2nd Wireless LAN Id.............................. 2
2nd Wireless LAN Network Name (SSID)............. PRP1
2nd Wireless LAN Profile Name.................... PRP1
Hotspot (802.11u)................................ Not Supported
Connected For ................................... 56696 secs
BSSID............................................ 70:ea:1a:29:90:8f
Channel.......................................... 36
2nd BSSID........................................ f8:0f:6f:c9:2a:9f
2nd Connected For ............................... 68424 secs
2nd Channel...................................... 108
IP Address....................................... 10.80.80.58
Gateway Address.................................. 10.80.80.1
Netmask.......................................... 255.255.255.0
IPv6 Address..................................... fe80::5faa:5113:e3ee:1515
Association Id................................... 0
Authentication Algorithm......................... Open System
Reason Code...................................... 1
Client IPSK-TAG.................................. N/A
Status Code...................................... 0
2nd Association Id............................... 1
2nd Authentication Algorithm..................... Open System
2nd Reason Code.................................. 1
2nd Status Code.................................. 0
Session Timeout.................................. 0
Client CCX version............................... No CCX support
```

```
2nd FlexConnect Data Switching.................. Local
2nd FlexConnect Dhcp Status..................... Local
2nd FlexConnect Vlan Based Central Switching..... No
2nd FlexConnect Authentication.................. Central
2nd FlexConnect Central Association............. No
2nd FlexConnect VLAN NAME....................... Unavailable
2nd Quarantine VLAN............................. 0
2nd Access VLAN................................. 106
2nd Local Bridging VLAN......................... 106
QoS Level....................................... Silver
Avg data Rate................................... 0
Burst data Rate................................. 0
Avg Real time data Rate......................... 0
Burst Real Time data Rate....................... 0
Avg Uplink data Rate............................ 0
Burst Uplink data Rate.......................... 0
Avg Uplink Real time data Rate.................. 0
Burst Uplink Real Time data Rate................ 0
802.1P Priority Tag............................. disabled
Security Group Tag.............................. Unknown(0)
KTS CAC Capability.............................. No
Qos Map Capability.............................. No
```

Step 5 On infrastructure side aggregation switch, execute **show mac address-table** to check if Client2 is learned in two VLANs (PRP outer VLAN ID).

Example:

```
IOTLABSWITCH#show mac address-table dynamic
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
   1    0077.8daa.c747    STATIC      Vl1
  77    0077.8daa.c773    STATIC      Vl77
  11    0077.8daa.c754    STATIC      Vl11
  40    0077.8daa.c764    STATIC      Vl40
  41    0077.8daa.c776    STATIC      Vl41
  47    0077.8daa.c751    STATIC      Vl47
  65    0077.8daa.c77b    STATIC      Vl65
 104    0077.8daa.c769    STATIC      Vl104
 104    d4c9.3ce3.16ec    DYNAMIC     Gi1/0/2
 105    0077.8daa.c779    STATIC      Vl105
 105    00e0.4c53.4458    DYNAMIC     Gi1/0/32
 105    00ee.ab49.b619    DYNAMIC     Gi1/0/9
 105    00ee.ab49.b643    DYNAMIC     Gi1/0/9
 105    1c39.47c8.3f11    DYNAMIC     Gi1/0/9
 105    706d.157c.1274    DYNAMIC     Gi1/0/32
 106    0077.8daa.c74d    STATIC      Vl106
 106    00e0.4c53.4458    DYNAMIC     Gi1/0/32
 106    00ee.ab49.b619    DYNAMIC     Gi1/0/5
 106    00ee.ab49.b643    DYNAMIC     Gi1/0/5
 106    1c39.47c8.3f11    DYNAMIC     Gi1/0/5
 106    68a3.c4a0.2568    DYNAMIC     Gi1/0/32
 106    c412.f530.e10b    DYNAMIC     Gi1/0/48
 106    d4c9.3ceb.3490    DYNAMIC     Gi1/0/32
 107    0077.8daa.c75d    STATIC      Vl107
 402    0077.8daa.c77b    STATIC      Vl402
  20    0077.8daa.c756    STATIC      Vl20
  93    0077.8daa.c774    STATIC      Vl93
 800    0077.8daa.c752    STATIC      Vl800
 803    0077.8daa.c757    STATIC      Vl803
```

Step 6 On infrastructure side IE4000 switch, execute **show mac address-table** to check if Client2 MAC is learned in correct VLAN (inner VLAN).

Example:

```
IE4K-Switch2#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
   1    0077.8daa.c705    DYNAMIC     PR1
   1    0077.8daa.c709    DYNAMIC     PR1
   1    0077.8daa.c74d    DYNAMIC     PR1
   1    0077.8daa.c779    DYNAMIC     PR1
   1    706d.157c.1274    DYNAMIC     PR1
   1    c412.f530.e10b    DYNAMIC     PR1
   1    d4c9.3ceb.3490    DYNAMIC     PR1
 800    00e0.4c53.4458    DYNAMIC     PR1
 800    1c39.47c8.3f11    DYNAMIC     Gi1/11
```

Troubleshooting Downstream Traffic

In IoT scenarios, multiple VLAN deployment is a typical solution. Customers assign different OT/IT devices with different VLAN IDs across the whole network.

To configure multi-VLAN network, see Configuring WGB Multiple Client VLAN, on page 11 for more information.

In real use cases, some device on WGB side may be a passive client, for example, a client with static IP address. When the peer device wants to make communication with the client, it broadcasts ARP within the segment.

The broadcasted ARP REQUEST will be flooded across the wired network and reach the infrastructure AP eventually. To preserve the VLAN ID, the infrastructure AP converts the broadcast address to a special multicast address by filling the VLAN ID into that address.

When the packet reaches WGB, WGB converts the special multicast to broadcast and recovers the VLAN ID, forwards the broadcast ARP REQUEST to corresponding GigabitEthernet sub-interface.

Note Flex mode AP in PRP solution only sends one broadcast or converted multicast packets over the air when broadcast-tagging configuration is enabled on IW3702 WGB. By default the Broadcast ARP requests packets are sent as unconverted in the Native VLAN only. The non-native broadcast packets to the wired clients behind WGB will be converted as multicast and native broadcast packets (non QinQ) will not be converted. The native VLAN broadcasts will still be sent with original broadcast address as the destination. On the WGB, the presence of ARP entries should be validated as a debugging step when roaming related PRP solutions are debugged in real time use case scenarios.

To troubleshoot above scenario, use the following procedure to track the packet hop by hop.

Procedure

Step 1 Make capture on infrastructure AP side, and check that the ARP is in Q-in-Q format.

Step 2 Check following debug logs:

a) In Root AP, enable **debug dot11 d[0|1] trace print xmt** to check if special mcast+vlan is transmitted over the air.

Example:

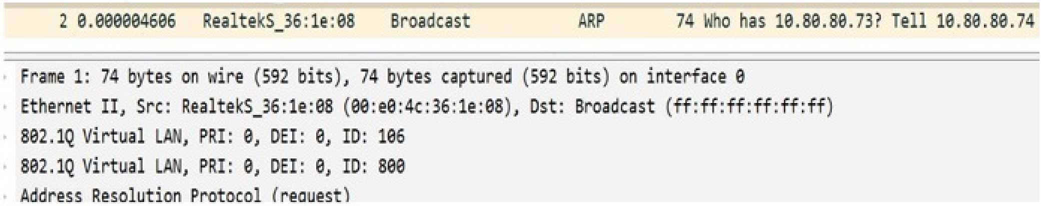
```
ICMP ping code 0 chk D3BD, id 2591 seq 12170
  9E21 665E 0000 0000 2446 0300 0000 0000 1011 1213 1415 1617 1819 1A1B 1C1D
*Mar  9 16:24:35.131: 343DD786 t 18     0  - 0842 000 m01005E C92A9F 361E08 6F40 198
   IP 10.80.80.255 < 10.80.80.74 f1-0-0 id 0 ttl64 sum 84C0 prot 1 len 84
```

b) Enable **debug dot11 forwarding** and **debug dot11 d[0|1] trace print rcv** to see if special mcast+vlan is received on WGB.

Example:

```
*Nov  8 21:44:53.590: C572B747 r 18      39/62/128/57 57- 0842 000 m01005E C92A9F 361E08 F150 1114

  IV AAAA0300   0000 0800 4500 0054 0000 4000 4001 84C0 0A50 504A 0A50 50FF
  0800 BE39 0A1F 2DEE 0120 665E 0000 0000 D367 0800 0000 0000 1011 1213 1415
  1617 1819 1A1B 1C1D 1E1F 2021 2223 2425 2627 2829 2A2B 2C2D 2E2F 3031 3233


*Nov  8 21:46:30.754: Unified WGB convert specific mcast+vlan pak to ffff.ffff.ffff:00e0.4c36.1e08

 on Virtual-Dot11Radio0 received, link 7, dest_vlan_id 0x4320 packet for
ffff.ffff.ffff:00e0.4c36.1e08
 on Virtual-Dot11Radio0 received, link 7 to_host 1 rc 9 smf_result 201 Virtual-Dot11Radio0.106,
0,
```

Step 3 Perform packet capture behind WGB to check if ARP is converted to broadcast in correct VLAN.



```
    2 0.000004606   RealtekS_36:1e:08    Broadcast         ARP       74 Who has 10.80.80.73? Tell 10.80.80.74

Frame 1: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
Ethernet II, Src: RealtekS_36:1e:08 (00:e0:4c:36:1e:08), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 106
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 800
Address Resolution Protocol (request)
```

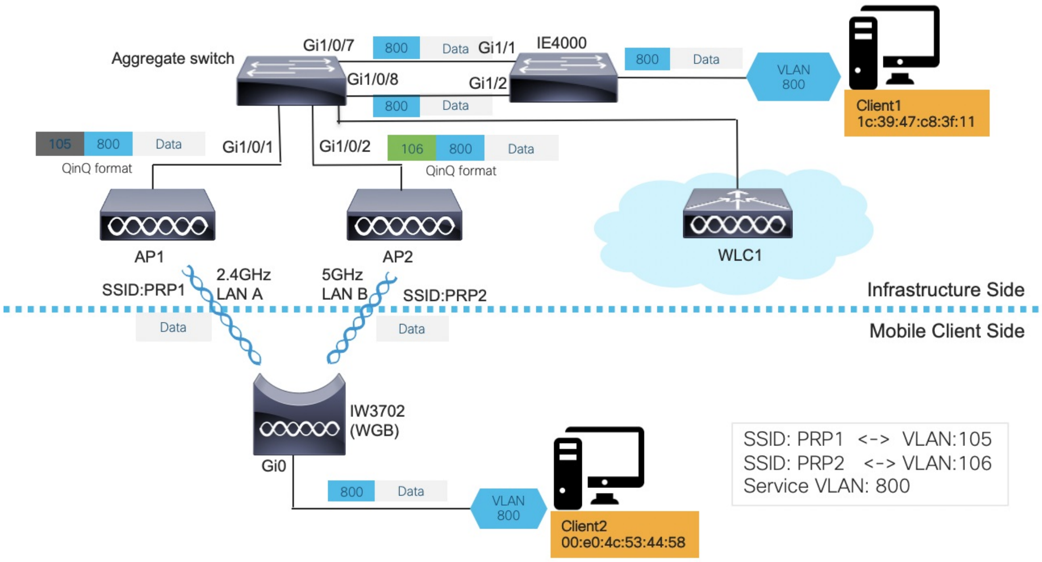
What to do next

For downstream unicast traffic, it’s similar but in the reverse way as upstream. On PRP-WGB-SW, execute **show prp statistics ingressPacketStatistics**.

Example:

```
IE4K-Switch1#show prp statistics ingressPacketStatistics
 PRP channel-group 1 INGRESS STATS: ingress
   pkt lan a: 7359054 ingress pkt lan b:
   10102696 ingress crc lan a: 0
   ingress crc lan b: 0
   ingress danp pkt acpt: 7376949 ingress
   danp pkt dscrd: 1648270 ingress supfrm rcv
   a: 4175430 ingress supfrm rcv b: 4262230
```

Single WGB Dual Radio PRP Redundancy Option



In above diagram, two wired clients communicate with each other. Client1 (1c:39:47:c8:3f:11) resides on the infrastructure side while Client2 (00:e0:4c:53:44:58) is on mobile client side.

Normally, wired Client2 will initialize the communication, using protocols such as DHCP, ARP, GARP, etc. But it is possible that wired Client2 is a passive client, which means it doesn’t make any talk until it receives packets from the infrastructure side, for example, downstream ARP from wired Client1.

The troubleshooting procedures will be described in the following two sections.

Troubleshooting Upstream Traffic

To troubleshoot upstream traffic, use the following procedure to track the packet hop by hop.

Procedure

Step 1 On client side IE4000 switch, execute **show mac address-table dynamic** to check if wired Client2 is learned in the MAC address table with correct VLAN ID.

Example:

```
IE4K-Switch1#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 800    00e0.4c53.4458    DYNAMIC     Gi1/24
 800    1c39.47c8.3f11    DYNAMIC     PR1
   1    00ee.ab49.b643    DYNAMIC     PR1
   1    706d.157c.1274    DYNAMIC     PR1
   1    d4c9.3ceb.3490    DYNAMIC     PR1
   1    f80f.6fc9.2a90    DYNAMIC     PR1
Total Mac Addresses for this criterion: 28
```

Step 2 On WGB, execute **show bridge** to check if the wired client MAC is learned in correct bridge group (bridge id).

Example:

```
WGB1#show bridge
Total of 300 station blocks, 291 free
Codes: P - permanent, S - self

Bridge Group 1:

    Address       Action   Interface       Age   RX count   TX count
1c39.47c8.3f11   forward   Vi0.106           0       5168          0
68a3.c4a0.2568   forward   Vi0.106           3          2          0
00ee.ab49.bc1a   forward   Gi0.106           0       2385          0
00ee.ab49.b619   forward   Vi0.106           0      20269          0
f80f.6fc9.2a90   forward   Vi0.106           0        158          0
00ee.ab49.b643   forward   Vi0.106           0         50          0

Bridge Group 2:

00e0.4c53.4458   forward   Gi0.800           0       3299          0
1c39.47c8.3f11   forward   Vi0.800           0          1        119
00ee.ab49.bc41   forward   Gi0.800           1          6          0
```

Step 3 On WGB, execute **show dot11 wgb prp** to check LAN-A and LAN-B egress counter. If both PRP radios are in UP state, you should see below sent counters increase equally.

Example:

```
Current work mode     : dual-radio
Link selection mode   : PRP
Available uplink count: 2
Index: 0  Status: UP  Name: Dot11Radio0/Virtual-Dot11Radio0  Peer: 54a2.7474.d920
Index: 1  Status: UP  Name: Dot11Radio1/Virtual-Dot11Radio1  Peer: 54a2.7474.d92f
================== PRP STATISTICS ==================
LAN-A Send               : 23991
LAN-B Send               : 23991
Send Difference          : 0
LAN-A Rcv                : 0
LAN-B Rcv                : 0
Rcv Difference           : 0
LAN-A Error              : 0
LAN-B Error              : 0
Discard                  : 0
Table Usage(INTERNAL)    : 0
Max Dup-Delay(INTERNAL): 0
====================================================
```

Step 4 On WLC, execute **show client detail** <*mac_of_client*> to check if the client is learned and both WGBs details are learned on WLC.

Example:

```
(Cisco Controller) >show client detail 00:e0:4c:53:44:58
Client MAC Address............................... 00:e0:4c:53:44:58
Client Username ................................. N/A
Client Webauth Username ......................... N/A
Hostname: .......................................
Device Type: .................................... Unclassified
AP MAC Address................................... 70:ea:1a:29:90:80
AP Name.......................................... PRP_Root2_E984
AP radio slot Id................................. 1
2nd AP MAC Address............................... f8:0f:6f:c9:2a:90
2nd AP Name...................................... PRP_Root1_B89C
2nd AP radio slot Id............................. 1
```

```
Client State..................................... Associated
User Authenticated by ........................... None
Client User Group................................
Client NAC OOB State............................. Access
Workgroup Bridge Client.......................... WGB:  70:79:b3:87:89:b0
Workgroup Bridge Client.......................... 2nd WGB:  70:79:b3:44:73:60
Wireless LAN Id.................................. 3
Wireless LAN Network Name (SSID)................. PRP2
Wireless LAN Profile Name........................ PRP2
WLAN Profile check for roaming................... Disabled
2nd Wireless LAN Id.............................. 2
2nd Wireless LAN Network Name (SSID)............. PRP1
2nd Wireless LAN Profile Name.................... PRP1
Hotspot (802.11u)................................ Not Supported
Connected For ................................... 56696 secs
BSSID............................................ 70:ea:1a:29:90:8f
Channel.......................................... 36
2nd BSSID........................................ f8:0f:6f:c9:2a:9f
2nd Connected For ............................... 68424 secs
2nd Channel...................................... 108
IP Address....................................... 10.80.80.58
Gateway Address.................................. 10.80.80.1
Netmask.......................................... 255.255.255.0
IPv6 Address..................................... fe80::5faa:5113:e3ee:1515
Association Id................................... 0
Authentication Algorithm......................... Open System
Reason Code...................................... 1
Client IPSK-TAG.................................. N/A
Status Code...................................... 0
2nd Association Id............................... 1
2nd Authentication Algorithm..................... Open System
2nd Reason Code.................................. 1
2nd Status Code.................................. 0
Session Timeout.................................. 0
Client CCX version............................... No CCX support
2nd FlexConnect Data Switching................... Local
2nd FlexConnect Dhcp Status...................... Local
2nd FlexConnect Vlan Based Central Switching..... No
2nd FlexConnect Authentication................... Central
2nd FlexConnect Central Association.............. No
2nd FlexConnect VLAN NAME........................ Unavailable
2nd Quarantine VLAN.............................. 0
2nd Access VLAN.................................. 106
2nd Local Bridging VLAN.......................... 106
QoS Level........................................ Silver
Avg data Rate.................................... 0
Burst data Rate.................................. 0
Avg Real time data Rate.......................... 0
Burst Real Time data Rate........................ 0
Avg Uplink data Rate............................. 0
Burst Uplink data Rate........................... 0
Avg Uplink Real time data Rate................... 0
Burst Uplink Real Time data Rate................. 0
802.1P Priority Tag.............................. disabled
Security Group Tag............................... Unknown(0)
KTS CAC Capability............................... No
Qos Map Capability............................... No
```

Step 5 On infrastructure side aggregation switch, execute **show mac address-table** to check if Client2 is learned in two VLANs (PRP outer VLAN ID).

Example:

```
IOTLABSWITCH#show mac address-table dynamic
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
   1    0077.8daa.c747    STATIC      Vl1
  77    0077.8daa.c773    STATIC      Vl77
  11    0077.8daa.c754    STATIC      Vl11
  40    0077.8daa.c764    STATIC      Vl40
  41    0077.8daa.c776    STATIC      Vl41
  47    0077.8daa.c751    STATIC      Vl47
  65    0077.8daa.c77b    STATIC      Vl65
 104    0077.8daa.c769    STATIC      Vl104
 104    d4c9.3ce3.16ec    DYNAMIC     Gi1/0/2
 105    0077.8daa.c779    STATIC      Vl105
 105    00e0.4c53.4458    DYNAMIC     Gi1/0/32
 105    00ee.ab49.b619    DYNAMIC     Gi1/0/9
 105    00ee.ab49.b643    DYNAMIC     Gi1/0/9
 105    1c39.47c8.3f11    DYNAMIC     Gi1/0/9
 105    706d.157c.1274    DYNAMIC     Gi1/0/32
 106    0077.8daa.c74d    STATIC      Vl106
 106    00e0.4c53.4458    DYNAMIC     Gi1/0/32
 106    00ee.ab49.b619    DYNAMIC     Gi1/0/5
 106    00ee.ab49.b643    DYNAMIC     Gi1/0/5
 106    1c39.47c8.3f11    DYNAMIC     Gi1/0/5
 106    68a3.c4a0.2568    DYNAMIC     Gi1/0/32
 106    c412.f530.e10b    DYNAMIC     Gi1/0/48
 106    d4c9.3ceb.3490    DYNAMIC     Gi1/0/32
 107    0077.8daa.c75d    STATIC      Vl107
 402    0077.8daa.c77b    STATIC      Vl402
  20    0077.8daa.c756    STATIC      Vl20
  93    0077.8daa.c774    STATIC      Vl93
 800    0077.8daa.c752    STATIC      Vl800
 803    0077.8daa.c757    STATIC      Vl803
```

Step 6 On infrastructure side IE4000 switch, execute **show mac address-table** to check if Client2 MAC is learned in correct VLAN (inner VLAN).

Example:

```
IE4K-Switch2#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
   1    0077.8daa.c705    DYNAMIC     PR1
   1    0077.8daa.c709    DYNAMIC     PR1
   1    0077.8daa.c74d    DYNAMIC     PR1
   1    0077.8daa.c779    DYNAMIC     PR1
   1    706d.157c.1274    DYNAMIC     PR1
   1    c412.f530.e10b    DYNAMIC     PR1
   1    d4c9.3ceb.3490    DYNAMIC     PR1
 800    00e0.4c53.4458    DYNAMIC     PR1
 800    1c39.47c8.3f11    DYNAMIC     Gi1/11
```

Troubleshooting Downstream Traffic

In IoT scenarios, multiple VLAN deployment is a typical solution. Customers assign different OT/IT devices with different VLAN IDs across the whole network.

To configure multi-VLAN network, see Configuring WGB Multiple Client VLAN, on page 11 for more information.

In real use cases, some device on WGB side may be a passive client, for example, a client with static IP address. When the peer device wants to make communication with the client, it broadcasts ARP within the segment.

The broadcasted ARP REQUEST will be flooded across the wired network and reach the infrastructure AP eventually. To preserve the VLAN ID, the infrastructure AP converts the broadcast address to a special multicast address by filling the VLAN ID into that address.

When the packet reaches WGB, WGB converts the special multicast to broadcast and recovers the VLAN ID, forwards the broadcast ARP REQUEST to corresponding GigabitEthernet sub-interface.

To troubleshoot above scenario, use the following procedure to track the packet hop by hop.

Procedure

Step 1 Make capture on infrastructure AP side, and check that the ARP is in Q-in-Q format.

Step 2 Check following debug logs:

a) In Root AP, enable **debug dot11 d[0|1] trace print xmt** to check if special mcast+vlan is transmitted over the air.

Example:

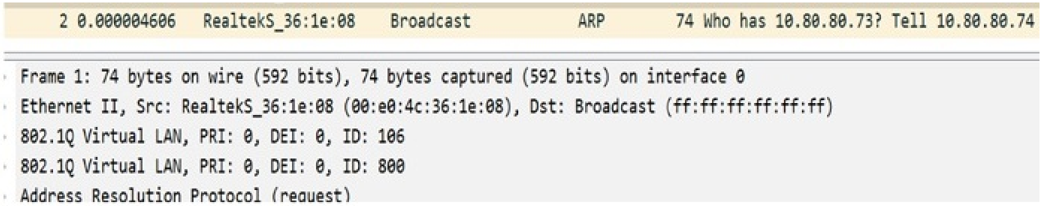
```
ICMP ping code 0 chk D3BD, id 2591 seq 12170
  9E21 665E 0000 0000 2446 0300 0000 0000 1011 1213 1415 1617 1819 1A1B 1C1D
*Mar  9 16:24:35.131: 343DD786 t 18      0  - 0842 000 m01005E C92A9F 361E08 6F40 198
   IP 10.80.80.255 < 10.80.80.74 f1-0-0 id 0 ttl64 sum 84C0 prot 1 len 84
```

b) Enable **debug dot11 forwarding** and **debug dot11 d[0|1] trace print rcv** to see if special mcast+vlan is received on WGB.

Example:

```
*Nov  8 21:44:53.590: C572B747 r 18      39/62/128/57 57- 0842 000 m01005E C92A9F 361E08 F150 1114

  IV AAAA0300   0000 0800 4500 0054 0000 4000 4001 84C0 0A50 504A 0A50 50FF
  0800 BE39 0A1F 2DEE 0120 665E 0000 0000 D367 0800 0000 0000 1011 1213 1415
  1617 1819 1A1B 1C1D 1E1F 2021 2223 2425 2627 2829 2A2B 2C2D 2E2F 3031 3233


*Nov  8 21:46:30.754: Unified WGB convert specific mcast+vlan pak to ffff.ffff.ffff:00e0.4c36.1e08

 on Virtual-Dot11Radio0 received, link 7, dest_vlan_id 0x4320 packet for
ffff.ffff.ffff:00e0.4c36.1e08
 on Virtual-Dot11Radio0 received, link 7 to_host 1 rc 9 smf_result 201 Virtual-Dot11Radio0.106,
0,
```

Step 3 Perform packet capture behind WGB to check if ARP is converted to broadcast in correct VLAN.



```
     2 0.000004606    RealtekS_36:1e:08    Broadcast           ARP       74 Who has 10.80.80.73? Tell 10.80.80.74

Frame 1: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
Ethernet II, Src: RealtekS_36:1e:08 (00:e0:4c:36:1e:08), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 106
802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 800
Address Resolution Protocol (request)
```

What to do next

For downstream unicast traffic, it’s similar but in the reverse way as upstream. On WGB, execute **show dot11 wgb prp** to check LAN-A and LAN-B ingress counter. If both PRP radios are in UP state, you should see below received counters increase equally.

Example:

```
Current work mode : dual-radio
Link selection mode : PRP
Available uplink count : 2
Index: 0  Status: UP Name: Dot11Radio0/Virtual-Dot11Radio0 Peer: 54a2.7474.d920
Index: 1  Status: UP Name: Dot11Radio1/Virtual-Dot11Radio1 Peer: 54a2.7474.d92f
================== PRP STATISTICS ==================
LAN-A Send              : 23991
LAN-B Send              : 23991
Send Difference         : 0
LAN-A Rcv               : 53223
LAN-B Rcv               : 53223
Rcv Difference          : 0
LAN-A Error             : 0
LAN-B Error             : 0
Discard                 : 0
Table Usage(INTERNAL)   : 0
Max Dup Delay(INTERNAL): 0
====================================================
```

Related Documents

- Parallel Redundancy Protocol Enhancement on AP and WGB
- Dual Radio Parallel Redundancy Protocol Enhancement on WGB

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE. ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS MANUAL ARE BELIEVED TO BE ACCURATE BUT ARE PRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. USERS MUST TAKE FULL RESPONSIBILITY FOR THEIR APPLICATION OF ANY PRODUCTS.

THE SOFTWARE LICENSE AND LIMITED WARRANTY FOR THE ACCOMPANYING PRODUCT ARE SET FORTH IN THE INFORMATION PACKET THAT SHIPPED WITH THE PRODUCT AND ARE INCORPORATED HEREIN BY THIS REFERENCE. IF YOU ARE UNABLE TO LOCATE THE SOFTWARE LICENSE OR LIMITED WARRANTY, CONTACT YOUR CISCO REPRESENTATIVE FOR A COPY.

NOTWITHSTANDING ANY OTHER WARRANTY HEREIN, ALL DOCUMENT FILES AND SOFTWARE OF THESE SUPPLIERS ARE PROVIDED “AS IS" WITH ALL FAULTS. CISCO AND THE ABOVE-NAMED SUPPLIERS DISCLAIM ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THOSE OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OR ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

IN NO EVENT SHALL CISCO OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE THIS MANUAL, EVEN IF CISCO OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

All printed copies and duplicate soft copies of this document are considered uncontrolled. See the current online version for the latest version.

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

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA 95134-1706
USA

Asia Pacific Headquarters
CiscoSystems(USA)Pte.Ltd.
Singapore

Europe Headquarters
CiscoSystemsInternationalBV
Amsterdam,TheNetherlands

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.