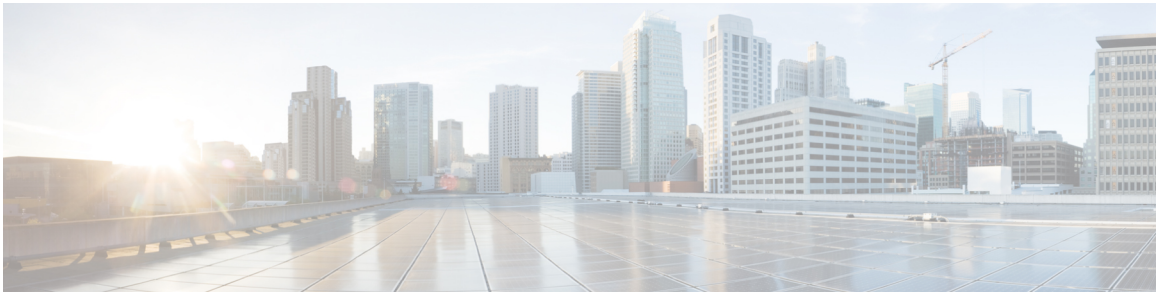
Cisco Catalyst IW9167E Heavy Duty Access Point Configuration Guide, Release 17.16.x

First Published: 2024-12-11

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883



CONTENTS

CHAPTER 1 **Introduction** 1

Overview of the Access Point 1

Determine Image on IW9167EH 2

Configuring AP to Boot up with Different Image Options 3

Upgrade IW9167EH with 17.9.x to Support WGB/uWGB 3

Related Documentation 4

CHAPTER 2 **AP Mode Configuration** 7

Configuring Indoor Deployment for -E Domain 7

802.11ax 1600ns and 3200ns Guard Interval Support 10

Configuring 802.11ax Long Guard Interval 10

GNSS Support 11

RAP Ethernet Daisy Chain 12

WSTP Overview 13

Comparison with Previous Release 13

RAP Ethernet Daisy Chain Configuration 14

Preconfiguring RAP Ethernet Daisy Chain Before Field Deployment 14

Enabling RAP Ethernet Daisy Chain 16

Configuring Super Root 17

Configuring Primary Ethernet Port 18

Configuring Ethernet Bridging and Ethernet Port 18

Show and Debug Command 21

CHAPTER 3 **Workgroup Bridges** 23

Overview 24

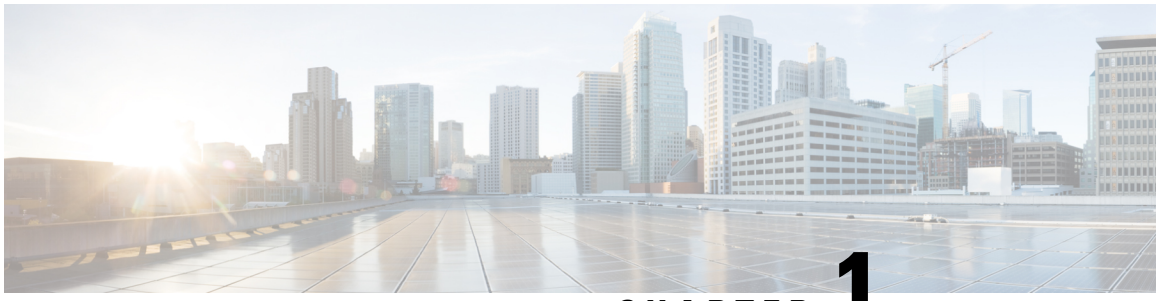
Limitations and Restrictions 24
Configuring Strong Password in Day0 26
Controller Configuration for WGB 27
uWGB Image Upgrade 28
WGB Configuration 29
Configure IP address 29
Configure IPv4 address 29
Configure IPv6 address 30
Configure a Dot1X credential 30
Deauthenticate WGB wired client 30
Configure an EAP profile 31
Configure trustpoint manual enrollment for terminal 31
Configure trustpoint auto-enrollment for WGB 33
Configure manual certificate enrollment using TFTP server 34
SSID configuration 35
Create an SSID profile 35
Configuring Radio Interface for Workgroup Bridges 36
Configuring WGB/uWGB Timer 37
uWGB Configuration 37
Configure IP address 38
Configure IPv4 address 38
Configure IPv6 address 38
Configure a Dot1X credential 39
Configure an EAP profile 39
Configure trustpoint manual enrollment for terminal 40
Configure trustpoint auto-enrollment for WGB 41
Configure manual certificate enrollment using TFTP server 42
SSID configuration 43
Create an SSID profile 43
Configuring Radio Interface for uWGB 44
Converting Between WGB and uWGB 45
LED Pattern 45
Configuring HT Speed Limit 45
Radio Statistics Commands 47

Syslog 49
Event Logging 50
802.11v 51
Configure Aux Scanning 52
Overview of scanning-only mode 53
Scanning only mode 53
Radio 4 as Scanning-Only Mode 54
Configuring Aux-Scan Handoff Mode 56
Optimized Roaming with Dual-Radio WGB 58
Configuring Layer 2 NAT 58
Configuration Example of Host IP Address Translation 61
Configuration Example of Network Address Translation 62
Configuring Native VLAN on Ethernet Ports 63
Low Latency Profile 63
Configuring WGB optimized-video EDCA Profile 64
Configuring WGB optimized-automation EDCA Profile 64
Configuring WGB customized-wmm EDCA profile 65
Configuring Low Latency Profile on WGB 65
Configuring EDCA Parameters (Wireless Controller GUI) 66
Configuring EDCA Parameters (Wireless Controller CLI) 66
Configuring A-MPDU 67
Configuring WGB/uWGB Radio Parameters 68
Configuring WGB Radio Antenna 68
802.11ax 1600ns and 3200ns Guard Interval 68
Customized Transmit Power 68
Assign Country Code to WGB/uWGB With -ROW PID 69
Indoor Deployment for -E Domain and United Kingdom 69
Configuring WGB Roaming Parameters 70
Importing and Exporting WGB Configuration 70
Verifying the Configuration of WGB and uWGB 70
Configuring and Validating SNMP With WGB 72
Supported SNMP MIB File 73
Configuring SNMP from the WGB CLI 79
Verifying SNMP from WGB CLI 80

Support for QoS ACL Classification and Marking 81
Overview 81
Traffic Classification Based on QoS and ACL 82
Configuring Quality of Service Mapping Profile 84
Verifying WGB Quality of Service Mapping 86
Packet Capture: TCP Dump on WGB 87
TCP Dump on WGB 87
Enable Wired Packet Capture on WGB 90
Disable Wired Packet Capture on WGB 92
Verify Wired Packet Capture on WGB 92
AAA User Authentication Support 93
Information About AAA User Authentication Support 93
Configuring AAA Server 94
Enable or Disable RADIUS Authentication for Login User 95
Enable or Disable TACACS+ Authentication for Login User 95
Verify the AAA Authentication Configuration 95
Port Address Translation on WGB 96
Port Address Translation 96
NAPT rule and mapping table 98
Upstream and downstream data flow 99
Configure NAPT on WGB 99
Delete NAPT mapping rule 101
Delete NAPT IP address 101
Verify NAPT on WGB 102
Port Address Translation on uWGB 102
Port Address Translation 102
NAPT rule and mapping table 103
Upstream and downstream data flow 104
Configure NAPT on uWGB 104
Delete NAPT mapping rule 106
Delete NAPT IP address 106
Manage uWGB in NAPT deployment 107
Verify NAPT on uWGB 108
10 Mbps Speed Port Support on Cisco IW9167EH WGB 109

10 Mbps speed negotiation on Ethernet port 109
Enable 10 Mbps speed port on Cisco IW9167EH WGB 109
Disable 10 Mbps speed port on Cisco IW9167EH WGB 110

CHAPTER 4 **Automated Frequency Coordination** 111
AFC Support for 6 GHz Standard Power Mode 111
Verifying AFC Status on AP 112



CHAPTER 1

Introduction

- Overview of the Access Point, on page 1
- Determine Image on IW9167EH, on page 2
- Configuring AP to Boot up with Different Image Options, on page 3
- Upgrade IW9167EH with 17.9.x to Support WGB/uWGB, on page 3
- Related Documentation, on page 4

Overview of the Access Point

The Cisco Catalyst IW9167E Heavy Duty Access Point provides reliable wireless connectivity for mission-critical applications in a state-of-the art platform. It can operate as Cisco Catalyst Wi-Fi (CAPWAP) mode or Cisco Ultra-Reliable Wireless Backhaul (Cisco URWB) mode starting from IOS XE Cupertino 17.9.3 Software Release. The IW9167EH access point has the flexibility to change the operating mode from Wi-Fi to Cisco URWB, and vice versa.

Starting from Cisco IOS XE Dublin 17.11.1, Workgroup Bridge (WGB) and Universal WGB (uWGB) are supported on the Cisco Catalyst IW9167E Heavy Duty Access Points.

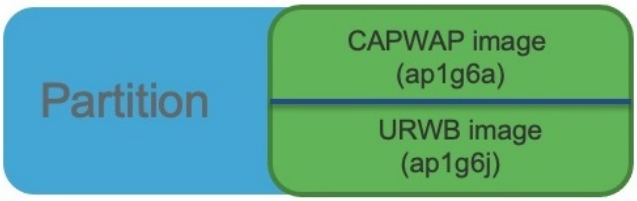
This document covers configuration of CAPWAP mode and WGB/uWGB mode specific to the IW9167EH access points.

For CAPWAP mode, the access points can operate in the following modes:

- Local
- Flexconnect
- Bridge
- Flexconnect + Bridge
- Sniffer
- Monitor
- Site survey

Determine Image on IW9167EH

Software images are stored under different folders on the same partition on IW9167EH.



You need to choose the image to boot up with according to the mode your AP is runnning, CAPWAP, Cisco URWB, or WGB/uWGB. The following table provides the software images of each mode:

Table 1: IW9167EH Software Images

IW9167EH Mode	Software Image
CAPWAP	**ap1g6a-k9w8-xxx.tar**
Cisco URWB	Unified Industrial Wireless image **ap1g6j-k9c1-xxx.tar**
WGB/uWGB	

To determine the image that your IW9167EH is running, use the **show version** command.

- If the **show version** output displays **Cisco AP Software, (ap1g6a)** as shown in the following example, it means that AP is running the CAPWAP image **ap1g6a-k9w8-xxx.tar**, which supports the CAPWAP mode.

```
Cisco AP Software, (ap1g6a), C9167, RELEASE SOFTWARE
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Fri Jul 29 01:56:00 PDT 2022

ROM: Bootstrap program is U-Boot boot loader
BOOTLDR: U-Boot boot loader Version 2022010100

APFC58.9A16.E648 uptime is 0 days, 1 hours, 03 minutes
Last reload time   : Mon Sep 19 02:23:13 UTC 2022
Last reload reason : Image Upgrade

cisco IW9167EH-B ARMv8 Processor rev 4 (v8l) with 1757076/1006864K bytes of memory.
```

- If the **show version** output displays **Cisco AP Software (ap1g6j)** as shown in the following example, it means that AP is running **ap1g6j-k9c1-xxx.tar** image, which supports the Cisco URWB mode or Cisco WGB/uWGB.

```
Cisco AP Software, (ap1g6j), C9167, RELEASE SOFTWARE
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2022 by Cisco Systems, Inc.
Compiled Thu Aug 18 01:01:29 PDT 2022

ROM: Bootstrap program is U-Boot boot loader
BOOTLDR: U-Boot boot loader Version 2022010100

APFC58.9A16.E464 uptime is 1 days, 3 hours, 58 minutes
```

```
Last reload time   : Wed Sep 7 11:17:00 UTC 2022
Last reload reason : reload command

cisco IW9167EH-B ARMv8 Processor rev 4 (v8l) with 1759128/1091316K bytes of memory.
```

Configuring AP to Boot up with Different Image Options

To configure the access point to boot up with CAPWAP, URWB, or WGB/uWGB mode, follow these steps:

Note Switching between different modes performs full factory reset. Any configuration and data will be removed completely.

Procedure

Step 1 **enable**

Enables privileged EXEC mode. Enter your password if prompted.

Step 2 **configure boot mode** {**capwap** | **urwb** | **wgb**}

Configures AP to CAPWAP, URWB, or WGB/uWGB mode. AP will reboot with specified mode.

Upgrade IW9167EH with 17.9.x to Support WGB/uWGB

If your IW9167EH is shipped with Cisco IOS XE Cupertino 17.9.3 software and operating as CAPWAP mode, and you want to upgrade your AP to Cisco IOS XE Dublin 17.11.1 to support WGB/uWGB mode, you need to switch your AP to Cisco URWB mode first, and then you can upgrade to 17.11.1.

To determine whether your IW9167EH is running CAPWAP mode or Cisco URWB mode, use the **show version** command.

- If the **show version** output displays **Cisco AP Software (ap1g6a)**, your AP is running as CAPWAP mode.
- If the **show version** output displays **Cisco AP Software (ap1g6j)**, your AP is running as Cisco URWB mode.

Cisco WGB/uWGB mode shares the same image with Cisco URWB. You cannot upgrade the **ap1g6j** image to 17.11.1 in CAPWAP mode (**ap1g6a**). Because the **archive download** command checks image type, upgrade gets aborted if image types mismatch.

Procedure

Step 1 Convert CAPWAP mode to Cisco URWB mode.

Example:

```
#configure boot mode urwb
       Before image swapping device need factory reset. Are you sure to proceed? (Y/N):y
       Converting to Cisco URWB Mode...
       <rebooting…>
```

Step 2 Log in with default credential (Cisco/Cisco/Cisco).

Step 3 Configure Cisco URWB, to make it work in **Offline** mode.

Example:

```
#configure iotod-iw offline
       Switching to IOTOD IW Offline mode...
       Will switch from Provisioning Mode to IOTOD IW offline Mode, device need to reboot: Y/N?  Y
       <rebooting…>
```

Step 4 Configure networking in Cisco URWB (IP/netmask/gateway, passphrase)

Example:

```
Cisco-23.174.76#configure wireless passphrase unit1
Cisco-23.174.76#configure ap address ipv4 static 192.168.1.200 255.255.255.0 192.168.1.1
Cisco-23.174.76#write
Cisco-23.174.76#reload
     <rebooting…>
```

Note
Passphrase is optional, but it is recommended to assign different passphrases if you are upgrading multiple units at the same time and they are connected to the same Layer 2 network. Because Cisco URWB forms MPLS network automatically if all nodes have the same passphrase, without further MPLS configuration, your IP service might not work properly.

Step 5 Upgrade to 17.11.1.

Example:

```
#archive download-sw /reload tftp://<TFTP_SERVER>/<ap1g6j-FILENAME>
          <rebooting…>
```

Step 6 Convert the AP from Cisco URWB mode to Cisco WGB/uWGB mode.

Example:

```
#configure boot mode wgb
           <rebooting…>
```

Related Documentation

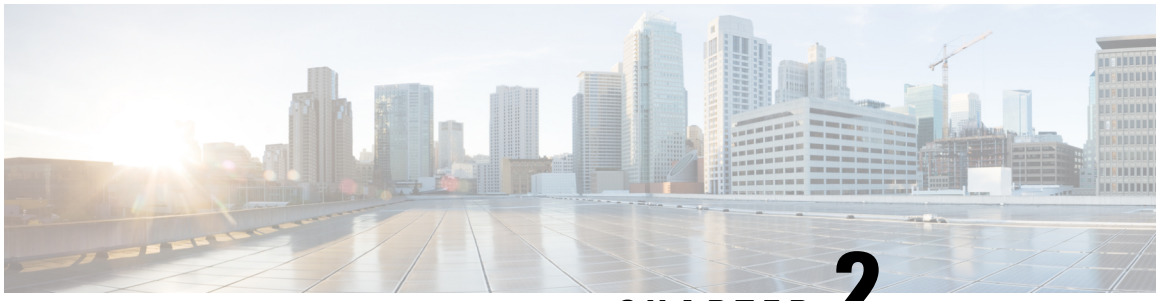
To view all support information for the Cisco Catalyst IW9167E Heavy Duty Access Point, see https://www.cisco.com/c/en/us/support/wireless/catalyst-iw9167-series/series.html.

In addition to the documentation available on the support page, you will need to refer to the following guides:

- For information about IW9167EH hardware, see Cisco Catalyst IW9167E Heavy Duty Access Point Hardware Installation Guide.
- A full listing of the AP's features and specifications is provided in Cisco Catalyst IW9167E Heavy Duty Access Point Data Sheet.
- For more information about the configuration on Cisco Catalyst 9800 Series Wireless Controllers, see https://www.cisco.com/c/en/us/support/wireless/catalyst-9800-series-wireless-controllers/products-installation-and-configuration-guides-list.html.
- For information about Cisco URWB mode configuration, see the relevant documents at:

  https://www.cisco.com/c/en/us/support/wireless/catalyst-iw9167-series/series.html.
- For more information about Cisco IOS XE, see the relevant documents at:

  http://www.cisco.com/c/en/us/products/ios-nx-os-software/ios-xe/index.html



CHAPTER 2

AP Mode Configuration

- Configuring Indoor Deployment for -E Domain, on page 7
- 802.11ax 1600ns and 3200ns Guard Interval Support, on page 10
- GNSS Support, on page 11
- RAP Ethernet Daisy Chain, on page 12

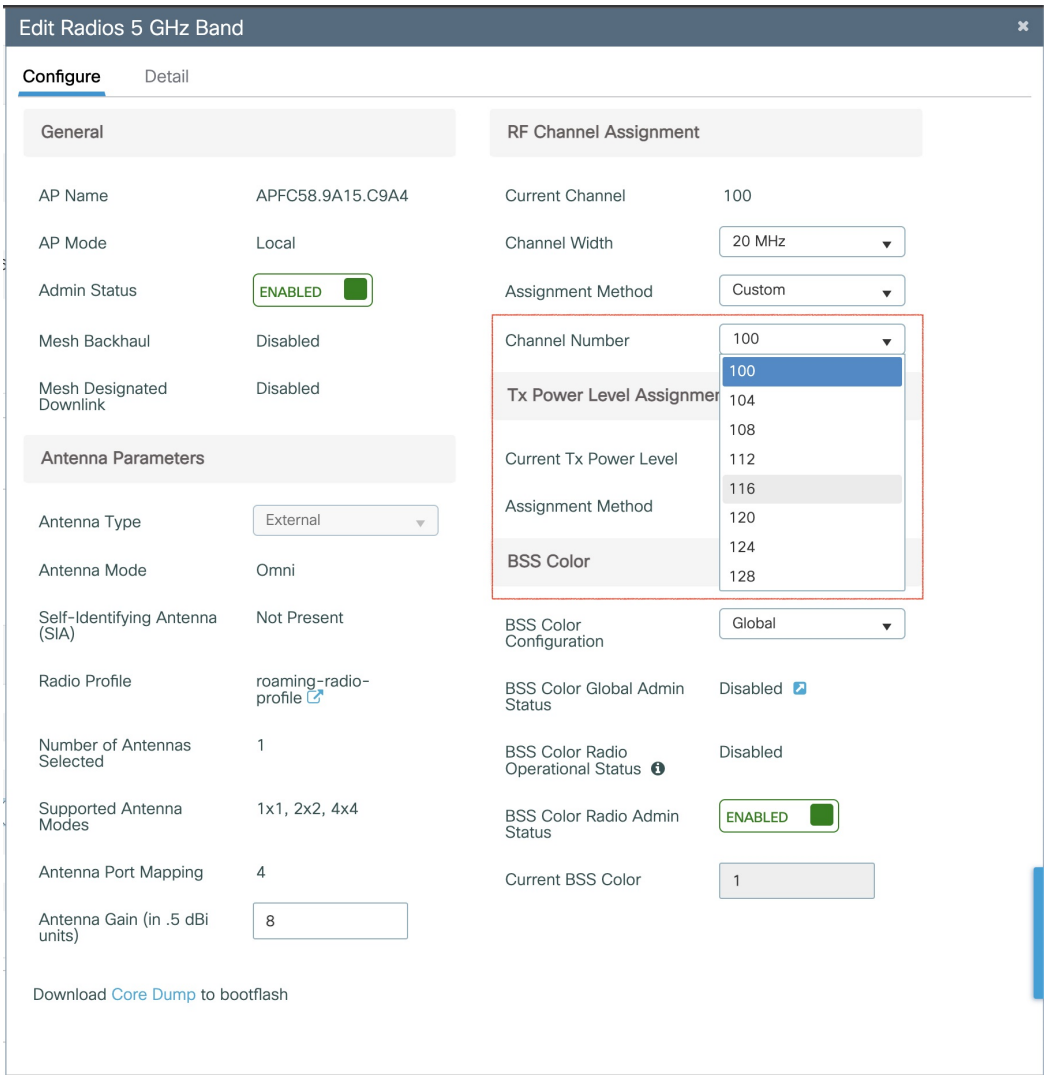
Configuring Indoor Deployment for -E Domain

IW9167EH supports indoor deployment for -E domain.

By default, indoor deployment is disabled, and the 5G radio supports channels 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140. After factory reset, indoor deployment configuration is reset to default, which is disabled.

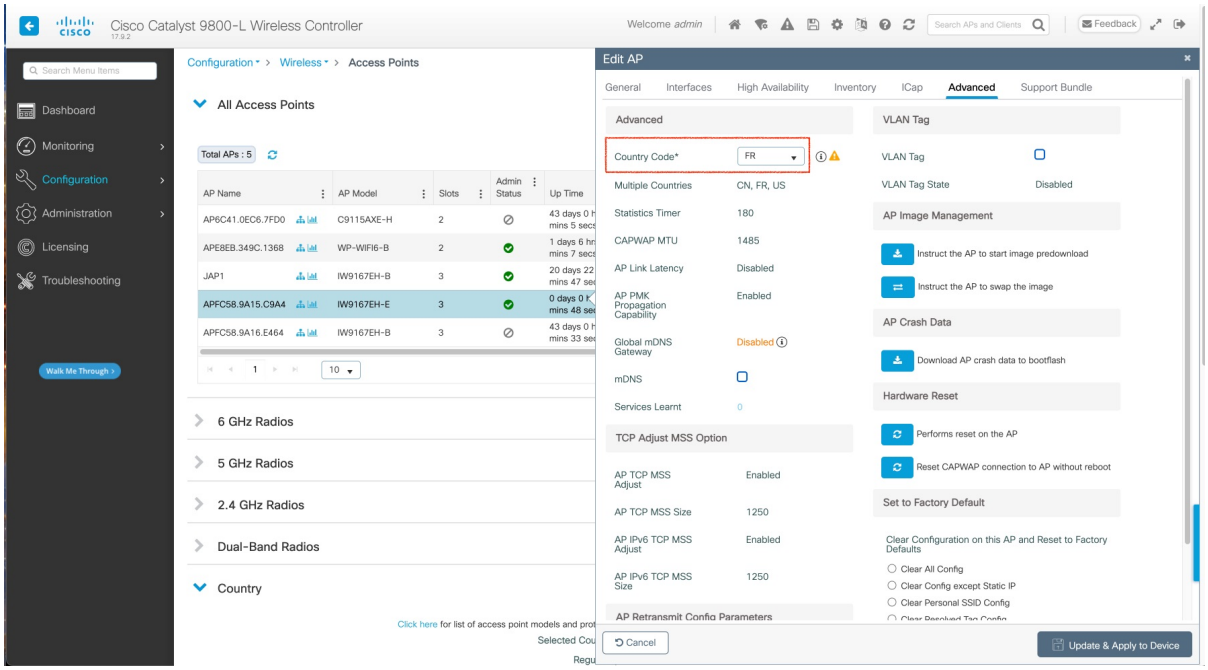
You can check AP mode by using the **show ap name <ap-name> config general | section Indoor** command. In the command output, "Enabled" means AP is in indoor mode, and "Disabled" means AP is in outdoor mode, as shown in the following example.

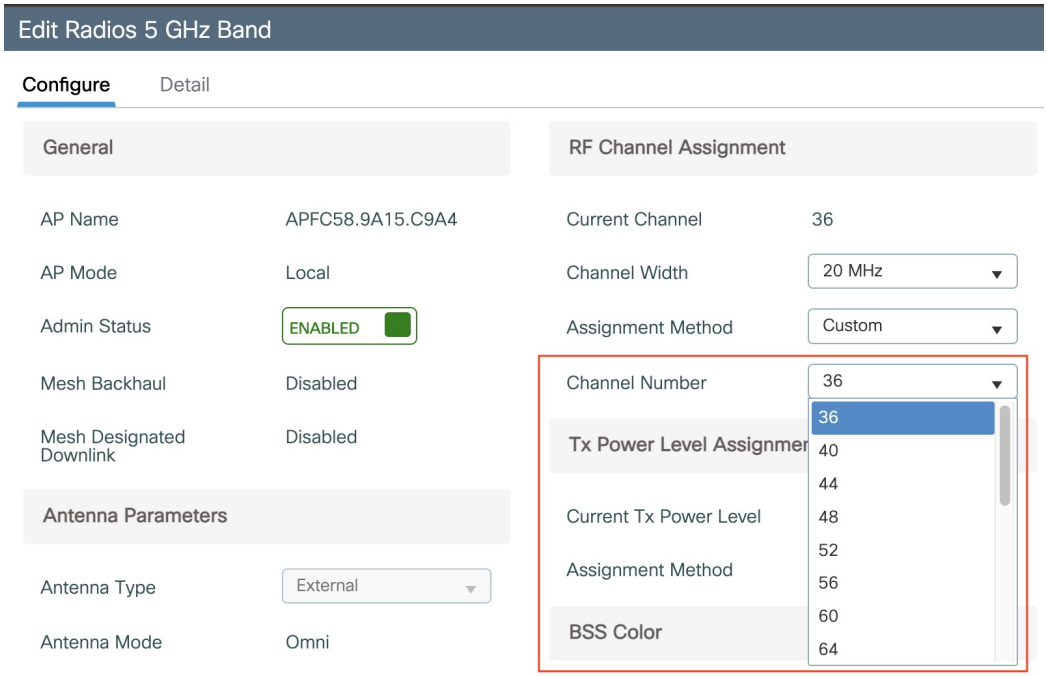
```
#show ap name APFC58.9A15.C9A4 config general | inc Indoor
    AP Indoor Mode                                  : Disabled
```



To configure the AP to indoor mode, use the **ap name** <*ap-name*> **indoor** command from wireless LAN controller. This command triggers an AP rebooting. After AP registers to the wireless LAN controller after rebooting, you need to assign corresponding country code to the AP. When indoor deployment is enabled, 5G radio supports channels 36, 40, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140.

Note To disable indoor deployment, use the **ap name** <*ap-name*> **no indoor** command.





Note Channel list extends from U-NII-2c to U-NII-1, U-NII-2a, U-NII-2c (channel 144 is excluded).

802.11ax 1600ns and 3200ns Guard Interval Support

802.11ac has two Guard Interval (GI) options – long GI (800ns) and short GI (400ns). 802.11ax introduces new guard interval options. It has three types of GI – 800ns, 1600ns, and 3200ns. Longer guard intervals provide improved performance in environments with multi-path and delay spread. It improves link reliability for longer-range outdoor deployments and helps to prevent inter-symbol interference in outdoor environments and therefore improve coverage and performance.

The following table compares 802.11ax to the previous two standards.

Table 2: 802.11ax Guard Interval Comparing With Previous Standards

Capabilities	802.11n	802.11ac	802.11ax
Physical Layer (PHY)	High Throughput (HT)	Very High Throughput (VHT)	High-Efficiency (HE)
Guard Interval	800/400 ns	800/400 ns	800/1600/3200 ns

Configuring 802.11ax Long Guard Interval

HE mode guard intervals should be configured in RF profiles.

Procedure

Step 1 Enters global configuration mode.

```
Device#configure terminal
```

Example:

```
Device#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2 Configures RF profile and enters RF profile configuration mode

ap dot11 {**24ghz**|**5ghz**} **rf-profile** *<profile-name>*

Example:

```
Device(config)#ap dot11 24ghz rf-profile 24G-RF-profile
```

Step 3 Configures guard interval for the RF profile.

guard-interval {**GUARD_INTERVAL_1600NS** | **GUARD_INTERVAL_3200NS** | **GUARD_INTERVAL_400NS** | **GUARD_INTERVAL_800NS**}

Example:

```
Device(config-rf-profile)#guard-interval GUARD_INTERVAL_1600NS
```

- GUARD_INTERVAL_1600NS: Set 1600 ns guard interval (only in HE mode)
- GUARD_INTERVAL_3200NS: Set 3200 ns guard interval (only in HE mode)

- GUARD_INTERVAL_400NS: Set 400 ns guard interval (HT VHT mode)
- GUARD_INTERVAL_800NS: Set 800 ns guard interval

Note
Valid guard interval values are 800, 1600, and 3200 ns for HE mode. By default, GI is 800 ns.

Step 4 Exit global configuration mode.

end

Example:

```
Device(config)#end
```

Use the following command to verify the configuration on wireless controller:

```
#show ap rf-profile name Demo-24G-RF-profile detail | inc Guard
Guard Interval        : 1600ns
#show ap rf-profile name Demo-5G-RF-profile detail | inc Guard
Guard Interval        : 3200ns
```

Example

1. Define GI in RF profile

```
ap dot11 24ghz rf-profile Demo-24G-RF-profile
shutdown
guard-interval GUARD_INTERVAL_1600NS
no shutdown
ap dot11 5ghz rf-profile Demo-5G-RF-profile
shutdown
guard-interval GUARD_INTERVAL_3200NS
no shutdown
```

2. Associate RF profile to RF tag

```
wireless tag rf Demo-Guard-Interval-RF-tag
24ghz-rf-policy Demo-24G-RF-profile
5ghz-rf-policy Demo-5G-RF-profile
```

3. Associate RF tag to AP

```
ap fc58.9a15.c83c
rf-tag Demo-Guard-Interval-RF-tag
```

GNSS Support

From Cisco IOS XE Dublin 17.11.1, GNSS is supported on IW9167EH. The AP tracks GPS information for devices deployed in the outdoor environment and sends the GNSS information to the wireless controller.

Use the following command to display the GNSS information on the AP:

ap# **show gnss info**.

Use the following commands to display the GPS location of the AP:

controller# **show ap geolocation summary**

controller# **show ap name** <*Cisco AP*> **geolocation detail**

RAP Ethernet Daisy Chain

The RAP Ethernet Daisy Chain feature enhances the existing Ethernet bridging functionality. It forces the bridge AP to stick to the Ethernet link, and block the selecting of wireless link for uplink backhaul. Even the Ethernet link failure happens, the access point will never select a parent over wireless backhaul.

The following figure shows an example of RAP Ethernet Daisy Chain topology. Standalone DC power source is provided to each RAP.

Figure 1: RAP Ethernet Daisy Chain Topology

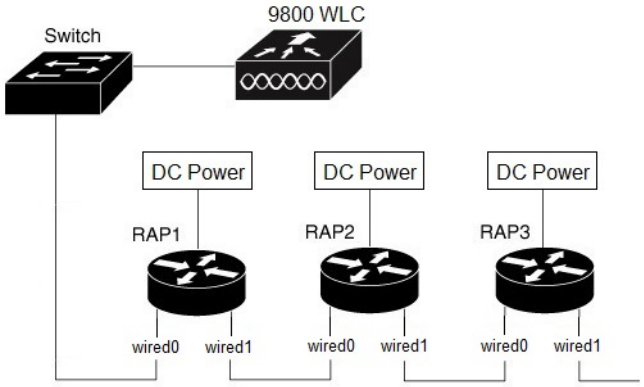


Table 3: Port Mapping

Panel Label	SW Interface
mGig POE-IN port	wired 0
SFP	wired 1

Note The supported SFP module for this feature is the 1000BASE-T rugged SFP (Cisco PID: GLC-T-RGD).

Follow these guidelines when you configure this feature:

- All APs in daisy chain is operating in mesh bridge mode or Flex+Bridge mode with Root AP role. The PoE-IN (wired0) and SFP (wired1) port can be used as uplink port and the PoE-IN (wired0) port has the higher priority than SFP (wired1).
- VLAN transparency should be disabled on all daisy-chained RAPs.
- To enable VLAN support on each root AP:
  - For bridge mode APs, use the **ap name name-of-rap mesh vlan-trunking [native] vlan-id** command to configure a trunk VLAN on the corresponding RAP.
  - For Flex+Bridge APs, you must configure the native VLAN ID under the corresponding flex profile.

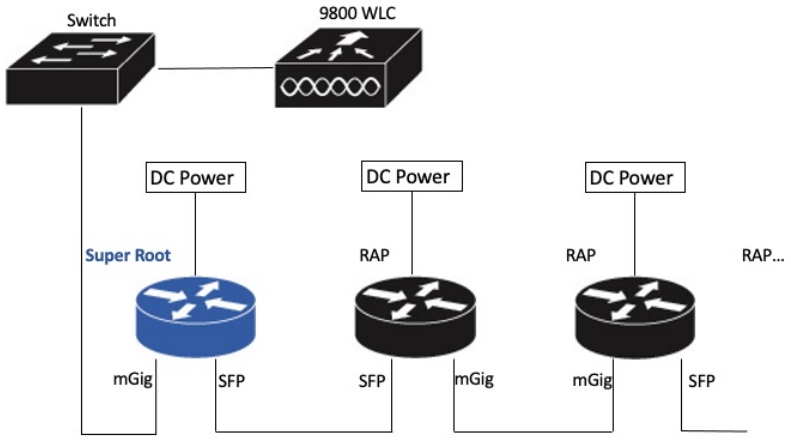
The RAP Ethernet Daisy Chain feature is already supported on Cisco IOS XE Cupertino 17.9.3, while it has the following limitations:

- Primary ethernet port (mGig port) must be used as uplink. In this case, SFP port to SFP port connection is not supported, which impacts network throughput (no 2.5Gbps or 5Gbps copper SFP available when SFP connect to mGig port).
- Reuse an existing command **persistant-ssid** to enable the RAP Ethernet Daisy Chain feature, which is misleading.

In Cisco IOS XE Dublin 17.11.1, the RAP Ethernet Daisy Chain feature is enhanced to support the following functions:

- Wireless Spanning Tree Protocol (WSTP) hello is enabled to support auto root port detection, so that RAP can use any port as its uplink. See the following topology.

Figure 2: RAP Ethernet Daisy Chain With WSTP Topology



- A separate and dedicated command **rap-eth-daisychain** is introduced to enable the feature.

WSTP Overview

Wireless LAN spanning tree protocol (WSTP) organizes a Cisco mesh network into a loop-free spanning tree topology. It quickly configure a mesh network into a stable, loop-free, optimal spanning tree topology, where an optimal topology provides least-cost paths to the primary Ethernet LAN. WSTP Hello messages are used to build the WSTP topology.

The WSTP super root is a single RAP that is elected as the highest level “super” root for the entire WSTP spanning tree. The super root is directly attached to the primary LAN. The super root transmits zero-cost WSTP SR Hello messages on its Ethernet root port to advertise the primary LAN to RAPs.

Comparison with Previous Release

The following table compares the daisy chain features in current release and prior to 17.11:

	Prior to Release 17.11.1	Release 17.11.1
Topology	**Fixed topology** RAP must use its mGig port as uplink in daisy chain topology	**Flexible topology** RAP can use either mGig port or SFP port as uplink in daisy chain topology by enabling WSTP on AP
Feature enablement	**Persistant-ssid** in AP profile [1]	**rap-eth-daisychain** in Mesh profile
Ring Topology	Not supported [2]	Not supported

[1] **Persistant-ssid** is still supported in 17.11, so that daisy chain function will not be impacted after upgrading from previous release to 17.11 with old configuration. But **Persistant-ssid** is not recommended in 17.11, and the new **rap-eth-daisychain** command is recommended.

[2] Supported only on IW6300 access point, by enabling **daisychain-stp-redundancy**. For more information, see the RAP Ethernet Daisy Chain Redundancy for STP Ring Topology section in Cisco Catalyst IW6300 Heavy Duty Series and 6300 Series Embedded Services Access Point Software Configuration Guide.

RAP Ethernet Daisy Chain Configuration

This section provides procedures for the RAP Ethernet daisy chain configuration.

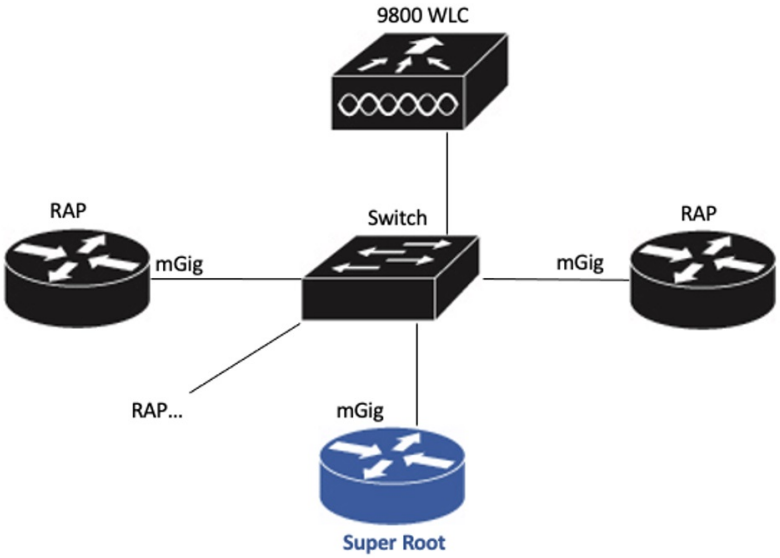
Preconfiguring RAP Ethernet Daisy Chain Before Field Deployment

This section provides the preconfiguration that you should complete in lab before you set up in field deployment.

Procedure

Step 1 Unpack, connect, and power on the AP.

Step 2 Join each AP to controller with mGig port. See the following figure for details.



Step 3 Configure AP to bridge mode and configure AP role to Root AP.

For detailed configuration procedures, see https://www.cisco.com/c/en/us/td/docs/wireless/controller/9800/17-11/config-guide/b_wl_17_eleven_cg/m_mesh_ewlc.html#task_pnb_bwy_mlb.

Step 4 Configuring RAP Ethernet Daisy Chain.

a) Create mesh profile and enable the Rap Ethernet Daisy chain feature.

See Enabling RAP Ethernet Daisy Chain, on page 16.

b) Attach the profile to all the RAP.

c) Configure one AP as Super Root which should be the first hop to the wireless controller.

See Configuring Super Root, on page 17.

d) Configure primary Ethernet port on the Super Root AP if you use SFP port as uplink.

See Configuring Primary Ethernet Port, on page 18.

Step 5 Enable Ethernet Bridging and Configure Ethernet port.

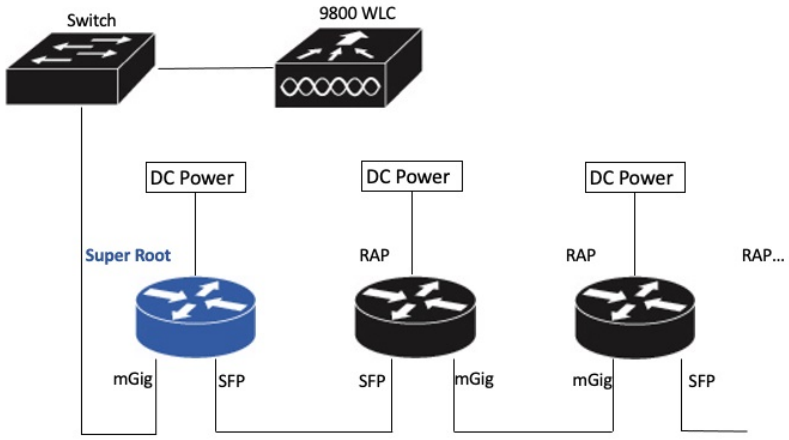
See Configuring Ethernet Bridging and Ethernet Port, on page 18.

a) Enable Ethernet Bridging.

b) Ethernet port configuration on both Port 0 and Port 1, including port mode and vlan. It is recommended to configure port to trunk mode.

Step 6 Verify the behavior in daisy chain topology.

a) Connecting the RAP via wired port one by one.



Note
The RAP which is the first hop from wireless controller should be configured as Super Root, as shown in the above figure.

b) Make sure that RAP of each hop can join the controller.

Note
In field deployment, just repeat Step 6 of this procedure. Make sure you configure the first hop as Super Root.

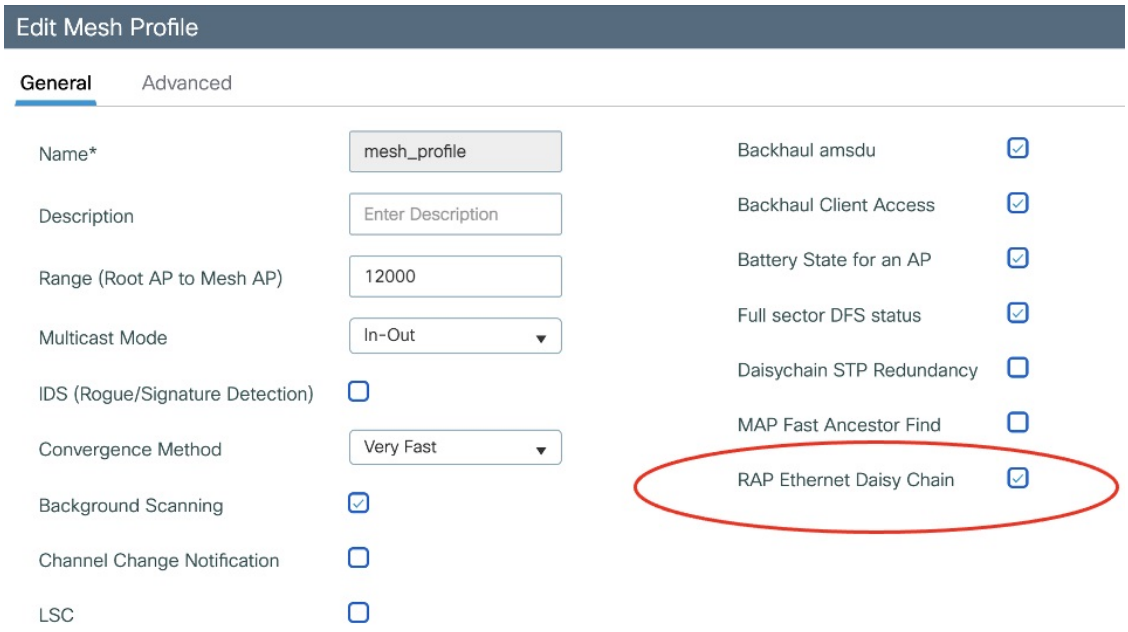
Enabling RAP Ethernet Daisy Chain

To enable RAP Ethernet Daisy Chain feature, use the **rap-eth-daisychain** command, or configure from GUI.

The following example shows enabling the feature from CLI:

```
#configure terminal
(config)#wireless profile mesh default-mesh-profile
(config-wireless-mesh-profile)#ethernet-bridging
(config-wireless-mesh-profile)#rap-ethernet-daisychain
```

The following figure shows enabling the feature from GUI:



To verify the configuration, use the **show wireless profile mesh detailed** command or **show wireless mesh ethernet daisy-chain summary** command from wireless controller, as shown in the following examples:

```
#show wireless profile mesh detailed <profile name>
…
RAP ethernet daisychain       : ENABLED

#show wireless mesh ethernet daisy-chain summary
AP Name      BVI MAC        BGN        Backhaul          Ethernet      STP Red        Super
 Root
-----------------------------------------------------------------------------------------------
APxxxxxx     xxxxxxx       xxxxx       Ethernet0          Up Up          NA
Enabled
```

Or use the **show mesh config** command on AP, as shown in the following example:

```
#show mesh config
…
RAP Ethernet Daisy Chain: Enabled
  Daisy Chain Root: Disabled
```

Configuring Super Root

The first RAP which connects to the upstream switch should be configured as super root, which means it's the source of all WSTP hello. Other RAPs only start hello after receiving a hello.

You can configure the super root from wireless controller or from AP.

- From wireless controller, use the **ap name <name> [no] mesh rap-eth-daisychain super-root** command to configure a super root.

  To verify the configuration, use the following command:

  ```
  #show ap name <name> config general
  …
  RAP ethernet daisychain                : Enabled
  Super Root                             : Enabled
  ```

- On AP, use the **capwap ap mesh wstp super-root** command to configure a super root.

  To verify the configuration, use the following command:

```
#show mesh config
…
RAP Ethernet Daisy Chain: Enabled
  Daisy Chain Root: Enabled
```

Configuring Primary Ethernet Port

Super root must use its primary Ethernet port to connect to upstream switch. For IW9167EH, the default primary Ethernet port is Ethernet port 0. To manually configure the primary Ethernet port, use the **ap name <name> mesh backhaul ethernet <0/1>** command from wireless controller.

To verify the configuration, use the following command from wireless controller:

```
#show ap name <name> config general
…
AP Primary Ethernet port                        : 1
RAP ethernet daisychain                         : Enabled
Super Root                                      : Disabled
```

Or use the following commands on AP:

```
#show mesh config
…
RAP Ethernet Daisy Chain: Enabled
  Daisy Chain Root: Enabled
AP Primary ethernet backhaul interface: 1

#show mesh adjacency parent
AdjInfo: Wired Backhaul: 1 [xx:xx:xx:xx:xx:xx]
```

Configuring Ethernet Bridging and Ethernet Port

Configuring Ethernet Bridging (CLI)

The Ethernet port on the MAPs are disabled by default. It can be enabled only by configuring Ethernet bridging on the Root AP and the other respective MAPs. Follow these steps to enable Ethernet bridging on the AP.

Procedure

Step 1 Enters global configuration mode.

```
Device#configure terminal
```

Step 2 Creates a mesh profile.

wireless profile mesh *profile-name*

Example:

```
(config)#wireless profile mesh rap-eth-daisy
```

Step 3 **ethernet-bridging**

Example:

```
(config-wireless-mesh-profile)#ethernet-bridging
```

Connects remote wired networks to each other.

Step 4 Disables VLAN transparency to ensure that the bridge is VLAN aware.

no ethernet-vlan-transparent

Example:

```
(config-wireless-mesh-profile)#no ethernet-vlan-transparent
```

Step 5 Exit global configuration mode.

end

Example:

```
(config-wireless-mesh-profile)#end
```

Example

Use the following command to verify the configuration:

```
#show wireless profile mesh detailed rap-eth-daisy

Mesh Profile Name           : rap-eth-daisy
-------------------------------------
Description                 :
Bridge Group Name           : unconfigured
Strict match BGN            : DISABLED
Amsdu                       : ENABLED
Background Scan             : DISABLED
Channel Change Notification : DISABLED
Backhaul client access      : DISABLED
Ethernet Bridging           : ENABLED
Ethernet Vlan Transparent   : DISABLED
Daisy Chain SP Redundancy   : DISABLED
Full Sector DFS             : ENABLED
```

Configuring Ethernet Bridging (GUI)

Follow these steps to configure Ethernet Bridging from wireless controller GUI:

Procedure

Step 1 Choose **Configuration** > **Wireless** > **Mesh** > **Profiles**

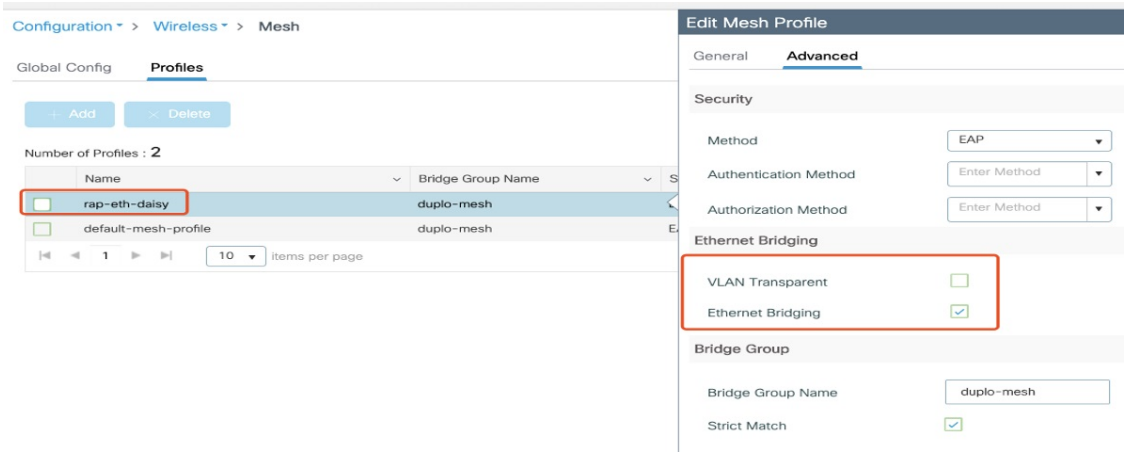
Step 2 Click **Add**.

Step 3 In **General** tab, enter the **Name** of the mesh profile.

Step 4 In **Advanced** tab, uncheck the **VLAN Transparent** check box to disable VLAN transparency.

Step 5 In **Advanced** tab, check the **Ethernet Bridging** check box.

Step 6 Click **Apply to Device**.



Configuring Ethernet Port (CLI)

RAP Ethernet secondary port supports Access mode and Trunk mode. Follow these steps to configure Ethernet port mode.

- Use the following command to configure access mode.

  #**ap name** *ap-name* **mesh ethernet 1 mode access** *Vlan-ID*

- Use the following commands to configure trunk mode. VLAN support must be enabled in advance, and VLAN transparent should be disabled in your mesh profile.
  - Configure a trunk VLAN on the corresponding RAP.

    #**ap name** *ap-name* **mesh vlan-trunking native** *Vlan-ID*

  - Configure the native VLAN for the trunk port.

    #**ap name** *ap-name* **mesh ethernet 1 mode trunk vlan native** *Vlan-ID*

  - Configure the allowed VLANs for the trunk port. Permits VLAN filtering on an ethernet port of any Mesh or Root Access Point. Active only when VLAN transparency is disabled in the mesh profile.

    #**ap name** *ap-name* **mesh ethernet 1 mode trunk allowed** *Vlan-ID*

Configuring Ethernet Port (GUI)

Follow these steps to configure Ethernet port from wireless controller GUI:

Procedure

Step 1 Choose **Configuration** > **Wireless** > **Access Points**.

The **All Access Points** section, which lists all the configured APs in the network, is displayed with their corresponding details.

Step 2 Click the configured mesh AP.

The **Edit AP** window is displayed.

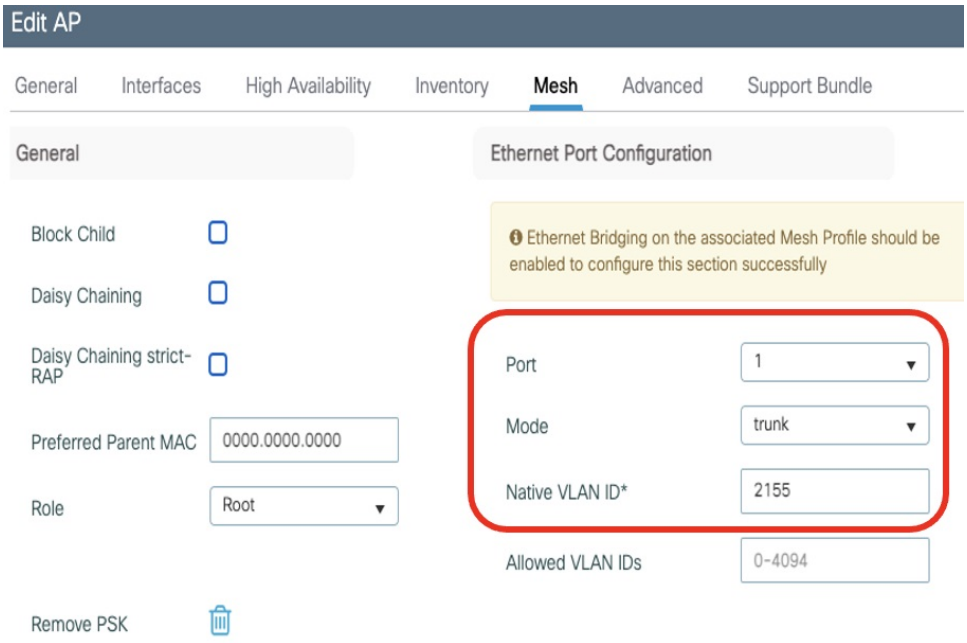
Step 3 Choose the **Mesh** tab.

Step 4 In the **Ethernet Port Configuration** section, from the **Port** drop-down list, choose the port to configure.

Step 5 From the **Mode** drop-down list, choose access mode or trunk mode.

Step 6 In the **Native VLAN ID** field, enter the native VLAN for the trunk port.

Step 7 Click **Update and Apply to Device**.



Show and Debug Command

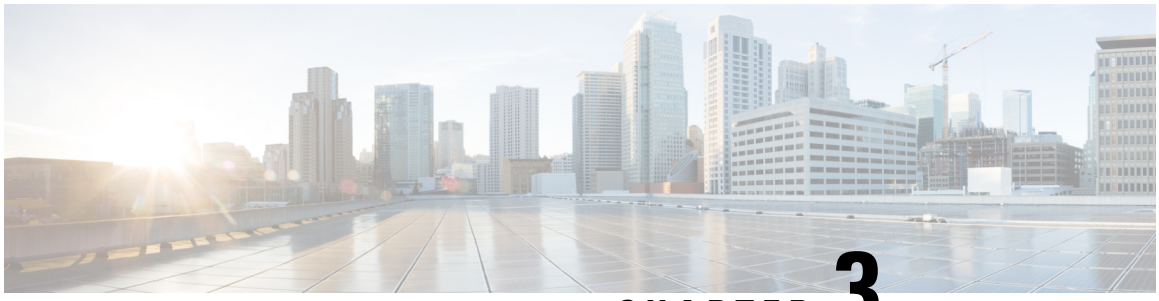
- Use the following command to debug WTP:

```
AP#debug mesh wstp
  error     Mesh wstp error debugs
  events    Mesh wstp events debugs
  packets   Mesh wstp packet debugs
```

```
03:05:24.5918] chatter: wstp_ctl :: WstpControl: RX Hello(00) - BID:FC:58:9A:15:C8:04 SR:FC:58:9A:15:C8:04/0 Flags:02 Port:wired0
03:05:24.5918] chatter: wstp_ctl :: WstpControl - wired_hello_only, hello received, update parent record
03:05:24.5946] chatter: wstp_ctl :: WstpControl: TX Hello(00) - BID:FC:58:9A:17:58:EC SR:FC:58:9A:15:C8:04/0 Flags:02 Port:wired1
03:05:26.5918] chatter: wstp_ctl :: WstpControl: RX Hello(00) - BID:FC:58:9A:15:C8:04 SR:FC:58:9A:15:C8:04/0 Flags:02 Port:wired0
03:05:26.5918] chatter: wstp_ctl :: WstpControl - wired_hello_only, hello received, update parent record
03:05:26.5946] chatter: wstp_ctl :: WstpControl: TX Hello(00) - BID:FC:58:9A:17:58:EC SR:FC:58:9A:15:C8:04/0 Flags:02 Port:wired1
```

- Use the following command to display the WSTP statistics:

```
AP#show mesh stats
WSTP stats:
Attach-Cnt Hello-TX Hello-Rx TCN-TX TCN-RX SR-Chg-Cnt ST-Roam-Cnt
         0       58       58      0      0          0           0
```



CHAPTER 3

Workgroup Bridges

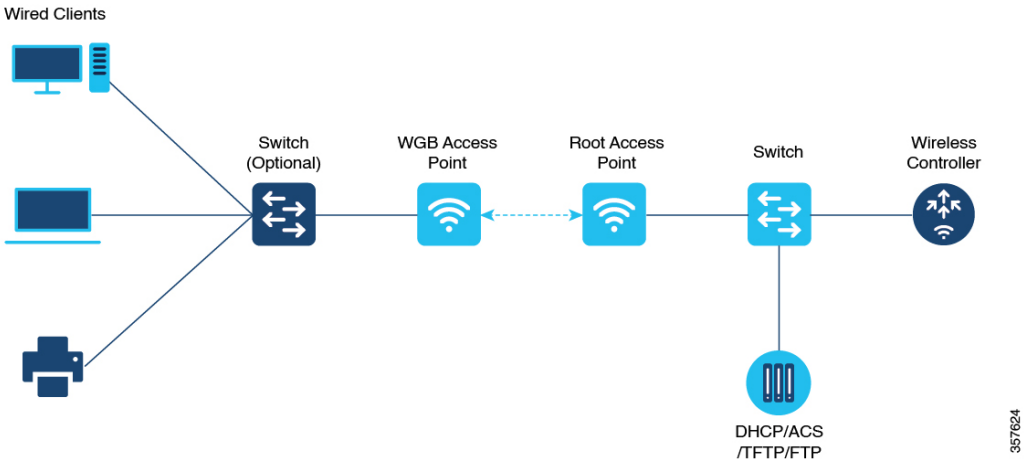
- Overview, on page 24
- Limitations and Restrictions, on page 24
- Configuring Strong Password in Day0, on page 26
- Controller Configuration for WGB, on page 27
- uWGB Image Upgrade, on page 28
- WGB Configuration, on page 29
- uWGB Configuration, on page 37
- Converting Between WGB and uWGB, on page 45
- LED Pattern, on page 45
- Configuring HT Speed Limit, on page 45
- Radio Statistics Commands, on page 47
- Syslog, on page 49
- Event Logging, on page 50
- 802.11v , on page 51
- Configure Aux Scanning, on page 52
- Configuring Layer 2 NAT, on page 58
- Configuring Native VLAN on Ethernet Ports, on page 63
- Low Latency Profile, on page 63
- Configuring WGB/uWGB Radio Parameters, on page 68
- Assign Country Code to WGB/uWGB With -ROW PID, on page 69
- Indoor Deployment for -E Domain and United Kingdom, on page 69
- Configuring WGB Roaming Parameters, on page 70
- Importing and Exporting WGB Configuration, on page 70
- Verifying the Configuration of WGB and uWGB, on page 70
- Configuring and Validating SNMP With WGB, on page 72
- Support for QoS ACL Classification and Marking, on page 81
- Packet Capture: TCP Dump on WGB, on page 87
- AAA User Authentication Support, on page 93
- Port Address Translation on WGB, on page 96
- Port Address Translation on uWGB, on page 102
- 10 Mbps Speed Port Support on Cisco IW9167EH WGB, on page 109

Overview

A workgroup bridge (WGB) is an Access Point (AP) mode to provide wireless connectivity to wired clients that are connected to the Ethernet port of the WGB AP. A WGB connects a wired network over a single wireless segment by learning the MAC addresses of its wired clients on the Ethernet interface and reporting them to the WLC through infrastructure AP using Internet Access Point Protocol (IAPP) messaging. The WGB establishes a single wireless connection to the root AP, which in turn, treats the WGB as a wireless client.

Universal WGB (uWGB) is a complementary mode of WGB feature that acts as a wireless bridge between the wired client connected to uWGB and wireless infrastructure including Cisco and non-Cisco wireless network. One of the wireless interface is used to connect with the access point. The radio MAC is used to associate AP.

Figure 3: Example of a WGB



Starting from Cisco IOS XE Dublin 17.11.1, WGB is supported on the Cisco Catalyst IW9167E Heavy Duty Access Points.

Limitations and Restrictions

This section provides limitations and restrictions for WGB and uWGB modes.

- The WGB can associate only with Cisco lightweight access points. The universal WGB can associate to a third party access point.
- In a Meraki wireless infrastructure that uses WPA1 security, uWGB do not associate with any SSIDs.
- Speed and duplex are automatically negotiated based on the capabilities of the locally connected endpoint and cannot be manually configured on the AP's wired 0 and wired 1 interfaces.
- Per-VLAN Spanning Tree (PVST) and packets are used to detect and prevent loops in the wired and wireless switching networks. WGB transparently bridge STP packets. WGB can bridge STP packets between two wired segments. Incorrect or inconsistent configuration of STP in the wired segments can cause WGB wireless link to be blocked by the connected switch(es) to Access Point or WGB. This could

cause WGB to disconnect from AP or AP disconnection to Controller to drop, and wired clients not receiving IP addresses, as STP begins to block switch port in the wired network. If administrator needs to disable bridging of STP between the wired segments by the WGB, we recommend disabling the STP on the directly connected switches in the wireless network.

- The following features are not supported for use with a WGB:
  - Idle timeout
  - Web authentication
- With Layer 3 roaming, if you plug a wired client into the WGB network after the WGB has roamed to another controller (for example, to a foreign controller), the wired client's IP address displays only on the anchor controller, not on the foreign controller.
- When you deauthenticate a WGB record from a controller, all of the WGB wired clients' entries are also deleted.
- These features are not supported for wired clients connected to a WGB:
  - MAC filtering
  - Link tests
  - Idle timeout
- Associating a WGB to a WLAN that is configured for Adaptive 802.11r is not supported.
- WGB supports IPv6 only when IPv4 is enable. But there is no impact on WGB wired clients IPv6 traffic.
- WGB management IPv6 does not work after WGB uplink association is completed. WGB can get an IPv6 address when the association is successful. But IPv6 ping will not be passed from or to WGB. SSH from wireless or wired client to WGB management IPv6 is not working. The workaround to bypass the pingable issue is to re-enable IPv6, even though IPv6 has already been enabled and the IPv6 address has been assigned.
- uWGB mode does not support SSH connecting to itself.
- uWGB mode supports neither TFTP nor SFTP. For software upgrade, you should perform it from WGB mode. For more information, see uWGB Image Upgrade, on page 28.
- uWGB does not support host IP service. Some functions, such as image upgrade via radio uplink and remote management via SSH session, are not supported.
- For IW9167EH WGB/uWGB mode, the **packet retries [N] drop** command does not work in IOS XE Release 17.11.1.
- DFS channels are supported on IW9167EH WGB/uWGB from Release 17.13.1.
- Only Dot11Radio 0 and Dot11Radio 1 interfaces can be used as wireless uplink on IW9167EH WGB/uWGB.
- When the infrastructure AP operates on a non-DFS (Dynamic Frequency Selection) channel and changes its channel bandwidth, the WGB stays connected to the infrastructure AP using the original channel bandwidth.

To make sure the WGB connects to the AP with the correct channel bandwidth. Use **wireless client mac-address** <*wgb-wireless-client-mac-address*> **deauthenticate** command on the wireless controller to deauthenticate the WGB wireless client.

Configuring Strong Password in Day0

It is required to set a strong password for WGB/uWGB after first login. The username and strong password should follow these rules:

1. Username length is between 1 and 32 characters.
2. Password length is between 8 to 120 characters.
3. Password must contain at least one uppercase character, one lowercase character, one digit, and one punctuation.
4. Password can contain alphanumeric characters and special characters (ASCII decimal code from 33 to 126), but the following special characters are not permitted: " (double quote), ' (single quote), ? (question mark).
5. Password cannot contain three sequential characters.
6. Password cannot contain three same characters consecutively.
7. Password cannot be the same as or reverse of the username.
8. New password must have at least four different characters compared to the current password.

For example, by default, the credential is

- username: Cisco
- password: Cisco
- enable password: Cisco

To reset the credential with the following strong password:

- username: demouser
- password: DemoP@ssw0rd
- enable password: DemoE^aP@ssw0rd

```
User Access Verification
Username: Cisco
Password: Cisco

% First Login: Please Reset Credentials

Current Password:Cisco
Current Enable Password:Cisco
New User Name:demouser
New Password:DemoP@ssw0rd
Confirm New Password:DemoP@ssw0rd
New Enable Password:DemoE^aP@ssw0rd
Confirm New Enable Password:DemoE^aP@ssw0rd
```

```
% Credentials changed, please re-login

[*04/18/2023 23:53:44.8926] chpasswd: password for user changed
[*04/18/2023 23:53:44.9074]
[*04/18/2023 23:53:44.9074] Management user configuration saved successfully
[*04/18/2023 23:53:44.9074]


User Access Verification
Username: demouser
Password: DemoP@ssw0rd
APFC58.9A15.C808>enable
Password:DemoE^aP@ssw0rd
APFC58.9A15.C808#
```

Note In above example, all passwords are displayed in plain text for demonstration purpose. In real case, they are hidden by asterisks (*).

Controller Configuration for WGB

For a WGB to join a wireless network, you need to configure specific settings on the WLAN and related policy profile on the controller.

Follow these steps to configure the Cisco Client Extensions option and set the support of Aironet IE in the WLAN:

1. Enter WLAN configuration submode. The *profile-name* is the profile name of the configured WLAN.

   ```
   #wlan profile-name
   ```

2. Configure the Cisco Client Extensions option and set the support of Aironet IE on the WLAN.

   ```
   #ccx aironet-iesupport
   ```

Note Without this configuration, WGB is not able to associate to AP.

Follow these steps to configure WLAN policy profile:

1. Enter wireless policy configuration mode.

   ```
   #wireless profile policy profile-policy
   ```

2. Assign the profile policy to the VLAN.

   ```
   #vlan vlan-id
   ```

3. Configure WGB VLAN client support.

   ```
   #wgb vlan
   ```

uWGB Image Upgrade

uWGB mode does not support TFTP or SFTP. To perform a software upgrade, follow these steps:

Procedure

Step 1 Connect a TFTP or SFTP server to wired 0 port of uWGB.

Step 2 Turn radio interfaces into Administratively Down state.

configure Dot11Radio <0|1> disable

Example:

```
#configure Dot11Radio 0 disable
#configure Dot11Radio 1 disable
```

Step 3 Convert uWGB to WGB mode.

configure Dot11Radio *slot_id* **mode wgb ssid-profile** *ssid_profile_name*

Example:

```
#configure Dot11Radio 1 mode wgb ssid-profile a_uwgb_demo_ssid

This command will reboot with downloaded configs.
Are you sure you want continue? <confirm>
```

Note
ssid_profile_name can be any existing SSID profile configured by users.

Step 4 After rebooting, assign a static IP address to the WGB.

configure ap address ipv4 static *IPv4_address netmask Gateway_IPv4_address*

Example:

```
#configure ap address ipv4 static 192.168.1.101 255.255.255.0 192.168.1.1
```

Step 5 Verify the ICMP ping works.

ping *server_IP*

Example:

```
#ping 192.168.1.20
Sending 5, 100-byte ICMP Echos to 192.168.1.20, timeout is 2 seconds

PING 192.168.1.20
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0.858/0.932/1.001 ms
```

Step 6 Upgrade the software.

archive download /reload <**tftp | sftp | http**>://*server_ip*/*file_path*

Step 7 Convert WGB back to uWGB.

configure Dot11Radio *slot_id* **mode uwgb** *wired_client_mac_addr* **ssid-profile** *ssid_profile_name*

Example:

```
#configure Dot11Radio 1 mode uwgb 00b4.9e00.a891 ssid-profile a_uwgb_demo_ssid
```

WGB Configuration

The typical WGB configuration involves the following steps:

1. Create an SSID profile.
2. Configure radio as workgroup, and associate the SSID profile to the radio.
3. Turn on the radio.

WGB uplink supports various security methods, including:

- Open (unsecured)
- PSK
- Dot1x (LEAP, PEAP, FAST-EAP, TLS)

The following is an example of Dot1x FAST-EAP configuration:

```
configure dot1x credential demo-cred username demouser1 password Dem0Pass!@
configure eap-profile demo-eap-profile dot1x-credential demo-cred
configure eap-profile demo-eap-profile method fast
configure ssid-profile demo-FAST ssid demo-fast authentication eap profile demo-eap-profile
 key-management wpa2
configure dot11radio 0 mode wgb ssid-profile demo-FAST
configure dot11radio 0 enable
```

The following sections provide detailed information about WGB configuration.

Configure IP address

Configure IPv4 address

- Use the **configure ap address** *ipv4 dhcp* command to configure IPv4 address using DHCP.

  ```
  Device#configure ap address ipv4 dhcp
  ```

- Use the **configure ap address** *ipv4 static ipv4_addr netmask gateway* command to configure the static IPv4 address. By doing so, you can manage the device using a wired interface without an uplink connection.

  ```
  Device#configure ap address ipv4 static ipv4_addr netmask gateway
  ```

Verify current IP configuration

Use **show ip interface brief** command to view the current IP address configuration.

```
Device#show ip interface brief
```

Configure IPv6 address

Use the **configure ap address ipv6 static** *ipv6_addr prefixlen [gateway]* command to configure the static IPv6 address. This configuration allows you to manage the AP through a wired interface without uplink connection.

```
Device#configure ap address ipv6 static ipv6_addr prefixlen [gateway]
```

Enable IPv6 auto configuration

Use the **configure ap address ipv6 auto-config enable** command to enable the IPv6 auto configuration on the AP.

```
Device#configure ap address ipv6 auto-config enable
```

Note

- Use the **configure ap address ipv6 auto-config disable** command to disable the IPv6 auto configuration on the AP.
- Use the **configure ap address ipv6 auto-config enable** command to enable IPv6 SLAAC. Note that SLAAC does not apply to CoS of WGB. This command configures IPv6 address with DHCPv6 instead of SLAAC.

Configure IPv6 address using DHCP

Use the **configure ap address** *ipv6 dhcp* command to configure IPv6 address using DHCP.

```
Device#configure ap address ipv6 dhcp
```

Verify current IP configuration

Use the **show ipv6 interface brief** command to verify current IP address configuration.

```
Device#show ipv6 interface brief
```

Configure a Dot1X credential

Use the **configure dot1x credential** *profile-name* **username** *name* **password** *pwd* command to configure Dot1x credential.

```
Device#configure dot1x credential profile-name username name password pwd
```

Verify WGB EAP Dot1x profile

Use the **show wgb eap dot1x credential profile** command to view the status of WGB EAP Dot1x profile.

```
Device#show wgb eap dot1x credential profile
```

Deauthenticate WGB wired client

Use the **clear wgb client** {**all** |**single** *mac-addr*} command to deauthenticate WGB wired client.

```
Device#clear wgb client {all |single mac-addr}
```

Configure an EAP profile

Perform these steps to configure an EAP profile:

1. Attach the Dot1x credential profile to the EAP profile.
2. Attach the EAP profile to the SSID profile.
3. Attach the SSID profile to the radio.

Procedure

Step 1 Use the **configure eap-profile** *profile-name* **method** {**fast** | **leap** | **peap** | **tls**} command to configure the EAP profile.

```
Device#configure eap-profile profile-name method { fast | leap | peap | tls}
```

Note
Choose an EAP profile method.

- fast
- peap, or
- tls.

Step 2 Use the **configure eap-profile** *profile-name* **trustpoint** {**default** | **name** *trustpoint-name*} command to attach the CA trustpoint for TLS. By default, the WGB uses the internal MIC certificate for authentication.

```
Device#configure eap-profile profile-name trustpoint { default | name trustpoint-name}
```

Step 3 Use the **configure eap-profile** *profile-name* **dot1x-credential** *profile-name* command to attach the dot1x-credential profile.

```
Device#configure eap-profile profile-name dot1x-credential profile-name
```

Step 4 [Optional] Use the **configure eap-profile** *profile-name* **delete** command to delete an EAP profile.

```
Device#configure eap-profile profile-name delete
```

Configure trustpoint manual enrollment for terminal

Procedure

Step 1 Use the **configure crypto pki trustpoint** *ca-server-name* **enrollment terminal** command to create a trustpoint in WGB.

```
Device#configure crypto pki trustpoint ca-server-name enrollment terminal
```

Step 2 Use the **configure crypto pki trustpoint** *ca-server-name* **authenticate** command to authenticate a trustpoint manually.

```
Device#configure crypto pki trustpoint ca-server-name authenticate
```

Enter the base 64 encoded CA certificate.

Enter **quit** to finish the certificate.

Note
If you use an intermediate certificate, import all the certificate chains in the trustpoint.

Example:

```
Device#configure crypto pki trustpoint demotp authenticate

Enter the base 64 encoded CA certificate.
....And end with the word "quit" on a line by itself....

-----BEGIN CERTIFICATE-----
[base64 encoded root CA certificate]
-----END CERTIFICATE-----
-----BEGIN CERTIFICATE-----
[base64 encoded intermediate CA certificate]
-----END CERTIFICATE-----
quit
```

Step 3 Use the **configure crypto pki trustpoint** *ca-server-name* **key-size** *key-length* command to configure a private key size.

```
Device#configure crypto pki trustpoint ca-server-name key-size key-length
```

Step 4 Use the **configure crypto pki trustpoint** *ca-server-name* **subject-name** *name* `[Optional]` *2ltr-country-code state-name locality org-name org-unit email* command to configure the subject-name.

```
Device#configure crypto pki trustpoint ca-server-name subject-name name [Optional] 2ltr-country-code
 state-name locality org-name org-unit email
```

Step 5 Use the **configure crypto pki trustpoint** *ca-server-name* **enroll** command to generate a private key and certificate signing request (CSR).

```
Device#configure crypto pki trustpoint ca-server-name enroll
```

Create the digitally signed certificate using the CSR output in the CA server.

Step 6 Use the **configure crypto pki trustpoint** *ca-server-name* **import certificate** command to import the signed certificate in WGB.

```
Device#configure crypto pki trustpoint ca-server-name import certificate
```

Enter the base 64 encoded CA certificate.

Enter **quit** to finish the certificate.

```
Device#quit
```

Step 7 [Optional] Use the **configure crypto pki trustpoint** *trustpoint-name* **delete** command to delete a trustpoint.

```
Device#configure crypto pki trustpoint trustpoint-name delete
```

Step 8 Use the **show crypto pki trustpoint** command to view the trustpoint summary.

```
Device#show crypto pki trustpoint
```

Step 9 Use the **show crypto pki trustpoint** *trustpoint-name* **certificate** command to view the content of the certificates that are created for a trustpoint.

```
Device#show crypto pki trustpoint trustpoint-name certificate
```

Configure trustpoint auto-enrollment for WGB

Procedure

Step 1 Use the **configure crypto pki trustpoint** *ca-server-name* **enrollment url** *ca-server-url* command to enroll a trustpoint in the WGB using the server URL.

```
Device#configure crypto pki trustpoint ca-server-name enrollment url ca-server-url
```

Step 2 Use the **configure crypto pki trustpoint** *ca-server-name* **authenticate** command to authenticate a trustpoint.

```
Device#configure crypto pki trustpoint ca-server-name authenticate
```

This command fetches the CA certificate from CA server automatically.

Step 3 Use the **configure crypto pki trustpoint** *ca-server-name* **key-size** *key-length* command to configure a private key size.

```
Device#configure crypto pki trustpoint ca-server-name key-size key-length
```

Step 4 Use the **configure crypto pki trustpoint** *ca-server-name* **subject-name** *name* `[Optional]` *2ltr-country-code state-name locality org-name org-unit email* command to configure the subject-name.

```
Device#configure crypto pki trustpoint ca-server-name subject-name name [Optional] 2ltr-country-code
 state-name locality org-name org-unit email
```

Step 5 Use the **configure crypto pki trustpoint** *ca-server-name* **enroll** command to enroll the trustpoint.

```
Device#configure crypto pki trustpoint ca-server-name enroll
```

Request the digitally signed certificate from the CA server.

Step 6 Use the **configure crypto pki trustpoint** *ca-server-name* **auto-enroll enable** *renew-percentage* command to enable auto-enroll.

```
Device#configure crypto pki trustpoint ca-server-name auto-enroll enable renew-percentage
```

Note
Use the **configure crypto pki trustpoint** *ca-server-name* **auto-enroll disable** command to disable the auto-enroll.

Step 7 [Optional] Use the **configure crypto pki trustpoint** *trustpoint-name* **delete** command to delete a trustpoint.

```
Device#configure crypto pki trustpoint trustpoint-name delete
```

Step 8 Use the **show crypto pki trustpoint** command to view the trustpoint summary.

```
Device#show crypto pki trustpoint
```

Step 9 Use the **show crypto pki trustpoint** *trustpoint-name* **certificate** command to view the details of the certificate for a specific trustpoint.

```
Device#show crypto pki trustpoint trustpoint-name certificate
```

Step 10 Use the **show crypto pki timers** command to view the public key infrastructure (PKI) timer information.

show crypto pki timers

```
Device#show crypto pki timers
```

Configure manual certificate enrollment using TFTP server

Procedure

Step 1 Specify the enrollment method.

Use the **configure crypto pki trustpoint** *ca-server-name* **enrollment tftp** *tftp-addr/file-name* command to retrieve the CA and client certificate for a trustpoint.

```
Device#configure crypto pki trustpoint ca-server-name enrollment tftp tftp-addr/file-name
```

Step 2 Use the **configure crypto pki trustpoint** *ca-server-name* **authenticate** command to authenticate a trustpoint manually.

```
Device#configure crypto pki trustpoint ca-server-name authenticate
```

This retrieves and authenticates the CA certificate from the specified TFTP server. If the file specification is included, the WGB adds the extension **.ca** to the specified filename.

Step 3 Use the **configure crypto pki trustpoint** *ca-server-name* **key-size** *key-length* command to configure a private key size.

```
Device#configure crypto pki trustpoint ca-server-name key-size key-length
```

Step 4 Use the **configure crypto pki trustpoint** *ca-server-name* **subject-name** *name* `[Optional]` *2ltr-country-code state-name locality org-name org-unit email* command to configure the subject-name.

```
Device#configure crypto pki trustpoint ca-server-name subject-name name [Optional] 2ltr-country-code
 state-name locality org-name org-unit email
```

Step 5 Use the **configure crypto pki trustpoint** *ca-server-name* **enroll** command to generate a private key and Certificate Signing Request (CSR).

```
Device#configure crypto pki trustpoint ca-server-name enroll
```

This generates certificate request and sends the request to the TFTP server. The filename to be written is appended with the **.req** extension.

Step 6 Use the **configure crypto pki trustpoint** *ca-server-name* **import certificate** command to import the signed certificate in WGB.

```
Device#configure crypto pki trustpoint ca-server-name import certificate
```

The console terminal uses TFTP to import a certificate and the WGB tries to get the approved certificate from the TFTP. The filename to be written is appended with the **.crt** extension.

Step 7 Use the **show crypto pki trustpoint** command to view the trustpoint summary.

```
Device#show crypto pki trustpoint
```

Step 8 Use the **show crypto pki trustpoint** *trustpoint-name* **certificate** command to view the content of the certificates that are created for a trustpoint.

```
Device#show crypto pki trustpoint trustpoint-name certificate
```

SSID configuration

SSID configuration consists of the following two parts:

1. Create an SSID profile, on page 35
2. Configuring Radio Interface for Workgroup Bridges, on page 36

Create an SSID profile

Choose one of these authentication protocols to configure the SSID profile:

1. Configure an SSID profile using open authentication
2. Configure an SSID profile using PSK authentication
   - PSK WPA2 authentication
   - PSK Dot11r authentication, and
   - PSK Dot11w authentication.
3. Configure an SSID profile using Dot1x authentication

Configure an SSID profile using open authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *radio-serv-name* **authentication** *open* command to configure an SSID profile using open authentication.

```
Device#configure ssid-profile ssid-profile-name ssid radio-serv-name authentication open
```

Configure an SSID profile using PSK authentication

Choose one of the these authentication protocols to configure an SSID profile using PSK authentication:

- configure an SSID profile using PSK WPA2 authentication
- configure an SSID profile using PSK Dot11r authentication, and
- configure an SSID profile using PSK Dot11w authentication .

Configure an SSID profile using PSK WPA2 authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *SSID_name* **authentication psk** *preshared-key* **key-management wpa2** command to configure an SSID profile using PSK WPA2 authentication.

```
Device#configure ssid-profile ssid-profile-name ssid SSID_name authentication psk
preshared-key key-management wpa2
```

Configure an SSID profile using PSK Dot11r authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *SSID_name* **authentication psk** *preshared-key* **key-management dot11r** command to configure an SSID profile using PSK Dot11r authentication.

```
Device#configure ssid-profile ssid-profile-name ssid SSID_name authentication psk
preshared-key key-management dot11r
```

Configure an SSID profile using PSK Dot11w authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *SSID_name* **authentication psk** *preshared-key* **key-management dot11w** command to configure an SSID profile using PSK Dot11w authentication

```
Device#configure ssid-profile ssid-profile-name ssid SSID_name authentication psk
preshared-key key-management dot11w
```

Configure an SSID profile using Dot1x authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *radio-serv-name* **authentication eap profile** *eap-profile-name* **key-management** {**dot11r** | **wpa2** | **dot11w** {**optional | required**} } command to configure an SSID profile using Dot1x authentication.

```
Device#configure ssid-profile ssid-profile-name ssid radio-serv-name authentication eap
profile eap-profile-name key-management { dot11r | wpa2 | dot11w { optional | required}}
```

Configure an SSID profile using Dot1x EAP-PEAP authentication

Here is an example that shows the configuration of an SSID profile using Dot1x EAP-PEAP authentication:

```
Device#configure dot1x credential c1 username wgbusr password cisco123456
Device#configure eap-profile p1 dot1x-credential c1
Device#configure eap-profile p1 method peap
Device#configure ssid-profile iot-peap ssid iot-peap authentication eap profile p1
key-management wpa2
```

Configuring Radio Interface for Workgroup Bridges

- From the available two radio interfaces, before configuring WGB mode on one radio interface, configure the other radio interface to root-ap mode.

  Map a radio interface as root-ap by entering this command:

  # **configure dot11radio** *radio-slot-id* **mode root-ap**

  Example

  ```
  # configure dot11radio 0 mode root-ap
  ```

  Note When an active SSID or EAP profile is modified, you need to reassociate the profile to the radio interface for the updated profile to be active.

- Map a radio interface to a WGB SSID profile by entering this command:

  # **configure dot11radio** *radio-slot-id* **mode wgb ssid-profile** *ssid-profile-name*

  Example

  ```
  # configure dot11radio 1 mode wgb ssid-profile psk_ssid
  ```

- Configure a radio interface by entering this command:

  # **configure dot11radio** *radio-slot-id*{ **enable** | **disable** }

  Example

  ```
  # configure dot11radio 0 disable
  ```

Note Only one radio or slot is allowed to operate in WGB mode.

Configuring WGB/uWGB Timer

The timer configuration CLIs are common for both WGB and uWGB. Use the following commands to configure timers:

- Configure the WGB association response timeout by entering this command:

  # **configure wgb association response timeout** *response-millisecs*

  The default value is 100 milliseconds. The valid range is between 100 and 5000 milliseconds.

- Configure the WGB authentication response timeout by entering this command:

  # **configure wgb authentication response timeout** *response-millisecs*

  The default value is 100 milliseconds. The valid range is between 100 and 5000 milliseconds.

- Configure the WGB EAP timeout by entering this command:

  # **configure wgb eap timeout** *timeout-secs*

  The default value is 3 seconds. The valid range is between 2 and 60 seconds.

- Configure the WGB bridge client response timeout by entering this command:

  # **configure wgb bridge client timeout** *timeout-secs*

  Default timeout value is 300 seconds. The valid range is between 10 and 1000000 seconds.

uWGB Configuration

The universal WGB is able to interoperate with non-Cisco access points using uplink radio MAC address, thus the universal workgroup bridge role supports only one wired client.

Most WGB configurations apply to uWGB. The only difference is that you configure wired client's MAC address with the following command:

configure dot11 <**0**|**1**> **mode uwgb** <*uwgb_wired_client_mac_address*> **ssid-profile** <*ssid-profile*>

The following is an example of Dot1x FAST-EAP configuration:

```
configure dot1x credential demo-cred username demouser1 password Dem0Pass!@
configure eap-profile demo-eap-profile dot1x-credential demo-cred
configure eap-profile demo-eap-profile method fast
configure ssid-profile demo-FAST ssid demo-fast authentication eap profile demo-eap-profile
 key-management wpa2
configure dot11radio 0 mode uwgb fc58.220a.0704 ssid-profile demo-FAST
configure dot11radio 0 enable
```

The following sections provide detailed information about uWGB configuration.

Configure IP address

Configure IPv4 address

- Use the **configure ap address** *ipv4 dhcp* command to configure IPv4 address using DHCP.

```
Device#configure ap address ipv4 dhcp
```

- Use the **configure ap address** *ipv4 static ipv4_addr netmask gateway* command to configure the static IPv4 address. By doing so, you can manage the device using a wired interface without an uplink connection.

```
Device#configure ap address ipv4 static ipv4_addr netmask gateway
```

Verify current IP configuration

Use **show ip interface brief** command to view the current IP address configuration.

```
Device#show ip interface brief
```

Configure IPv6 address

Use the **configure ap address ipv6 static** *ipv6_addr prefixlen [gateway]* command to configure the static IPv6 address. This configuration allows you to manage the AP through a wired interface without uplink connection.

```
Device#configure ap address ipv6 static ipv6_addr prefixlen [gateway]
```

Enable IPv6 auto configuration

Use the **configure ap address ipv6 auto-config enable** command to enable the IPv6 auto configuration on the AP.

```
Device#configure ap address ipv6 auto-config enable
```

Note

- Use the **configure ap address ipv6 auto-config disable** command to disable the IPv6 auto configuration on the AP.
- Use the **configure ap address ipv6 auto-config enable** command to enable IPv6 SLAAC. Note that SLAAC does not apply to CoS of WGB. This command configures IPv6 address with DHCPv6 instead of SLAAC.

Configure IPv6 address using DHCP

Use the **configure ap address** *ipv6 dhcp* command to configure IPv6 address using DHCP.

```
Device#configure ap address ipv6 dhcp
```

Verify current IP configuration

Use the **show ipv6 interface brief** command to verify current IP address configuration.

```
Device#show ipv6 interface brief
```

Configure a Dot1X credential

Use the **configure dot1x credential** *profile-name* **username** *name* **password** *pwd* command to configure Dot1x credential.

```
Device#configure dot1x credential profile-name username name password pwd
```

Verify WGB EAP Dot1x profile

Use the **show wgb eap dot1x credential profile** command to view the status of WGB EAP Dot1x profile.

```
Device#show wgb eap dot1x credential profile
```

Configure an EAP profile

Perform these steps to configure an EAP profile:

1. Attach the Dot1x credential profile to the EAP profile.
2. Attach the EAP profile to the SSID profile.
3. Attach the SSID profile to the radio.

Procedure

Step 1 Use the **configure eap-profile** *profile-name* **method** {**fast** | **leap** | **peap** | **tls**} command to configure the EAP profile.

```
Device#configure eap-profile profile-name method { fast | leap | peap | tls}
```

Note
Choose an EAP profile method.

- fast
- peap, or
- tls.

Step 2 Use the **configure eap-profile** *profile-name* **trustpoint** {**default** | **name** *trustpoint-name*} command to attach the CA trustpoint for TLS. By default, the WGB uses the internal MIC certificate for authentication.

```
Device#configure eap-profile profile-name trustpoint { default | name trustpoint-name}
```

Step 3 Use the **configure eap-profile** *profile-name* **dot1x-credential** *profile-name* command to attach the dot1x-credential profile.

```
Device#configure eap-profile profile-name dot1x-credential profile-name
```

Step 4 [Optional] Use the **configure eap-profile** *profile-name* **delete** command to delete an EAP profile.

```
Device#configure eap-profile profile-name delete
```

Configure trustpoint manual enrollment for terminal

Procedure

Step 1 Use the **configure crypto pki trustpoint** *ca-server-name* **enrollment terminal** command to create a trustpoint in WGB.

```
Device#configure crypto pki trustpoint ca-server-name enrollment terminal
```

Step 2 Use the **configure crypto pki trustpoint** *ca-server-name* **authenticate** command to authenticate a trustpoint manually.

```
Device#configure crypto pki trustpoint ca-server-name authenticate
```

Enter the base 64 encoded CA certificate.

Enter **quit** to finish the certificate.

Note
If you use an intermediate certificate, import all the certificate chains in the trustpoint.

Example:

```
Device#configure crypto pki trustpoint demotp authenticate

Enter the base 64 encoded CA certificate.
....And end with the word "quit" on a line by itself....

-----BEGIN CERTIFICATE-----
[base64 encoded root CA certificate]
-----END CERTIFICATE-----
-----BEGIN CERTIFICATE-----
[base64 encoded intermediate CA certificate]
-----END CERTIFICATE-----
quit
```

Step 3 Use the **configure crypto pki trustpoint** *ca-server-name* **key-size** *key-length* command to configure a private key size.

```
Device#configure crypto pki trustpoint ca-server-name key-size key-length
```

Step 4 Use the **configure crypto pki trustpoint** *ca-server-name* **subject-name** *name* `[Optional]` *2ltr-country-code state-name locality org-name org-unit email* command to configure the subject-name.

```
Device#configure crypto pki trustpoint ca-server-name subject-name name [Optional] 2ltr-country-code
 state-name locality org-name org-unit email
```

Step 5 Use the **configure crypto pki trustpoint** *ca-server-name* **enroll** command to generate a private key and certificate signing request (CSR).

```
Device#configure crypto pki trustpoint ca-server-name enroll
```

Create the digitally signed certificate using the CSR output in the CA server.

Step 6 Use the **configure crypto pki trustpoint** *ca-server-name* **import certificate** command to import the signed certificate in WGB.

```
Device#configure crypto pki trustpoint ca-server-name import certificate
```

Enter the base 64 encoded CA certificate.

Enter **quit** to finish the certificate.

```
Device#quit
```

Step 7 [Optional] Use the **configure crypto pki trustpoint** *trustpoint-name* **delete** command to delete a trustpoint.

```
Device#configure crypto pki trustpoint trustpoint-name delete
```

Step 8 Use the **show crypto pki trustpoint** command to view the trustpoint summary.

```
Device#show crypto pki trustpoint
```

Step 9 Use the **show crypto pki trustpoint** *trustpoint-name* **certificate** command to view the content of the certificates that are created for a trustpoint.

```
Device#show crypto pki trustpoint trustpoint-name certificate
```

Configure trustpoint auto-enrollment for WGB

Procedure

Step 1 Use the **configure crypto pki trustpoint** *ca-server-name* **enrollment url** *ca-server-url* command to enroll a trustpoint in the WGB using the server URL.

```
Device#configure crypto pki trustpoint ca-server-name enrollment url ca-server-url
```

Step 2 Use the **configure crypto pki trustpoint** *ca-server-name* **authenticate** command to authenticate a trustpoint.

```
Device#configure crypto pki trustpoint ca-server-name authenticate
```

This command fetches the CA certificate from CA server automatically.

Step 3 Use the **configure crypto pki trustpoint** *ca-server-name* **key-size** *key-length* command to configure a private key size.

```
Device#configure crypto pki trustpoint ca-server-name key-size key-length
```

Step 4 Use the **configure crypto pki trustpoint** *ca-server-name* **subject-name** *name* `[Optional]` *2ltr-country-code state-name locality org-name org-unit email* command to configure the subject-name.

```
Device#configure crypto pki trustpoint ca-server-name subject-name name [Optional] 2ltr-country-code
 state-name locality org-name org-unit email
```

Step 5 Use the **configure crypto pki trustpoint** *ca-server-name* **enroll** command to enroll the trustpoint.

```
Device#configure crypto pki trustpoint ca-server-name enroll
```

Request the digitally signed certificate from the CA server.

Step 6 Use the **configure crypto pki trustpoint** *ca-server-name* **auto-enroll enable** *renew-percentage* command to enable auto-enroll.

```
Device#configure crypto pki trustpoint ca-server-name auto-enroll enable renew-percentage
```

Note
Use the **configure crypto pki trustpoint** *ca-server-name* **auto-enroll disable** command to disable the auto-enroll.

Step 7 [Optional] Use the **configure crypto pki trustpoint** *trustpoint-name* **delete** command to delete a trustpoint.

```
Device#configure crypto pki trustpoint trustpoint-name delete
```

Step 8 Use the **show crypto pki trustpoint** command to view the trustpoint summary.

```
Device#show crypto pki trustpoint
```

Step 9 Use the **show crypto pki trustpoint** *trustpoint-name* **certificate** command to view the details of the certificate for a specific trustpoint.

```
Device#show crypto pki trustpoint trustpoint-name certificate
```

Step 10 Use the **show crypto pki timers** command to view the public key infrastructure (PKI) timer information.

show crypto pki timers

```
Device#show crypto pki timers
```

Configure manual certificate enrollment using TFTP server

Procedure

Step 1 Specify the enrollment method.

Use the **configure crypto pki trustpoint** *ca-server-name* **enrollment tftp** *tftp-addr/file-name* command to retrieve the CA and client certificate for a trustpoint.

```
Device#configure crypto pki trustpoint ca-server-name enrollment tftp tftp-addr/file-name
```

Step 2 Use the **configure crypto pki trustpoint** *ca-server-name* **authenticate** command to authenticate a trustpoint manually.

```
Device#configure crypto pki trustpoint ca-server-name authenticate
```

This retrieves and authenticates the CA certificate from the specified TFTP server. If the file specification is included, the WGB adds the extension **.ca** to the specified filename.

Step 3 Use the **configure crypto pki trustpoint** *ca-server-name* **key-size** *key-length* command to configure a private key size.

```
Device#configure crypto pki trustpoint ca-server-name key-size key-length
```

Step 4 Use the **configure crypto pki trustpoint** *ca-server-name* **subject-name** *name* `[Optional]` *2ltr-country-code state-name locality org-name org-unit email* command to configure the subject-name.

```
Device#configure crypto pki trustpoint ca-server-name subject-name name [Optional] 2ltr-country-code
 state-name locality org-name org-unit email
```

Step 5 Use the **configure crypto pki trustpoint** *ca-server-name* **enroll** command to generate a private key and Certificate Signing Request (CSR).

```
Device#configure crypto pki trustpoint ca-server-name enroll
```

This generates certificate request and sends the request to the TFTP server. The filename to be written is appended with the **.req** extension.

Step 6 Use the **configure crypto pki trustpoint** *ca-server-name* **import certificate** command to import the signed certificate in WGB.

```
Device#configure crypto pki trustpoint ca-server-name import certificate
```

The console terminal uses TFTP to import a certificate and the WGB tries to get the approved certificate from the TFTP. The filename to be written is appended with the **.crt** extension.

Step 7 Use the **show crypto pki trustpoint** command to view the trustpoint summary.

```
Device#show crypto pki trustpoint
```

Step 8 Use the **show crypto pki trustpoint** *trustpoint-name* **certificate** command to view the content of the certificates that are created for a trustpoint.

```
Device#show crypto pki trustpoint trustpoint-name certificate
```

SSID configuration

SSID configuration consists of the following two parts:

1. Create an SSID profile, on page 35
2. Configuring Radio Interface for uWGB, on page 44

Create an SSID profile

Choose one of these authentication protocols to configure the SSID profile:

1. Configure an SSID profile using open authentication
2. Configure an SSID profile using PSK authentication
   - PSK WPA2 authentication
   - PSK Dot11r authentication, and
   - PSK Dot11w authentication.
3. Configure an SSID profile using Dot1x authentication

Configure an SSID profile using open authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *radio-serv-name* **authentication** *open* command to configure an SSID profile using open authentication.

```
Device#configure ssid-profile ssid-profile-name ssid radio-serv-name authentication open
```

Configure an SSID profile using PSK authentication

Choose one of the these authentication protocols to configure an SSID profile using PSK authentication:

- configure an SSID profile using PSK WPA2 authentication
- configure an SSID profile using PSK Dot11r authentication, and
- configure an SSID profile using PSK Dot11w authentication .

Configure an SSID profile using PSK WPA2 authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *SSID_name* **authentication psk** *preshared-key* **key-management wpa2** command to configure an SSID profile using PSK WPA2 authentication.

```
Device#configure ssid-profile ssid-profile-name ssid SSID_name authentication psk
preshared-key key-management wpa2
```

Configure an SSID profile using PSK Dot11r authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *SSID_name* **authentication psk** *preshared-key* **key-management dot11r** command to configure an SSID profile using PSK Dot11r authentication.

```
Device#configure ssid-profile ssid-profile-name ssid SSID_name authentication psk
preshared-key key-management dot11r
```

Configure an SSID profile using PSK Dot11w authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *SSID_name* **authentication psk** *preshared-key* **key-management dot11w** command to configure an SSID profile using PSK Dot11w authentication

```
Device#configure ssid-profile ssid-profile-name ssid SSID_name authentication psk
preshared-key key-management dot11w
```

Configure an SSID profile using Dot1x authentication

Use the **configure ssid-profile** *ssid-profile-name* **ssid** *radio-serv-name* **authentication eap profile** *eap-profile-name* **key-management** {**dot11r** | **wpa2** | **dot11w** {**optional | required**}} command to configure an SSID profile using Dot1x authentication.

```
Device#configure ssid-profile ssid-profile-name ssid radio-serv-name authentication eap
profile eap-profile-name key-management { dot11r | wpa2 | dot11w { optional | required}}
```

Configure an SSID profile using Dot1x EAP-PEAP authentication

Here is an example that shows the configuration of an SSID profile using Dot1x EAP-PEAP authentication:

```
Device#configure dot1x credential c1 username wgbusr password cisco123456
Device#configure eap-profile p1 dot1x-credential c1
Device#configure eap-profile p1 method peap
Device#configure ssid-profile iot-peap ssid iot-peap authentication eap profile p1
key-management wpa2
```

Configuring Radio Interface for uWGB

- From the available two radio interfaces, before configuring WGB mode on one radio interface, configure the other radio interface to root-ap mode.

  Map a radio interface as root-ap by entering this command:

  # **configure dot11radio** *radio-slot-id* **mode root-ap**

  Example

  ```
  # configure dot11radio 0 mode root-ap
  ```

Note When an active SSID or EAP profile is modified, you need to reassociate the profile to the radio interface for the updated profile to be active.

- Map a radio interface to a WGB SSID profile by entering this command:

  # **configure dot11radio** *radio-slot-id* **mode uwgb** *uwgb-wired-client-mac-address* **ssid-profile** *ssid-profile-name*

- Configure a radio interface by entering this command:

  # **configure dot11radio** *radio-slot-id*{ **enable** | **disable** }

  Example

  ```
  # configure dot11radio 0 disable
  ```

Note After configuring the uplink to the SSID profile, we recommend you to disable and enable the radio for the changes to be active.

Note Only one radio or slot is allowed to operate in uWGB or WGB mode.

Converting Between WGB and uWGB

To convert from WGB to uWGB, use the following command:

#**configure dot11radio** <**0**|**1**> **mode uwgb** <*WIRED_CLIENT_MAC*> **ssid-profile** <*SSID_PROFILE_NAME*>

To convert from uWGB to WGB, use the following command. This conversion involves a reboot of the AP.

#**configure Dot11Radio 1 mode wgb ssid-profile** <*SSID_PROFILE_NAME*>

```
This command will reboot with downloaded configs.
Are you sure you want continue? [confirm]
```

LED Pattern

Two new LED patterns are added to IW9167EH WGB mode:

- When WGB is in disassociated state, the System LED is blinking RED.
- When WGB makes association to parent AP, System LED turns to solid GREEN.

Configuring HT Speed Limit

In WGB field moving case deployment, you can manually set a transmission rate limit with High Throughput (HT) Modulation and Coding Scheme (MCS).

The following is an example to configure WGB to transmit with 802.11n HT m4. m5. rate:

Config dot11radio [**1**|**2**] **802.11ax disable**

Config dot11radio [**1**|**2**] **802.11ac disable**

Config dot11radio [1|2] speed ht-mcs m4. m5.

WGB also supports to configure legacy rates.

- For 802.11b/g, the legacy rates are configured as following:

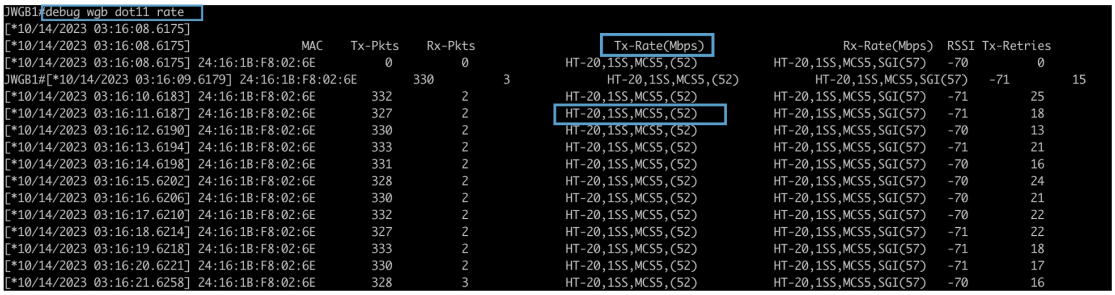
```
configure dot11radio 0 speed legacy-rate
1.0 Allow 1.0 Mb/s rate
11.0 Allow 11.0 Mb/s rate
12.0 Allow 12.0 Mb/s rate
18.0 Allow 18.0 Mb/s rate
2.0 Allow 2.0 Mb/s rate
24.0 Allow 24.0 Mb/s rate
36.0 Allow 36.0 Mb/s rate
48.0 Allow 48.0 Mb/s rate
5.5 Allow 5.5 Mb/s rate
54.0 Allow 54.0 Mb/s rate
6.0 Allow 6.0 Mb/s rate
9.0 Allow 9.0 Mb/s rate
basic-1.0 Require 1.0 Mb/s rate
basic-11.0 Require 11.0 Mb/s rate
basic-12.0 Require 12.0 Mb/s rate
basic-18.0 Require 18.0 Mb/s rate
basic-2.0 Require 2.0 Mb/s rate
basic-24.0 Require 24.0 Mb/s rate
basic-36.0 Require 36.0 Mb/s rate
basic-48.0 Require 48.0 Mb/s rate
basic-5.5 Require 5.5 Mb/s rate
basic-54.0 Require 54.0 Mb/s rate
basic-6.0 Require 6.0 Mb/s rate
basic-9.0 Require 9.0 Mb/s rate
default Set default legacy rates
```

- For 802.11a, the legacy rates are configured as following:

```
configure dot11radio [1|2] speed legacy-rate
12.0 Allow 12.0 Mb/s rate
18.0 Allow 18.0 Mb/s rate
24.0 Allow 24.0 Mb/s rate
36.0 Allow 36.0 Mb/s rate
48.0 Allow 48.0 Mb/s rate
54.0 Allow 54.0 Mb/s rate
6.0 Allow 6.0 Mb/s rate
9.0 Allow 9.0 Mb/s rate
basic-12.0 Require 12.0 Mb/s rate
basic-18.0 Require 18.0 Mb/s rate
basic-24.0 Require 24.0 Mb/s rate
basic-36.0 Require 36.0 Mb/s rate
basic-48.0 Require 48.0 Mb/s rate
basic-54.0 Require 54.0 Mb/s rate
basic-6.0 Require 6.0 Mb/s rate
basic-9.0 Require 9.0 Mb/s rate
default Set default legacy rates
```

Legacy rate is used by 802.11 management frame and control frame. WGB legacy rates should match AP's legacy rates, or at least, having overlap between these two rate sets. Otherwise, WGB association will be rejected due to mismatched rates.

To check WGB Tx MCS rate, use the **debug wgb dot11 rate** command. The following example shows the output of this command.



Radio Statistics Commands

To help troubleshooting radio connection issues, use the following commands:

- **#debug wgb dot11 rate**

```
#debug wgb dot11 rate
[*03/13/2023 18:00:08.7814]                MAC     Tx-Pkts    Rx-Pkts
  Tx-Rate(Mbps)                      Rx-Rate(Mbps)  RSSI    SNR Tx-Retries
[*03/13/2023 18:00:08.7814] FC:58:9A:17:C2:51          0          0
HE-20,2SS,MCS6,GI0.8 (154)       HE-20,3SS,MCS4,GI0.8 (154)   -30    62          0
[*03/13/2023 18:00:09.7818] FC:58:9A:17:C2:51          0          0
HE-20,2SS,MCS6,GI0.8 (154)       HE-20,3SS,MCS4,GI0.8 (154)   -30    62          0
```

In this example, FC:58:9A:17:C2:51 is the parent AP radio MAC.

- **#show interfaces dot11Radio** <*slot-id*> **statistics**

```
#show interfaces dot11Radio 1 statistics
Dot11Radio Statistics:
        DOT11 Statistics (Cumulative Total/Last 5 Seconds):
RECEIVER                                TRANSMITTER
Host Rx K Bytes:        965570/0        Host Tx K Bytes:       1611903/0
Unicasts Rx:            379274/0        Unicasts Tx:           2688665/0
Broadcasts Rx:         3166311/0        Broadcasts Tx:               0/0
Beacons Rx:          722130099/1631     Beacons Tx:          367240960/784
Probes Rx:           588627347/2224     Probes Tx:            78934926/80
Multicasts Rx:         3231513/0        Multicasts Tx:           53355/0
Mgmt Packets Rx:     764747086/1769     Mgmt Packets Tx:     446292853/864
Ctrl Frames Rx:        7316214/5        Ctrl Frames Tx:              0/0
RTS received:                0/0       RTS transmitted:             0/0
Duplicate frames:            0/0       CTS not received:            0/0
MIC errors:                  0/0       WEP errors:            2279546/0
FCS errors:                  0/0       Retries:                896973/0
Key Index errors:            0/0       Tx Failures:              8871/0
                                       Tx Drops:                    0/0


Rate Statistics for Radio::
[Legacy]:
6 Mbps:
 Rx Packets:     159053/0            Tx Packets:      88650/0
                                     Tx Retries:       2382/0
9 Mbps:
 Rx Packets:         43/0            Tx Packets:         23/0
                                     Tx Retries:         71/0
12 Mbps:
 Rx Packets:          1/0            Tx Packets:        119/0
                                     Tx Retries:        185/0
18 Mbps:
 Rx Packets:          0/0            Tx Packets:          5/0
```

```
                                    Tx Retries:        134/0
24 Mbps:
 Rx Packets:        235/0           Tx Packets:      20993/0
                                    Tx Retries:       5048/0
36 Mbps:
 Rx Packets:          0/0           Tx Packets:        781/0
                                    Tx Retries:        227/0
54 Mbps:
 Rx Packets:        133/0           Tx Packets:       9347/0
                                    Tx Retries:       1792/0


[SU]:
M0:
 Rx Packets:          7/0           Tx Packets:          0/0
                                    Tx Retries:          6/0
M1:
 Rx Packets:       1615/0           Tx Packets:      35035/0
                                    Tx Retries:       3751/0
M2:
 Rx Packets:      15277/0           Tx Packets:     133738/0
                                    Tx Retries:      22654/0
M3:
 Rx Packets:      10232/0           Tx Packets:       1580/0
                                    Tx Retries:      21271/0
M4:
 Rx Packets:     218143/0           Tx Packets:     190408/0
                                    Tx Retries:      36444/0
M5:
 Rx Packets:     399283/0           Tx Packets:     542491/0
                                    Tx Retries:     164048/0
M6:
 Rx Packets:    3136519/0           Tx Packets:     821537/0
                                    Tx Retries:     329003/0
M7:
 Rx Packets:    1171128/0           Tx Packets:     303414/0
                                    Tx Retries:     154014/0



Beacons missed: 0-30s 31-60s 61-90s 90s+
                     2      0      0    0
```

- **#show wgb dot11 uplink latency**

```
AP4C42.1E51.A050#show wgb dot11 uplink latency
Latency Group Total Packets Total Latency Excellent(0-8) Very Good(8-16) Good (16-32
ms) Medium (32-64ms) Poor (64-256 ms) Very Poor (256+ ms)
        AC_BK             0             0              0               0
 0                0                0                 0
        AC_BE          1840       4243793           1809              10
14                7                0                 0
        AC_VI             0             0              0               0
 0                0                0                 0
        AC_VO            24         54134             24               0
 0                0                0                 0
```

- **#show wgb dot11 uplink**

```
AP4C42.1E51.A050#show wgb dot11 uplink

HE Rates: 1SS:M0-11 2SS:M0-11
Additional info for client 8C:84:42:92:FF:CF
RSSI: -24
PS  : Legacy (Awake)
Tx Rate: 278730 Kbps
```

```
Rx Rate: 410220 Kbps
VHT_TXMAP: 65530
CCX Ver: 5
Rx Key-Index Errs: 0
              mac     intf TxData TxUC TxBytes TxFail TxDcrd TxCumRetries MultiRetries
 MaxRetriesFail RxData RxBytes RxErr               TxRt(Mbps)               RxRt(Mbps)
   LER PER stats_ago
8C:84:42:92:FF:CF wbridge1   1341 1341  184032      0      0          543           96
              0    317   33523     0 HE-40,2SS,MCS6,GI0.8 (309) HE-40,2SS,MCS9,GI0.8
(458) 27272   0  1.370000
Per TID packet statistics for client 8C:84:42:92:FF:CF
Priority Rx Pkts Tx Pkts Rx(last 5 s) Tx (last 5 s)
       0      35    1314            0             8
       1       0       0            0             0
       2       0       0            0             0
       3       0       0            0             0
       4       0       0            0             0
       5       0       0            0             0
       6     182      24            1             0
       7       3       3            0             0
Rate Statistics:
Rate-Index    Rx-Pkts    Tx-Pkts Tx-Retries
         0         99          3          0
         4          1          1          9
         5         21         39         35
         6         31        185         64
         7         26        124         68
         8         28        293         82
         9         77        401        151
        10         32        140         97
        11          2        156         37
```

Syslog

Overview of syslog

Syslog is a common protocol; it sends event data logs to a central location for storing. However, Syslog currently supports only UDP mode. If you enable the debug command in WGB, it collects debug logs. All collected logs are sent to the syslog server are in the kernel facility and at the warning level.

Enable or disable WGB syslog

Use the **logging host enable** <*server_ip*> **UDP** command to enable WGB syslog.

```
Device#logging host enable <server_ip> UDP
```

Note Use the **logging host disable** <*server_ip*> **UDP** command to disable default WGB syslog.

Verify WGB syslog

Use the **show running-config** command to view current syslog configuration.

```
show running-config
```

Event Logging

For WGB field deployment, event logging will collect useful information (such as WGB state change and packets rx/tx) to analyze and provide log history to present context of problem, especially in roaming cases.

You can configure WGB trace filter for all management packet types, including probe, auth, assoc, eap, dhcp, icmp, and arp. To enable or disable WGB trace, use the following command:

#**config wgb event trace** {**enable**|**disable**}

Four kinds of event types are supported:

- **Basic event**: covers most WGB basic level info message
- **Detail event**: covers basic event and additional debug level message
- **Trace event**: recording wgb trace event if enabled
- **All event**: bundle trace event and detail event

The log format is [*timestamp*] *module*:*level* <*event log string*>.

When abnormal situations happen, the eventlog messages can be dumped manually to memory by using the following show command which also displays WGB logging:

#**show wgb event** [**basic**|**detail**|**trace**|**all**]

The following example shows the output of **show wgb event all**:

```
APC0F8.7FE5.F3C0#show wgb event all
[*08/16/2023 08:18:25.167578] UP_EVT:4 R1 IFC:58:9A:17:B3:E7] parent_rssi: -42 threshold:
-70
[*08/16/2023 08:18:25.329223] UP_EVT:4 R1 State CONNECTED to SCAN_START
[*08/16/2023 08:18:25.329539] UP_EVT:4 R1 State SCAN_START to STOPPED
[*08/16/2023 08:18:25.330002] UP_DRV:1 R1 WGB UPLINK mode stopped
[*08/16/2023 08:18:25.629405] UP_DRV:1 R1 Delete client FC:58:9A:17:B3:E7
[*08/16/2023 08:18:25.736718] UP_CFG:8 R1 configured for standard: 7
[*08/16/2023 08:18:25.989936] UP_CFG:4 R1 band 1 current power level: 1
[*08/16/2023 08:18:25.996692] UP_CFG:4 R1 band 1 set tx power level: 1
[*08/16/2023 08:18:26.003904] UP_DRV:1 R1 WGB uplink mode started
[*08/16/2023 08:18:26.872086] UP_EVT:4 Reset aux scan
[*08/16/2023 08:18:26.872096] UP_EVT:4 Pause aux scan on slot 2
[*08/16/2023 08:18:26.872100] SC_MST:4 R2 reset uplink scan state to idle
[*08/16/2023 08:18:26.872104] UP_EVT:4 Aux bring down vap - scan
[*08/16/2023 08:18:26.872123] UP_EVT:4 Aux bring up vap - serv
[*08/16/2023 08:18:26.872514] UP_EVT:4 R1 State STOPPED to SCAN_START
[*08/16/2023 08:18:26.8727091 SC_MST:4 R1 Uplink Scan Started.
[*08/16/2023 08:18:26.884054] UP_EVT:8 R1 CH event 149
```

Note It might take a long time to display the **show wgb event** command output in console. Using *ctrl+c* to interrupt the printing will not affect log dump to memory.

The following clear command erases WGB events in memory:

#**clear wgb event** [**basic**|**detail**|**trace**|**all**]

To save all event logs to WGB flash, use the following command:

#**copy event-logging flash**

The package file consists of four separate log files for different log levels.

You can also save event log to a remote server by using the following command:

#**copy event-logging upload** <**tftp**|**sftp**|**scp**>://A.B.C.D[/*dir*][/*filename.tar.gz*]

The following example saves event log to a TFTP server:

```
APC0F8.7FE5.F3C0#copy event-logging upload
tftp://192.168.100.100/tftpuser/evtlog-2023-05-31_11:45:49.tar.gz
Starting upload of WGB config
tftp://192.168.100.100/tftpuser/evtlog-2023-05-31_11:45:49.tar.gz ...
It may take a few seconds. If longer, please cancel command, check network and try again.
###################################################################### 100.0%
Config upload completed.
```

802.11v

Overview of 802.11v

802.11v is the wireless network management standard of the IEEE 802.11 family. It includes enhancements such as network-assisted roaming. This feature helps with load balancing and directs poorly connected clients to better APs.

Enhancement of roaming with 802.11v support

By adding 802.11v support to a WGB, WGB becomes capable of detecting an upcoming disconnection before it occurs. It then actively initiates a roam to select an appropriate AP from a list of neighboring APs. The WGB periodically checks for the latest neighbor APs to ensure optimal association during the next roam.

Basic service set transition request frame

The Basic Service Set (BSS) Transition Request frame includes channel information of neighboring APs. It helps in reducing roaming latency in environments with multiple channels by allowing scans of only those channels.

Disassociate the client on the AP using WLC

The WLC can disassociate a client based on factors such as load balance, RSSI value, and data rate on the AP side. This disassociation can be communicated to an 802.11v client. If the client does not re-associate with another AP within a configurable period, the disassociation occurs. You can enable the disassociation-imminent configuration on the WLC. This action activates the optional field within the BSS transition management request frame. For detailed information of 802.11v configuration on the WLC, see Cisco Catalyst 9800 Series Wireless Controller Software Configuration Guide.

Use these commands to configure 802.11v support on WGB:

Enable 802.11v support on WGB

Use the **configure wgb mobile station interface dot11Radio** <*radio_slot_id*> **dot11v-bss-transition enable** command to enable 802.11v support on WGB. When you enable 802.11v support, WGB scans only the channels learned from neighbor list.

```
Device#configure wgb mobile station interface dot11Radio <radio_slot_id> dot11v-bss-transition
 enable
```

Note Use **configure wgb mobile station interface dot11Radio** <*radio_slot_id*> **dot11v-bss-transition disable** command to disable 802.11v support on WGB.

Configure BSS transition query interval

Use **configure wgb neighborlist-update-interval** <*1-900*> command to configure the time interval that WGB sends BSS transition query message to the parent AP.

```
Device# configure wgb neighborlist-update-interval <1-900>
```

Note The default value is 10 seconds and configure the time interval in seconds format.

Verify neighbor list

Use **show wgb dot11v bss-transition neighbour** command to check neighbor list received from associated AP.

```
Device#show wgb dot11v bss-transition neighbour
```

Verify channel list

Use **show wgb dot11v bss-transition channel** command to check channel list from dot11v neighbor, aux radio scanned, and residual channel scanned.

```
Device#show wgb dot11v bss-transition channel
```

Clear neighbor list

Use this command to clear neighbor list to provide error condition recovery.

```
Device#clear wgb dot11v bss-transition neighbor
```

Configure Aux Scanning

The aux-scan mode can be configured as either scanning only or handoff mode on WGB radio 2 (5 GHz) to improve roaming performance. When roaming is triggered, the WGB refers to the scanning table to find the best parent AP. The scanning table is updated using: radio 0 or radio 4 for 2.4 GHz, and radio 1 or radio 4 for 5 GHz.

- Overview of scanning-only mode
- Scanning only mode
- Radio 4 as Scanning-Only Mode
- Configuring Aux-Scan Handoff Mode
- Optimized Roaming with Dual-Radio WGB

Overview of scanning-only mode

- The AP allows the radio to operate only for scanning purposes rather than providing client connectivity.
- The AP scans the wireless environment continuously to gather data on network performance, interference, rogue devices, and other critical metrics.

Scanning only mode

When slot 2 radio is configured as scanning only mode, slot 1 (5G) radio will always be picked as uplink. Slot 2 (5G) radio will keep scanning configured SSID based on the channel list. By default, the channel list contains all supported 5G channels (based on reg domain). The scanning list can be configured manually or learned by 802.11v.

When roaming is triggered, the algorithm looks for candidates from scanning table and skips scanning phase if the table is not empty. WGB then makes an assocaition to that candidate AP.

Configure scanning only mode

Use the **configure dot11Radio 2 mode scan only** command to configure scanning only mode.

```
Device#configure dot11Radio 2 mode scan only
```

Manually configure the channel list

Use the **configure wgb mobile station interface dot11Radio 1 scan** <*channel*> **add** command to manually add the channel to the channel list.

```
Device#configure wgb mobile station interface dot11Radio 1 scan <channel> [add|delete]
```

Note Use the **configure wgb mobile station interface dot11Radio 1 scan** <*channel*> **delete** command to manually delete the channel from the channel list.

Configure scanning table timer

Use the **configure wgb scan radio 2 timeout***1500* command to adjust the timer. By default, candidate AP entries in scanning table are automatically removed in 1200 ms.

```
Device#configure wgb scan radio 2 timeout 1500
```

Note

- Scanning AP expire time is from 1 to 5000.
- From the scanning table, the AP selects the candidate with the best RSSI value. However, sometimes the RSSI values might not be updated and it lead to roaming failures.

Verify scanning table

Use **show wgb scan** command to verify the scanning table.

```
Device#show wgb scan
Best AP expire time: 5000 ms

************[ AP List ]***************
BSSID                 RSSI    CHANNEL    Time
FC:58:9A:15:E2:4F      84      136        1531
FC:58:9A:15:DE:4F      37      136        41

***********[ Best AP ]****************
BSSID                 RSSI    CHANNEL    Time
FC:58:9A:15:DE:4F     37      136        41
```

Radio 4 as Scanning-Only Mode

Before the Cisco IOS-XE 17.15.1 release, only radio 2 (5 GHz) could be configured for scanning purposes. From CiscoIOS-XE 17.15.1 release, radio 4 (in IW9167E AP) can be configured in scanning-only mode.

Radio 4 has the following transmission and reception antennas:

- One transmission antenna for transmitting data from 2.4 GHz and 5 GHz frequency bands.
- Two reception antennas for receiving data from 2.4 GHz, 5 GHz, and 6 GHz frequency bands.

Note When both radio 2 and radio 4 are enabled with the scanning function simultaneously, the WGB uses radio 4 for scanning purpose, and the radio 2 becomes inactive.

Advantages of using Radio 4 as Scanning Only Mode

- The WGB aux scanning and roaming now support both 2.4 GHz and 5 GHz frequencies.
- The antenna resource can be saved because the scanning radio shares its antenna with the serving radio.

Note The roaming performance remains same along with the WGB aux scanning function on radio 2.

Comparision Between Radio 2 or Radio 4 as Scanning Only Mode

Scanning Support	Radio 2 (5 GHz)	Radio 4 (Dedicated Aux Radio)
2.4 GHz	No	Yes
5 GHz	Yes	Yes
Scanning only mode	Yes	Yes
Scan handoff mode	Yes	No
Aux-Scan antenna requirement	Additional antennas are required to provide the benefit of RF coverage diversity.	The scanning radio uses the antenna of serving radio.

Connection Map between Dedicated Aux Radio and Serving Radios

Dedicated Aux Radio	Serving Radio
2.4 GHz transmission	Antenna 1
5 GHz transmission	Antenna 4
2.4 GHz reception	Antenna 2 Antenna 3
5 GHz reception	Antenna 3 Antenna 2

Configure Radio 4 as Scanning Only Mode

To configure radio 4 to operate in scanning-only mode, use the command given here:

```
#config wgb aux-radio scan
```

To disable radio 4 for scanning-only mode, use the command given here:

```
#config wgb aux-radio disable
```

Verify Radio 4 Scanning Only Mode Configuration

To verify radio 4 as scanning-only mode, use the command given here:

```
#show running-config
AP Name             : APFC58.9A16.E538
AP Mode             : WorkGroupBridge
CDP State            : Enabled
Watchdog monitoring : Enabled
SSH State            : Enabled
AP Username          : cisco
Session Timeout     : 300
WGB Trace           : Disabled
Syslog Host          : 0.0.0.0
Radio and WLAN-Profile Mapping
====================================
Radio ID    Radio Mode    SSID-Profile       SSID         Authentication
-------------------------------------------------------------------------------
1           WGB           wyj-open           wyj-open     OPEN
2           SCAN          wyj-open           wyj-open     OPEN

Radio Configurations
   .
   .
   .
   Radio Id                    : 2
   Admin state              : ENABLED
   Mode                     : SCAN - Handoff
   Spatial Stream           : AUTO
   Guard Interval           : 800 ns
   Dot11 type               : 11ax
   11v BSS-Neighbor         : Disabled
   A-MPDU priority          : 0x3f
   A-MPDU subframe number   : 255
   RTS Protection           : 2347(default)
   Rx-SOP Threshold         : AUTO
```

```
   Radio profile           : NA
Radio Id                   : 4 (Aux Radio)
   Admin state             : ENABLED
   Mode                    : SCAN
```

The scan result shown with the following show command:

```
#show wgb scan
 Aux Scanning Configure:
 Radio Id: 1
        Admin State: ENABLED
        Mode: WGB
Radio Id: 2
        Admin State: ENABLED
        Mode: SCAN - Handoff
Radio Id: 4 (Aux Radio)
        Admin State: ENABLED
        Mode: SCAN
Best AP expire time: 5000 ms
Aux Scanning State: RUNNING
Aux Scanning Radio Results (Radio 4)
************[ AP List]***************
BSSID                RSSI   CHANNEL   Time
C8:84:A1:D9:B6:8E     35     149       2914

***********[ Best AP]****************
BSSID                RSSI   CHANNEL   Time
C8:84:A1:D9:B6:8E    35     149       2914

Aux Serving Radio Results (Radio1)
************[ AP List]***************
BSSID                RSSI   CHANNEL   Time
C8:84:A1:D0:A3:8E     18     36       4

***********[ Best AP]****************
BSSID                RSSI   CHANNEL   Time
C8:84:A1:D0:A3:8E    18     36       5
```

Configuring Aux-Scan Handoff Mode

When slot 2 radio is configured as handoff mode, both radio 1 and radio 2 are the uplink candidate. While one radio maintains wireless uplink, the other radio keeps scanning the channels. The scanning list can be configured manually or learned by 802.11v.

Radio 2 shares the same MAC address with radio 1, and supports the scanning function, association, and data serving. Both radios can work as **serving** or **scanning** role. When a roaming is triggered, the algorithm looks for the scanning database (internal tables), selects the best candidate AP and makes connection. The radio roles and traffic will dynamically switch between slot 1 and slot 2 after each roaming. WGB always uses the radio with operating role of **scanning** to complete the roaming association to a new AP. With this configuration, the roaming interruption time can be improved to 20-50 ms.

The following table compares roaming interruption time (3 channel case) in various mechanisms:

Roaming Interruption Time	Normal Channel Setting	Aux-scan Only	Aux-scan Handoff
Scanning	(40+20)*3=180 ms	0+40 ms	0 ms
Association	30-80 ms	30-80 ms	20-50 ms

Roaming Interruption Time	Normal Channel Setting	Aux-scan Only	Aux-scan Handoff
Total	~210 ms	70-120 ms	20-50 ms

Use the following command to configure the WGB slot2 radio to aux-scan mode:

configure dot11Radio 2 mode scan handoff

Use the **show run** command to check your configuration:

```
#show run
...
Radio Id                    : 1
   Admin state              : ENABLED
   Mode                     : WGB
   Spatial Stream           : 1
   Guard Interval           : 800 ns
   Dot11 type               : 11n
   11v BSS-Neighbor         : Disabled
   A-MPDU priority          : 0x3f
   A-MPDU subframe number   : 12
   RTS Protection           : 2347(default)
   Rx-SOP Threshold         : AUTO
   Radio profile            : Default
   Encryption mode          : AES128
Radio Id                    : 2
   Admin state              : ENABLED
   Mode                     : SCAN - Handoff
   Spatial Stream           : 1
   Guard Interval           : 800 ns
   Dot11 type               : 11n
   11v BSS-Neighbor         : Disabled
   A-MPDU priority          : 0x3f
   A-MPDU subframe number   : 12
   RTS Protection           : 2347(default)
   Rx-SOP Threshold         : AUTO
   Radio profile            : Default
```

Use the **show wgb scan** command to display the current role of each radio and the aux scanning results:

```
APFC58.9A15.C808#show wgb scan
Best AP expire time: 2500 ms

Aux Scanning Radio Results (slot 2)
************[ AP List ]***************
BSSID                RSSI   CHANNEL   Time
FC:58:9A:15:DE:4E     54     153       57
FC:58:9A:15:E2:4E     71     153       64

***********[ Best AP ]****************
BSSID                RSSI   CHANNEL   Time
FC:58:9A:15:DE:4E    54     153       57

Aux Serving Radio Results
************[ AP List ]***************
BSSID                RSSI   CHANNEL   Time
FC:58:9A:15:DE:4E     58     153       57
FC:58:9A:15:E2:4E     75     153       133

***********[ Best AP ]****************
BSSID                RSSI   CHANNEL   Time
FC:58:9A:15:DE:4E    58     153       57
```

Optimized Roaming with Dual-Radio WGB

From the Cisco IOS-XE 17.15.1 release, devices with dual-radio configurations have improved roaming efficiency. Roaming is triggered due to continuous missing beacon frames or maximum packet retries. The second radio allows the WGB to skip the scanning phase and directly check the scanning table for potential APs. This process reduces service downtime.

Trigger Factors for Roaming

Roamingis triggered in these events:

- Low RSSI: Measures the power level that a wireless device, such as an AP, receives from a signal. Use RSSI values to determine the quality of the wireless connection to troubleshoot and optimize wireless networks.
- Beacon miss-count: Indicates the number of consecutive beacon frames that a client device has missed from an AP in a wireless network.
- Maximum packet retries: Specifies the maximum number of times a data packet can be retransmitted if the client device does not send an acknowledgement.

Dual-Radio Configuration

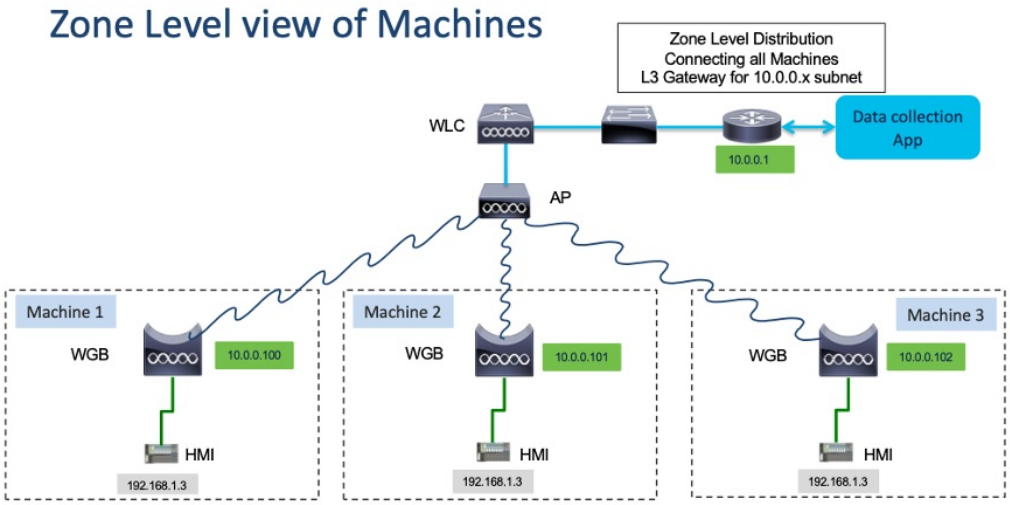
Hereare the possible configurations for the IW9167E AP in a dual-radio setup:

Dual-Radio	AP
2.4 GHz radio 0 + radio 4 (dedicated aux radio)	IW9167E
5 GHz radio 1 + radio 2 (scanning-only mode)	
5 GHz radio 1 + radio 2 (aux-scan handoff mode)	
5 GHz radio 1 + radio 4 (dedicated aux radio)	

Configuring Layer 2 NAT

One-to-one (1:1) Layer 2 NAT is a service that allows the assignment of a unique public IP address to an existing private IP address (end device), so that the end device can communicate with public network. Layer 2 NAT has two translation tables where private-to-public and public-to-private subnet translations can be defined.

In the industrial scenario where the same firmware is programmed to every HMI (customer machine, such as a Robot), firmware duplication across machines means IP address is reused across HMIs. This feature solves the problem of multiple end devices with the same duplicated IP addresses in the industrial network communicating with the public network.



The following table provides the commands to configure Layer 2 NAT:

Table 4: Layer 2 NAT Configuration Commands

Command	Description
#**configure l2nat** {**enable**|**disable**}	Enables or disables L2 NAT.
#**configure l2nat default-vlan** <*vlan_id*>	Specifies the default vlan where all NAT rules will be applied. If *vlan_id* is not specified, all NAT rules will be applied to vlan 0.
#**configure l2nat** {**add**|**delete**} **inside from host** <*original_ip_addr*> **to** <*translated_ip_addr*>	Adds or deletes a NAT rule which translates a private IP address to a public IP address. • *original_ip_addr*—Private IP address of the wired client connected to WGB Ethernet port. • *translated_ip_addr*—Public IP address that represents the wired client at public network.
#**configure l2nat** {**add**|**delete**} **outside from host** <*original_ip_addr*> **to** <*translated_ip_addr*>	Adds or deletes a NAT rule which translates a public IP address to a private IP address. • *original_ip_addr*—Public IP address of an outside network host. • *translated_ip_addr*—Private IP address which represents the outside network host at private network.

Command	Description
#**configure l2nat** {**add**|**delete**} **inside from network** <*original_nw_prefix*> **to** <*translated_nw_prefix*> <*subnet_mask*>	Adds or deletes a NAT rule which translates a private IP address subnet to a public IP address subnet. • *original_nw_prefix*—Private IP network prefix. • *translated_nw_prefix*—Public IP network prefix.
#**configure l2nat** {**add**|**delete**} **outside from network** <*original_nw_prefix*> **to** <*translated_nw_prefix*> <*subnet_mask*>	Adds or deletes a NAT rule which translates a public IP address subnet to a private IP address subnet. • *original_nw_prefix*—Public IP network prefix. • *translated_nw_prefix*—Private IP network prefix.

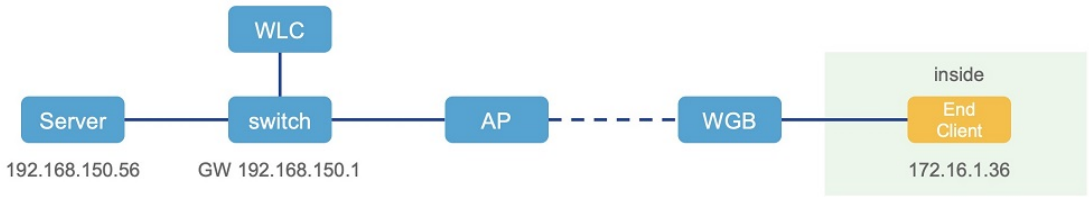
The following table provides the show and debug commands to verify and troubleshoot your Layer 2 NAT configuration:

Table 5: Layer 2 NAT Show and Debug Commands

Command	Description
#**show l2nat entry**	Displays the Layer 2 NAT running entries.
#**show l2nat config**	Displays the Layer 2 NAT configuration details.
#**show l2nat stats**	Displays the Layer 2 NAT packet translation statistics.
#**show l2nat rules**	Displays the Layer 2 NAT rules from the configuration.
#**clear l2nat statistics**	Clears packet translation statistics.
#**clear l2nat rule**	Clears Layer 2 NAT rules.
#**clear l2nat config**	Clears Layer 2 NAT configuration.
#**debug l2nat**	Enables debugging of packet translation process.
#**debug l2nat all**	Prints out the NAT entry match result when a packet arrives. **Caution** This debug command may create overwhelming log print in console. Console may lose response because of this command, especially when Syslog service is enabled with a broadcast address.
#**undebug l2nat**	Disables debugging of packet translation process.

Configuration Example of Host IP Address Translation

In this scenario, the end client (172.16.1.36) connected to WGB needs to communicate with the server (192.168.150.56) connected to the gateway. Layer 2 NAT is configured to provide an address for the end client on the outside network (192.168.150.36) and an address for the server on the inside network (172.16.1.56).



The following table shows the configuration tasks for this scenario.

Command	Purpose
#configure l2nat add inside from host 172.16.1.36 to 192.168.150.36 **#configure l2nat add outside from host 192.168.150.56 to 172.16.1.56**	Adds NAT rules to make inside client and outside server communicate with each other.
#configure l2nat add inside from host 172.16.1.1 to 192.168.150.1 **#configure l2nat add inside from host 172.16.1.255 to 192.168.150.255**	Adds NAT for gateway and broadcast address.

The following show commands display your configuration.

- The following command displays the Layer 2 NAT configuration details. In the output, I2O means "inside to outside", and O2I means "outside to inside".

```
#show l2nat config
L2NAT Configuration are:
================================
Status: enabled
Default Vlan: 0
The Number of L2nat Rules: 4
Dir      Inside                  Outside                 Vlan
O2I      172.16.1.56             192.168.150.56          0
I2O      172.16.1.36             192.168.150.36          0
I2O      172.16.1.255            192.168.150.255         0
I2O      172.16.1.1              192.168.150.1           0
```

- The following command displays the Layer 2 NAT rules.

```
#show l2nat rule
Dir      Inside                  Outside                 Vlan
O2I      172.16.1.56             192.168.150.56          0
I2O      172.16.1.36             192.168.150.36          0
I2O      172.16.1.255            192.168.150.255         0
I2O      172.16.1.1              192.168.150.1           0
```

- The following command displays Layer 2 NAT running entries.

```
#show l2nat entry
Direction           Original            Substitute             Age    Reversed
inside-to-outside   172.16.1.36@0       192.168.150. 36@0      -1     false
inside-to-outside   172.16.1.56@0       192.168.150. 56@0      -1     true
inside-to-outside   172.16.1.1@0        192.168.150. 1@0       -1     false
```

```
inside-to-outside    172.16.1.255@0       192.168.150. 255@0     -1     false
outside-to-inside    192.168.150.36@0     172.16.1.36@0          -1     true
outside-to-inside    192.168.150.56@0     172.16.1.56@0          -1     false
outside-to-inside    192.168.150.1@0      172.16.1.1@0           -1     true
outside-to-inside    192.168.150.255@0    172.16.1.255@0         -1     true
```

- The following command displays the WGB wired clients over the bridge.
  - Before Layer 2 NAT is enbled:

```
#show wgb bridge
    ***Client ip table entries***
                mac vap     port vlan_id          seen_ip  confirm_ago  fast_brg
B8:AE:ED:7E:46:EB   0   wired0       0      172.16.1.36     0.360000       true
24:16:1B:F8:05:0F   0 wbridge1       0         0.0.0.0  3420.560000       true
```

  - After Layer 2 NAT is enbled:

```
#show wgb bridge
    ***Client ip table entries***
                mac vap     port vlan_id          seen_ip  confirm_ago  fast_brg
B8:AE:ED:7E:46:EB   0   wired0       0   192.168.150.36     0.440000       true
24:16:1B:F8:05:0F   0 wbridge1       0         0.0.0.0  3502.220000       true
```

  If there are E2E traffic issues for wired client in NAT, restart the client register process by using the following command:

```
#clear wgb client single B8:AE:ED:7E:46:EB
```

- The following command displays the Layer 2 NAT packet translation statistics.

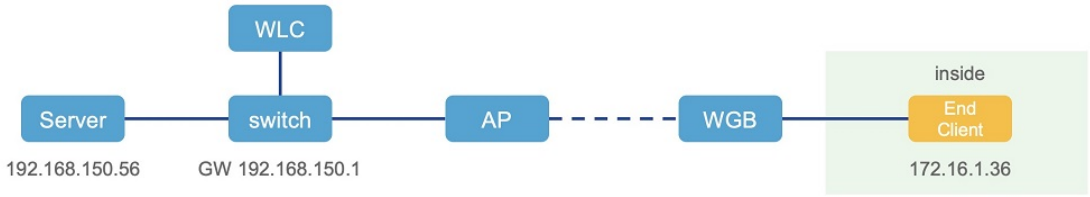
```
#show l2nat stats
Direction          Original              Substitute            ARP  IP   ICMP UDP  TCP
inside-to-outside  172.16.1.1@2660       192.168.150.1@2660    1    4    4    0    0
inside-to-outside  172.16.1.36@2660      192.168.150.36@2660   3    129  32   90   1
inside-to-outside  172.16.1.56@2660      192.168.150.56@2660   2    114  28   85   1
inside-to-outside  172.16.1.255@2660     192.168.150.255@2660  0    0    0    0    0
outside-to-inside  192.168.150.1@2660    172.16.1.1@2660       1    4    4    0    0
outside-to-inside  192.168.150.36@2660   172.16.1.36@2660      3    39   38   0    1
outside-to-inside  192.168.150.56@2660   172.16.1.56@2660      2    35   34   0    1
outside-to-inside  192.168.150.255@2660  172.16.1.255@2660     0    0    0    0    0
```

  To reset statistics number, use the following command:

```
#clear l2nat stats
```

Configuration Example of Network Address Translation

In this scenario, Layer 2 NAT is configured to translate the inside addresses from 172.16.1.0 255.255.255.0 subnet to addresses in the 192.168.150.0 255.255.255.0 subnet. Only the network prefix will be replaced during the translation. The host bits of the IP address remain the same.



The following command is configured for this scenario:

```
#configure l2nat add inside from network 172.16.1.0 to 192.168.150.0 255.255.255.0
```

Configuring Native VLAN on Ethernet Ports

A typical deployment of WGB is that a single wired client connects directly to the WGB Ethernet port. As a result, wired client traffic must be on the same VLAN as the WGB (or WLC/AP/WGB) management VLAN. If you need the wired client traffic to be on a different VLAN other than the WGB management VLAN, you should configure native VLAN on the Ethernet port.

Note Configuring native VLAN ID per Ethernet port is not supported. Both Ethernet ports share the same native VLAN configuration.

Note When WGB broadcast tagging is enabled and a single wired passive client connects directly to the WGB Ethernet port, it may hit the issue that infrastructure DS side client fails to ping this WGB behind the passive client. The workaround is to configure the following additional commands: **configure wgb ethport native-vlan enable** and **configure wgb ethport native-vlan id X**, where X is the same VLAN as the WGB (or WLC/AP/WGB) management VLAN.

The following table provides the commands to configure native VLAN:

Table 6: Native VLAN Configuration Commands

Command	Description
#**config wgb ethport native-vlan** {**enable**|**disable**} **Example:** `#config wgb ethport native-vlan enable`	Enables or disables native VLAN configuration.
#**config wgb ethport native-vlan id** <*vlan-id*> **Example:** `#config wgb ethport native-vlan id 2735`	Specifies native VLAN ID.

To verify your configuration, use the **show wgb ethport config** or **show running-config** command.

Low Latency Profile

IEEE 802.11 networks have a great role to play in supporting and deploying the Internet of Things (IoT) for the low latency and QoS requirement by applying the Enhanced Distributed Channel Access (EDCA), aggregated MAC protocol data unit (AMPDU), and aggregated or non-aggregated packet retry.

Enhanced Distributed Channel Access (EDCA) parameters are designed to provide preferential wireless channel access for voice, video, and other quality of service (QoS) traffic.

Configuring WGB optimized-video EDCA Profile

To configure optimized low latency profile for video use case, use the following command:

#**configure dot11Radio** <*radio_slot_id*> **profile optimized-video** {**enable** | **disable**}

Use the following command to verify the configuration:

```
WGB1#show controllers dot11Radio 1
EDCA profile: optimized-video
EDCA in use
=============
AC Type CwMin CwMax Aifs Txop ACM
AC_BE L 4 10 11 0 0
AC_BK L 6 10 11 0 0
AC_VI L 3 4 2 94 0
AC_VO L 2 3 1 47 0

Packet parameters in use
=============
wbridge1 A-MPDU Priority 0: Enabled
wbridge1 A-MPDU Priority 1: Enabled
wbridge1 A-MPDU Priority 2: Enabled
wbridge1 A-MPDU Priority 3: Enabled
wbridge1 A-MPDU Priority 4: Disabled
wbridge1 A-MPDU Priority 5: Disabled
wbridge1 A-MPDU Priority 6: Disabled
wbridge1 A-MPDU Priority 7: Disabled
wbridge1 A-MPDU subframe number: 3
wbridge1 Packet retries drop threshold: 16
```

Configuring WGB optimized-automation EDCA Profile

To configure optimized low latency profile for automation use case, use the following command:

#**configure dot11Radio** <*radio_slot_id*> **profile optimized-automation** {**enable** | **disable**}

Use the following command to verify the configuration:

```
WGB1#show controllers dot11Radio 1
EDCA profile: optimized-automation
EDCA in use
=============
AC Type CwMin CwMax Aifs Txop ACM
AC_BE L 7 10 12 0 0
AC_BK L 8 10 12 0 0
AC_VI L 7 7 3 0 0
AC_VO L 3 3 1 0 0

Packet parameters in use
=============
wbridge1 A-MPDU Priority 0: Enabled
wbridge1 A-MPDU Priority 1: Enabled
wbridge1 A-MPDU Priority 2: Enabled
wbridge1 A-MPDU Priority 3: Enabled
wbridge1 A-MPDU Priority 4: Disabled
wbridge1 A-MPDU Priority 5: Disabled
wbridge1 A-MPDU Priority 6: Disabled
wbridge1 A-MPDU Priority 7: Disabled
wbridge1 A-MPDU subframe number: 3
wbridge1 Packet retries drop threshold: 16
```

Configuring WGB customized-wmm EDCA profile

To configure customized Wi-Fi Multimedia (WMM) profile, use the following command:

#**configure dot11Radio** <*radio_slot_id*> **profile customized-wmm** {**enable** | **disable**}

To configure customized WMM profile parameters, use the following command:

#**configure dot11Radio** {**0**|**1**|**2**} **wmm** {**be** | **vi** | **vo** | **bk**} {**cwmin** <*cwmin_num*> | **cwmax** <*cwmax_num*> | **aifs** <*aifs_num*> | **txoplimit** <*txoplimit_num*>}

Parameter descriptions:

- be—best-effort traffic queue (CS0 and CS3)
- bk—background traffic queue (CS1 and CS2)
- vi—video traffic queue (CS4 and CS5)
- vo—voice traffic queue (CS6 and CS7)
- aifs—Arbitration Inter-Frame Spacing, <1-15> in units of slot time
- cwmin—Contention Window min, <0-15> 2^n-1, in units of slot time
- cwmax—Contention Window max, <0-15> 2^n-1, in units of slot time
- txoplimit—Transmission opportunity time, <0-255> integer number, in units of 32us

Configuring Low Latency Profile on WGB

Use the following command to configure low latency profile on WGB:

AP# **configure dot11Radio** <*radio_slot_id*> **profile low-latency** [**ampdu** <*length*>] [**sifs-burst** {**enable** | **disable**}] [**rts-cts** {**enable** | **disable**}] [**non-aggr** <*length*>] [**aggr** <*length*>]

Use the following command to display iot-low-latency profile EDCA detailed parameters:

```
#show controllers dot11Radio 1 | beg EDCA
EDCA config
L: Local C:Cell A:Adaptive EDCA params
  AC   Type  CwMin  CwMax Aifs Txop ACM
AC_BE     L      4      6   11    0   0
AC_BK     L      6     10   11    0   0
AC_VI     L      3      4    1    0   0
AC_VO     L      0      2    0    0   1
AC_BE     C      4     10   11    0   0
AC_BK     C      6     10   11    0   0
AC_VI     C      3      4    2   94   0
AC_VO     C      2      3    1   47   1
```

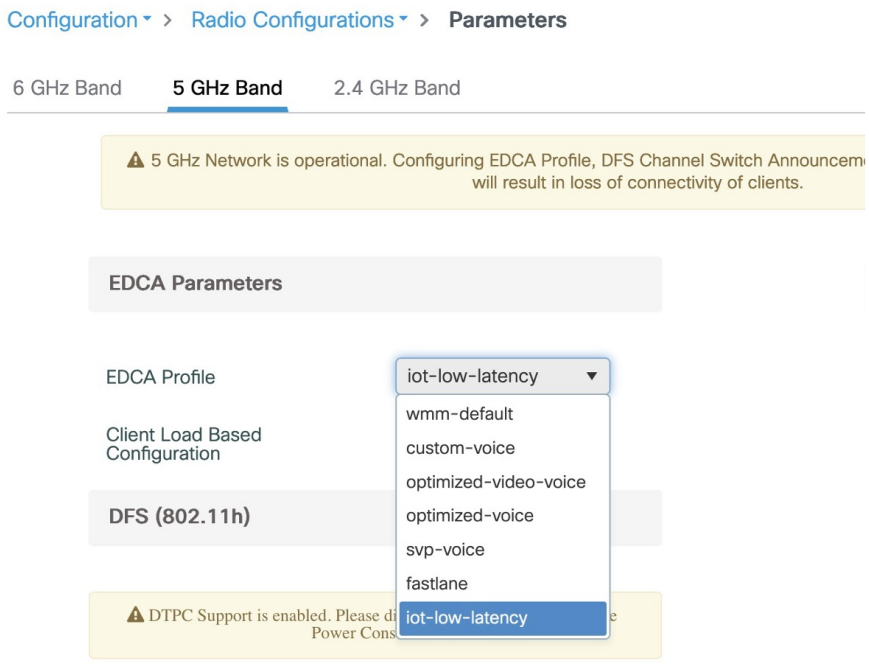
Configuring EDCA Parameters (Wireless Controller GUI)

Procedure

Step 1 Choose **Configuration > Radio Configurations > Parameters**. Using this page, you can configure global parameters for 6 GHz, 5 GHz, and 2.4 GHz radios.

Note
You cannot configure or modify parameters, if the radio network is enabled. Disable the network status on the **Configuration > Radio Configurations > Network** page before you proceed.

Step 2 In the **EDCA Parameters** section, choose an EDCA profile from the **EDCA Profile** drop-down list. Enhanced Distributed Channel Access (EDCA) parameters are designed to provide preferential wireless channel access for voice, video, and other quality-of-service (QoS) traffic.



Step 3 Click **Apply**.

Configuring EDCA Parameters (Wireless Controller CLI)

Procedure

Step 1 Enters global configuration mode.

configure terminal

Example:

```
Device# configure terminal
```

Step 2 Disables the radio network.

ap dot11 {**5ghz** | **24ghz** | **6ghz**} **shutdown**

Example:

```
Device(config)# ap dot11 5ghz shutdown
```

Step 3 Enables iot-low-latency EDCA profile for the 5 GHz, 2.4 GHz, or 6 GHz network.

ap dot11 {**5ghz** | **24ghz** | **6ghz**} **edca-parameters iot-low-latency**

Example:

```
Device(config)# ap dot11 5ghz edca-parameters iot-low-latency
```

Step 4 Enables the radio network.

no ap dot11 {**5ghz** | **24ghz** | **6ghz**} **shutdown**

Example:

```
Device(config)# no ap dot11 5ghz shutdown
```

Step 5 Returns to privileged EXEC mode.

end

Example:

```
Device(config)# end
```

Step 6 Displays the current configuration.

show ap dot11 {**5ghz** | **24ghz** | **6ghz**} **network**

Example:

```
Device(config)# show ap dot11 5ghz network
EDCA profile type check                  : iot-low-latency
```

Configuring A-MPDU

Aggregation is the process of grouping packet data frames together, rather than transmitting them separately. Two aggregation methods are available: Aggregated MAC Protocol Data Unit (A-MPDU) and Aggregated MAC Service Data Unit (A-MSDU).

The A-MPDU parameters define the size of an aggregated packet and define the proper spacing between aggregated packets so that the receive side WLAN station can decode the packet properly.

To configure profiled based A-MPDU under 2.4G, 5G and 6G radio, use the following commands:

WLC(config)# **ap dot11** {**5ghz** | **24ghz** | **6ghz**} **rf-profile** <*profile-name*>

WLC(config-rf-profile)# [**no**] **dot11n a-mpdu tx block-ack window-size** <*1-255*>

Global configuration is a special profile which can also be configured bu using the following command:

WLC(config)#[**no**] **ap dot11** {**5ghz** | **24ghz** | **6ghz**} **dot11n a-mpdu tx block-ack window-size** <*1-255*>

To bind different RF profiles with the radio RF tag, use the following command:

WLC(config)# **wireless tag rf** <*rf-tag-name*>

WLC (config-wireless-rf-tag)# **5ghz-rf-policy** <*rf-profile-name*>

Note RF profile level configured **a-mpdu tx block-ack window-size** value takes preference over globally configured value.

To display configured a-mpdu length value, use the following command:

show controllers dot11Radio <*radio_slot_id*>

```
AP# show controllers dot11Radio 1
Radio Aggregation Config:
=========================

TX A-MPDU Priority: 0x3f
TX A-MSDU Priority: 0x3f
TX A-MPDU Window:   0x7f
```

Configuring WGB/uWGB Radio Parameters

Configuring WGB Radio Antenna

Use the following command to configure WGB radio antenna gain. The default antenna gain is 4 dBi.

configure dot11 <**0|1|2**> **antenna gain** <*1-30*>

Use the following command to configure WGB radio antenna. Default is abcd-antenna.

configure dot11 <**0|1|2**> **antenna** <**a-antenna**|**ab-antenna**|**abcd-antenna**>

802.11ax 1600ns and 3200ns Guard Interval

802.11ax supports multiple Guard Interval (GI) value: 800ns, 1600ns, and 3200ns. By default, GI is set to 800ns. But you can set it to a different value.

Longer GI is commonly used in outdoor deployment.

```
#configure dot11radio <0|1|2> guard-interval
  1600  Configure 1600 ns guard interval (only in HE mode)
  3200  Configure 3200 ns guard interval (only in HE mode)
  800   Configure 800 ns guard interval
```

Customized Transmit Power

By default, the transmit power of the radio is set to AUTO(0) level.

To manually set the transmit power of the radio use the following command:

configure Dot11Radio <**0|1|2**> **txpower-level** <*0-8*>

Assign Country Code to WGB/uWGB With -ROW PID

On day 0, you should assign proper country code to the WGB/uWGB with -ROW reg domain. WGB will load corresponding power table after rebooting.

To assign country code, use the following command:

```
#configure countrycode
  Supported ROW country codes:
  GB VN

  WORD  Select one of above ROW country codes.
```

Note After the ROW country code is configured, if you want to change the configuration to another country, you need to perform a factory reset first, and then configure the new country code.

Indoor Deployment for -E Domain and United Kingdom

IW9167EH supports indoor deployment for -E domain and GB in -ROW domain .

For outdoor mode, the IW9167EH 5G radio supports channels 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140. When indoor deployment is enabled, 5G radio supports channels 36, 40, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140.

To configure indoor mode, use the **configure wireless indoor-deployment enable** command.

To disable indoor mode, use the **configure wireless indoor-deployment disable** command.

```
#configure wireless indoor-deployment
  disable  Disable indoor deployment
  enable   Enable indoor deployment
```

You can check the indoor or outdoor mode by using the **show controllers Dot11Radio [1|2]** command. In the command output, "-Ei" means the indoor mode is enabled, and "-E" means indoor mode is disabled, as shown in the following examples. The CLI output also shows the supported channels.

```
#show controllers Dot11Radio [1|2]
…
Radio Info Summary:
=======================
Radio: 5.0GHz
Carrier Set: (-Ei)  ( GB )
Base radio MAC: FC:58:9A:15:B7:C0
Supported Channels:
36 40 44 48 52 56 60 64 100 104 108 112 116 120 124 128 132 136 140

#show controllers Dot11Radio [1|2]
…
Radio Info Summary:
=======================
Radio: 5.0GHz
Carrier Set: (-E)  ( GB )
Base radio MAC: FC:58:9A:15:B7:C0
Supported Channels:
100 104 108 112 116 120 124 128 132 136 140
```

Configuring WGB Roaming Parameters

Use the following command to configure the threshold duration and signal strength to trigger reconnecting. Default value is: period 20s and threshold -70db.

```
# configure wgb mobile period <time> <rssi-threshold>
```

Use the following command to configure beacon miss count to trigger reconnecting. Default value is 10.

```
# config wgb beacon miss-count <count>
```

Use the following command to configure max packet retry to trigger reconnecting. Default value is 64.

```
# configure wgb packet retries <retry-count>
```

Use the following command to configure the static roaming channel:

```
# configure wgb mobile station interface dot11Radio <slot_id> scan <channel_id> add
```

Use the following command to delete the mobile channel:

```
# configure wgb mobile station interface dot11Radio <slot_id> scan <channel_id> delete
```

Use the following command to scan all channels:

```
# configure wgb mobile station interface Dot11Radio 1 scan all
```

Importing and Exporting WGB Configuration

You can upload the working configuration of an existing WGB to a server, and then download it to the new deployed WGBs.

To upload the configuration to a server, use the following command:

```
#copy configuration upload <sftp:|tftp://> ip-address [directory] [file-name]
```

To download a sample configuration to all WGBs in the deployment, use the following command:

```
#copy configuration download <sftp:|tftp://> ip-address [directory] [file-name]
```

The access point will reboot after the **copy configuration download** command is executed. The imported configuration will take effect after the rebooting.

Verifying the Configuration of WGB and uWGB

Use the **show run** command to check whether the AP is in WGB mode or uWGB mode.

- WGB:

```
#show run
AP Name              : APFC58.9A15.C808
AP Mode              : WorkGroupBridge
CDP State            : Enabled
Watchdog monitoring  : Enabled
SSH State            : Disabled
AP Username          : admin
Session Timeout      : 300


Radio and WLAN-Profile mapping:-
```

```
====================================
Radio ID    Radio Mode    SSID-Profile                    SSID
          Authentication
-------------------------------------------------------------------------------
--------------------------
1           WGB           myssid                          demo
          OPEN


Radio configurations:-
==============================
Radio Id             : NA
   Admin state       : NA
   Mode              : NA
Radio Id             : 1
   Admin state       : DISABLED
   Mode              : WGB
   Dot11 type        : 11ax
Radio Id             : NA
   Admin state       : NA
   Mode              : NA
```

- uWGB:

```
#show run
AP Name              : APFC58.9A15.C808
AP Mode              : WorkGroupBridge
CDP State            : Enabled
Watchdog monitoring  : Enabled
SSH State            : Disabled
AP Username          : admin
Session Timeout      : 300


Radio and WLAN-Profile mapping:-
====================================
Radio ID    Radio Mode    SSID-Profile                    SSID
          Authentication
-------------------------------------------------------------------------------
--------------------------
1           UWGB          myssid                          demo
          OPEN


Radio configurations:-
==============================
Radio Id             : NA
   Admin state       : NA
   Mode              : NA
Radio Id             : 1
   Admin state       : DISABLED
   Mode              : UWGB
   Uclient mac       : 0009.0001.0001
   Current state     : WGB
   UClient timeout   : 0 Sec
   Dot11 type        : 11ax
Radio Id             : NA
   Admin state       : NA
   Mode              : NA
```

Use the **show wgb dot11 associations** command to verify the configuration of WGB and uWGB.

- WGB:

```
#show wgb dot11 associations
Uplink Radio ID : 1
Uplink Radio MAC : 00:99:9A:15:B4:91
SSID Name : roam-m44-open
Parent AP Name : APFC58.9A15.C964
Parent AP MAC : 00:99:9A:15:DE:4C
Uplink State : CONNECTED
Auth Type : OPEN
Dot11 type : 11ax
Channel : 100
Bandwidth : 20 MHz
Current Datarate (Tx/Rx) : 86/86 Mbps
Max Datarate : 143 Mbps
RSSI : 53
IP : 192.168.1.101/24
Default Gateway : 192.168.1.1
IPV6 : ::/128
Assoc timeout : 100 Msec
Auth timeout : 100 Msec
Dhcp timeout : 60 Sec
```

- uWGB:

```
#show wgb dot11 associations
Uplink Radio ID : 1
Uplink Radio MAC : 00:09:00:01:00:01
SSID Name : roam-m44-open
Parent AP MAC : FC:58:9A:15:DE:4C
Uplink State : CONNECTED
Auth Type : OPEN
Uclient mac : 00:09:00:01:00:01
Current state : UWGB
Uclient timeout : 60 Sec
Dot11 type : 11ax
Channel : 36
Bandwidth : 20 MHz
Current Datarate (Tx/Rx) : 77/0 Mbps
Max Datarate : 143 Mbps
RSSI : 60
IP : 0.0.0.0
IPV6 : ::/128
Assoc timeout : 100 Msec
Auth timeout : 100 Msec
Dhcp timeout : 60 Sec
```

Configuring and Validating SNMP With WGB

Simple Network Management Protocol (SNMP) is an application-layer protocol that provides a message format for communication between SNMP managers and agents. SNMP provides a standardized framework and a common language that is used for monitoring and managing devices in a network.

WGBs provide network administrators with an SNMP interface, allowing them to poll various states and counters. This enables administrators to easily monitor the health of their WGBs in the field.

By default, SNMP is disabled.

The SNMP framework has the following components, which are as follows.

- **SNMP Manager :** The Simple Network Management Protocol (SNMP) manager is a system that controls and monitors the activities of network hosts using SNMP. The most common managing system is a

network management system (NMS). The term NMS can be applied either to a dedicated device used for network management or to the applications used on such a device.

- **SNMP Agent:** The Simple Network Management Protocol (SNMP) agent is the software component within a managed device that maintains the data for the device and reports this data, as needed, to managing systems.
- **SNMP MIB:** An SNMP agent contains MIB variables, whose values the SNMP manager can request or change through Get or Set operations. A manager can get a value from an agent or store a value in that agent. The agent gathers data from the SNMP MIB, the repository for information about device parameters and network data. The agent can also respond to manager requests to get or set data.

The following illustration shows the SNMP process. SNMP agent receives a request from SNMP client, and it passes the request to the subagent. The subagent then returns a response to the SNMP agent and the agent creates an SNMP response packet and sends the response to the remote network management station that initiated the request.

Figure 4: SNMP Process

SNMP Versions

Cisco IOS software supports the following versions of SNMP:

- SNMPv2c—The community-string-based administrative framework for SNMPv2. SNMPv2c is an update of the protocol operations and data types of SNMPv2p (SNMPv2 classic), and uses the community-based security model of SNMPv1.
- SNMPv3—Version 3 of SNMP. SNMPv3 uses the following security features to provide secure access to devices:
  - Message integrity—Ensuring that a packet has not been tampered with in transit.
  - Authentication—Determining that the message is from a valid source.
  - Encryption—Scrambling the contents of a packet to prevent it from being learned by an unauthorized source.

Supported SNMP MIB File

The Management Information Base (MIB) is a database of the objects that can be managed on a device. The managed objects, or variables, can be set or read to provide information on the network devices and interfaces and are organized hierarchically. The MIB consists of collections of managed objects identified by object identifiers. MIBs are accessed using a network management protocol such as SNMP.

The MIB module provides network management information on IEEE 802.11 wireless device association management and data packet forwarding configuration and statistics.

An Object Identifier (OID) uniquely identifies a MIB object on a managed network device. The OID identifies the MIB object's location in the MIB hierarchy, and provides a means of accessing the MIB object in a network of managed devices

Given below is a list of objects that are supported by the SNMP Management and Information Base (MIB): CISCO-DOT11-ASSOCIATION-MIB.

Table 7: Supported OIDs

OID Object Name	OID	OID Type	OID Description
cDot11ParentAddress	1.3.6.1.4.1.9.9.273.1.1.1	String	Provides the MAC address of the parent access point.
cDot11ActiveWirelessClients	1.3.6.1.4.1.9.9.273.1.1.2.1.1	Gauge	The device on this interface is currently associating with the number of wireless clients.
cDot11ActiveBridges	1.3.6.1.4.1.9.9.273.1.1.2.1.2	Gauge	The device on this interface is currently associating with the number of bridges.
cDot11ActiveRepeaters	1.3.6.1.4.1.9.9.273.1.1.2.1.3	Gauge	The device on the interface is currently associating with the number of repeaters.
cDot11AssStatsAssociated	1.3.6.1.4.1.9.9.273.1.1.3.1.1	Counter	When device restarts, the object counts the number of stations associated with the device on the interface.
cDot11AssStatsAuthenticated	1.3.6.1.4.1.9.9.273.1.1.3.1.2	Counter	When the device restarted, it currently counts the number of stations authenticated with the device on the interface.
cDot11AssStatsRoamedIn	1.3.6.1.4.1.9.9.273.1.1.3.1.3	Counter	When the device restarted, the object counts the number of stations roamed from another device to the device on the interface.

OID Object Name	OID	OID Type	OID Description
cDot11AssStatsRoamedAway	1.3.6.1.4.1.9.9.273.1.1.3.1.4	Counter	This object counts the number of stations roamed away from the device on the interface since device re-started.
cDot11AssStatsDeauthenticated	1.3.6.1.4.1.9.9.273.1.1.3.1.5	Counter	This object counts the number of stations deauthenticated with this device on the interface since device re-started
cDot11AssStatsDisassociated	1.3.6.1.4.1.9.9.273.1.1.3.1.6	Counter	This object counts the number of stations disassociated with this device on the interface since device re-started
cd11IfCipherMicFailClientAddress	1.3.6.1.4.1.9.9.273.1.1.4.1.1	String	This is MAC address of the client attached to the radio interface that caused the most recent MIC failure
cd11IfCipherTkipLocalMicFailures	1.3.6.1.4.1.9.9.273.1.1.4.1.2	Counter	When the device restarted, the object counts the number of MIC failures encountered on the radio interface.
cd11IfCipherTkipRemotMicFailures	1.3.6.1.4.1.9.9.273.1.1.4.1.3	Counter	When the device restarted, the object counts the number of MIC failures reported by clients on the radio interface.

OID Object Name	OID	OID Type	OID Description
cd11IfCipherTkipCounterMeasInvok	1.3.6.1.4.1.9.9.273.1.1.4.1.4	Counter	When the device restarted, the object counts the number of TKIP Counter Measures invoked on the interface.
cd11IfCipherCcmpReplaysDiscarded	1.3.6.1.4.1.9.9.273.1.1.4.1.5	Counter	When the device restarted, the object counts the number of received unicast fragments discarded by replay mechanism on the interface.
cd11IfCipherTkipReplaysDetected	1.3.6.1.4.1.9.9.273.1.1.4.1.6		When the device restarted, the object counts the number of TKIP replay errors detected on this interface.
cDot11ClientRoleClassType	1.3.6.1.4.1.9.9.273.1.2.1.1.3	Counter	The role classification of the client
cDot11ClientDevType	1.3.6.1.4.1.9.9.273.1.2.1.1.4	EnumVal	The device type of the client.
cDot11ClientRadioType	1.3.6.1.4.1.9.9.273.1.2.1.1.5	EnumVal	The radio classification of the client.
cDot11ClientWepEnabled	1.3.6.1.4.1.9.9.273.1.2.1.1.6	EnumVal	Whether WEP key mechanism is used for transmitting frames of data for the client
cDot11ClientWepKeyMixEnabled	1.3.6.1.4.1.9.9.273.1.2.1.1.7	EnumVal	Whether this client is using WEP key mixing
cDot11ClientMicEnabled	1.3.6.1.4.1.9.9.273.1.2.1.1.8	EnumVal	Whether the MIC is enabled for the client
cDot11ClientPowerSaveMode	1.3.6.1.4.1.9.9.273.1.2.1.1.9	EnumVal	The power management mode of the client.

OID Object Name	OID	OID Type	OID Description
cDot11ClientAid	1.3.6.1.4.1.9.9.273.1.2.1.1.10	Gauge	This is the association identification number of clients or multicast addresses associating with the device.
cDot11ClientDataRateSet	1.3.6.1.4.1.9.9.273.1.2.1.1.11	String	Is a set of data rates at which this client can transmit and receive data
cDot11ClientSoftwareVersion	1.3.6.1.4.1.9.9.273.1.2.1.1.12	String	Cisco IOS software version
cDot11ClientName	1.3.6.1.4.1.9.9.273.1.2.1.1.13	String	Cisco IOS device hostname
cDot11ClientAssociationState	1.3.6.1.4.1.9.9.273.1.2.1.1.14	EnumVal	The object indicates the state of the authentication and association process
cDot11ClientVlanId	1.3.6.1.4.1.9.9.273.1.2.1.1.17	Gauge	The VLAN which the wireless client is assigned to when it is successfully associated to the wireless station.
cDot11ClientSubIfIndex	1.3.6.1.4.1.9.9.273.1.2.1.1.18	Integer	This is the ifIndex of the sub-interface which this wireless client is assigned to when it is successfully associated to the wireless station.
cDot11ClientAuthenAlgorithm	1.3.6.1.4.1.9.9.273.1.2.1.1.19	EnumVal	The IEEE 802.1x authentication methods performed between the wireless station and this client during association

OID Object Name	OID	OID Type	OID Description
cDot11ClientDot1xAuthenAlgorithm	1.3.6.1.4.1.9.9.273.1.2.1.1.21	Octet String	The IEEE 802.1x authentication methods performed between the wireless client and the authentication server.
cDot11ClientUpTime	1.3.6.1.4.1.9.9.273.1.3.1.1.2	Gauge	The time in seconds that this client has been associated with this device
cDot11ClientSignalStrength	1.3.6.1.4.1.9.9.273.1.3.1.1.3	Integer	The device-dependent measure the signal strength of the most recently received packet from the client.
cDot11ClientSigQuality	1.3.6.1.4.1.9.9.273.1.3.1.1.4	Gauge	The device-dependent measure the signal quality of the most recently received packet from the client.
cDot11ClientPacketsReceived	1.3.6.1.4.1.9.9.273.1.3.1.1.6	Counter	The number of packets received from this client.
cDot11ClientBytesReceived	1.3.6.1.4.1.9.9.273.1.3.1.1.7	Counter	The number of bytes received from the client.
cDot11ClientPacketsSent	1.3.6.1.4.1.9.9.273.1.3.1.1.8	Counter	The number of packets sent to the client.
cDot11ClientBytesSent	1.3.6.1.4.1.9.9.273.1.3.1.1.9	Counter	The number of bytes sent to the client.
cDot11ClientMsduRetries	1.3.6.1.4.1.9.9.273.1.3.1.1.11	Counter	The counter increases when it successfully transmits an MSDU after one or more retransmissions.

OID Object Name	OID	OID Type	OID Description
cDot11ClientMsduFails	1.3.6.1.4.1.9.9.273.1.3.1.1.12	Counter	The counter increments when the client fails to transmit an MSDU successfully because the number of transmit attempts exceeds a certain limit.

Configuring SNMP from the WGB CLI

The following CLI commands are used for SNMP configuration.

Note

- SNMP CLI logic modified for SNMP configuration, all parameters of SNMP are required to be configured before enable SNMP feature by CLI: configure snmp enabled.
- All the related configurations of SNMP will be removed automatically when disable SNMP feature.

Procedure

Step 1 Enter the **SNMP v2c community ID** number (SNMP v2c only).

Device#**configure snmp v2c community-id** <**length 1-64**>

Step 2 Specify the **SNMP protocol version**.

Device#**configure snmp version** {**v2c** | **v3**}

Step 3 Specify the **SNMP v3 authentication** protocol (SNMP v3 only).

Device#**configure snmp auth-method** <**md5** | **sha**>

Step 4 Enter the **SNMP v3 username** (SNMP v3 only).

Device#**configure snmp v3 username** <**length 32**>

Step 5 Enter the **SNMP v3 user password** (SNMP v3 only).

Device#**configure snmp v3 password** <**length 8-64**>

Step 6 Specify the **SNMP v3 encryption protocol** (SNMP v3 only).

Device#**configure snmp encryption** {**des** | **aes** | **none**}

Note
Possible encryption values are des or aes. Alternatively, enter none if a v3 encryption protocol is not needed.

Step 7 Enter the **SNMP v3 encryption passphrase** (SNMP v3 only).

Device#**configure snmp secret** <**length 8-64**>

Step 8 **Enable SNMP** functionality in WGB.

Device#**configure snmp enabled**

To configure SNMP **v2c**, repeat Step 1 through Step 2 and Step 8.

To configure SNMP **v3**, repeat Step 2 through Step 8.

Step 9 **Disable SNMP configuration**.

Device#**configure snmp disabled**

When SNMP is disabled, all related configuration is removed.

Example

Example of SNMP configuration.

- **CLI for configuring SNMP v2c:**

```
Device#configure snmp v2 community-id <length 1-64>
Device#configure snmp version v2c
Device#configure snmp enabled
```

- **CLI for configuring SNMP v3 (security level AuthPriv):**

```
Device#configure snmp auth-method <md5|sha>
Device#configure snmp v3 username <length 32>
Device#configure snmp v3 password <length 8-64>
Device#configure snmp secret <length 8-64>
Device#configure snmp encryption <aes|des>
Device#configure snmp version v3
Device#configure snmp enabled
```

- **CLI for configuring SNMP v3 (security level AuthNoPriv):**

```
Device#configure snmp auth-method <md5|sha>
Device#configure snmp v3 username <length 32>
Device#configure snmp v3 password <length 8-64>
Device#configure snmp encryption none
Device#configure snmp version v3
Device#configure snmp enabled
```

Verifying SNMP from WGB CLI

Use the following show command to verify the SNMP configuration.

- **Show output of SNMP version v3:**

```
Device# show snmp
SNMP: enabled
Version: v3
Community ID: test
Username: username
Password: password
```

```
Authentication method: SHA
Encryption: AES
Encryption Passphrase: passphrase
Engine ID: 0x8000000903c0f87fe5f314
```

- **Show output of SNMP version v2c:**

```
Device# show snmp
SNMP: enabled
Version: v2c
Community ID: test
Username: username
Password: password
Authentication method: SHA
Encryption: AES
Encryption Passphrase: passphrase
Engine ID: 0x8000000903c0f87fe5f314
```

Support for QoS ACL Classification and Marking

Starting from Cisco Unified Industrial Wireless Software Release 17.14.1, WGB allows you to classify different packets from two wired ports and mark them to the different access control driver queues according to the user configuration.

In addition to TCP or UDP, WGB also supports ethertype-based and DSCP-based classification. To meet the jitter and latency requirement, the WGB must classify packets and assign them to different access control queues based on the field environment.

Overview

WGB allows you to create custom rules to map incoming packets from an Ethernet port to specific priority queues on the wireless side. WGB offers the functionality to map upstream data traffic based on either IEEE 802.1p (dot1p) or Differentiated Services Code Point (DSCP).

You can configure the rules based on Ethernet type (for example, Profinet), transport layer port numbers or port range, and DSCP. It ensures forwarding packets to the different access control queues on the wireless network, facilitating efficient QoS enforcement.

As incoming packets arrive at the Ethernet port, it directs them to a specific access control queue on the wireless side using a customized rule-based mapping.

The customized rule dictates the classification and assignment of packets to different access control queues based on predetermined criteria such as source/destination IP addresses, port numbers, or protocol types. Once defined, the rules identify critical services or traffic within the incoming packets. Matching these critical services using the defined rules enables mapping them to higher priority queues within the network infrastructure.

Using rule-based traffic classification and mapping on the WGB, you can effectively manage and prioritize network traffic to meet the specific demands of critical applications and services. This approach enables you to enforce QoS policies effectively within your network to maintain optimal network performance, minimizes latency for critical services, and enhances overall user experience.

Traffic Classification Based on QoS and ACL

Classification is the process of distinguishing one traffic from another by examining the fields in the packet. The device enables classification only when QoS is enabled.

During classification, the device performs a lookup and assigns a QoS label to the packet. The QoS label indicates all QoS actions to perform on the packet and identifies the queue from which the packet is sent.

Layer 2 ethernet frames use the Ethertype field to carry classification information. The ethertype field, typically 2 bytes in size, normally indicates the type of data encapsulated in the frames

Layer 3 IP packets carry the classification information in the type of service (ToS) field that has 8 bits. The ToS field carries either an IP precedence value or a Differentiated Services Code Point (DSCP) value. IP precedence values range 0–7. DSCP values range 0–63.

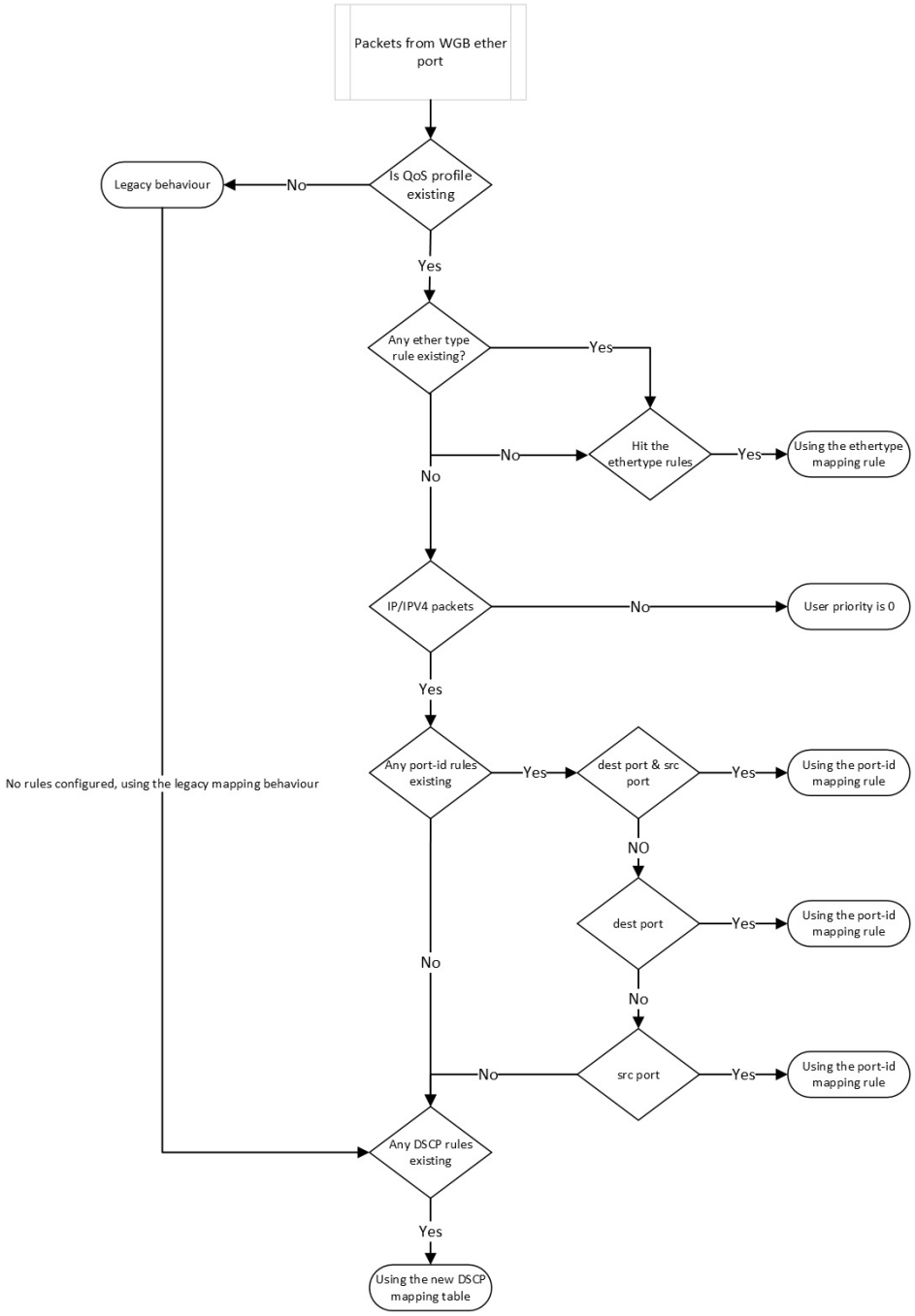
Layer 4 TCP segments or UDP datagrams carry the classification information in the source or destination port field. These port fields specify the port numbers associated with the sender and receiver of the data, enabling networking devices to classify traffic based on predetermined criteria.

The system assigns traffic to a specific service class based on ether type, DSCP, or UDP/TCP port (or port range), treating packets within the service class consistently. The WGB help to classify different packets from the two wired ports and map them to the different driver queues according to the user config.

The data plane statistics provide counts of how many times each rule hit by network traffic. These counters are essential for network administrators to analyse the effectiveness of their rules and policies, and optimize network performance.

The control plane is a part of a network architecture responsible for managing and configuring how data is forwarded though the network.

Figure 5: Flowchart of traffic flows from WGB ethernet port



When QoS is disabled, access points follows the legacy mapping behavior and perform the following:

1. Retrieve the Tag Control Information (TCI) priority from the VLAN element for the specified ethertype 0x8100.
2. For ethertype 0x8892 (profinet) QoS mapping, assigns the TCI priority as 6.

3. For ethertype 0x0800 (IP) and 0x86DD (IPv6), the DSCP priority is set according to the default dscp2dot1p mapping table.

```
======= dscp mapping =======
Default dscp2dot1p Table Value:
[0]->0 [1]->0 [2]->0 [3]->0 [4]->0 [5]->0 [6]->0 [7]->0
[8]->1 [9]->1 [10]->1 [11]->1 [12]->1 [13]->1 [14]->1 [15]->1
[16]->2 [17]->2 [18]->2 [19]->2 [20]->2 [21]->2 [22]->2 [23]->2
[24]->3 [25]->3 [26]->3 [27]->3 [28]->3 [29]->3 [30]->3 [31]->3
[32]->4 [33]->4 [34]->4 [35]->4 [36]->4 [37]->4 [38]->4 [39]->4
[40]->5 [41]->5 [42]->5 [43]->5 [44]->5 [45]->5 [46]->5 [47]->5
[48]->6 [49]->6 [50]->6 [51]->6 [52]->6 [53]->6 [54]->6 [55]->6
[56]->7 [57]->7 [58]->7 [59]->7 [60]->7 [61]->7 [62]->7 [63]->7
```

When QoS is enabled, access points perform the following:

1. The priority for an ethertype QoS mapping 0x8892 (profinet) is based on the configuration setting.
2. For ethertype 0x0800 (IP) and 0x86DD (IPv6), the priority is based on mapping rules that consider port or DSCP.
   - Check the UDP/TCP port (or port range) rule.
   - Check the DSCP rule.
3. Assigns the user priority value 0 to non-IPv4/IPv6 packets.
4. If there is no rule configuration, the QoS profile follows the legacy mapping behavior.

Note if 802.1p priority exists, it overrides any customised rule.

Configuring Quality of Service Mapping Profile

The following commands allow users to define the different classification rules for configuring WGB QoS mapping.

Procedure

Step 1 Enable the QoS mapping profile.

Device#**config wgb qos-mapping** <**profile-name**> **enable**

Example:

```
Device#configure wgb qos-mapping demo-profile enable
```

Step 2 WGB QoS mapping profile rules based on **ethernet type**.

The below command is used to set the rules based on ethernet frame type.

- Add rules based on ethernet type.

  Device#**config wgb qos-mapping** <**profile-name**> **add ethtype hex** <**number**> **priority** <**0-7**>

Example:

```
Device#configure wgb qos-mapping demo-profile add ethtype hex 8892 priority 5
```

If the command specify a profile that does not exist, the command will create a new empty profile and then add mapping rule to it.

- Delete rules based on ethernet type

  Device#**config wgb qos-mapping** <**profile-name**> **delete ethtype hex** <**number**>

Example:

```
Device#configure wgb qos-mapping demo-profile delete ethtype hex 8892
```

The command will issue a warning message if it specifies a profile that does not exist. Furthermore, if deleting the specified mapping rule leaves the profile empty, it will be automatically removed.

Step 3 Rules based on **port-id/range**.

The below command is used to set the rules based on L4 port id/range.

- Add rules based on port-id/range.

  Device#**config wgb qos-mapping** <**profile-name**> add **srcport** <**number**> | <**range** <**start-number**> <**end-number**>> [**dstport** <**number**> | <**range** <**start-number**> <**end-number**>>] **priority** <**0-7**>

Example:

```
Device#configure wgb qos-mapping demo-profile add srcport range 5050 5070 dstport 8000 priority 3
```

If the command specify a profile that does not exist, the command will create a new empty profile and then add mapping rule to it.

- Delete rules based on port-id/range.

  Device#**config wgb qos-mapping** <**profile-name**> delete [**srcport** <**number**> | <**range** <**start-number**> <**end-number**>> [**dstport** <**number**> | <**range** <**start-number**> <**end-number**>>]]

Example:

```
Device#configure wgb qos-mapping demo-profile delete srcport range 5050 5070 dstport 8000
```

The command will issue a warning message if it specifies a profile that does not exist. Furthermore, if deleting the specified mapping rule leaves the profile empty, it will be automatically removed.

Step 4 Rules based on **DSCP**.

The below command is used to set the rules based on IPv4/IPv6 packet DSCP value.

- Add

  Device#**config wgb qos-mapping** <**profile-name**> add dscp <**number**> priority < **0-7**>

Example:

```
Device#configure wgb qos-mapping demo-profile add dscp 63 priority 4
```

If the command specify a profile that does not exist, the command will create a new empty profile and then add mapping rule to it.

- Delete

  Device#**config wgb qos-mapping** <**profile-name**> delete dscp <**number**> priority < **0-7**>

Example:

```
Device#configure wgb qos-mapping demo-profile delete dscp 63
```

The command will issue a warning message if it specifies a profile that does not exist. Furthermore, if deleting the specified mapping rule leaves the profile empty, it will be automatically removed.

Note
After deleting the DSCP mapping rule, the rules are reset to the default values of the DSCP mapping.

Step 5 Disable the QoS mapping profile.

Device#**config wgb qos-mapping** <**profile-name**> disable

Example:

```
Device#configure wgb qos-mapping demo-profile disable
```

When disabled, the command clear the profile from the datapath and retain it in the WGB configuration file. If the specified profile does not exist, the command issue a warning message and will not create a new empty profile.

Step 6 Delete the QoS mapping profile.

Device#**config wgb qos-mapping** <**profile-name**> delete

Example:

```
Device#configureure wgb qos-mapping demo-profile delete
```

When deleted, the profile is removed from data path and WGB configuration.

Verifying WGB Quality of Service Mapping

To verify the WGB QoS mapping configuration on the Control Plane, run the **show wgb qos-mapping**.

```
Device# show wgb qos-mapping

Number of QoS Mapping Profiles: 2
====================================
Profile name : qos1
Profile status : active
Number of Rules: 8
Rules:
L4 srcport : 31000-31100, dstport : 6666-7777, priority : 7
L4 srcport : 23000, dstport : N/A, priority : 3
L4 srcport : N/A, dstport : 20000-20100, priority : 5
L4 srcport : N/A, dstport : 2222, priority : 2
L4 srcport : 12300-12500, dstport : N/A, priority : 6
IPv4/IPv6 dscp: 43, priority : 1
Ethernet type : 0x8892, priority : 0
L4 srcport : 8888, dstport : 9999, priority : 4

Profile name : qos2
Profile status : inactive
Number of Rules: 8
Rules:
L4 srcport : 31000-31100, dstport : 6666-7777, priority : 2
L4 srcport : 23000, dstport : N/A, priority : 6
L4 srcport : N/A, dstport : 20000-20100, priority : 4
L4 srcport : N/A, dstport : 2222, priority : 7
L4 srcport : 12300-12500, dstport : N/A, priority : 3
```

```
IPv4/IPv6 dscp: 43, priority : 0
Ethernet type : 0x8892, priority : 1
L4 srcport : 8888, dstport : 9999, priority : 5
```

To verify the WGB QoS mapping configuration on the Data Plane, run the **show datapath qos-mapping rule**.

```
Device# show datapath qos-mapping rule

Status: active
QoS Mapping entries
======= dscp mapping =======
Default dscp2dot1p Table Value:
[0]->0 [1]->0 [2]->0 [3]->0 [4]->0 [5]->0 [6]->0 [7]->0
[8]->1 [9]->1 [10]->1 [11]->1 [12]->1 [13]->1 [14]->1 [15]->1
[16]->2 [17]->2 [18]->2 [19]->2 [20]->2 [21]->2 [22]->2 [23]->2
[24]->3 [25]->3 [26]->3 [27]->3 [28]->3 [29]->3 [30]->3 [31]->3
[32]->4 [33]->4 [34]->4 [35]->4 [36]->4 [37]->4 [38]->4 [39]->4
[40]->5 [41]->5 [42]->5 [43]->5 [44]->5 [45]->5 [46]->5 [47]->5
[48]->6 [49]->6 [50]->6 [51]->6 [52]->6 [53]->6 [54]->6 [55]->6
[56]->7 [57]->7 [58]->7 [59]->7 [60]->7 [61]->7 [62]->7 [63]->7

active dscp2dot1p Table Value:
[0]->0 [1]->0 [2]->0 [3]->0 [4]->0 [5]->0 [6]->0 [7]->0
[8]->1 [9]->1 [10]->1 [11]->1 [12]->1 [13]->1 [14]->1 [15]->1
[16]->7 [17]->2 [18]->2 [19]->2 [20]->2 [21]->2 [22]->2 [23]->2
[24]->3 [25]->3 [26]->3 [27]->3 [28]->3 [29]->3 [30]->3 [31]->3
[32]->4 [33]->4 [34]->4 [35]->4 [36]->4 [37]->4 [38]->4 [39]->4
[40]->5 [41]->5 [42]->5 [43]->5 [44]->5 [45]->5 [46]->5 [47]->5
[48]->6 [49]->6 [50]->6 [51]->6 [52]->6 [53]->6 [54]->6 [55]->6
[56]->7 [57]->7 [58]->7 [59]->7 [60]->7 [61]->7 [62]->7 [63]->7
```

To verify the WGB QoS mapping statistics on Data Plane, run the **show datapath qos-mapping statistics** command.

```
Device# show datapath qos-mapping statistics

======= pkt stats per dscp-mapping rule =======
dscp up pkt_cnt
16 7 0
```

To clear the WGB QoS mapping statistics on Data Plane, run the **clear datapath qos-mapping statistics** command.

Note The command clears packet count statistics per rule on data-plane.

Packet Capture: TCP Dump on WGB

TCP Dump on WGB

The TCP dump utility is a network packet analyzer commonly used for network monitoring and data acquisition. When applied to a WGB, the TCP dump can capture, display, and save the packets transmitted over the wired interfaces of the WGB.

TCP Dump on WGB chapter provides information on how to enable TCP dump through the WGB wired interface on the Catalyst IW9167EH .

Purpose of TCP Dump Utility

TCP dump on a WGB monitors and troubleshoots network communications, ensuring the WGB relays frames correctly between the wired clients and the wireless networks.

Functions of TCP Dump Utility

- display captured packets in real time on the WGB terminal, and
- capture packets to storage.

Note The TCP dump utility does not support the simultaneous capture of packets to storage and printing them on the WGB terminal.

Packet Capture Modes

- Default: Displays captured packets with header in the real time on the WGB terminal
- Verbose: Parses and prints real-time packets on the WGB terminal, displaying the headers and prints the data of each packet, including its link-level header, in hexadecimal format.

Note Reformat the verbose output for text2pcap compatibility.

In default or verbose mode, the WGB terminal can print a maximum of 1000 packet entries.

- Capture: Captures packets to a file storage instead of printing them in real time. Use the **show pcap** command to view the captured internal wired packets.

Note Every round of Packet Capture (PCAP) clears the existing PCAP file.

Before any new PCAP session, transfer the current PCAP file to an external server to prevent it from being overwritten.

PCAP stops automatically when the PCAP file reaches a size of 100 MB.

Protocol Packet Capture Capabilities on WGB

You can capture packets from an AP either using a default or custom filter through the WGB wired port and then upload them to an external server.

The default filter captures three main protocol packets such as IP, TCP, or UDP.

A custom filter captures specific packets that are relevant for troubleshooting specific issues or monitoring certain types of network activity.

You can use different protocol filters to capture packets for debugging. For instance, include the given protocols in your filter expression:

- Transmission Control Protocol
- Internet Control Message Protocol (ICMP) and ICMPv6
- Profinet with IP proto 0x8892
- Address Resolution Protocol (ARP)
- Internet Group Management Protocol (IGMP)
- User Datagram Protocol
- Dynamic Host Configuration Protocol (DHCP) with port 67 or port 68 and DHCPv6 with port 546 or port 547
- Common Industrial Protocol (CIP) with TCP port 44818
- Domain Name System (DNS) with port 53
- Simple Network Management Protocol with port 161 or port 162.

Note The protocols listed represent only a portion of the PCAP capabilities.

Filter expressions for packet captures

The filter expression for a PCAP comprises at least one primitive. Primitives usually consist of qualifiers followed by an identifier. The identifier can be a name or a number.

There are three kinds of qualifiers.

- Type: Specifies the type of the identifier. The type can be a port, a host, a network, or a range of ports.

  For example: **port** 20

- Dir: Specifies that the capture is for only packets with a given transfer direction.

  For example: **src x.x.x.x and port** ftp-data or **dst x.x.x.x and port** ftp

- Proto: Limits the capture to a specific protocol.

  For example: **tcp port** 21.

The filter expressions can be combined using the logical operators AND, OR, and NOT to create more specific and complex filters.

Note When constructing filter expressions, it is important to understand the order of operations and use parentheses to group expressions when necessary to ensure the correct interpretation.

Enable Wired Packet Capture on WGB

Procedure

Step 1 To enable PCAP, choose one of the options given here:

a. PCAP using default filter:

Device#**debug traffic wired** [*0* | *1*] {**ip** | **tcp** | **udp**} [**verbose** | **capture**]

[0-1]: Specifies the wired interface number. If not selected, capture packets from all the wired interface.

This table lists examples of PCAP in default, verbose, and capture modes:

Mode	Example
Default: Captures IP protocol header packets.	Device#**debug traffic wired 1 ip** APXXXX.XXXX.XXXX#reading from file /dev/click_wired_log, link-type EN10MB (Ethernet) 1 08:35:50.529851 IP 209.165.200.213 > 209.165.200.1: ICMP echo request, id 13721, seq 1, length 64 2 08:35:50.534813 IP 209.165.200.1 > 209.165.200.213: ICMP echo reply, id 13721, seq 1, length 64
Verbose: Captures detailed information of the UDP protocol packets.	Device#**debug traffic wired 1 udp verbose** APXXXX.XXXX.XXXX#reading from file /dev/click_wired_log, link-type EN10MB (Ethernet) 1 08:25:59.696990 IP6 fe80::322c:712c:5787:f246.dhcpv6-client > ff02::1:2.dhcpv6-server: dhcp6 solicit 0x0000: 3333 0001 0002 fc58 9a16 e428 86dd 6001 0x0010: 7b92 006d 1101 fe80 0000 0000 0000 322c 0x0020: 712c 5787 f246 ff02 0000 0000 0000 0000 0x0030: 0000 0001 0002 0222 0223 006d 00a6 010c 0x0040: d064 0008 0002 ffff 0006 001e 0034 0011 0x0050: 0015 0016 0017 0018 001f 0038 0040 0043 0x0060: 0052 0053 005e 005f 0060 0001 000a 0003 0x0070: 0001 fc58 9a16 e428 0014 0000 0027 0013 0x0080: 0006 4150 4643 3538 0439 4131 3604 4534 0x0090: 3238 0000 0300 0c00 0000 0100 0000 0000 0x00a0: 0000 00
Capture: Writes TCP packet information to the PCAP file.	Device#**debug traffic wired 1 tcp capture** % Writing packets to "/pcap/APXXXX.XXXX.XXXX_capture.pcap0" APXXXX.XXXX.XXXX#reading from file /dev/click_wired_log, link-type EN10MB (Ethernet)

b. PCAP using custom filter:

Note
Enable only one PCAP process at a time. Do not use unsupported characters like " ` $ ^ & | \ > < ? ; and ~ in the filter expressions.

Device#**debug traffic wired** [*0* | *1*] **filter** *expression* [**verbose** | **capture**]

This table lists examples of PCAP in default, verbose, and capture modes:

Mode	Example
Default: Captures IP protocol header packets.	Device#**debug traffic wired 0 filter icmp** APXXXX.XXXX.XXXX#reading from file /dev/click_wired_log, link-type EN10MB (Ethernet) 1 10:38:59.948729 IP 209.165.200.213 > 209.165.200.1: ICMP echo request, id 16204, seq 1, length 64 2 10:38:59.954308 IP 209.165.200.1 > 209.165.200.213: ICMP echo reply, id 16204, seq 1, length 64
Verbose: Captures detailed information of the UDP protocol packets.	Device#**debug traffic wired 1 filter icmp verbose** APXXXX.XXXX.XXXX##reading from file /dev/click_wired_log, link-type EN10MB (Ethernet) 17:13:30.706493 IP 209.165.200.213 > 209.165.200.1: ICMP echo request, id 986, seq 1, length 64 0x0000: fc58 9a17 afd4 f8e4 3b9d 7322 0800 4500 0x0010: 0054 57a0 4000 4001 889e c0a8 6cc8 c0a8 0x0020: 6c51 0800 940c 03da 0001 7f3d 5365 0000 0x0030: 0000 cea2 0000 0000 0000 1011 1213 1415 0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 0x0060: 3637 17:13:30.710567 IP 209.165.200.1 > 209.165.200.213: ICMP echo reply, id 986, seq 1, length 64 0x0000: f8e4 3b9d 7322 fc58 9a17 afd4 0800 4500 0x0010: 0054 9102 0000 4001 8f3c c0a8 6c51 c0a8 0x0020: 6cc8 0000 9c0c 03da 0001 7f3d 5365 0000 0x0030: 0000 cea2 0000 0000 0000 1011 1213 1415 0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 0x0060: 3637
Capture: Writes TCP packet information to the PCAP file.	Device#**ddebug traffic wired 1 filter icmp capture** % Writing packets to "/tmp/pcap/APXXXX.XXXX.XXXX_capture.pcap0" APXXXX.XXXX.XXXX#reading from file /dev/click_wired_log, link-type EN10MB (Ethernet)

For more information on filter expressions, see *TCP dump pcap-filter* documentation.

c. PCAP in multiple vlan using custom filter:

Note
Some custom filters miss traffic in non-native VLANs. For example, the custom filter command **#debug traffic wired 0 filter icmp** fails to capture downlink ICMP traffic in non-native VLANs.

To capture downlink traffic in non-native VLANs, you have two options:

- Include the VLAN in the filter expression to capture bidirectional traffic of the wired client in a non-native VLAN

```
Device#debug traffic wired 0 filter "icmp or (vlan and icmp)"
1  12:27:40.833815 IP 209.165.200.102 > 209.165.200.1: ICMP echo request, id 27279, seq 1, length 64
2  12:27:40.841331 IP 209.165.200.1 > 209.165.200.102: ICMP echo reply, id 27279, seq 1, length 64
```

- To capture all IP traffic including native vlan and non-native vlan, use the default IP filter.

```
Device#debug traffic wired 0 ip
1  12:27:40.833815 IP 209.165.200.102 > 209.165.200.1: ICMP echo request, id 27279, seq 1, length 64
2  12:27:40.841331 IP 209.165.200.1 > 209.165.200.102: ICMP echo reply, id 27279, seq 1, length 64
```

To disable wired PCAP, see Disable Wired Packet Capture on WGB.

Step 2 To upload the packets to an external server, use the command given here:

Note
Before uploading the packets, complete the PCAP process and save the packets to file.

Use TFTP, SFTP, or SCP server to upload the PCAP file to an external server.

Device#**copy pcap APxxxx.xxxx.xxxx_capture.pcap0 <tftp|sftp>://A.B.C.D[/dir][/filename]**

copy pcap APxxxx.xxxx.xxxx_capture.pcap0 scp://username@A.B.C.D[:port]:/dir[/filename]

Example:

```
Device#copy pcap APXXXX.XXXX.XXXX_capture.pcap0 scp://iot@209.165.200.213:/capture/wgb_sniffer.pcap
copy ""/pcap/APXXXX.XXXX.XXXX_capture.pcap0"" to
"scp://iot@209.165.200.213:/capture/wgb_dhcp_sniffer_0_46_29.pcap" (Y/N)Y
iot@209.165.200.213 password:
APXXXX.XXXX.XXXX_capture.pcap0                 0%    0     0.0KB/s   --:-- ETA
APXXXX.XXXX.XXXX_capture.pcap0               100% 2530   916.5KB/s   00:00
```

Disable Wired Packet Capture on WGB

Procedure

To disable PCAP, use the command given here:

a. Default filter:

Device#**no debug traffic wired** [*0-3*] {**ip** | **tcp** | **udp**} [**verbose** | **capture**]

b. Custom filter:

Device#**no debug traffic wired** [*0-3*] **filter** *expression* [**verbose** | **capture**]

Note
Use either the **no debug** or **undebug all** command to terminate the capture process.

Verify Wired Packet Capture on WGB

- To verify the debug status, use the **show debug** command.

```
Device#show debug
traffic:
  wired tcp debugging is enabled
```

- To view the captured internal wired packets stored in the file, use the **show pcap** command.

Note After capturing packets to the file, use the **show pcap** command to view them.

```
Device#show pcap
reading from file /pcap/APXXXX.XXXX.XXXX_capture.pcap0, link-type EN10MB (Ethernet)
1  00:00:00.000000 IP 0.0.0.0 > 224.0.0.1: igmp query v2
2  09:41:48.903670 IP 209.165.200.189 > 209.165.200.1: ICMP echo request, id 29920, seq
 1, length 64
3  09:41:48.908927 IP 209.165.200.1 > 209.165.200.189: ICMP echo reply, id 29920, seq
1, length 64
4  09:41:49.904914 IP 209.165.200.102 > 209.165.200.1: ICMP echo request, id 29920, seq
 2, length 64
5  09:41:49.909009 IP 209.165.200.1 > 209.165.200.102: ICMP echo reply, id 29920, seq
2, length 64
```

- To filter and view the basic content of captured packets sequentially, run the **show pcap [filter** *expression***]** command.

```
Device#show pcap filter "src 209.165.200.189″
reading from file /pcap/APXXXX.XXXX.XXXX_capture.pcap0, link-type EN10MB (Ethernet)
 1  09:41:48.903670 IP 209.165.200.189 > 209.165.200.1: ICMP echo request, id 29920,
seq 1, length 64
 2  09:41:48.908927 IP 209.165.200.1 > 209.165.200.189: ICMP echo reply, id 29920, seq
 1, length 64
```

- To filter and view the detailed content of a specific packet, run the **show pcap [filter** *expression***][detail** *no***]** command.

```
Device#show pcap filter "src 209.165.200.189" detail 2
2024-04-25 09:41:49.904914
000000 18 59 f5 96 af 74 00 50 56 85 8a 0a 08 00 45 00
000010 00 54 14 6c 40 00 40 01 b7 9d 64 16 53 72 64 16
000020 53 01 08 00 70 81 74 e0 00 02 d4 3e 2b 66 00 00
000030 00 00 50 24 04 00 00 00 00 00 10 11 12 13 14 15
000040 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25
000050 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 34 35
000060 36 37
```

AAA User Authentication Support

Information About AAA User Authentication Support

This chapter provides information on how to use AAA to control the use of network resources (via authentication) and define permissible actions (via authorization). From Release 17.15.1, AAA-based user management and authentication are supported on IW9167EH WGB.

The AAA server assigns a privilege level from 0-15 to clients using an Authorization-Reply message. Only levels 1 (view user) and 15 (management user) are currently supported, with levels 2-14 reserved. Privilege levels 0 and 2-14 must not be used when adding users to the AAA server. If a user is added without a privilege level, WGB will assign the lowest privilege level to that user.

Features of AAA-based user management and authentication are as follows:

- Provides multiple-user support
- Stores usernames and passwords on the AAA server

- Utilizes AAA for user authentication
- Supports differentiated user privileges
- Restricts CLI access based on user privileges

Note Similar to a Cisco Router or Switch, the Workgroup Bridge (WGB) can also create and store usernames and passwords locally.

Configuring AAA Server

Before you begin

- You can add a secondary AAA server (RADIUS or TACACS+) before adding a primary AAA server. Once the primary AAA server is added, clients connect to the primary AAA server.
- When both primary and secondary RADIUS servers are configured, the WGB attempts to connect with the primary RADIUS server three times before switching to the secondary RADIUS server.
- For the TACACS+ server, the connection attempt is done only once with the primary TACACS+ server. If the primary TACACS+ server fails to respond, the secondary TACACS+ server is used.

Note The WGB AAA RADIUS server configuration command is officially supported starting from the 17.15.1 release.

When you downgrade the image from the 17.15.1 release or later to the 17.14.1 release or earlier, or upgrade from the 17.14.1 release or earlier to the 17.15.1 release or later, the originally configured RADIUS server port is reset to zero. You need to reconfigure the RADIUS server port again.

Procedure

Step 1 Configure a AAA server (RADIUS or TACACS+) using the following command:

Device# **config** {**radius** | **tacplus**} **authentication** {**primary** | **secondary**} **address** {**ipv4** | **ipv6**} *ip-address* **port** *port-number* **secret** *secret-string*

Note
Do not use unsupported characters like vertical bar (|), semicolon (;) , dollar sign ($), less than (<), greater than (>), ampersand (&), caret (^), grave accent(`), backslash (\), carriage return (\r), and double quotation marks (“”) in secret-string parameters.

Step 2 (Optional) To remove a AAA server (RADIUS or TACACS+), use the following command:

Device# **config** {**radius** | **tacplus**} **authentication** {**primary** | **secondary**} **delete**

Enable or Disable RADIUS Authentication for Login User

Procedure

Step 1 Run the following command to enable AAA RADIUS authentication for the login user:
Device# **config ap management aaa radius enable**

Step 2 (Optional) Run the following command to disable AAA RADIUS authentication for the login user:
Device# **config ap management aaa radius disable**

Enable or Disable TACACS+ Authentication for Login User

Before you begin

Procedure

Step 1 Run the following command to enable AAA TACACS+ authentication for the login user:
Device# **config ap management aaa tacplus enable**

Step 2 (Optional) Run the following command to disable AAA TACACS+ authentication for the login user:
Device# **config ap management aaa tacplus disable**

Verify the AAA Authentication Configuration

To verify the AAA server (RADIUS or TACACS+) configuration, use the **show running-configuration** command.

The following is a sample output when AAA RADIUS authentication is enabled:

```
Device# show running-config

AAA server configuration:-
==============================
Status: Enabled
AAA server type : radius
Primary RADIUS IP address : 192.0.2.0
Primary RADIUS port : 1812
.
.
.
```

The following is a sample output when AAA tacplus authentication is enabled:

```
Device# show running-config
```

```
AAA server configuration:-
==============================
Status: Enabled
AAA server type : tacplus
Primary TACPLUS IP address : 192.0.2.0
Primary TACPLUS port : 49
.
.
.
```

Port Address Translation on WGB

Port Address Translation

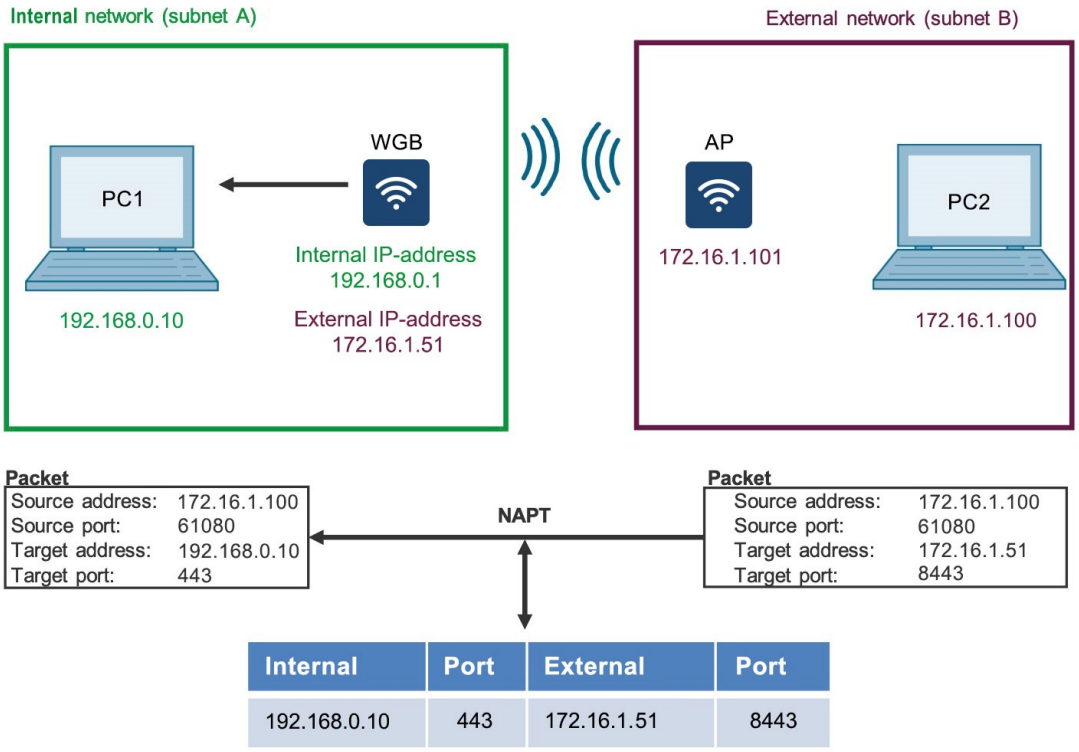
From UIW Release 17.16.1, Port Address Translation (PAT) is supported on the IW9167EH WGB APs of each Automated Guided Vehicle (AGV).

PAT, also known as Network Address and Port Translation (NAPT), translates multiple internal wired client private IP addresses and port numbers to unique public IP address and port numbers before sending the packets to the external network.

A private or internal IP address is used only in an internal network, whereas a public or external IP address is used on the Internet and is globally unique.

NAPT mapping is based on the IP address and the port number. With NAPT, packets from multiple internal hosts are mapped to the same external IP address with different port numbers.

Client devices within the internal local subnet can reuse the same IP addresses across different AGVs.



Profinet clients on the AGV must be configured with a unique IP address belonging to the global subnet.

NAPT configuration supports upstream and downstream data flow. For more information, see Upstream and downstream data flow, on page 99.

Supported protocol

NAPT supports TCP or UDP to communicate between devices on the internal and external network.

Limitation

The limitations of NAPT on WGB are:

- The WGB NAPT feature does not support NAT for incoming packets with an 802.1Q VLAN tag behind the device.
- The WGB NAPT feature does not support multicast traffic for WGB NAT inside wired client.
- The WGB NAPT feature supports FTP traffic in active mode. For passive mode FTP traffic, the WGB PAT feature supports only when the FTP server is located within the NAT inside.
- The WGB NAPT feature supports the TFTP protocol only when the TFTP server resides inside the NAT.
- The WGB NAPT feature does not support Application Layer Gateway (ALG).

NAPT rule and mapping table

NAPT rule

The WGB creates the default mapping rule based on the configured IP addresses, and it translates traffic flow triggered by internal client devices.

The default mapping rule consists of `<inside-IP-address, inside-tcp-or-udp-port>, <outside-ip-address, predefined port range>, and <protocol>`, where the protocol can be either UDP or TCP.

Note The configuration supports a maximum of 256 IP NAT rules.

NAPT mapping table

The WGB creates and manages the mapping table based on the traffic and NAPT rules.

NAPT uses entries that include the source IP address, source port number, protocol type, destination IP address, and destination port number (TCP or UDP) to translate addresses and filter packets to index the NAPT mapping table.

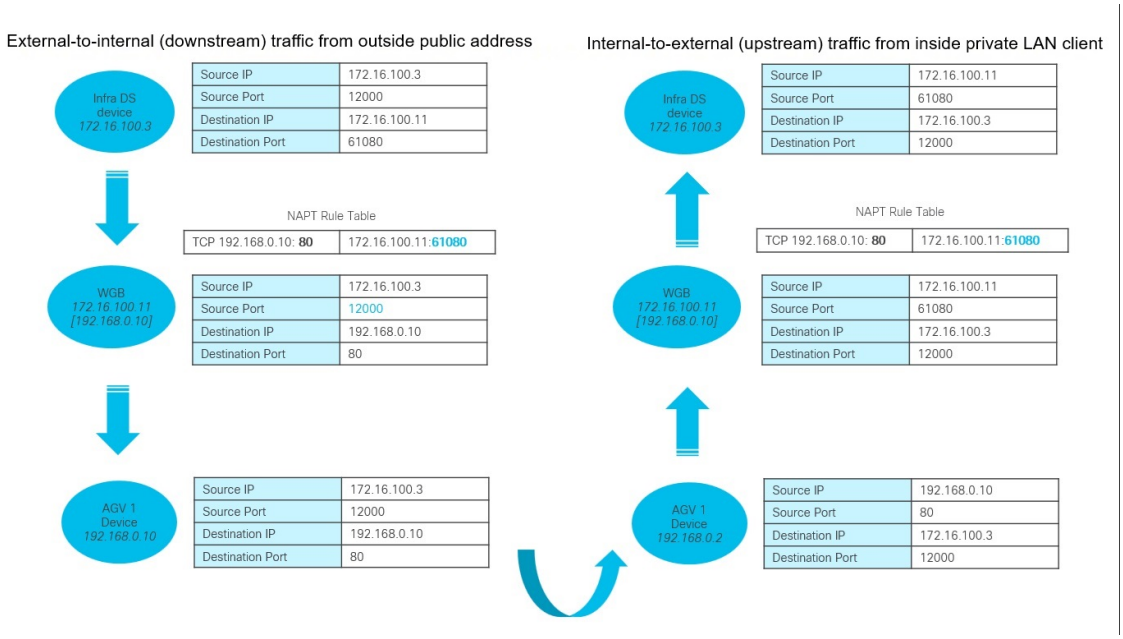
Note The maximum number of mapping entries in NAPT translation table is 4096.

Table 8: NAPT Mapping Table

Protocol	Internal Local IP Address and Port	WGB Global IP Address	External Global IP Address and Port
TCP	192.168.0.10: 80	172.16.100.11	172.16.100.11: 61080

Upstream and downstream data flow

Figure 6: Upstream and downstream data flow Using NAPT



Upstream data flow using SNAT

Upstream data flow refers to the flow of packets from the internal networks to the external networks. The WGB acts as a gateway between the internal and external networks.

The WGB translates all outgoing packets from the internal network to the external network using Source Network Address Translation (SNAT).

The SNAT for upstream traffic translates the source IP address and port numbers of the packets passing through the WGB replacing it with the WGB's IP address. This ensures that internal IP addresses are not exposed to the external network.

Downstream data flow using NAPT

Downstream data flow refers to the flow of data from the external network to the AGV's internal network. The WGB acts as a gateway between the external and internal networks.

When the WGB receives packets with the external IP address and port number, WGB checks the mapping table to match the destination IP address and the port number of the incoming packet.

WGB then translates and forwards packets to the internal network according to the destination IP address and port number.

Configure NAPT on WGB

To configure NAPT on the WGB, use the given commands.

Follow Step 1 through Step 3 to configure upstream data flow using SNAT.

Follow Step 4 and Step 5 to configure downstream data flow using NAPT.

Procedure

Step 1 Use the **configure ip nat enable** command to enable NAPT on WGB.

```
Device#configure ip nat enable
```

Note
Use the **configure ip nat disable** command to disable the NAPT on WGB.

Step 2 Use the **configure ip nat address add ip** *inside- ip-address* **netmask** *netmask* command to configure inside IPv4 address and netmask on WGB.

```
Device#configure ip nat address add ip 192.168.0.1 netmask 255.255.255.0
```

Step 3 (Optional) Use the **configure ip nat inside port range** *min-port-number max-port-number* command to configure SNAT port range on the WGB for upstream data flow.

```
Device#configure ip nat inside port range 32000 33000
```

Inside port valid range is from 1 to 65535.

The default range for inside port is from 30000 to 59999.

Note
Ensure that the SNAT port range and the NAPT port range do not overlap.

Step 4 Use the **configure ip nat outside port range** *min-port-number max-port-number* command to configure NAPT port range on WGB for downstream data flow.

```
Device#configure ip nat outside port range 34000 62000
```

Outside port number valid ranges is from 1025 to 65535.

Note
When creating a NAPT rule, do not use the reserved port numbers 1233, 1234, and 20000 for outside ports.

Ensure that the NAPT port range and the SNAT port range do not overlap.

Step 5 Use the **configure ip nat rule add inside ip** *inside-ip-address* **port** *inside-port-number* **outside port** *outside-port-number* **protocol** {**tcp** | **udp**} command to configure the NAPT mapping rule for downstream data flow.

```
Device#configure ip nat rule add inside ip 192.168.0.10 port 80 outside port 61080 protocol tcp
```

inside-ip-address is the internal wired client network IP address.

inside-port-number is the internal wired client network TCP or UDP port number.

The configuration supports the downstream data flow.

Note
Ensure that the outside port number is within the port range specified in Step 4.

Delete NAPT mapping rule

Use this task to delete the NAPT mapping rule on the WGB.

Procedure

Delete the configuration using the given commands as required.

- Use the **configure ip nat rule delete inside ip** *inside- ip-address* **port** *inside-port-number* **outside port** *outside-port-number* **protocol** {**tcp** | **udp**} command to delete the NAPT mapping rule.

```
Device#configure ip nat rule delete inside ip 192.168.1.10 port 80 outside port 61080 protocol
tcp
```

- Use the **configure ip nat entry delete** *rule-id* command to delete the NAPT mapping rule as per the rule-id.

```
Device#configure ip nat entry del 0
```

Note
Use the **show ip nat configuration** command to view the rule-id.

- Use the **configure ip nat entry delete** *all* command to delete all the NAPT mapping rules on the WGB.

```
Device#configure ip nat entry delete all
```

Delete NAPT IP address

Use this task to delete NAPT IP address on the WGB.

Note To remove all the NAPT configuration, you should also delete the IP address and interface.

Procedure

Delete the NAPT IP address on the WGB using the given commands as required.

- Use the **configure ip nat address delete** command to delete the gateway IPv4 address for the internal wired client on the uWGB.

```
Device#configure ip nat address delete
```

- Use the **configure interface nat-outside address delete** command to delete the external IPv4 address on the uWGB.

```
Device#configure interface nat-outside address delete
```

Verify NAPT on WGB

Verify NAPT configuration

Use the **show ip nat configuration** command to print the current NAPT configuration on WGB.

```
Device#show ip nat configuration
IP NAT Configuration are:
===================================
Status: enabled
inside interface ip/netmask: 192.168.0.1/255.255.255.0
SNAT port range: 10000 - 20000
NAPT port range: 61000 - 65535
The number of ip nat rules: 1
Id       Outside_port    Inside_ip          Inside_port    Protocol
0        61080           192.168.0.10       80             tcp
```

Verify NAPT entry

Use the **show ip nat tranlations** command to print the current NAPT translation entries from the NAPT rule table.

```
Device#show ip nat translations
UDP:
    src_ip    port    dst_ip    port    =>    src_ip    port    dst_ip    port   direction
    expiry_time
(192.168.0.10, 41278, 172.16.1.51, 22000) => (172.16.1.101, 30004, 172.16.1.51, 22000)
[forward] exp: 290
(172.16.1.51, 22000, 172.16.1.101, 61080) => (172.16.1.51, 22000, 192.168.0.10, 41278)
[reverse] exp: 290
===================================
TCP:
    src_ip    port    dst_ip    port    =>    src_ip    port    dst_ip    port   direction
    expiry_time
(192.168.0.10, 80, 172.16.100.3, 443) => (172.16.100.11, 30000, 172.16.100.3, 443) [forward]
 exp: 138
(172.16.100.3, 443, 172.16.100.11, 30000) => (172.16.100.3, 443, 192.168.0.10, 80) [reverse]
 exp: 138
```

In the output, forward refers to the log details of the WGB processed data packets, which include details such as source, destination and any translation performed.

Reverse refers to the log details of the return traffic based on the original packets forwarded by the WGB. It ensures the response from the destination correctly reaches back to the source by reversing the direction of the original traffic.

Port Address Translation on uWGB

Port Address Translation

From UIW Release 17.16.1, Port Address Translation (PAT) is supported on the IW9167EH uWGB of each Automated Guided Vehicle (AGV).

PAT, also known as Network Address and Port Translation (NAPT), translates multiple internal wired client private IP addresses and port numbers to unique public IP address and port numbers before sending the packets to the external network.

A private or internal IP address is used only in an internal network, whereas a public or external IP address is used on the Internet and is globally unique.

NAPT mapping is based on the IP address and the port number. With NAPT, packets from multiple internal hosts are mapped to the same external IP address with different port numbers.

Client devices within the internal local subnet can reuse the same IP addresses across different AGVs.

Precondition

In a NAPT deployment, AGV devices in the internal local subnet have pre-configured IP address.

Supported protocol

NAPT supports TCP or UDP to communicate between devices on the internal and external network.

Limitation of NAPT

The NAPT limitations are:

- The NAPT does not support Access Control Lists (ACLs).
- The NAPT supports only one private LAN as the NAPT inside network.

NAPT rule and mapping table

NAPT rule

The uWGB creates the default mapping rule based on the configured IP addresses, and it translates traffic flow triggered by internal client devices.

Configure a NAPT mapping rule to manage translation for traffic coming from external hosts.

The default mapping rule consists of `<inside-IP-address, inside-tcp-or-udp-port>, <outside-ip-address, predefined port range>, and <protocol>`, where the protocol can be either UDP or TCP.

NAPT mapping table

The uWGB creates and manages the mapping table based on the traffic and NAPT rules.

NAPT uses flow identifiers such as source address, source port, destination address, destination port, and IP protocol (TCP or UDP) to index the NAPT mapping table.

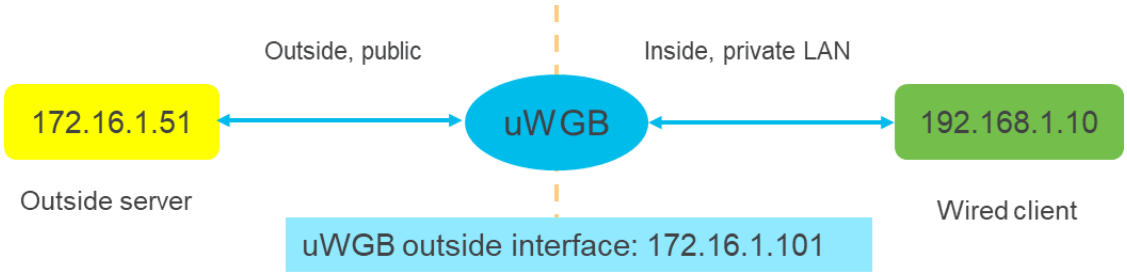
Note The maximum number of mapping entries in NAPT translation table is 4096, and these entries automatically appear in pairs.

Table 9: NAPT Mapping Table

Protocol	Inside Local IP Address and Port	uWGB Global IP Address	Outside Global IP Address and Port
TCP	192.168.1.10: 80	172.16.1.101	172.16.1.101: 61080

Upstream and downstream data flow

Figure 7: Upstream and downstream Data Flow Using NAPT



Upstream data flow using SNAT

Upstream data flow refers to the flow of packets from the internal networks to the external networks. The uWGB acts as a gateway between the internal and external networks. The uWGB translates all outgoing packets from the internal network to the external network using Source Network Address Translation (SNAT).

The SNAT translates the source IP address of the packets passing through the uWGB replacing it with the uWGB client IP address. This ensures that internal IP address are not exposed to the external network.

Downstream data flow using NAPT

Downstream data flow refers to the flow of data from the external network to the AGV's internal network. The uWGB acts as a gateway between the external and internal networks.

When the uWGB receives the packets with the external IP address and port, uWGB checks the mapping table to match the destination IP address and the destination TCP or UDP port of the incoming packet.

If the rule matches, uWGB translates the destination IP address and port numbers according to the matched entry in the table and forwards the packets to the internal network.

Configure NAPT on uWGB

To configure NAPT on the uWGB, use the given commands.

Follow Step 1 through Step 4 to configure support for upstream data flow using SNAT.

Follow Step 5 and Step 6 to to configure support for downstream data flow using NAPT.

Procedure

Step 1 Use the **config ip nat enable** command to enable NAPT on the uWGB.

```
Device#config ip nat enable
```

Note
Use the **configure ip nat disable** command to disable the NAPT on the uWGB.

Step 2 (Optional) Use the **configure ip nat inside port range** *min-port-number max-port-number* command to configure SNAT port range on the uWGB for upstream data flow.

```
Device#configure ip nat inside port range 32000 33000
```

Inside port valid range is from 1025 to 65535.

The default range for inside port is from 30000 to 59999.

The SNAT port range is the source port that the uWGB uses when sending traffic from internal network to the external network.

Note
Ensure that the SNAT port range and the NAPT port range do not overlap.

Step 3 Use the **config ip nat address add ip** *inside-ip-address* **netmask** *netmask* command to configure the gateway IPv4 address for the internal wired client on the uWGB.

```
Device#config ip nat address add ip 192.168.1.1 netmask 255.255.255.0
```

Step 4 Use the **configure interface nat-outside address ipv4 static** *static-ip-address static-netmask gateway-ip-address* command to configure external IPv4 address on the uWGB.

```
Device#configure interface nat-outside address ipv4 static 172.16.1.101 255.255.255.0 172.16.1.1
```

static-ip-address is the uWGB own public address

gateway-ip-address is the uWGB external IP address.

The outside port number is automatically generated for upstream data flow.

The configuration supports the internal-to-external traffic flow.

Step 5 Use the **configure ip nat outside port range** *min-port-number max-port-number* command to configure NAPT port range on the uWGB to receive traffic from the external network to the internal network.

```
Device#configure ip nat outside port range 34000 62000
```

Outside port valid range is from 1025 to 65535.

Note
Ensure that the NAPT port range and the SNAT port range do not overlap.

Step 6 Use the **config ip nat rule add inside ip** *inside-ip-address* **port** *inside-port-number* **outside port** *outside-port-number* **protocol** {**tcp** | **udp**} command to configure the NAPT mapping rule for downstream data flow.

```
Device#config ip nat rule add inside ip 192.168.1.10 port 80 outside port 61080 protocol tcp
```

Note
When creating a NAPT rule, do not use the reserved port numbers 1233, 1234, and 20000 for outside ports.

inside-ip-address is the internal wired client network IP address.

inside-port-number is the internal wired client network port number.

The configuration supports the downstram data flow.

Delete NAPT mapping rule

Follow this procedure to delete the NAPT mapping rule on the uWGB.

Procedure

Delete the configuration using the given commands as required.

- Use the **config ip nat rule delete inside ip** *inside- ip-address* **port** *inside-port-number* **outside port** *outside-port-number* **protocol** {**tcp** | **udp**} command to delete the NAPT mapping rule.

```
Device#config ip nat rule delete inside ip 192.168.1.10 port 80 outside port 61080 protocol tcp
```

- Use the **configure ip nat entry delete** *rule-id* command to delete the NAPT mapping rule as per the rule-id.

```
Device#configure ip nat entry del 0
```

Note
Use the **show ip nat configuration** command to view the rule-id.

- Use the **configure ip nat entry delete** *all* command to delete all the NAPT mapping rules on the uWGB.

```
Device#configure ip nat entry delete all
```

Delete NAPT IP address

Follow this procedure to delete NAPT function IP address on the uWGB.

Note To completely remove the NAPT configuration, ensure to delete the IP address and the interface.

Procedure

Delete the necessary IP address of the NAPT function using the given commands as required.

- Use the **config ip nat address delete** command to delete the internal IPv4 address.

```
Device#Device#config ip nat address delete
```

- Use the **configure interface nat-outside address delete** command to delete the external IPv4 address.

```
Device#configure interface nat-outside address delete
```

Manage uWGB in NAPT deployment

Follow this procedure to manage uWGB in a NAPT deployment.

Before you begin

Ensure that all uWGB wired clients are in the private LAN.

Procedure

Step 1 Use the **configure dot11Radio 1 mode uwgb** *mac_address ssid_profile test_ssid* command to configure radio mode to uWGB.

```
Device#configure dot11Radio 1 mode uwgb FC:58:9A:17:0D:52 ssid-profile testssid
```

You can choose any unique MAC addresss, or use the optional method given below to calculate a unique MAC address.

Note
Ensure MAC address does not conflict with existing devices on the network to prevent connectivity issue.

(Optional) To calculate the unique MAC address, add the offset 0x12 to the base MAC address.

Formula: base MAC address + offset = unique MAC address

Note
Ensure that the offset value is at least 0x12.

Example: FC:58:9A:17:0D:40 + 0x12 = FC:58:9A:17:0D:52

Use the **show controllers dot11Radio 1** command to find the base MAC address.

```
Device#show controllers dot11Radio 1
wifi1     Link encap:Ethernet  HWaddr FC:58:9A:17:0D:40
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:9109 errors:70 dropped:59043 overruns:0 frame:0
          TX packets:27920 errors:13 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:2699
          RX bytes:913806 (892.3 KiB)  TX bytes:5399794 (5.1 MiB)
```

Step 2 Use the **show wgb dot11 associations** command to verify the uWGB is in the WGB state.

```
Device#show wgb dot11 associations
Uplink Radio ID            : 1
Uplink Radio MAC           : FC:58:9A:17:0D:52
SSID Name                  : SSID_NAME
Connected Duration         : 56 hours, 37 minutes, 11 seconds
Parent AP MAC              : B0:B8:67:3D:5E:D6
Uplink State               : CONNECTED
Auth Type                  : PSK
Key management Type        : WPA2
Uclient mac                : FC:58:9A:17:0D:52
Current state              : WGB
Uclient timeout            : 60 Sec
```

```
Dot11 type                 : 11ac
Channel                    : 157
Bandwidth                  : 20 MHz
Current Datarate (Tx/Rx)   : 156/144 Mbps
Max Datarate               : 156 Mbps
RSSI                       : 35
IP                         : 172.16.1.101/24
Default Gateway            : 172.16.1.1
IPV6                       : ::/128
Assoc timeout              : 100 Msec
Auth timeout               : 100 Msec
Dhcp timeout               : 60 Sec'
```

Step 3 Configure NAPT for uWGB wired client end-to-end traffic flow.

Verify NAPT on uWGB

Verify NAPT configuration

Use the **show ip nat configuration** command to print the current NAPT configuration on uWGB.

```
Device#show ip nat configuration

IP NAT Configuration are:
====================================
Status: enabled
inside interface ip/netmask: 192.168.1.1/255.255.255.0
SNAT port range: 30000 - 59999
NAPT port range: 60000 - 65000
outside proxy ip/netmask/gateway: 172.16.1.101/255.255.255.0/172.16.1.1
The number of ip nat rules: 2
Id       Outside_port    Inside_ip          Inside_port    Protocol
0        61001           192.168.1.10       20001          udp
1        61002           192.168.1.10       20002          tcp
```

Verify NAPT entry

Use the **show ip nat tranlations** command to print the current NAPT translation entries from the NAPT rule table.

```
Device#show ip nat translations
ICMP:
    src_ip    dst_ip    port     =>       src_ip    dst_ip    port      direction
expiry_time
(172.16.1.1, 172.16.1.101, 30257) => (172.16.1.1, 192.168.1.10, 267) [reverse] exp: 272
(192.168.1.10, 172.16.1.1, 11) => (172.16.1.101, 172.16.1.1, 30001) [forward] exp: 272
====================================
UDP:
    src_ip    port    dst_ip    port    =>    src_ip    port    dst_ip    port   direction
    expiry_time
(192.168.1.10, 20000, 172.16.1.51, 35200) => (172.16.1.101, 61001, 172.16.1.51, 35200)
[reverse] exp: 214
(192.168.1.10, 51184, 172.16.1.51, 22000) => (172.16.1.101, 30001, 172.16.1.51, 22000)
[forward] exp: 161
(172.16.1.51, 35200, 172.16.1.101, 61001) => (172.16.1.51, 35200, 192.168.1.10, 20000)
[forward] exp: 214
(172.16.1.51, 22000, 172.16.1.101, 30001) => (172.16.1.51, 22000, 192.168.1.10, 51184)
[reverse] exp: 161
====================================
```

```
TCP:
    src_ip    port    dst_ip    port    =>    src_ip    port    dst_ip    port   direction
    expiry_time
(192.168.1.10, 44155, 172.16.1.51, 23000) => (172.16.1.101, 30002, 172.16.1.51, 23000)
[forward] exp: 238
(172.16.1.51, 23000, 172.16.1.101, 30002) => (172.16.1.51, 23000, 192.168.1.10, 44155)
[reverse] exp: 238
====================================
```

In the output, forward means an entry from an actual traffic stream that uWGB processes and forwards. It logs the details of the packets translated and sent through the uWGB.

Reverse means an entry by reversing the direction of an existing forward. It records the expected return path or response for the traffic originally forwarded.

10 Mbps Speed Port Support on Cisco IW9167EH WGB

10 Mbps speed negotiation on Ethernet port

Earlier than Cisco IOS XE Release 17.16.1, the IW9167EH WGB does not support 10 Mbps speed on its ethernet ports. However, some clients still use devices with 10 Mbps Ethernet port. To enable compactibility with these devices.

Starting from Cisco IOS XE Release 17.16.1, the IW9167EH WGB supports 10 Mbps speed negotiation on the wired 0 port. This document explains how to enable and disable 10 Mbps speed negotiation on the WGB wired 0 port.

The WGB wired 0 port connects wired devices to the WGB, bridging wired and wireless network segments.

Speed negotiation

Speed negotiation, or auto-negotiation, is a process where two connected Ethernet devices automatically choose the best common transmission parameters, like speed and duplex mode, to optimize communication.

Speed and duplex are auto-negotiated based on the capabilities of the locally connected endpoint.

Note Disable the 10 Mbps feature when you connect devices that support 100 Mbps and 1 Gbps.

Benefits

This feature allows you to connect your 10 Mbps Ethernet devices to the IW9167EH WGB APs without replacing them.

Enable 10 Mbps speed port on Cisco IW9167EH WGB

Use this task to enable the 10 Mbps speed on the Ethernet port. You can execute the **show** commands as needed and do not have to follow a specific sequence.

Procedure

Step 1 Use the **enable** command to enable privileged EXEC mode.

```
Device>enable
```

Step 2 Use the **configure wired** *0* **speed** *10* **enable** command to enable 10 Mbps speed capability on the wired 0 port.

```
Device#configure wired 0 speed 10 enable
```

Step 3 (Optional) Use the **show running-config** command to verify 10 Mbps speed port status on the wired 0 port.

```
Device#show running-config
feature 10M speed

Interface wired0 10Mbps Configuration:
====================================
Status: Enable
```

Step 4 Use the **show ip interface brief** command to verify speed negotiation on the wired 0 port.

```
Device#show ip interface brief
Interface            IP-Address      Method   Status   Protocol   Speed      Duplex
*wired0              unassigned      unset    up       up         10         full
wired1               n/a             n/a      down     down       n/a        n/a
auxiliary-client     192.168.163.91  static   up       up         n/a        n/a
wifi0                n/a             n/a      down     down       n/a        n/a
wifi1                n/a             n/a      up       up         n/a        n/a
wifi2                n/a             n/a      up       up         n/a        n/a
```

Disable 10 Mbps speed port on Cisco IW9167EH WGB

Use this task to disable the 10 Mbps speed on the Ethernet port. You can execute the **show** commands as needed and do not have to follow a specific sequence.

Procedure

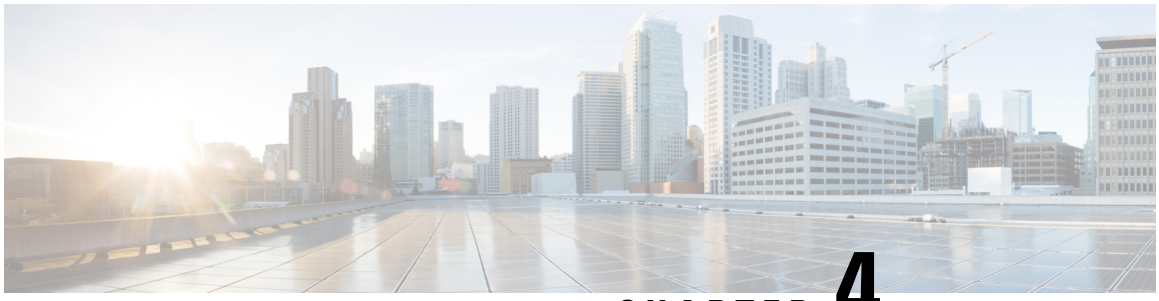
Step 1 Use the **configure wired** *0* **speed** *10* **disable** command to disable 10 Mbps speed capability on the wired 0 port.

```
Device# configure wired 0 speed 10 disable
```

Step 2 (Optional) Use the **show running-config** command to verify 10 Mbps Speed Port Status on the wired 0 port.

```
Device#show running-config
feature 10M speed

Interface wired0 10Mbps Configuration:
====================================
Status: Disable
```



CHAPTER 4

Automated Frequency Coordination

- AFC Support for 6 GHz Standard Power Mode , on page 111
- Verifying AFC Status on AP, on page 112

AFC Support for 6 GHz Standard Power Mode

The Cisco Catalyst IW9167EH access point has eight N-type female connectors to support multiple antenna options, such as the Self-Identifying Antennas (SIA) on designated three SIA ports, dual-band antennas, and single-band antennas. The IW9167EH is compatible with SIA antennas for the 6 GHz band.

The IW9167EH supports the Automated Frequency Coordination (AFC) 6 GHz Standard Power mode. A standard power AP joins the system. Before enabling standard power, the AP must get the available frequencies and the power in each frequency range from the AFC system.

The AFC system computes the available frequencies and maximum allowable power based on the information provided by the regulatory body (FCC for United States). The response is sent back to controller, which may assign a standard power channel to the AP based on the allowed channel list returned by the AFC system.

Standard Power AP coordinate through an AFC service. The AFC accesses information and, along with the AP's geographical location and antenna characteristics, creates a topographical propagation map modeling the AP's interference radius. This map allows you to assign maximum transmission power and coordinate/configure the channel settings to avoid interference.

Note A power cycle is mandatory after the first installation of the SIA antenna.

Table 10: Radio 6 GHz power mode support

Deployment Mode	Low Power Indoor Support	Standard Power Support
Outdoor	No	Yes

The transmission power is limited to a maximum of 36 dB Effective Isotropic Radiated Power (EIRP), and APs must be coordinated through an AFC service. These APs are allowed to operate in the UNII-5 (5.925-6.425 GHz) and UNII-7 (6.525-7.125 GHz) in the -B (U.S) domain.

Table 11: 6 GHz Target Power

Conducter Per Path Power		Antenna Gain	Tx x Rx Chains	Max EIRP	Max EIRP (SP/AFC)
20-80Mhz	160Mhz				
17 dBm	16 dBm	7 dBi*	4x4	30 dBm*	36 dBm

Verifying AFC Status on AP

To verify the AFC request and response data on AP, run the **show rrm afc** command.

```
Device#show rrm afc
Location Type: 1
Deployment Type: 2
Height: 129
Uncertainty: 5
Height Type: 0
Request Status: 5
Request Status Timestamp: 2023-08-31T06:20:17Z
Request Id Sent: 5546388983266789933
Ellipse 1: longitude: -121.935066 latitude: 37.512830 major axis: 43 minor axis:
 9 orientation: 36.818100
AFC Response Request ID: 5546388983266789933
AFC Response Ruleset ID: US_47_CFR_PART_15_SUBPART_E
```

To verify the current operating power mode, run the **show controllers dot11Radio 2 | i Radio** command.

```
Device#show controllers dot11Radio 2 | i Radio
Dot11Radio2     Link encap:Ethernet  HWaddr 24:16:1B:F8:06:C0
Radio Info Summary:
Radio: 6.0GHz (SP)
```