Configuring QoS in a Wireless Environment

This chapter describes how to configure quality of service (QoS) on your Cisco wireless interface. With this feature, you can provide preferential treatment to certain traffic at the expense of other traffic. Without QoS, the device offers best-effort service to each packet, regardless of the packet contents or size. It sends the packets without any assurance of reliability, delay bounds, or throughput.

This chapter consists of these sections:

Understanding QoS for Wireless LANs

By default, networks operate on a best-effort delivery basis, which means that all traffic has equal priority and an equal chance of being delivered in a timely manner. When congestion occurs, all traffic has an equal chance of being dropped.

When you configure QoS on the device, you prioritize network traffic, creating QoS policies and applying the policies to the VLAN configured on your device. Implementing QoS in your wireless LAN makes network performance more predictable and bandwidth utilization more effective. If you do not use VLANs on your network, you can apply your QoS policies to the Ethernet and radio ports.

Note When you enable QoS, the device uses Wi-Fi Multimedia (WMM) mode by default.

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QoS for Wireless LANs Versus QoS on Wired LANs

The QoS implementation on wireless LANs differs from QoS implementations on wired networks. With QoS enabled, bridges:

- Do not classify packets; they prioritize packets based on differentiated services code point (DSCP) value, client type (such as a wireless phone), or the priority value in the 802.1q or 802.1p tag.
- They do not match packets using ACL; they use only modular quality of service (MQC) class-map for matching clauses.
- They do not construct internal DSCP values; they only support mapping by assigning IP DSCP, precedence, or protocol values to Layer 2 COS values.
- They carry out Enhanced Distributed Coordination Function (EDCF)-like queuing on the radio egress port only.
- They do only FIFO queuing on the Ethernet egress port.
- They support only 802.1Q/P tagged packets. Bridges do not support InterSwitch Link Protocol (ISL).
- They support only MQC policy-map **set cos** action.

To contrast the wireless LAN QoS implementation with the QoS implementation on other Cisco network devices, see the *Cisco IOS Quality of Service Solutions Configuration Guide* at this URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fqos_c/index.htm

Impact of QoS on a Wireless LAN

Wireless LAN QoS features are a subset of the proposed 802.11e draft. QoS on wireless LANs provides prioritization of traffic from the device over the WLAN based on traffic classification.

Just as in other media, you might not notice the effects of QoS on a lightly loaded wireless LAN. The benefits of QoS become more obvious as the load on the wireless LAN increases, keeping the latency, jitter, and loss for selected traffic types within an acceptable range.

QoS on the wireless LAN focuses on downstream prioritization from the device. These are the effects of QoS on network traffic:

- The radio downstream flow is traffic transmitted out the device radio to another bridge. This traffic is the main focus for QoS on a wireless LAN.
- The radio upstream flow is traffic received on the device radio from another bridge. QoS for wireless LAN does not affect this traffic.
- The Ethernet downstream flow is traffic sent from a switch or a router to the Ethernet port on the device. If QoS is enabled on the switch or router, the switch or router might prioritize and rate-limit traffic to the device.
- The Ethernet upstream flow is traffic sent from the device Ethernet port to a switch or router on the wired LAN. The device does not prioritize traffic that it sends to the wired LAN based on traffic classification.

Precedence of QoS Settings

When you enable QoS, the device queues packets based on the Layer 2 class of service value for each packet. The device applies QoS policies in this order:

1. Packets already classified—When the device receives packets from a QoS-enabled switch or router that has already classified the packets with non-zero 802.1Q/P user_priority values, the device uses that classification and does not apply other QoS policy rules to the packets. An existing classification takes precedence over all other policies on the device.

Note A Cisco device always acts on tagged 802.1P packets that it receives over the radio interface, even if a QoS policy has not been configured.

2. Policies you create on the device—QoS Policies that you create and apply to VLANs or to the device interfaces are second in precedence after previously classified packets.
3. Default classification for all packets on VLAN—If you set a default classification for all packets on a VLAN, that policy is third in the precedence list.

Using Wi-Fi Multimedia Mode

When you enable QoS, the device uses Wi-Fi Multimedia (WMM) mode by default.

The following features of the WMM specification are supported:

- Addition of the WMM information element to associate request frames
- Addition of the WMM parameter element to the beacon, probe response and association response frames
- Addition of the QoS control field to data frames
- Support for setting the field sent in the WMM parameter element (per access class):
  - contention window (CW) min
  - CW max
  - Arbitration Interframe Space (AIFS)
  - Admission control required
  - Transmit opportunity (TXOP) size
- Separate transmit sequence numbers for each access class and for frames that do not have the QoS control field
- Separate duplicate sequence number checking lists on receive for each access class and for frames that do not have the QoS control field
- No ACK frames for QOS control fields that do not require ACK
- Negotiation of WMM capability with client on reassociation
- Support for burst transmission of multiple frames in a transmit opportunity
- Support for the WMM specified backoff procedure
- Support for the WMM retransmit procedure
- Addition of 802.1d priority for WMM enabled clients

- Support for separate Temporal Key Integrity Protocol (TKIP) replay detection counters on receive for each access class and for frames that do not have the QOS control field

The following features of the WMM specification are supported only on Cisco 3201 WMIC:

- Transmission of a packet with the *no ACK required* bit set in the QoS control field
- End of service period (EOSP) bit in the QoS control field
- Management action frames
- Traffic Specification (TSPEC) element
- Admission control procedure
- Enforcement of admission control required field
- Triggered power save delivery

Configuring QoS

QoS is enabled by default. This section describes how to configure QoS on your device. Before configuring QoS on your device, you should be aware of this information:

- The most important guideline in QoS deployment is to be familiar with the traffic on your wireless LAN. If you know the applications used by wireless client devices, the applications' sensitivity to delay, and the amount of traffic associated with the applications, you can configure QoS to improve performance.
- QoS does not create additional bandwidth for your wireless LAN; it helps control the allocation of bandwidth. If you have plenty of bandwidth on your wireless LAN, you might not need to configure QoS.

Layer2 QoS (RBCP and Voice)

Cisco devices can support wireless voice clients that are 802.11e compliant, transmitting and receiving frames with the Layer 2 802.1p priority bits set.

Between the host router and wireless device there is an Router Blade Control Protocol (RBCP) that monitors the health of a device by sending periodic keep alive packets. The device sends layer2 802.1q tagged RBCP packets with the highest priority (priority 7) in the keep alive packets to ensure the keep alive packets make it to the host router, even on a congested network.

The Layer 2 RBCP packet is shown in the following diagram.

12 bytes	4 byte	2 byte	3 bytes	5 bytes	42 to 1496 bytes
802.3 MAC	802.1Q	Type/Length	802.2 LLC	802.2 SNAP	Data

The tag field includes the field acronyms and the number of bits for each field.

No. of bits	16	3	1	12
Frame field	TPID	PRIORITY	CFI	VID

TPID-Tag Protocol Identifier

The Tag Protocol Identifier is a 16-bit field. It is set to a value of 0x8100 to identify the frame as an IEEE 802.1Q-tagged frame.

Priority

Also known as user priority, this 3-bit field refers to the IEEE 802.1p the frame priority level. The field is set to 0x111 (highest priority) for RBCP.

CFI-Canonical Format Indicator

The Canonical Format Indicator is a 1-bit field. The value is 0 for RBCP when the MAC address is in canonical format.

VID-VLAN Identifier

The VLAN Identifier is a 12-bit field that uniquely identifies the VLAN to which the frame belongs. The field is set to 0x000, which is supported by host routers.

Layer3 QoS (IP DSCP)

When a device is running Lightweight Access Point Protocol (LWAPP), the packets to the host router are encapsulated in a Layer 3 LWAPP header with the IP DSCP field set to one of the values indicated in the table below, depending on the type of traffic.

Table 1 LWAPP Packets and QoS Marking

Cisco AVVID 802.1pUP-Based Traffic Type	Cisco AVVID IP DSCP	Cisco AVVID 802.1p UP	IEEE 802.11e UP	Notes
Network Control	-	7	-	Reserved for network control only
Inter-Network Control	48	6	7 (AC_VO)	LWAPP control
Voice	46 (EF)	5	6 (AC_VO)	Controller: Platinum QoS profile
Video	34 (AF41)	4	5 (AC_VI)	Controller: Gold QoS profile
Voice Control	26 (AF31)	3	4 (AC_VI)	-
Best Effort	0 (BE)	0	3 (AC_BE)	
0 (AC_BE)	Controller: Silver QoS profile			

Table 1 LWAPP Packets and QoS Marking (continued)

Cisco AVVID 802.1pUP-Based Traffic Type	Cisco AVVID IP DSCP	Cisco AVVID 802.1p UP	IEEE 802.11e UP	Notes
Background (Cisco AVVID Gold Background)	18 (AF21)	2	2 (AC_BK)	-
Background (Cisco AVVID Silver Background)	10 (AF11)	1	1 (AC_BK)	Controller: Bronze QoS profile.

To provide optimum system QoS for packets going out from the wireless device to the host router and then routed to one of its outgoing interfaces, suitable policy maps must be configured on the host router's out-going interfaces to prioritize IP DSCP-based packets (devices running LWAPP) or map Class of Service (CoS) to IP DSCP (an autonomous device supporting wireless 802.1e clients). This ensures:

- Host router always sees the wireless device as being online when a **service-module wlan-ap 0 status** command is issued
- A wireless device running LWAPP does not lose connectivity to the wireless LAN controller (WLC) under congestion scenarios on other router switch-ports
- Voice calls from the wireless device can be provisioned under congestion scenarios on the other router switch-ports

IP DSCP precedence information is contained in the IP header TOS field:

- Best Effort
- Assured Forwarding — Class 1 Low
- Assured Forwarding — Class 1 Medium
- Assured Forwarding — Class 1 High
- Assured Forwarding — Class 2 Low
- Assured Forwarding — Class 2 Medium
- Assured Forwarding — Class 2 High
- Assured Forwarding — Class 3 Low
- Assured Forwarding — Class 3 Medium
- Assured Forwarding — Class 3 High
- Assured Forwarding — Class 4 Low
- Assured Forwarding — Class 4 Medium
- Assured Forwarding — Class 4 High
- Class Selector 1
- Class Selector 2
- Class Selector 3
- Class Selector 4
- Class Selector 5

- Class Selector 6
- Class Selector 7
- Expedited Forwarding

Radio Access Category Definitions

The device uses the radio access category definitions to calculate backoff times for each packet. As a rule, high-priority packets have short backoff times.

The default values for the minimum and maximum contention window and in the slottime are based on settings recommended in IEEE Draft Standard 802.11e. For detailed information on these values, consult that standard.

We recommend that you use the default settings. Changing these values can lead to unexpected blockages of traffic on your wireless LAN, and the blockages might be difficult to diagnose. If you change these values and find that you need to reset them to defaults, use the default settings listed in Table 2.

The values listed in Table 2 are to the power of 2. The device computes contention window values with this equation:

CW = 2 ** X minus 1

where X is the value from Table 2.

Table 2 Default QoS Radio Traffic Class Definitions

Class of Service	Min Contention Window	Max Contention Window	Fixed Slot Time
Background (CoS 1-2)	4	10	7
Best Effort (CoS 0)	4	6	3
Video (CoS 3-5)	3	4	1
Voice (CoS 6-7)	2	3	1

CW-min and CW-max Settings for Point-to-Point and Point-to-Multipoint Bridge Links

For best performance on your device links, adjust the CW-min and CW-max contention window settings according to the values listed in Table 3. The default settings, CW-min 3 and CW-max 10, are best for point-to-point links. However, for point-to-multipoint links, you should adjust the settings depending on the number of non-root bridges that associate to the root device.

Note If packet concatenation is enabled, adjust the CW-min and CW-max settings only for traffic class 0. Concatenation is disabled by default.

Table 3 CW-min and CW-max Settings for Point-to-Point and Point-to-Multipoint Bridge Links

Setting	Point-to-Point Links	Point-to-Multipoint Links with up to 5 Non-Root Bridges	Point-to-Multipoint Links with up to 10 Non-Root Bridges	Point-to-Multipoint Links with up to 17 Non-Root Bridges
CW-min	3	4	5	6
CW-max	10	10	10	10

To adjust the CW-min and CW-max settings, follow these steps, beginning in privileged EXEC mode:

	Command	Purpose
Step 1	**configure terminal**	Enters global configuration mode.
Step 2	**interface dot11radio** *radiointerface*	Enters interface configuration mode for the radio interface.
Step 3	**traffic-class** *class* { **cw-min** *number* } { **cw-max** *number* } { **fixed-slot** *number* }	Assigns CW-min, CW-max, and fixed-slot settings to a traffic class. Use the values in Table 3 to enter settings that provide the best performance for your network configuration. **Note** If packet concatenation is enabled, you need to adjust the CW-min and CW-max settings only for traffic class 0. Concatenation is enabled by default.
Step 4	**end**	Returns to privileged EXEC mode.

Use the **no** form of the command to reset the setting to defaults.

QoS Configuration Examples

QoS Example Configuration for VLAN

The following example queues all traffic from VLAN100 to the voice queue:

```
interface fastEthernet 0.1
 encapsulation dot1Q 1 native
 bridge-group 1

interface fastEthernet 0.100
 encapsulation dot1Q 100
 bridge-group 100

interface fastEthernet 0.101
 encapsulation dot1Q 101
 bridge-group 101

interface dot11Radio 0.1
 encapsulation dot1Q 1 native
 bridge-group 1

interface dot11Radio 0.100
 encapsulation dot1Q 100
 bridge-group 100

interface dot11Radio 0.101
 encapsulation dot1Q 101
 bridge-group 101

interface dot11Radio 0
 ssid qosABC-1
  vlan 1
  authentication open
 ssid qosABC-100
  vlan 100
  authentication open
 ssid qosABC-101
  vlan 101
  authentication open

class-map match-all alldata
 match any

policy-map v100traffic
 class alldata
  set cos 6

interface dot11Radio 0.100
 service-policy output v100traffic
```

QoS Example of IP DSCP and IP Precedence

The following example queues traffic data with the IP Precedence value 2 to Queue 0, IP DSCP value 12 to Queue 1, IP Precedence value 5 to Queue 2, and IP DSCP value 46 to queue 3.

```
class-map match-all dscp12
 match ip dscp af12

class-map match-all dscp46
 match ip dscp ef

class-map match-all prec2
 match ip precedence immediate

class-map match-all prec5
 match ip precedence critical

policy-map L3Map
class prec2
  set cos 2
 class dscp12
  set cos 0
class prec5
  set cos 5
class dscp46
  set cos 6

interface dot11Radio 0
 service-policy output L3Map
```

Additional Information

For more information, see:

Understanding the Lightweight Access Point Protocol (LWAPP) at
http://www.cisco.com/en/US/prod/collateral/wireless/ps5678/ps6306/prod_white_paper0900aecd802c18ee_ns337_Networking_Solutions_White_Paper.html

Quality of Service (QoS) at
http://www.cisco.com/en/US/products/ps6558/products_ios_technology_home.html