Quality of Service

Quality of Service (QoS) is essential to ensure that voice traffic receives timely and reliable treatment with low delay, low jitter, and little or no packet loss on the network. QoS ensures that voice traffic receives priority treatment when traveling across the network. It is required for both wired and wireless VoIP networks.

The following sections discuss QoS for wireless voice traffic:

QoS for Voice Traffic

Because WLANs operate as a shared medium, QoS is more difficult to achieve on wireless networks than on wired networks because the endpoints on a wireless network do not have dedicated bandwidth for sending and receiving traffic. The following characteristics apply to QoS for voice traffic on a wired network:

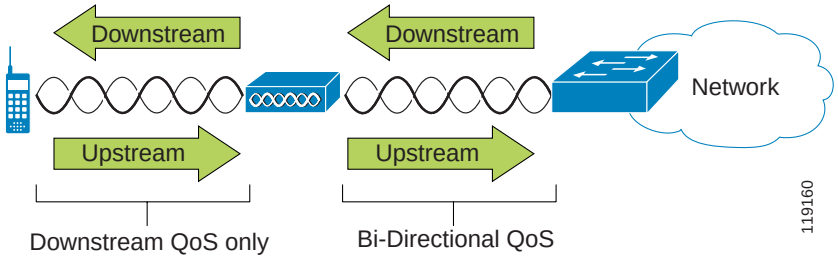
- Dedicated access per user or device (switched ethernet, point-to-point WAN)
- Packets marked with 802.1p and IP Type of Service (ToS) or Differentiated Services Code Point (DSCP)
- QoS can be applied to upstream or downstream traffic
- Can provide complete call admission control

The following characteristics apply to QoS for voice traffic on a wireless network:

- Shared access to bandwidth
- Packets marked with 802.1p and IP ToS or DSCP
- QoS is currently available to downstream traffic from the AP, but few devices other than the Cisco 7920 phone can provide upstream QoS toward the AP.
- Can provide only limited admission control

Unlike wired networks with dedicated bandwidth, WLAN networks have to consider traffic direction when implementing QoS. Traffic is considered as either upstream or downstream from the point of view of the AP, as shown in Figure 6-1.

Figure 6-1 Upstream and Downstream Traffic



WLAN Traffic Transmission

This section describes the following topics pertaining to traffic transmission over a WLAN:

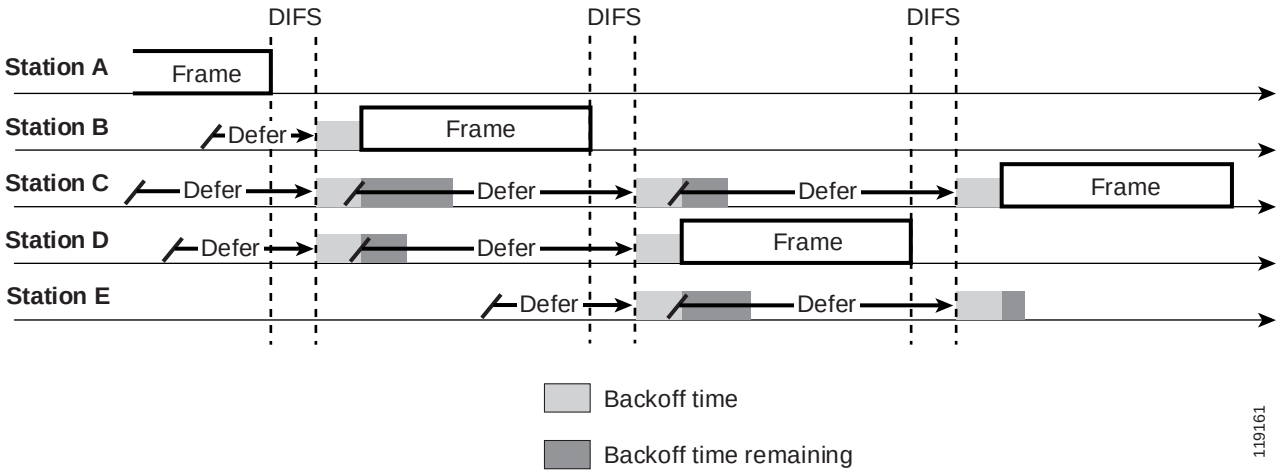
Collision Avoidance

Similar to wired Ethernet networks, 802.11b WLANs employ Carrier Sense Multiple Access (CSMA). However, instead of using collision detection (CD), WLANs use collision avoidance (CA). Instead of each station trying to transmit as soon as the medium is free, WLAN devices use a CA mechanism to prevent multiple stations from transmitting at the same time.

Distributed Coordination Function (DCF)

The model used for WLAN data transmission is called Distributed Coordination Function (DCF), illustrated in Figure 6-2.

Figure 6-2 802.11b DCF Model

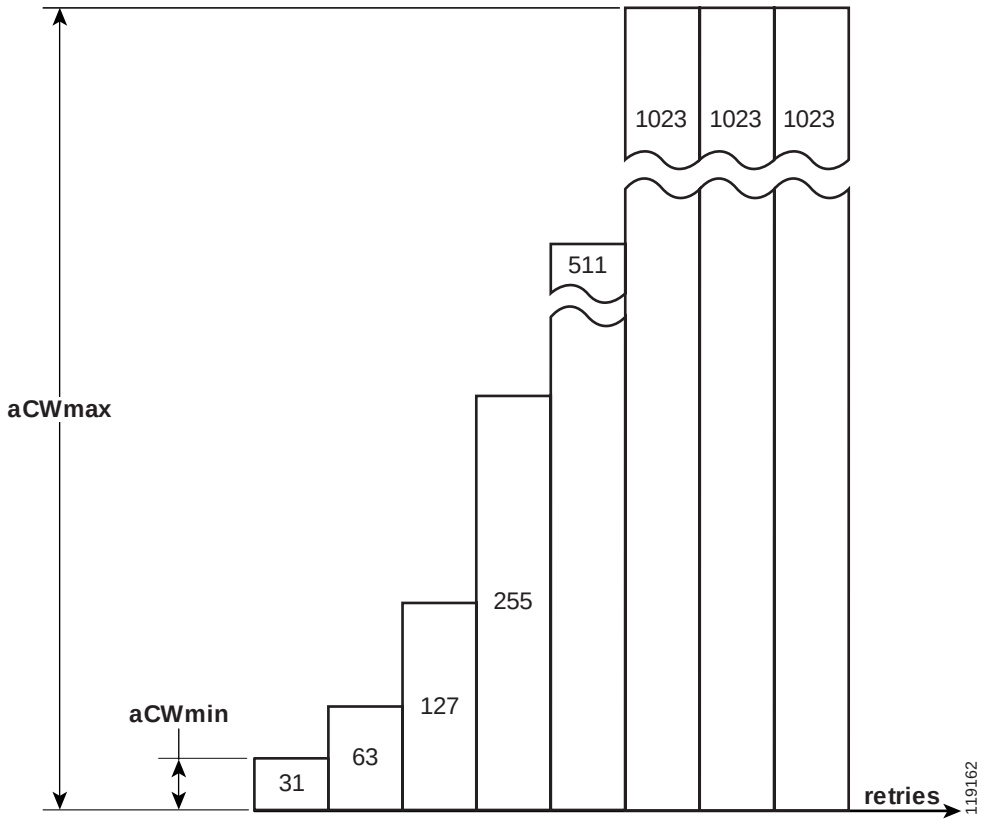


DCF ensures that the following events occur when the endpoints try to transmit data:

1. After the previous frame has been transmitted and detected by the other endpoints, each endpoint waits for a period of time called the inter-frame space (IFS). There are three potential values for the IFS:
   - Short IFS (SIFS) — The shortest interval, used by APs to send acknowledgements and management traffic
   - Point-coordination IFS (PIFS) — Not used by commercial products
   - Distributed IFS (DIFS) — The interval used by most other endpoints
2. After the IFS interval has expired, the endpoints begin their collision avoidance (CA) procedure. This procedure uses two contention window (CW) values, called CWmin and CWmax. The CW determines the additional amount of time an endpoint should wait, after the IFS, before attempting to transmit a packet. The value of the CW is determined by the following procedure:
   a. Each endpoint has the values for CWmin and CWmax defined.
   b. After the IFS expires, the endpoint selects a value between 0 and CWmin. The endpoint then waits the length of this value and determines if the medium is available for transmission.
   c. If the medium is available, the endpoint transmits its packets.
   d. If the medium is unavailable (that is, if another device sent a packet), the endpoint waits until the end-of-packet transmission (from another device) plus the IFS period. In addition, it doubles the value chosen in step "b" and then attempts to transmit.
   e. The endpoint continues to double the value from step "b" until it either reaches CWmax or the packet is transmitted.

Figure 6-3 shows the growth in the random backoff range with retries, as outlined in the preceding steps.

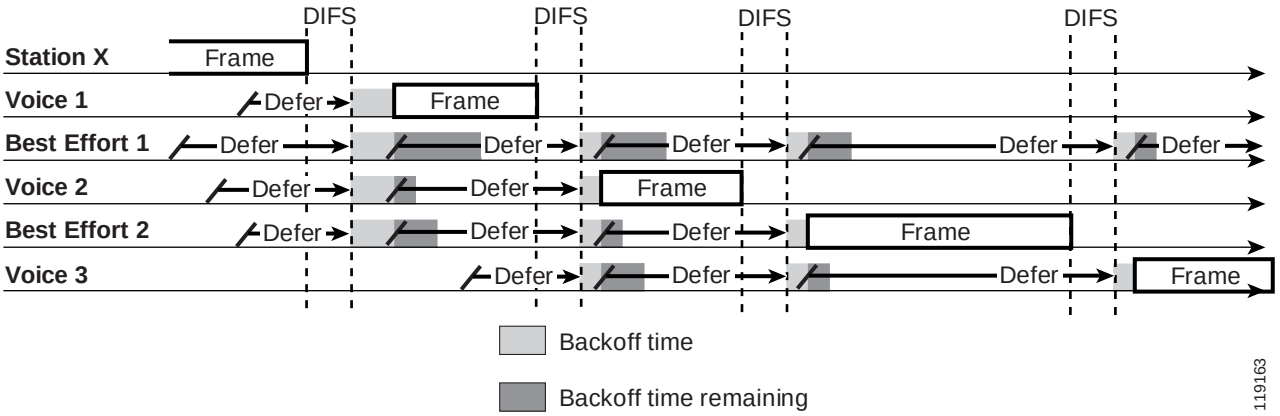
Figure 6-3 Growth in Random Backoff Range with Retries



Enhanced DCF (EDCF)

For WLAN QoS, Cisco APs and 7920 Wireless IP Phones use a technique similar to IEEE 802.11e, called enhanced DCF (EDCF). EDCF enables endpoint devices that have delay-sensitive multimedia traffic to modify their CWmin and CWmax values to allow for statically greater (and more frequent) access to the medium. In practice, EDCF on Cisco WLAN devices works as illustrated in Figure 6-4.

Figure 6-4 802.11b EDCF Model



The default values in Cisco IOS for CWmin and CWmax have been determined as the best possible values for a voice deployment. (Figure 7-7 shows an example of these default values.)

Queues

Beginning with Cisco IOS Release 12.2(11)JA, Cisco Aironet APs support EDCF-type QoS, with up to eight queues for downstream (toward the 802.11b clients) QoS. These queues can be allocated in any of the following ways:

- Based on ToS or DSCP settings of the packets
- Based on Layer 2 or Layer 3 access lists
- Based on VLAN
- Based on dynamic registration of devices such as the Cisco 7920 Wireless IP Phone

Although eight queues are supported on the AP, Cisco recommend that you have only two queues for traffic on the AP to ensure the best possible voice QoS. Voice (RTP) and signaling (SCCP) traffic should be placed into the highest priority queue, and all data traffic should be placed into a best-effort queue. While 802.11b EDCF does not guarantee that voice traffic will be protected from data traffic, using this queuing model should provide the best statistical results for voice QoS.

The Cisco 7920 phones support EDCF-type QoS for upstream (toward the AP) traffic. In addition, the Cisco 7920 phone dynamically announces its presence to the Cisco Aironet AP to ensure that its downstream traffic is placed into the high-priority queue on the AP. This dynamic announcement is done via Cisco Discovery Protocol (CDP). The CDP packets are sent from the Cisco 7920 phone to the AP, and they identify the phone so that the AP can place all traffic to the phone in the high-priority queue.

DSCP Marking

The SCCP signaling messages are marked with DSCP 26 or Per-Hop Behavior (PHB) AF31, and RTP packets are marked with DSCP 46 (PHB EF). These markings match the DSCP markings of Cisco wired Ethernet IP phones and make the QoS settings consistent for both LAN and WLAN environments.

Note The recommended DSCP or PHB marking for voice control signaling traffic has been changed from DSCP 26 (PHB AF31) to DSCP 24 (PHB CS3). A marking migration is planned within Cisco to reflect this change; however, many products (including the Cisco 7920 phone) still mark signaling traffic as DSCP 26 (PHB AF31). Therefore, in the interim, Cisco recommends that both PHB AF31 and PHB CS3 markings be used for access to call signaling queues.

QoS Basis Service Set (QBSS)

In addition to setting the DSCP or PHB markings correctly and supporting EDCF-type QoS, the Cisco 7920 phone also supports an intelligent mechanism to determine the QoS that can be provides by a given AP. This mechanism uses an algorithm that takes into consideration the Received Signal Strength Indicator (RSSI) and the RF channel utilization (CU) based on updates received by the Cisco AP in beacon messages using the QBSS element. Based on this information, the Cisco 7920 phone can determine if the load on a given AP is excessive and if it should attempt to associate with a less congested AP in order to preserve QoS for an IP Telephony call.

Additional Considerations

Beyond providing proper queuing and DSCP (or PHB) markings for the voice packets, you must consider delay and jitter. These factors are especially important for upstream traffic because there is no queuing among clients on the 802.11b side of the AP. The simplest way to reduce delay and jitter is to stay within the guidelines for the number of WLAN clients per AP. Exceeding these guidelines creates additional opportunities to introduce packet delay and jitter.

For more details about deploying QoS in WLAN networks, refer to the Cisco Aironet *Wireless Quality-of-Service Deployment Guide*, available at

http://www.cisco.com