WLAN Voice and Video Enhancement Technology White Paper

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Contents

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Keywords:

VoIP, voice and video, WMM, EDCA, IEEE 802.1p, IEEE 802.11e, DSCP, fast roaming

Abstract:

This document describes key technologies, application scenarios, and solution highlights of the voice and video enhancement function in WLAN V200R008C10.

1 Overview

1.1 Background

Different from common wireless network data services, Voice over Internet Protocol (VoIP) sessions among voice and video traffic flows are more prone to frame freezing or loss due to the delay, packet loss, and jitter of AP services.

More Quality of Service (QoS) control variables are available for transmission of voice and video services on WLANs than those on wired networks. If these new variables are not comprehensively or completely handled, WLANs can hardly provide users with satisfactory voice and video service experience.

It is unrealistic to eliminate network congestion by simply increasing bandwidth of WLANs. Improving end-to-end QoS can solve the problem. On one hand, the Wi-Fi Alliance (WFA) provides and defines basic protocols to ensure QoS of Wi-Fi networks. On the other hand, simply using WMM cannot deliver good user experience for high-end customers in diversified application scenarios.

Common WLANs provide equal access bandwidth for all associated Wi-Fi terminals. WMM ensures the same QoS for voice and video services as that for common data services, but provides no optimization for improving voice and video service experience.

1.2 QoS Measurement Parameters

Bandwidth/Throughput: Bandwidth typically refers to the frequency bandwidth that is occupied by signals. When used for channel description, bandwidth indicates the maximum frequency bandwidth of signals that can pass the channel, in Mbit/s.

Delay: indicates the duration for transmitting a packet from one end to another on a network. For example, the delay of voice services is the time for transmitting voice from a talker to a listener. A long delay causes unclear voice or interruption.

Jitter: also called delay variation, indicates the delay variances between different packets in the same service flow. Jitter is caused by differences in the queuing time of contiguous packets in a service flow. Jitter has the most significant impact on QoS. For some types of services, especially real-time services such as voice and video services, jitter cannot be tolerated. If packets reach the destination at different time, voice and video services are interrupted.

Packet loss rate: indicates the percentage of lost and error packets to the total number of transmitted packets within a sample period (1 second typically) during transmission. The packet length is an important factor that affects the packet loss rate. A small number of lost packets do not have much impact on services. If a large number of packets are lost, service transmission efficiency is compromised.

Voice and video services have different requirements on the network bandwidth, delay, jitter, and packet loss rate, as listed in the following table.

Service Type		Delay	Jitter	Packet Loss Rate
Voice	Media	⩽ 50 ms	⩽ 10 ms	⩽ 1%
	Signaling	⩽ 100 ms	⩽ 10 ms	⩽ 0.1%
Interactive personality TV (IPTV)	Multicast	⩽ 1s	⩽ 200 ms	⩽ 0.1%
	Video On Demand (VoD)	⩽ 10s	⩽ 200 ms	⩽ 0.1%

1.3 Customer Benefits

After the voice and video enhancement function is provided by WLAN products, it is enabled by default.

After the voice and video enhancement function is enabled, existing voice and video services on the upstream wired network and downstream air interface of a WLAN are assigned higher forwarding priorities than other data services. For example, with the voice and video enhancement function enabled, a Huawei WLAN provides 10% better user experience for the live WeLink video service than competitors' WLANs. Users' video mean opinion score (VMOS) values are increased, and the service transmission delay, jitter, and packet loss rate are reduced.

1.4 Target Audience

Pre-sales market expansion personnel (including GTM MOs, expansion MOs, market technology SEs, and industry sales managers) and customers

1.5 Change History

This is the first release of the voice and video enhancement function in WLAN V200R008C10.

2 Technical Solution

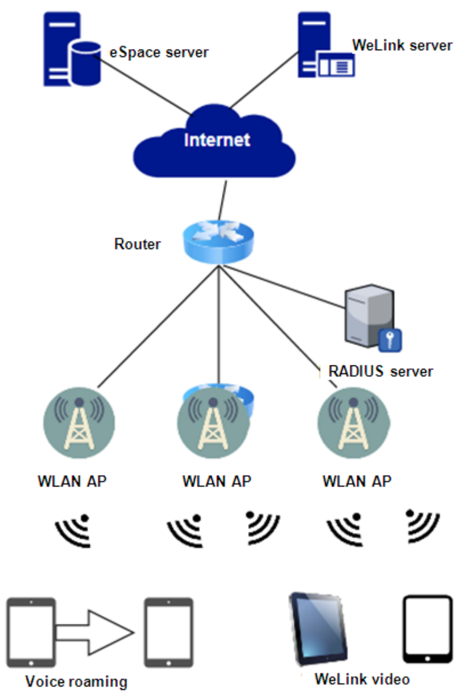
2.1 Overall Structure

In most cases, WLAN voice and video services are used in mobile office scenarios on enterprise campuses.

In AP+AC networking mode, various voice and video services exist, including inter-AP roaming voice call services on the same AC (not involving inter-AC roaming). It is required that voice and video service packets be identified and packet priorities be increased to achieve QoS scheduling and improve user experience.

In addition, visualized O&M is required for network IT personnel to learn the status and quality of voice and video services running on networks.

Figure 2-1 Networking for WLAN voice and video services

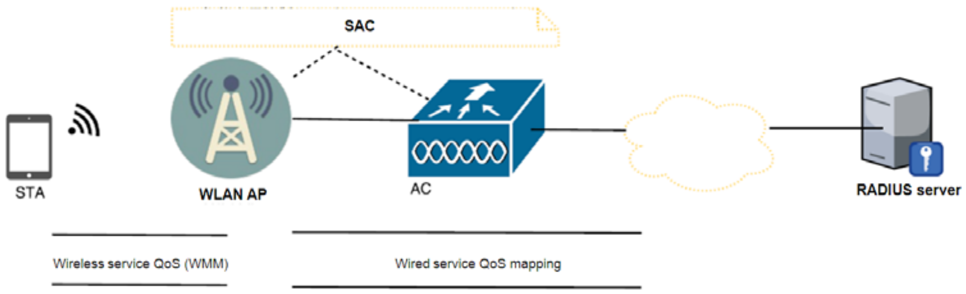


2.2 Technical Framework of the Voice and Video Enhancement Function

When no network congestion occurs on a WLAN, user experience on all services is good.

The MAC address layer of a WLAN is shared by multiple Wi-Fi terminals, and the total bandwidth of frequency bands is limited. Therefore, with the increase in the number of users and per-user service traffic volume, network congestion is inevitable. In this case, end-to-end QoS policies are critical to the WLAN. The voice and video enhancement function of WLAN devices aims to provide proper wireless network resources matching users' service traffic, and reduce the voice service delay and video data traffic loss by setting QoS priorities based on service and user types.

The voice and video enhancement function of WLAN devices is developed based on Smart Application Control (SAC) and the WLAN QoS technical framework. SAC provides service awareness capabilities, while WLAN QoS is classified into wireless service QoS (AP-STA) and wired service QoS (AP-AC). Wireless service QoS, in compliance with the IEEE 802.11e standard (WMM), provides wireless resource management and network congestion control based on user and service types. Wired service QoS, in compliance with the IEEE 802.11p standard, provides QoS mapping of wired bearer services, traffic class expediting, and dynamic multicast filtering.



3 Key Technologies

3.1 Voice and Video Service Identification

SAC is a smart engine developed by Huawei that can identify and classify application protocols. It is deployed on APs and ACs in distributed mode. SAC uses service awareness technology to identify dynamic protocols such as the Hypertext Transfer Protocol (HTTP) and Real-Time Transport Protocol (RTP) by checking Layer 4 to Layer 7 information in data packets. SAC provides a technical basis for fine-grained QoS policy control.

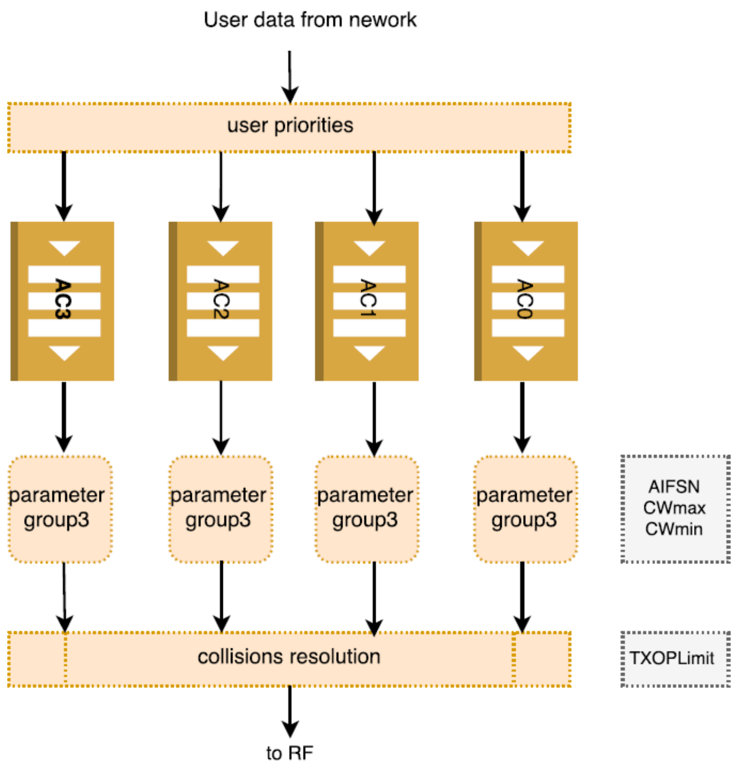
The SAC signature database of WLANs can identify the following types of voice and video services:

1. Session Initiation Protocol (SIP) voice and video
2. Voice service packets transmitted using RTP
3. Microsoft Skype4B and Lync/Skype for Business
4. Tencent QQ
5. Tencent WeChat
6. WeLink VoD
7. DingTalk

SAC is supported by all Huawei WLAN devices. For details about the technical principle, see WLAN product documentations.

3.2 Dynamic EDCA Parameter Adjustment

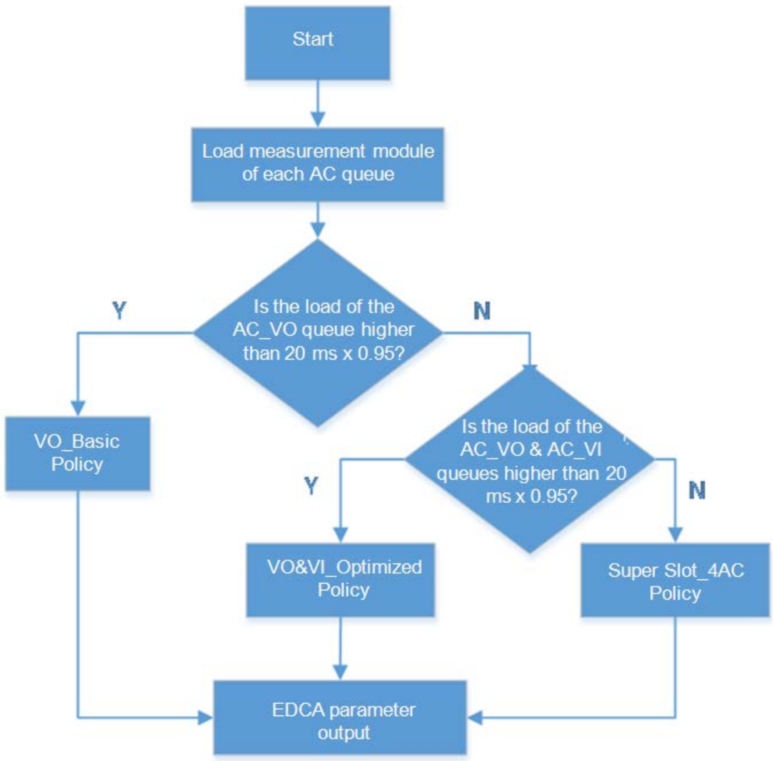
WMM defines enhanced distributed channel access (EDCA) parameters in 802.11e. EDCA classifies data packets into four access categories (ACs) in descending order of priorities: AC-voice (AC-VO), AC-video (AC-VI), AC-best effort (AC-BE), and AC-background (AC-BK). Data packets in a high-priority access category have greater capabilities in channel preemption. A set of EDCA parameters is set for each AC queue. These EDCA parameters determine the capabilities of AC queues in channel preemption. The following figure shows how AC queues preempt channels.



Parameter Name	Description
Arbitration Interframe Spacing Number (AIFSN)	In the distributed coordination function (DCF) mechanism, the DCF interframe space (DIFS) has a fixed value. WMM provides different DIFS values for different ACs. A large AIFSN value indicates that a STA must wait for a long time and has a low priority.
Exponent Form of CWmin (ECWmin) and Exponent Form of CWmax (ECWmax)	ECWmin specifies the minimum backoff time, and ECWmax specifies the maximum backoff time. They together determine the average backoff time. Large ECWmin and ECWmax values indicate that the average backoff time for a STA is long and the STA priority is low.
Transmission Opportunity Limit (TXOPLimit)	After successfully preempting a channel, a STA can occupy the channel within the period of TXOPLimit. A large TXOPLimit value indicates that the STA can occupy the channel for a long time. If the TXOPLimit value is 0, the STA can send only one data packet every time it preempts a channel.

Dynamic EDCA parameter adjustment is enabled for APs to dynamically adjust EDCA parameters of detected voice and video services. The following figure shows the dynamic EDCA parameter adjustment process.

Figure 3-1 Dynamic EDCA parameter adjustment process



The dynamic EDCA parameter adjustment process is described as follows:

1. Load measurement module of each AC queue: collects statistics on the forwarding duration of data packets to be sent in the AC queue on air interfaces for calculating the load of the AC queue to be scheduled.
2. Parameter configuration policy selection mechanism: Select a parameter configuration policy based on the weight of AC queue loads in a WLAN system.
3. Parameter configuration policy: The following parameter configuration policies are provided in a WLAN system: VO_Basic Policy, VO&VI_Optimized Policy, and Super Slot_4AC Policy.
4. By default, dynamic EDCA parameter adjustment is enabled on WLAN devices.

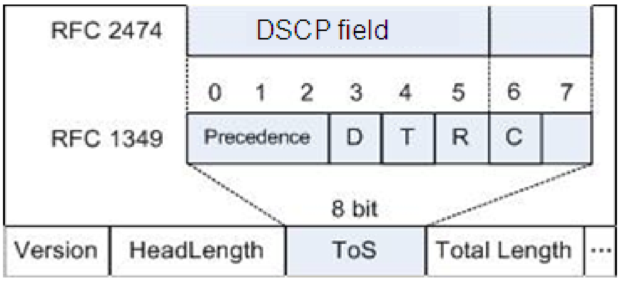
3.3 Traffic Mapping

The voice and video enhancement function defines priority mapping of users' voice and video services on networks.

Different from other data service packets, voice and video service packets are transmitted by APs carrying different QoS priorities. For example, VLAN packets carry 802.1p priorities, and IP packets carry DSCP priorities.

Priorities of VLAN frames are mapped based on the Class of Service (CoS) field in a VLAN frame header. The PRI field (802.1p priority) in a VLAN frame header identifies the QoS requirement. The PRI field defines eight transmission priorities 7, 6, 5, 4, 3, 2, 1 and 0 in descending order of priority. For example, packets with priority 7 enter queue 7, packets with priority 6 enter queue 6, and so on. The following figure shows the PRI field in a VLAN frame.

IP packets are marked by the first 3 bits (IP precedence field) or first 6 bits (DSCP field) in the Type of Service (ToS) field in an IP packet header. If the DSCP field is used to identify IP packets, IP packets can be classified into a maximum of 64 classes. The following figure shows the ToS field in an IP packet header.



The preceding describes how priorities of wired-side packets are classified and identified. When service packets from STAs are forwarded between APs and ACs, priority mapping needs to be configured to achieve QoS processing of the service packets on air interfaces and the wired side.

Table 3-1 Mapping from the DSCP priority to the 802.1p priority (CoS) and 802.11e user priority (WMM)

DSCP Priority	802.1p Priority (CoS)	802.11e User Priority (WMM)
0–7	0	0
8–15	1	1
16–23	2	2
24–31	3	3
32–39	4	4

DSCP Priority	802.1p Priority (CoS)	802.11e User Priority (WMM)
40–47	5	5
48–55	6	6
56–63	7	7

3.4 Fast Roaming Optimization

If a STA roams between APs when using voice and video services, voice and video service packets need to be processed in different ways based on the user access mode.

For example, if the user access mode of a WLAN is WPA/WPA2+PSK or WPA/WPA2+802.1X, STAs must negotiate keys with or be authenticated by a new AP when attempting to roam to it. This leads to a long roaming switchover time, a low roaming success rate, and even service interruption. Huawei WLAN devices support IEEE 802.11r, allowing for fast roaming of STAs without compromising STA access security.

The voice and video enhancement function of Huawei WLAN devices is also optimized on the basis of fast roaming in the following aspects:

1. When the user access mode of a WLAN is WPA-WPA2, fast roaming is supported if STAS' association request packets carry a pairwise master key (PMK).
2. In opportunistic key caching (OKC) based fast roaming scenarios, after a STA passes access authentication, an AC delivers a PMK to the associated AP and neighbor APs. Each time the STA roams, the AC delivers a PMK to neighbor APs. In this way, when determining that a STA is roaming, the AP to which the STA attempts to roam first checks whether the STA's PMK exists in the cache. If the cached PMK exists, a 4-way handshake process is triggered immediately. The AP waits for the AC to deliver a PMK only when the STA's PMK does not exist in the cache.

Voice and video service are delay-sensitive. The preceding measures shorten the time taken by a STA to roam to another AP.

4 Application Scenarios and Solution Highlights

4.1 Technical Highlights

The voice and video enhancement function of Huawei WLAN devices has the following highlights:

1. Supports in-service upgrade of the SAC signature database, which is not supported by Aruba.
2. Supports Tencent QQ, Tencent WeChat, WeLink VoD, and DingTalk services, which are not supported by competitors' WLAN devices.
3. Supports radio-based control of the number of voice users.
4. (Planning) Supports visualized O&M of voice and video services.

4.2 Capability Restrictions

Pay attention to the following precautions when configuring the voice and video enhancement function on Huawei WLAN devices:

1. This function can be configured in AC+Fit AP and AC＋central AP/RU networking modes. Fat, Fat central, cloud, and cloud central APs do not support this function.
2. WLANs only act as wireless communication channels for voice and video services, but do not guarantee end-to-end QoS of voice and video services.
3. Radio-based control of the number of video users is not supported.
4. In direct forwarding mode, the SAC signature database needs to be loaded on both ACs and APs.
5. Bandwidth cannot be reserved for roaming voice and video users.
6. The Wi-Fi Calling service does not support voice and video enhancement. Wi-Fi Calling is also called Voice over WiFi (VoWiFi) in the mobile carrier technical field.

5 Summary

Function	Description	Aruba	Cisco	H3C	Huawei
Voice user status monitoring	Monitoring of media service states, including voice calling, connection, and disconnection	Supports Apple FaceTime, Alcatel-Lucent New Office Environment (NOE), Microsoft Lync/Skype for Business, Cisco Jabber, Cisco Skinny Call Control Protocol (SCCP), SpectraLink Voice Priority (SVP), SIP, H.323, Vocera, and Wi-Fi Calling.	Supports SIP RFC 3261.	Not supported	Supports SIP and Microsoft Lync/Skype for Business.
WPA/WPA2 and OKC-based fast roaming	Improving mobile network access experience	Supported	Supported	N/A	Supported
Voice and video service identification enabled by default	Improving packet forwarding priorities	Supported (forwarding priority of voice packets: 46; forwarding priority of video packets: 34)	N/A	N/A	Supported
Dynamic EDCA	Improving air interface	Not supported	Not supported	Not supported	Supported

Function	Description	Aruba	Cisco	H3C	Huawei
parameter adjustment based on voice and video enhancement	performance				
Radio bandwidth reservation for voice users	Call Admission Control (CAC)	N/A	Supported	Not supported	Not supported
Voice user access control	CAC	N/A	Supported	Not supported	Supported
Radio-based control of the number of video users	CAC	N/A	Supported	Not supported	Not supported
Visualized O&M: supporting collection of statistics on the delay, jitter, packet loss, and MOS	Improving O&M capabilities	Supported	Not supported	Not supported	Supported

6 Appendix A: Acronyms and Abbreviations

Acronym or Abbreviation	Full Name	Description
AC	802.11 Access Category	
BE	Best effort	
BK	Background	
VI	Video	
VO	Voice	
TID	Traffic ID	
DCF	Distributed Coordination Function	
DSCP	Differentiated Services Code Point	
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance	
PCF	Point Coordination Function	
SIFS	Short Interframe Space	
AIFSN	Arbitrary Interframe Space Number	AIFSN determines the channel idle time.
ECWmin	Exponent form of Cwmin	ECWmin and ECWmax together determine the average backoff time.
ECWmax	Exponent form of Cwmax	ECWmin and ECWmax together determine the average backoff time.
MSDU	MAC service data unit	

Acronym or Abbreviation	Full Name	Description
802.1p		802.1p is a supplementary protocol of IEEE 802.1Q (which defines a VLAN tagging system). 802.1p and 802.1Q together enable Layer 2 network switches to provide traffic class expediting and dynamic multicast filtering. The Priority Code Point (PCP) field defines priority values 0 to 7 for differentiating traffic based on QoS and CoS of Layer 2 services. In addition, 802.1p provides the multicast traffic filtering function to ensure that traffic transmission is within the range of a Layer 2 switching network. Priorities VI (4), VO (5), BE (1), and BK (0) are mentioned in this document. Values in the quotation marks indicate priorities.
802.11e		802.11e defines QoS.
EDCA	Enhanced Distributed Channel Access	
WMM	Wi-Fi Multimedia	Through WMM, WFA defines four access categories including AC-voice (AC-VO), AC-video (AC-VI), AC-best effort (AC-BE), and AC-background (AC-BK) to optimize network communication quality and ensure stable access of corresponding applications to network resources.
QoS	Quality of Service	QoS indicates the capability of a network for providing better services for network transmission using various basic technologies. QoS is a security mechanism used to solve network problems such as delay and congestion.
RTMP	Real Time Messaging Protocol	RTMP is a protocol suite. It is a network protocol designed to implement real-time data transmission. It is developed by Adobe for public use for transmitting audio, video, and data over the Internet between a Flash player and a server.
SIP	Session Initiation Protocol	It is a multimedia communication protocol developed by the Internet Engineering Task Force (IETF).
SCCP	Skinny Call Control Protocol	SCCP is a Cisco's proprietary protocol used for communication between Cisco CallManager and VoIP phones.

Acronym or Abbreviation	Full Name	Description
WPA	Wi-Fi Protected Access	WPA is a substitute for WEP. There are four WPA authentication modes: WPA, WPA-PSK. WPA2, and WPA2-PSK. Two encryption modes are available: Advanced Encryption Standard (AES) and Temporal Key Integrity Protocol (TKIP).