INTERNET-DRAFT
Intended Status: Informational
Expires: April 17, 2014

John Kaippallimalil
Huawei
Rajesh S. Pazhyannur
Cisco
Parviz Yegani
Juniper
October 14, 2013

Mapping Wi-Fi QoS in a PMIPv6 Mobility Domain
draft-kaippallimalil-netext-pmip-qos-wifi-03

Abstract

This document provides a specification to enable end to end QoS in networks containing a Wi-Fi network coupled with a PMIPv6 mobility domain consisting of a local mobility anchor and mobility access gateway. This enables QoS policing and labeling of packets in a consistent manner on the 802.11 link between the MN and the AP as well as the link between the MAG and the LMA. To enable this, the document specifies mapping between QoS parameters on the 802.11 link and the QoS Mobility options in the PMIPv6 domain.

Table of Contents

1. Introduction

The deployment network considered here is where there is a Wi-Fi access link coupled with a PMIPv6 mobility domain. A MAG is co-located with the Access Point (AP) and in cases where the Wi-Fi network consists of Access Point and a Wireless LAN Controller (WLC), we assume that the MAG is located either at the AP or the WLC. Additionally, the Wi-Fi access network may be part of a 3GPP network. In such a case, the per user QoS Policy may be provided from the 3GPP network. Specifically, the 3GPP network may provision QoS during authorization of the user, and may also dynamically provision QoS for individual flows. [TS23.402] [TS23.273] describe the initial authorization and download of user profile, including QoS profile. In this specification we describe how end to end QoS may be established: spanning the access domain (Wi-Fi access network) and the PMIPv6 mobility domain between the MAG and the LMA. A key question from an end to end QoS standpoint is how QoS policies on the Wi-Fi access link is mapped to QoS in the PMIPv6 mobility domain and further to 3GPP QoS policies for per user/per flow.

[PMIP-QoS] defines a QoS option to enable QoS in the PMIPv6 mobility domain. The sub-options defined in the QoS option are mapped into corresponding parameters in the 3GPP specified QoS parameters. [PMIP-QoS] does not explicitly describe how the QoS signaling and QoS sub-options map into corresponding signaling and parameters in the Wi-Fi access network. This mapping is the focus of this document. The key distinction between [PMIP-QoS] and this document is that this focuses on the end-to-end flow (spanning 802.11 access and PMIPv6 domain) while [PMIP-QoS] focuses on the QoS within the PMIPv6 mobility domain. This document provides a systematic way to map to the various QoS parameters available in initial authorization, as well as setup of new sessions (such as a voice/video call). The mapping recommendations allow for proper provisioning and consistent interpretation between the various QoS parameters provided by PMIP QoS, 3GPP and 802.11.

The rest of the document is organized as follows. Chapter 2 provides an overview of the QoS mechanisms in 3GPP mobile networks and 802.11 networks. Chapter 3 describes different ways how end to end QoS with Wi-Fi admission control is achieved. Chapter 4 describes how end to end QoS without admission control is achieved.

1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

1.2. Definitions

Guaranteed Bit Rate (GBR)
: GBR in 3GPP mobile network defines the guaranteed (reserved) bit rate resources of service data flow on a connection (bearer) [TS23.203].

Aggregate Maximum Bit Rate (AMBR)
: AMBR represents the total bandwidth that all flows of a user is allowed.

Allocation Retention Priority (ARP)
: ARP is used in the mobile network to determine the order in which resources for a flow may be preempted during severe congestion or other resource limitation. ARP of 1 is the highest priority while 15 is the lowest [TS23.203].

Mean Data Rate
: In WMM, Mean Data Rate specifies the average data rate in bits per second. The Mean Data Rate does not include the MAC and PHY overheads [WMM 1.2.0].

1.3. Abbreviations

3GPP	Third Generation Partnership Project
AAA	Authentication Authorization Accounting
AMBR	Aggregate Maximum Bit Rate
ARP	Allocation and Retention Priority
AP	Access Point
DSCP	Differentiated Services Code Point
EPC	Enhanced Packet Core
GBR	Guaranteed Bit Rate
MAG	Mobility Access Gateway
MBR	Maximum Bit Rate
MN	Mobile Node
PDN-GW	Packet Data Network Gateway
QCI	QoS Class Indicator
QoS	Quality of Service
Tspec	Traffic Conditioning Spec
WLC	Wireless Controller

2. Background

2.1. QoS in 3GPP based Networks

3GPP has standardized QoS for EPC (Enhanced Packet Core) from Release 8 [TS 23.107]. 3GPP QoS policy configuration defines access agnostic QoS parameters that can be used to provide service differentiation in multi vendor and operator deployments. The concept of a bearer is used as the basic construct for which the same QoS treatment is applied for uplink and downlink packet flows between the MN (host) and gateway [TS23.402]. A bearer may have more than one packet filter associated and this is called a Traffic Flow Template (TFT). The IP five tuple (IP source address, port, IP destination, port, protocol) identifies a flow.

The access agnostic QoS parameters associated with each bearer are QCI (QoS Class Identifier), ARP (Allocation and Retention Priority), MBR (Maximum Bit Rate) and optionally GBR (Guaranteed Bit Rate). QCI is a scalar that defines packet forwarding criteria in the network. Mapping of QCI values to DSCP is well understood and GSMA has defined standard means of mapping between these scalars [GSMA-IR34].

In a 3GPP radio network, priority and packet delay budget in QCI determines the policy used for rate-shaping, scheduling and queue management. The ARP is used to determine if a connection session request should be allowed (e.g. insufficient radio resource) and the order in which flows should be pre-empted in case of severe congestion.

An MN may have more than one IP addresses associated with the same hardware (MAC) address corresponding to each of the networks than it is attached to. This corresponds to more than one PMIP mobility session for which QoS is provisioned in the WLC.

2.2. QoS in PMIPv6 Mobility domain

[PMIP-QoS] defines a mobility option that can be used by the mobility entities in the Proxy Mobile IPv6 domain to exchange Quality of Service parameters associated with a subscriber's IP flows. Using the QoS option, the local mobility anchor and the mobile access gateway can exchange available QoS attributes and associated values. This enables QoS policing and labeling of packets to enforce QoS differentiation on the path between the local mobility anchor and the mobile access gateway.

2.3. QoS in IEEE 802.11 based Networks

IEEE 802.11-2012 [802.11-2012] provides an enhancement of the MAC layer in WiFi networks to support QoS--EDCA (Enhanced Distributed Channel Access). EDCA uses a contention based channel access method.

The EDCA mechanism provides differentiated, distributed access using eight different UPs (User Priorities). EDCA also defines four access categories (AC) that provide support for the delivery of traffic. In EDCA, the random back-off timer and arbitration inter-frame space is adjusted according to the QoS priority. Frames with higher priority AC have shorter random back-off timers and arbitration inter-frame spaces. Thus, there is a better chance for higher priority frames to be transmitted. The Wi-Fi Alliance has created a specification referred to as WMM (Wi-Fi Multimedia) based on above.

In addition to the above, QoS can also be provided using admission control. The MN uses ADDTS (Add Traffic Specs) to setup a traffic stream between itself and the AP, and DELTS to delete that stream. In WMM [WMM 1.2.0], the AP advertises if admission control is mandatory for an access class. Admission control for best effort or background access classes is not recommended. The Wi-Fi Alliance has created a specification referred to as WMM-AC (Wi-Fi Multimedia Admission Control) based on the above.

3. End-to-End QoS with Admission Control

This section outlines a few use cases to illustrate how the parameters and mapping in section 4 are applied. These cases are not expected to be exhaustive.

There are two main types of interaction possible to provision QoS - one is where the UE initiates the QoS request and the network provisions the resources. The second is where the network provisions resources as a result of some out of band signaling (like application signaling). In this scenario, if the MN supports 802.11aa (TCLAS), the network can push the QoS configuration to the MN. If the MN only supports WMM QoS, then MN requests for QoS for the WiFi segment and the MAG provisions based on QoS already provisioned for the MN.

3.1. Case A: MN Initiated QoS Signaling

When an MN sets up a connection that requires admission control in the WiFi network, the level of QoS for the connection needs to be set up. When the MN is configured (e.g. in SIM, subscription) to start the QoS signaling, it sends an ADDTS request indicating the QoS required for the connection. The AP/WLC (MAG) obtains the corresponding level of QoS to be granted to the flow by sending a PMIPv6 PBU message with QoS options to the LMA. Details of the setup are described below.

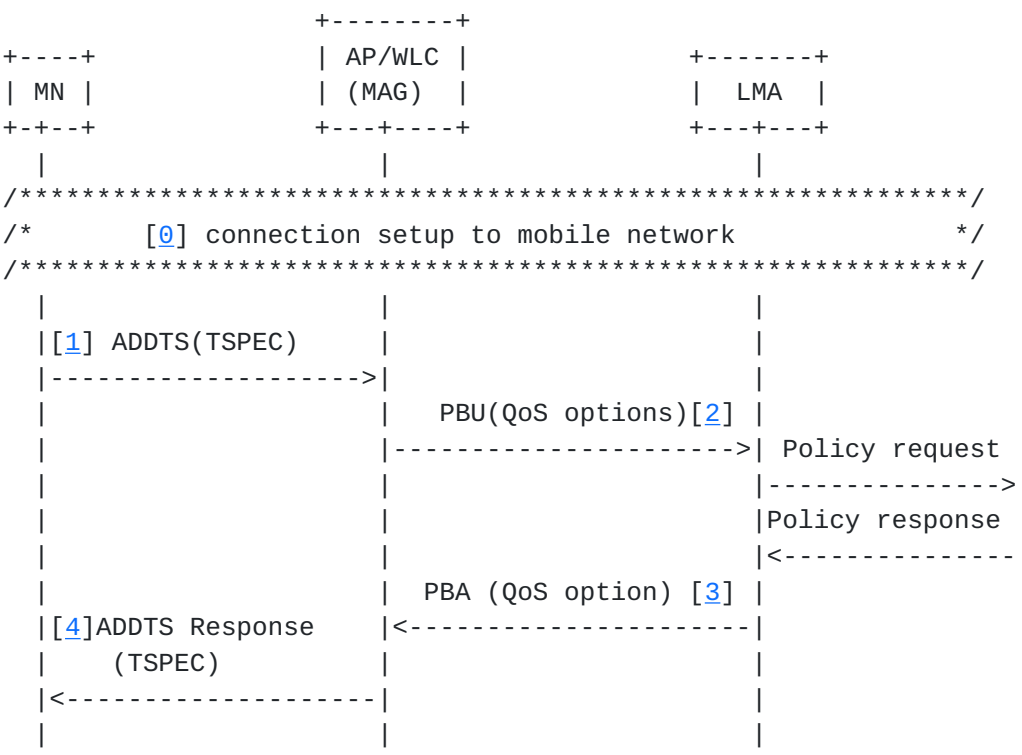


Figure 1: MN initiated QoS setup

[0] The MN starts signaling to setup the connection. In mobile networks, these are not default connections that are setup initially. Default connections are best effort and do not need explicit admission control with ADDTS.

[1] If the MN and network support 802.11aa and the MN is configured to start QoS signaling, the MN sends an ADDTS request specifying the QoS requested for the traffic stream including TSPEC element with connection setup identifier.

[2] The MAG (AP/WLC) identifies the PMIP based on the connection identifier and sends a PBU with QoS options requested.

[3] The LMA responds with the authorized QoS for the connection.

[4] The AP/WLC (MAG) provisions the corresponding QoS and replies with ADDTS Response containing authorized QoS in TSPEC.

3.2. Case B: Network Initiated QoS Signaling (802.11aa based)

When an MN has connections or flows that require admission control, the mobile network may provision correspond QoS in the MAG. This use case illustrates how an MN and WiFi network that supports 802.11aa

can provision QoS to the MN. In this case, the network is configured to start the QoS signaling, it sends an ADDTS request indicating the QoS required for the connection.

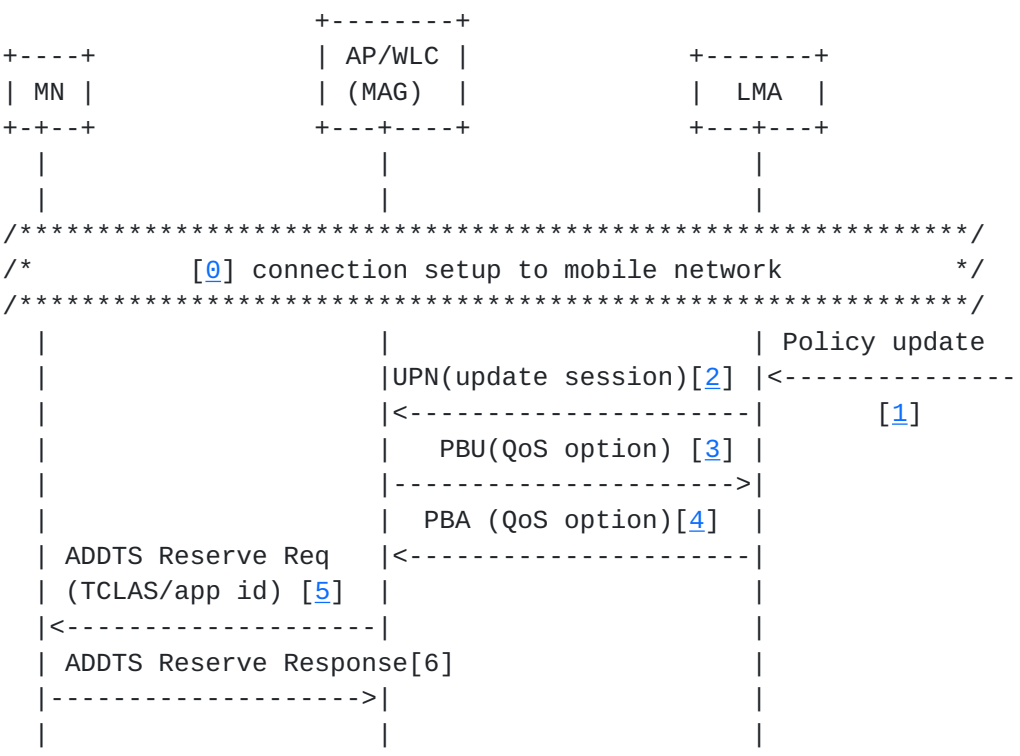


Figure 2: Network initiated QoS setup with 802.1aa

[0] The MN starts signaling to setup the connection. In mobile networks, these are not default connections that are setup initially. Default connections are best effort and do not need explicit admission control with ADDTS.

[1] The LMA gets a QoS policy update for an existing connection.

[2] LMA sends a PMIP UPN (Update Notification) message to the MAG requesting it to update session parameters.

[3] The MAG (AP/WLC) replies to UPN with a PBU including QoS options.

[4] The LMA responds with the authorized QoS for the connection.

[5] If the MN and network support 802.11aa, the AP/WLC (MAG) sends an ADDTS Reserve Request specifying the QoS reserved for the traffic stream including TSPEC and TCLAS element with the connection identifier (from PMIP).

[6] The MN notes the QoS reserved in the network and replies with ADDTS Reserve Response.

3.3. Case C: Hybrid (Network Initiated for PMIPv6 and MN initiated for Wi-Fi)

This example outlines a scenario where an MN attaches to the WiFi and then obtains services in the mobile network. When the MN attaches, PMIP signaling between the MAG and LMA establishes mobile connection and related QoS. Subsequently, the MN starts an application that requires dedicated bandwidth resources and signals that using TSPEC/ADDTS request. The details of this sequence are described below.

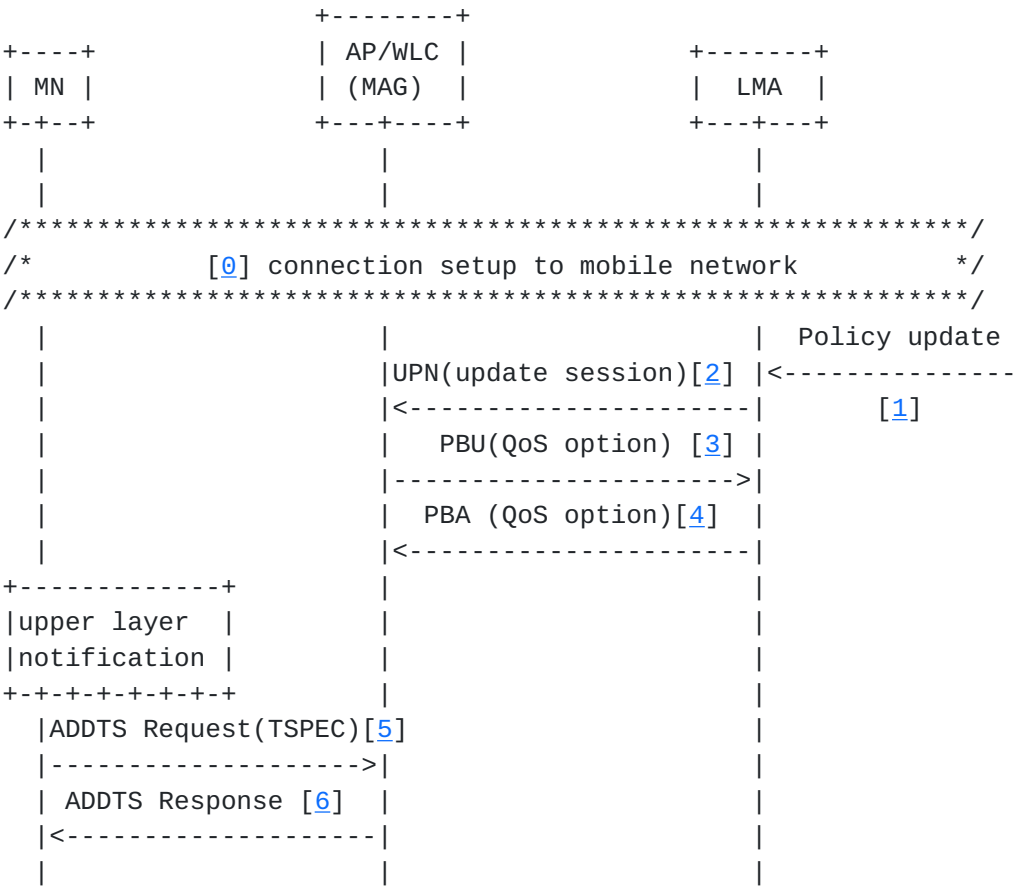


Figure 3: Network initiated QoS setup with WMM

[0] The MN starts signaling to setup the connection. In mobile networks, these are not default connections that are setup initially. Default connections are best effort and do not need explicit admission control with ADDTS.

[1] The LMA gets a QoS policy update for an existing connection.

[2] LMA sends a PMIP UPN (Update Notification) message to the MAG requesting it to update session parameters.

[3] The MAG (AP/WLC) replies to UPN with a PBU including QoS options.

[4] The LMA responds with the authorized QoS for the connection. Since the MAG or MN does not support 802.11aa, the MAG updates QoS profile of MN and waits for request from MN.

[5] When the MN receives upper layer signaling (e.g. SDP) indicating acceptance of codec or other media parameters, the MN requests for corresponding QoS in TSPEC of ADDTS Request.

[6] When the(AP/WLC (MAG) receives the ADDTS Request from MN, it checks the QoS profile for the MN to see if the additional QoS requested for the stream is consistent with the QoS profile stored for the MN. The AP/WLC then responds with ADDTS Response.

3.4. Mapping of Connection Parameters

This section outlines the handling of QoS connection (session) parameters between WiFi 802.11 and PMIP QoS.

Connection Mapping:

802.11 QoS in TSPEC is used to reserve QoS for a traffic stream (MN MAC, TS(Traffic Stream) id). The QoS reservation is for 802.11 frames and here is no IP prefix/flow associated during this reservation. The AP/WLC evaluates this request against policy installed using PMIP QoS. When PMIP QoS policy is installed in AP/WLC, the TSPEC request is granted if the MN (identified by MAC) is authorized. The AP/WLC may police subsequent flows with {MAC, TS, 802.1D, IP prefix} to match QoS policy installed by PMIP QoS for {IP prefix, DSCP}.

QoS Class:

802.11 QoS Access Class (AC_VO, AC_VI) requests corresponds to DSCP in PMIP QoS setup. Table 1 (section 4.1) below shows the complete mapping.

Bandwidth:

For flows with reservation, the 802.11 Mean Data Rate should be

equal to (or less than) Guaranteed Bit Rate (GBR). If the MN requests Mean Data Rate in ADDTS greater than GBR, then AP/WLC should deny the request in ADDTS Response.

For flows with no reservation, the bandwidth should not exceed MBR (Maximum Bit Rate). If such a flow is offloaded at AP/WLC, the policy obtained during authorization is used.

The total bandwidth used by all flows of an MN should not exceed AMBR (Aggregate Maximum Bit Rate).

Preemption Priority:

Mobile networks configure ARP (Allocation Retention Priority) during authorization and in [PMIP QoS]. If there is limited resource and multiple ADDTS requests, ARP should be used by the AP/WLC to determine which requests to grant. ARP has a range 1 to 15 with 1 being the highest priority [TS23.203].

During severe congestion or partial failure, if the AP/WLC has to preempt existing reservations, ARP may be used to determine the order of preemption.

3.5. Service Guarantees in 802.11

The GBR - Guaranteed Bit Rate in mobile networks are used to request and commit resources in the network for providing the bandwidth requested. In WiFi networks, a random backoff timer based on the access class only provides priority access to a shared medium. These mappings and recommendations allow the AP to schedule resources in a fair manner based on subscribed QoS and application request/policy server interaction.

However, there are no guaranteed or committed resources in the WiFi network - only prioritization that gives better opportunity for frames to compete for a shared medium.

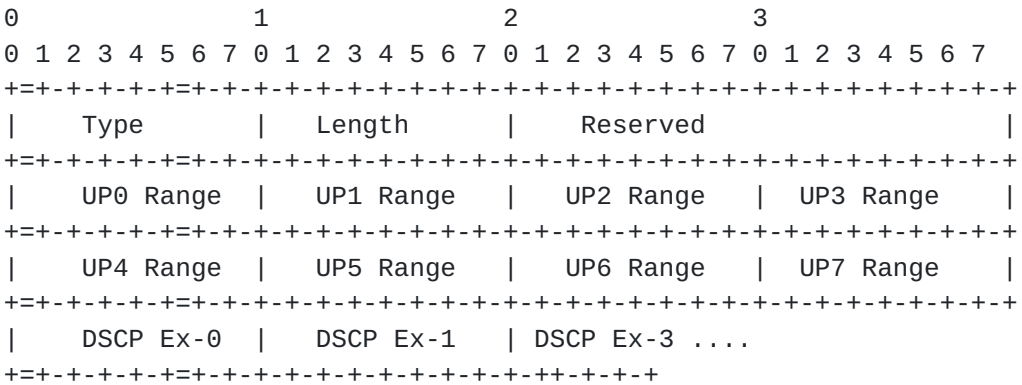
It should also be noted that unlike mobile networks which inform the MN about QoS for established or modified connections (bearers), there is no means for an MN in WiFi networks to find out the QoS that a policy server requests to be granted. Thus, the application in MN should make its determination to downgrade a request based on SDP and media parameters to downgrade to a lower quality.

4. End-to-End QoS without Admission Control

GSMA and IETF (RFC 4594) have defined mapping between DSCP and IEEE 802.11 UP (user Priority). The MAG could be pre-configured to use the mapping from one of these specifications. Per MN connection configuration may be setup at the AP/WLC based by PMIP QoS signaling during connection setup. This is described in [PMIP QoS], section 3.5.

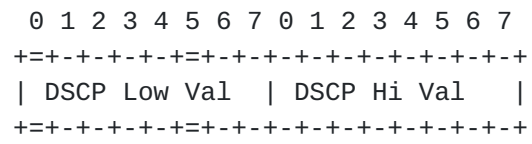
However, in many cases it may be beneficial to use a different set of mapping and potentially different mappings for different users. For example an operator may choose to provide only best effort service to one subscriber class while providing more enhanced (AF or EF) services to other subscriber classes. To enables such capabilities, a QoS Service Attribute called QoS MAP Set is introduced. This is modeled after an IEEE 802.11 element with the same name (see 8.4.2.97 in IEEE 802.11-2012).

The QoS Map Set attribute is used as follows. The LMA would send a specific DSCP to UP mapping in the Proxy Binding Update. In cases where the MAG is co-located with the AP, AP/MAG can ensure that received packets from the mobile node have the the correct DSCP to UP mapping(packets with inappropriate marking may be remarked). Similarly, on the downstream, the QoS Map Set enables the MAG/AP to determine the correct UP. This also ensures that a source ineligible for higher grades of service (provided by higher priority UP bits) cannot avail of such a service by marking the packets with DSCP values (for example by marking the packets with EF and AF codepoints). There is an additional benefit of providing the AP/MAG with the QoS Map Set. For mobile nodes that support the IEEE 802.11 QoS Map Set capability, the AP can provide the corresponding QoS Map Set information to the mobile node. This can ensure that the mobile node uses the correct DSCP to UP marking.

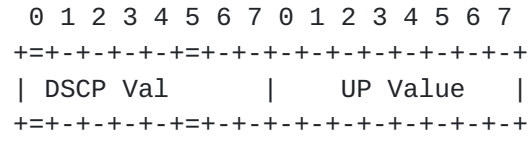


Type: TBD Length: Length of the following data value in octets, greater than or equal to 10.

The format of UP0,..,UP7 Range is as follows



The format of the DSCP Exception field is as follows



4.1. Default Values and Recommendations

The table below outlines a recommended mapping between 3GPP QCI, and 802.11 Access Category (AC)/ 802.1D UP.

QCI	DSCP	802.1D UP	WMM AC	Example Services
1	EF	6(VO)	3 AC_VO	conversational voice
2	EF	6(VO)	3 AC_VO	conversational video
3	EF	6(VO)	3 AC_VO	real-time gaming
4	AF41	5(VI)	2 AC_VI	buffered streaming
5	AF31	4(CL)	2 AC_VI	IMS signaling
6	AF32	4(CL)	2 AC_VI	buffered streaming
7	AF21	3(EE)	0 AC_BE	interactive gaming
8	AF11	1(BE)	0 AC_BE	web access
9	BE	0(BK)	1 AC_BK	e-mail

Table 1: QoS Mapping between QCI/DSCP, 802.1D UP, WMM AC

The QoS mapping table above provides recommendations and default mapping between DSCP provided in [PMIP QoS], WMM AC used for TSPEC reservation, and 802.1D UP in 802.11 frames.

5. Security Considerations

This document describes mapping of 3GPP QoS profile and parameters to IEEE 802.11 QoS parameters. No security concerns are expected as a result of using this mapping.

6. IANA Considerations

No IANA assignment of parameters are required in this document.

7. References

7.1. Normative References

[KEYWORDS] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC1776] Crocker, S., "The Address is the Message", RFC 1776, April 1 1995.

[TRUTHS] Callon, R., "The Twelve Networking Truths", RFC 1925, April 1 1996.

7.2. Informative References

[EVILBIT] Bellovin, S., "The Security Flag in the IPv4 Header", RFC 3514, April 1 2003.

[RFC5513] Farrel, A., "IANA Considerations for Three Letter Acronyms", RFC 5513, April 1 2009.

[RFC5514] Vyncke, E., "IPv6 over Social Networks", RFC 5514, April 1 2009.

[PMIP-QoS] Liebsch, et al., "Quality of Service Option for Proxy Mobile IPv6", draft-ietf-netext-pmip6-qos-00, June 2012.

[WMM 1.2.0] Wi-Fi Multimedia Technical Specification (with WMM-Power Save and WMM-Admission Control) Version 1.2.0

[802.11aa] Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification, Amendment 2: MAC Enhancements for Robust Audio Video Streaming, IEEE 802.11aa-2012.

[802.11-2012] 802.11-2012 - IEEE Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

[GSMA-IR34]Inter-Service Provider Backbone Guidelines 5.0, 22 December 2010

[RFC 2211] Wroclawski, J., "Specification of the Controlled Load Quality of Service", RFC 2211, September 1997.

[RFC 2212] Shenker, S., Partridge, C., and R. Guerin, "Specification of Guaranteed Quality of Service", RFC 2212, September 1997.

[RFC 2216] Shenker, S., and J. Wroclawski, "Network Element QoS Control Service Specification Template", RFC 2216, September 1997.

[TS23.107] Quality of Service (QoS) Concept and Architecture, Release 10, 3GPP TS 23.107, V10.2.0 (2011-12).

[TS23.207] End-to-End Quality of Service (QoS) Concept and Architecture, Release 10, 3GPP TS 23.207, V10.0.0 (2011-03).

[TS23.402] Architecture Enhancements for non-3GPP accesses(Release 12), 3GPP TS 23.402, V12.2.0 (2013-09).

[TS23.203] Policy and Charging Control Architecture, Release 11, 3GPP TS 23.203, V11.2.0 (2011-06).

[TS29.212] Policy and Charging Control over Gx/Sd Reference Point, Release 11, 3GPP TS 29.212, V11.1.0 (2011-06).

[TS29.273] 3GPP EPS AAA interfaces(Release 12), 3GPP TS 29.273 v12.1.0 (2013-09)

Authors' Addresses

John Kaippallimalil
5340 Legacy Drive, Suite 175
Plano, Texas 75024

E-Mail: john.kaippallimalil@huawei.com

Rajesh Pazhyannur
170 West Tasman Drive
San Jose, CA 95134

E-Mail: rpazhyan@cisco.com

Parviz Yegani
1194 North Mathilda Ave.
Sunnyvale, CA 94089-1206

E-Mail: pyegani@juniper.net

Appendix A: QoS Policy Architecture

The QoS architecture in this section provides a brief outline for provisioning QoS in a consistent manner across the WiFi network, backhaul and PMIP mobile network.

QoS information is available to AP/WLC when the MN attaches to the WiFi network and authenticates. The authorization profile includes QoS that the user/MN has subscribed to. When the MN attaches to the network, the LMA returns the session parameters such as IP address and may also include QoS profile as per [PMIP-QoS].

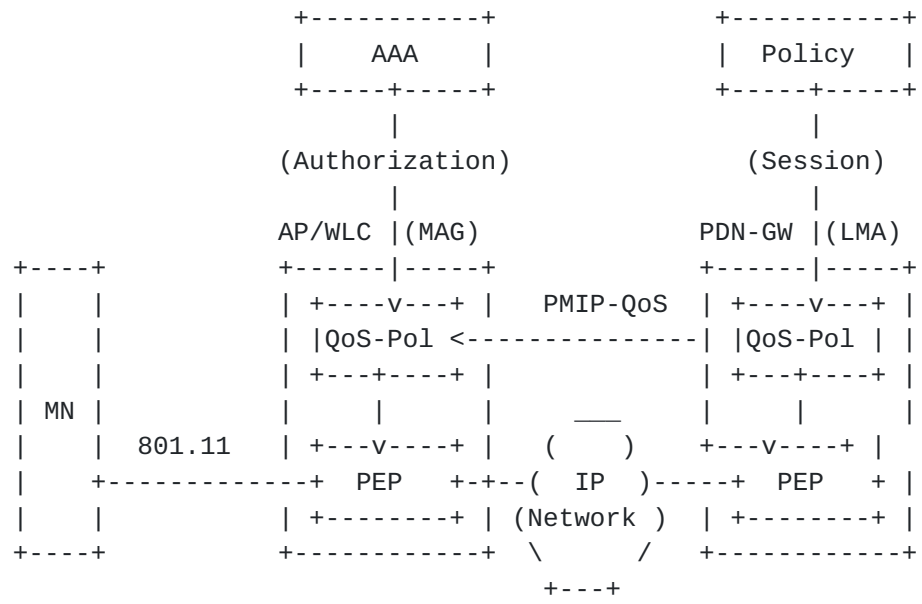


Figure 4: Architecture for provisioning QoS Policy on WiFi AP

Figure 4 provides an overview of the architecture in which QoS for an MN is provisioned on the AP/WLC. MN QoS policy from initial authorization and PMIP connection establishment is provisioned in the AP/WLC QoS-Pol (logical function). AP/WLC PEP uses the policies for handling QoS flows from an MN.

Policy Server provisioning of Admission control for connections has traditionally relied on information from Deep Packet Inspection (DPI) or Application Level Gateways (ALG). DPIs and ALGs cannot however determine the MNs subscribed bandwidth or QoS. The alternative is to provision QoS policy for a user's connections and use subscribed policy and PMIP QoS policy. When the AP/WLC has both the subscribed QoS policy and policy parameters from PMIP QoS, the QoS parameters obtained through PMIP reflect the policy that accounts for current network conditions.

In mobile networks, default connections are not setup with a bandwidth reservation and hence do not have a GBR (Guaranteed Bit Rate) associated. However, the PDN-GW (LMA) polices the AMBR (Aggregate Maximum Bandwidth Rate) - the maximum bit rate for all flows to/from the MN. Thus, upstream traffic should be policed by AP/WLC to not exceed the maximum prescribed in AMBR values. The AP/WLC should also schedule traffic for these connections as background or best effort (AC_BK, AC_BE) and the corresponding 802.1D

For voice, video and other applications that require reservation of QoS resources, a dedicated PMIP connection is setup in mobile networks and the PDN-GW (LMA) reserves resources as per GBR (Guaranteed Bit Rate) for upstream and downstream. In this also, the total bit rate of all flows to/from MN should not exceed the maximum bit rates in AMBR (Aggregate Maximum Bit Rate). Upstream and downstream traffic should be scheduled by MN and AP/WLC using ADDTS (TSPEC) for voice or video (AC_VO, AC_VI). The MN should also include the Mean Data Rate for the connection based on the requirements of the application or negotiated codec. The AP/WLC grants resources based on policy obtained over PMIP QoS. GBR values in PMIP QoS should be used to derive Mean Data Rate as described in section 4.1. When the MN completes the session, it may send DELTS to request release of associated QoS resources.

If the MN connection is offloaded to the internet by the AP/WLC, there is no corresponding PMIP session setup to the mobile network. In this case, the AP/WLC may use AMBR obtained during authorization if the MN has no other connections to the mobile network. If the MN has other connections to the mobile network, he AP/WLC should limit the maximum bit rate of all flows of the MN to AMBR obtained in PMIP QoS.

When the network is congested and the AP/WLC cannot grant the QoS requested by MN, the AP/WLC should refuse the ADDTS request and not continue the PMIP QoS signaling request. The application in MN may downgrade the codec and re-negotiate a new TSPEC/resource request that the AP/WLC may grant. If the AP/WLC cannot handle committed

connections due to network degradation or other partial failures, the AP/WLC may use the ARP (Allocation Retention Priority) values of the connection to gracefully release resources.