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Mapping PMIPv6 QoS Procedures with WLAN QoS procedures
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Abstract

This document provides guidelines for achieving end to end Quality-of-Service (QoS) in a Proxy Mobile IPv6 (PMIPv6) domain where the access network is based on IEEE 802.11. RFC 7222 describes QoS negotiation between a Mobility Access Gateway (MAG) and Local Mobility Anchor (LMA) in a PMIPv6 mobility domain. The negotiated QoS parameters can be used for QoS policing and marking of packets to enforce QoS differentiation on the path between the MAG and LMA. IEEE 802.11-2012, Wi-Fi Multimedia - Admission Control (WMM-AC) describes methods for QoS negotiation between a Wi-Fi Station (MN in PMIPv6 terminology) and an Access Point. This document provides a mapping between the above two sets of QoS procedures and the associated QoS parameters. This document is intended to be used as a companion document to RFC 7222 to enable implementation of end to end QoS.

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Table of Contents

1. Introduction 3
1.1. Terminology 4
1.2. Abbreviations 4
1.3. Definitions 5
2. Overview of IEEE 802.11 QoS 5
3. Mapping QoS Procedures between IEEE 802.11 and PMIPv6 6
3.1. MN Initiated QoS Service Request 6
3.1.1. MN Initiated QoS Service Request 6
3.1.2. MN Initiated QoS De-allocation Request 9
3.2. LMA Initiated QoS Service Request 11
3.2.1. LMA Initiated QoS Reservation Request 11
3.2.2. Discussion on QoS Request Handling with IEEE 802.11aa . 11
3.2.3. LMA Initiated QoS De-allocation Request 12
4. Mapping between IEEE 802.11 QoS and PMIPv6 QoS Parameters . . . 14
4.1 Connection Parameters 14
4.2 QoS Class 15
4.3 Bandwidth 16
5. Security Considerations 17
6. IANA Considerations 17
7. Acknowledgements 17
8. References 18
8.1. Normative References 18
8.2. Informative References 18
Authors' Addresses 19
APPENDIX A: LMA Initiated QoS Service Flow with IEEE 802.11aa . . 20

1. Introduction

[RFC 7222] describes an access network independent way to negotiate Quality-of-Service (QoS) for Proxy Mobile IPv6 (PMIPv6) mobility sessions. IEEE 802.11, Wi-Fi Multimedia (WMM), Wi-Fi Multimedia - Admission Control (WMM-AC) describe ways to provide QoS for Wi-Fi traffic between the Wi-Fi Station (STA) and Access Point (AP). This document describes how QoS can be implemented in a network where the access network is based on IEEE 802.11 (Wi-Fi). It requires a mapping between QoS procedures and information elements in two segments 1) Wi-Fi segment and 2) PMIPv6 segment (see Figure 1). The recommendations here allow for dynamic QoS policy information per Mobile Node (MN) and session to be configured by the IEEE 802.11 access network. PMIPv6 QoS signaling between Mobility Access Gateway (MAG) and Local Mobility Anchor (LMA) provisions the per MN QoS policies in the MAG. Further details on policy configuration and PCF (Policy Control Function) can be found in [RFC 7222], section 6.1. In the IEEE 802.11 access network modeled here, the MAG is located at the Access Point (AP)/ Wireless LAN Controller (WLC). Figure 1 below provides an overview of the entities and protocols.

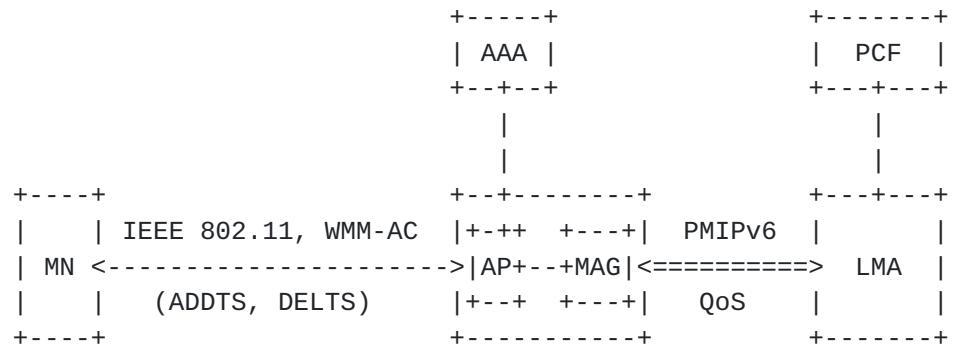


Figure 1: End-to-End QoS in Networks with IEEE 802.11 Access

MN and Access Point AP use IEEE 802.11 QoS mechanisms to setup QoS flows in the Wi-Fi segment. The MAG and LMA setup QoS flows using PMIPv6 QoS procedures. The protocols and mechanisms between AP and MAG are out of scope of this document. Some implementations may have AP and MAG in the same network node. However, this document does not exclude various deployments including those where AP and WLC are separate nodes, or the MAG control and data planes are separate.

The recommendations in this document use IEEE 802.11 QoS and PMIPv6 QoS [RFC 7222] mechanisms. State machines for QoS policy setup in IEEE 802.11 and PMIPv6 operate differently. Guidelines for installing QoS in the MN using 802.11 and PMIPv6 segments, and for mapping parameters between them are outlined below.

- Procedure Mapping:
  PMIPv6 [RFC 7222] defined procedures for QoS setup maybe triggered by the LMA or MAG. IEEE 802.11 QoS setup on the other hand is always triggered by the MN (IEEE 802.11 QSTA). The end-to-end QoS setup across these network segments should accommodate both network triggered and end-user triggered QoS.

- Parameter Mapping:
  There is no systematic method of mapping of specific parameters between PMIPv6 QoS parameters and IEEE 802.11 QoS. For example, parameters like Allocation Retention Priority (ARP) in PMIPv6 QoS have no equivalent in IEEE 802.11.

The rest of the document is organized as follows. Section 2 provides an overview of IEEE 802.11 QoS. Section 3 describes a mapping of QoS signaling procedures between IEEE 802.11 and PMIPv6. The mapping of parameters between IEEE 802.11 and PMIPv6 QoS is described in Section 4.

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 [RFC 2119].

1.2. Abbreviations

AAA	Authentication Authorization Accounting
AC	Access Category
ADDTS	ADD Traffic Stream
AMBR	Aggregate Maximum Bit Rate
ARP	Allocation and Retention Priority
AP	Access Point
DELTS	DELete Traffic Stream
DSCP	Differentiated Services Code Point
EPC	Enhanced Packet Core
GBR	Guaranteed Bit Rate
MAG	Mobility Access Gateway
MBR	Maximum Bit Rate
MN	Mobile Node
PCF	Policy Control Function
QCI	QoS Class Indicator
QoS	Quality of Service
STA	Station
TC	Traffic Class
TCLAS	Type Classification
TSPEC	Traffic Conditioning Spec
WLC	Wireless Controller

1.3. Definitions

Peak Data Rate
: In WMM, Peak Data Rate specifies the maximum data rate in bits per second. The Maximum Data Rate does not include the MAC and PHY overheads [WMM 1.2.0]. IP packet including header is included in the data rate.

  TSPECs for both uplink and downlink may contain Peak Data Rate

Mean Data Rate
: This is the average data rate in bits per second. The Mean Data Rate does not include the MAC and PHY overheads [WMM1.2.0]. IP packet including header is included in the data rate.

  TSPECs for both uplink and downlink must contain the Mean Data Rate.

Minimum Data Rate
: In WMM, Minimum Data Rate specifies the minimum data rate in bits per second. The Minimum Data Rate does not include the MAC and PHY overheads [WMM 1.2.0]. IP packet including header is included in the data rate.

  Minimum Data Rate is not used in QoS provisioning described here.

STA
: A station (STA) is a device that has the capability to use the 802.11 protocol. For example, a station maybe a laptop, a desktop PC, PDN, access point or WiFi phone [802.11-2012].

TSPEC
: The TSPEC element in IEEE 802.11 contains the set of parameters that define the characteristics and QoS expectations of a traffic flow [802.11-2012].

TCLAS
: The TCLAS element specifies an element that contains a set of parameters necessary to identify incoming MSDU (MAC Service Data Unit) that belong to a particular TS (Traffic Stream) [802.11-2012].

2. Overview of IEEE 802.11 QoS

IEEE 802.11-2012 defines a way of providing prioritized access for different traffic classes (video, voice, etc) by a mechanism called EDCA (Enhanced Distributed Channel Access). The levels of priority in EDCA are called access categories (ACs) and there are four levels

(in decreasing order of priority): Voice, Video, Best-Effort, Background. The prioritized access is achieved by using access category specific values for contention window (CW) and arbitration inter frame space (AIFS). (Higher priority categories have smaller values for minimum and maximum CW and AIFS.).

A subset of the QoS mechanisms is defined in WMM - a Wi-Fi Alliance certification of support for a set of features from an 802.11e draft (now part of IEEE 802.11). This certification is for both clients and APs, and certifies the operation of WMM. WMM is primarily the implementation of the EDCA component of 802.11e. WMM uses the 802.1P classification scheme developed by the IEEE (which is now a part of the 802.1D specification). The 802.1P classification scheme has eight priorities, which WMM maps to four access categories: AC_BK, AC_BE, AC_VI, and AC_VO. The lack of support in WMM for the TCLAS (used in identifying an IP flow) has an impact on the QoS provisioning. The impact is described in chapters 3 and 4 for WMM based QoS provisioning.

IEEE 802.11 defines the way a (non-AP) STA can request QoS to be reserved for an access category. Correspondingly, the AP can determine whether to admit or deny the request depending on the available resources. Further, the AP may require that Admission Control is mandatory for an access category. In such a case, the STA is expected to use the AC only after being successfully admitted. WMM-AC is a Wi-Fi Alliance certification of support for admission control based on a set of features in IEEE 802.11.

The QoS signaling in IEEE 802.11-2012 is initiated by the (non-AP) STA (by sending an ADDTS request). This specification references procedures in IEEE 802.11-2012, WMM and WMM-AC.

3. Mapping QoS Procedures between IEEE 802.11 and PMIPv6

There are two main types of interaction possible to provision QoS for flows that require admission control - one where the MN initiates the QoS request and the network provisions the resources. The second is where the network provisions resources as a result of PMIP QoS request. In the second scenario, the LMA can push the QoS configuration to the MAG. However, there are no standards defined way for the AP to initiate a QoS service request to the MN. Recommendations to setup QoS in both these cases are described in this section.

3.1. MN Initiated QoS Service Request

3.1.1. MN Initiated QoS Service Request

This procedure outlines the case where the MN is configured to start the QoS signaling. In this case, the MN sends an ADDTS request indicating the QoS required for the flow. The AP/MAG obtains the corresponding level of QoS to be granted to the flow by PMIPv6 PBU/PBA sequence with QoS options exchanged with the LMA. Details of the QoS provisioning for the flow are described below.

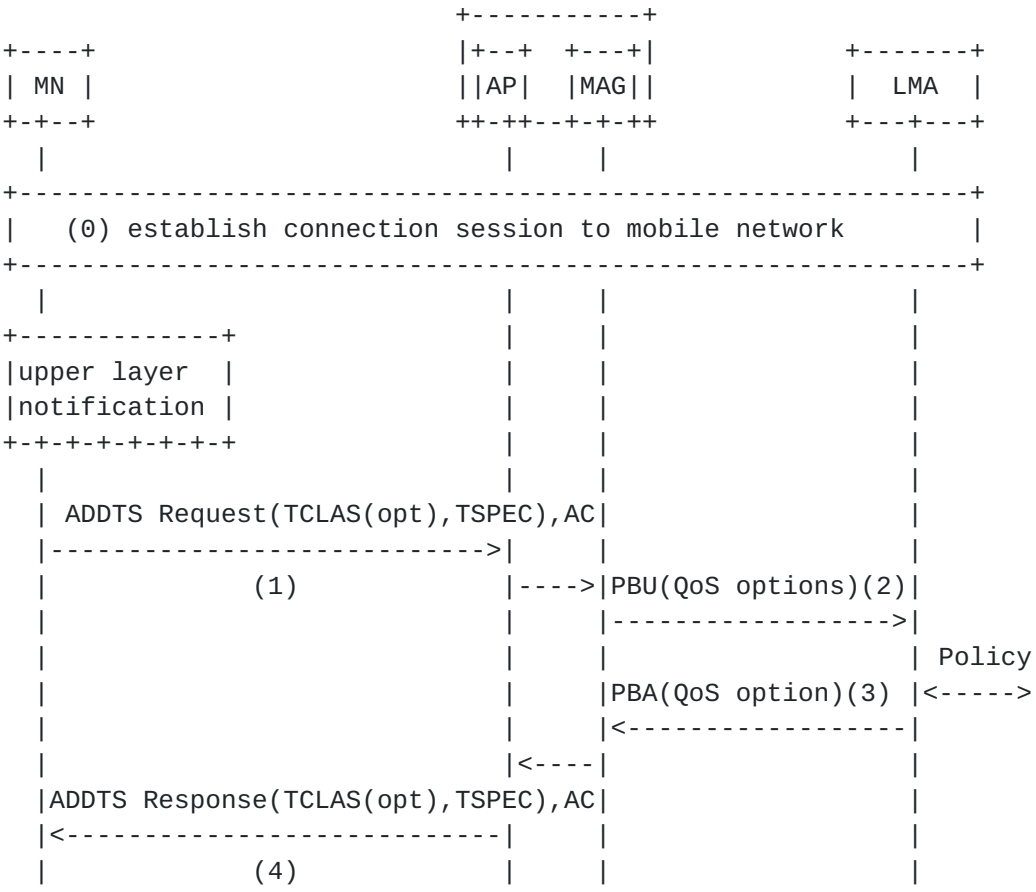


Figure 2: MN initiated QoS service request

In this use case shown in Figure 2, the MN initiates the QoS service request.

(0) The MN establishes a connectivity session as described in [RFC 7222], section 3.1, MAG-initiated QoS service request, steps 1-4. At this point, a connection with PMIPv6 tunnel is established to the LMA. This allows the MN to start application level signaling.

(1) The trigger for MN to request QoS is an upper layer notification. This may be the result of end-to-end application signaling and setup procedures (e.g. SIP).

Since the MN is configured to start QoS signaling, it sends an

ADDTS request with TSPEC and TCLAS identifying the flow for which QoS is requested.

It should be noted that WMM-AC specifications do not contain TCLAS. When TCLAS is not present, there is no direct way to derive flow specific attributes like Traffic Selector in PMIPv6. In this case functionality to derive IP flow details from information in upper layer protocols (e.g., SIP) and associate to subsequent QoS request may be used. This is not described further here, but it maybe functionality in an Application Layer Gateway (ALG) or Deep Packet Inspection (DPI). It should be noted that an ALG or DPI can increase the complexity of the AP/MAG implementation and affect its scalability. If no TCLAS is derived, the reservation applies to all flows of the MN (not desired). Parameter mapping in this case is shown in Table 2.

(2) If there are sufficient resources at the AP/WLC to satisfy the request, the MAG sends a PBU with QoS options, operational code ALLOCATE and Traffic Selector identifying the flow. The Traffic selector is derived from the TCLAS to identify the flow requesting QoS. IEEE 802.11 QoS parameters in TSPEC are mapped to PMIPv6 parameters. The mapping of TCLAS to PMIPv6 is shown in Table 1. TSPEC parameter mapping is shown in Table 4.

If TCLAS is not present (when WMM-AC is used), TCLAS maybe derived from information in upper layer protocols (as described in step 1) and populated in Traffic Selector. If TCLAS cannot be derived, the Traffic Selector field is not included in the QoS options.

(3) The LMA obtains the authorized QoS for the flow and responds to the MAG with operational code set to RESPONSE. Mapping of PMIPv6 to IEEE 802.11 TCLAS is shown in Table 1, TSPEC parameters in Table 4.

Reserved bandwidth for flows are accounted separately from the non-reserved session bandwidth. The Traffic Selector identifies the flow for which the QoS reservations are made.

If the LMA offers downgraded QoS values to the MAG, it should send a PBU to LMA with operational code set to DE-ALLOCATE (the LMA would respond with PBA to confirm completion of the request).

(4) The AP/MAG provisions the corresponding QoS and replies with ADDTS Response containing authorized QoS in TSPEC and flow identification in TSPEC and ResultCode set to SUCCESS.

The AP polices these flows according to the QoS provisioning.

If in step (3), the LMA sends a downgraded QoS or a PBA message with status code CANNOT_MEET_QOS_SERVICE_REQUEST (179), then the AP should respond to the MN with ADDTS Response and ResultCode set as follows:

- for downgraded QoS from LMA, ResultCode is set to REJECTED_WITH_SUGGESTED_CHANGES. Downgraded QoS values from LMA are mapped to TSPEC as per Table 4. This is still a rejection, but the MN may revise the QoS to a lower level and repeat this sequence if the application can adapt.

- if LMA cannot meet QoS service request, ResultCode is set to TCLAS_RESOURCES_EXHAUSTED.

REJECTED_WITH_SUGGESTED_CHANGES and TCLAS_RESOURCES_EXHAUSTED results in the rejection of the QoS reservation, but does not cause the removal of the session itself.

3.1.2. MN Initiated QoS De-allocation Request

QoS resources reserved for a session are released on completion of the session. When the application session completes, the LMA, or the MN may signal for the release of resources. In this use case shown in Figure 3, the MN initiates the release of QoS resources.



Figure 3: MN initiated QoS resource release

(0) The MN establishes and reserves QoS resources. When the application session terminates, the MN prepares to release QoS resources.

(1) MN releases its own internal resources and sends a DELTS Request to the AP with TS (Traffic Stream) INFO.

(2) AP receives the DELTS request, releases local resources and responds to MN with a DELTS response.

(3) MAG initiates a PBU, operational code set to DE-ALLOCATE and with Traffic Selector constructed from TCLAS and PMIPv6 QoS parameters from TSPEC (QoSx).

When TLCAS is not present, the MAG should de-allocate all flows with the same access category (AC) as indicated in the DELTS Request. In the typical case, if the client does not support TCLAS and only MN initiated QoS Service requests are supported,

then the MAG will have at most one QoS Service request per access category (AC).

(4) LMA receives the PBU and releases local resources. The LMA then responds with a PBA.

It should be noted that steps 3 and 4 can proceed independently of the DELTS Response (step 2).

3.2. LMA Initiated QoS Service Request

3.2.1. LMA Initiated QoS Reservation Request

This section describes the case when the QoS service request is initiated by the LMA. For example an application such as voice may request the network to initiate configuration of additional QoS policy as in [TS23.203], section 7.4.2. In the current WLAN specifications, there are no standards defined way for the AP to initiate a QoS service request to the MN. As a result, when the MAG receives a QoS request from the LMA, it does not have any standard mechanisms to initiate any QoS requests to the MN over the access network. Given this, the PMIPv6 QoS service requests and any potential WLAN service requests (such as described in Section 3.1) are handled asynchronously.

The PMIPv6 QoS service requests and WLAN QoS service request could still be coordinated to provide an end to end QoS. If the MAG receives a UPN request from the LMA to reserve QoS resources for which it has no corresponding QoS request from the MN, the MAG may in consultation with the AP provision a policy that can grant a subsequent QoS request from the MN. If the MN initiates QoS procedures after the completion of PMIPv6 QoS procedures the AP/MAG can ensure consistency between the QoS resources in the access network and QoS resources between the MAG and LMA.

For example, if the MN is requesting a mean data rate of x Mbps, the AP and MAG can ensure that the rate can be supported on the network between MAG-LMA based on previous PMIPv6 QoS procedures. If the MN subsequently requests for data rates of x Mbps or less, the AP can accept it based on the earlier PMIPv6 QoS provisioning. For the case where there is a mismatch, i.e., the network does not support the x Mbps, then either the MAG should re-negotiate the QoS resource and ask for increased QoS resources or the AP should reject the QoS request.

3.2.2. Discussion on QoS Request Handling with IEEE 802.11aa

The network initiated QoS service request scenario poses some

challenges outlined here. IEEE 802.11-2012 does not provide any mechanisms for the AP to initiate a QoS request. As a result, the AP/MAG cannot explicitly make any reservations in response to a QoS reservation request made using UPN. IEEE 802.11aa (which is an amendment to IEEE 802.11-2012) has a mechanism that enables the AP to ask the client to reserve QoS for a traffic stream. It does this via the ADDTS Reserve Request. The ADDTS Reserve Request contains a TSPEC, an optional TCLAS, and a mandatory Stream Identifier. The specification does not describe how the AP would obtain such a stream identifier. As a result, there needs to be a new higher layer protocol defined understood by the MN and AP that provides a common stream identifier to both ends. Alternately, the 802.11aa specification could be modified to make the usage optional. When (or if) the Stream Identifier is made optional, the TCLAS can provide information about the traffic stream.

Appendix A outlines a protocol sequence with PMIPv6 UPN/UPA if the above 802.11aa issues can be resolved.

3.2.3. LMA Initiated QoS De-allocation Request

QoS resources reserved for a session are released on completion of the session. When the application session completes, the LMA, or the MN may signal for the release of resources. In this use case, the network initiates the release of QoS resources.

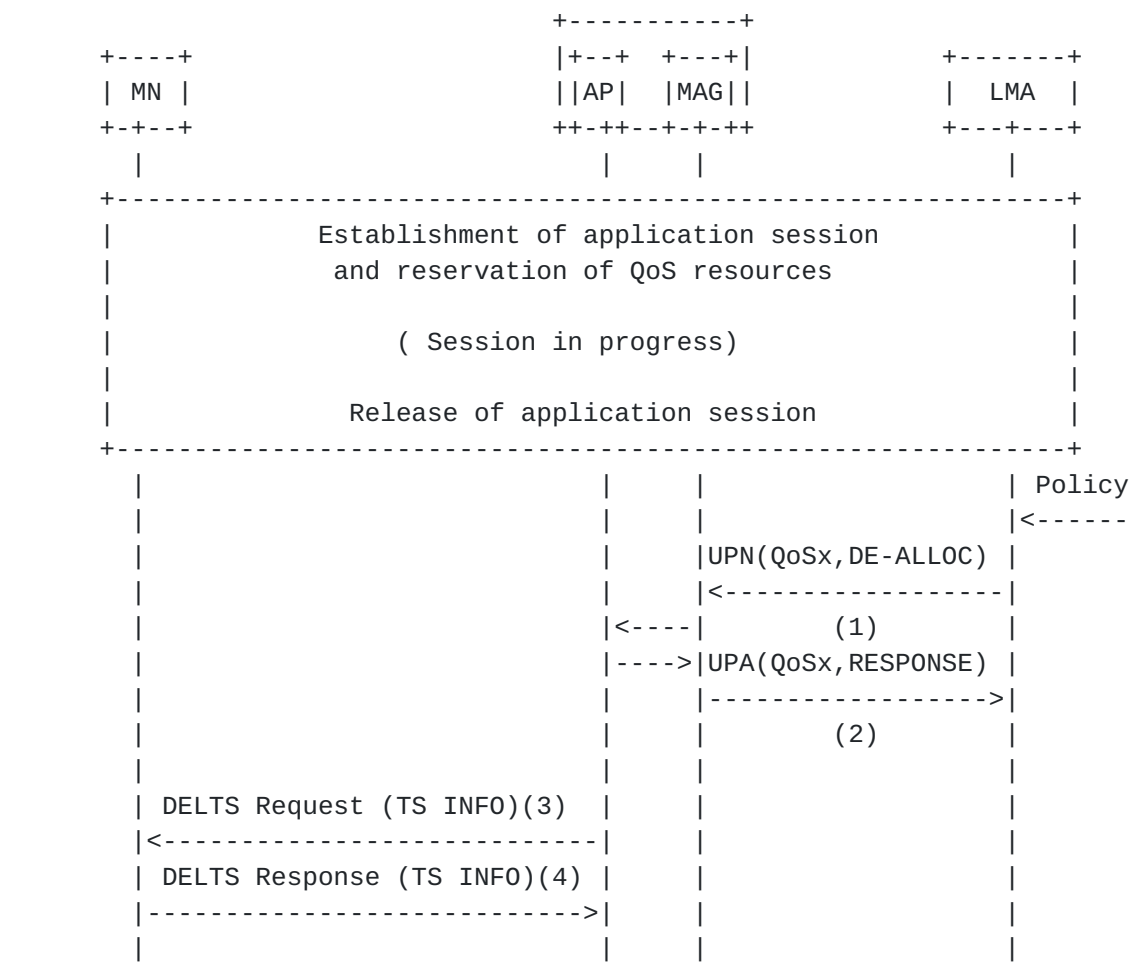


Figure 4: LMA initiated QoS resource release

In this use case shown in Figure 4, the network initiates the release of QoS resources. When the application session terminates, the LMA receives notification that the session has terminated. The LMA releases local QoS resources associated with the flow and initiates signaling to release QoS resources in the network.

(1) LMA sends a UPN with QoS options identifying the flow for which QoS resources are to be released, and operation code set to DE-ALLOCATE. No additional LMA QoS parameters are sent.

(2) MAG replies with UPA confirming the acceptance and operation code set to RESPONSE.

(3) AP/WLC (MAG) releases local QoS resources associated with the flow. The AP derives the corresponding Access Category from the Traffic Class (TC) field provided in the QoS option. In addition, if the AP supports TCLAS and the QoS option contains a Traffic Selector field, then the AP SHALL map the Traffic

Selector into a TCLAS element. In the case where the AP does not support TCLAS (for example a WMM-AC compliant AP) then the AP SHALL only use the Access Category. The AP sends a DELTS Request with TS INFO identifying the reservation.

(4) MN sends DELTS Response confirming release.

It should be noted that steps 3 and 4 can proceed independently of the UPA (step 2).

4. Mapping between IEEE 802.11 QoS and PMIPv6 QoS Parameters

4.1 Connection Parameters

TSPEC in IEEE 802.11 is used to reserve QoS for a traffic stream (MN MAC, TS(Traffic Stream) id). The IEEE 802.11 QoS reservation is for IEEE 802.11 frames associated with an MN's MAC address.

The TCLAS element with Classifier 1 (TCP/UDP Parameters) is used to identify a PMIPv6 QoS flow. We should note that WMM-AC procedures do not support TCLAS. When TCLAS is present, a one-to-one mapping between the TCLAS defined flow and the Traffic Selector is given below.

QoS reservations in 802.11 are made for a traffic stream (identified in TCLAS) and correspond to PMIPv6 QoS session parameters (identified by Traffic Selector). PMIPv6 QoS [RFC 7222] specifies that when QoS-Traffic-Selector is included along with the per-session bandwidth attributes described in section 4.3 below, the attributes apply at a per-session level.

MN <--> AP(IEEE 802.11)	MAG <--> LMA (PMIPv6)
(TCLAS Classifier 1)TCP/UDP IP	Traffic Selector (IP flow)
(TCLAS Classifier 1) DSCP	Traffic Class (TC)

Table 1: IEEE 802.11 - PMIPv6 QoS Connection mapping

If the MN or AP is not able to convey flow parameters in TCLAS, the QoS reservation request in 802.11 are derived as shown in Table 2.

MN <--> AP (WMM)	MAG <--> LMA (PMIPv6)
(no IP flow parameter/TCLAS)	(a) applies to all flows (b) derived out-of-band
User Priority (802.1D)	Traffic Class (TC) (derived using Table 3)

Table 2: WMM - PMIPv6 QoS Connection mapping

When WMM [WMM-1.2.0] is used, and TCLAS is not present to specify IP flow, one of two options apply for the MAG - LMA (PMIPv6) segment:

(a) Bandwidth parameters described in section 4.3 apply to all flows of the MN. This is not a preferred mode of operation if the LMA performs reservation for a single flow, e.g. a voice flow identified by an IP 5-tuple.

(b) The IP flow for which the MN requests reservation is derived out-of-band. For example, the AP/MAG observes application level signaling (e.g. SIP) or session level signaling (e.g. 3GPP WLCP (WLAN Control Protocol) [TS23.402])and associates subsequent ADDTS request using heuristics and then derives the IP flow/Traffic Selector field.

4.2 QoS Class

Table 3 contains a mapping between Access Class (WMM AC) and 802.1D User Priority (UP) tag in IEEE 802.11 frames, and DSCP in IP data packets. The table also provides the mapping between Access Class (WMM AC) and DSCP for use in IEEE 802.11 TSPEC and PMIPv6 QoS (Traffic Class). Mapping of QCI to DSCP uses the tables in [[GSMA-IR34].

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

The MN tags all data packets with DSCP and 802.1D UP corresponding to the application and the subscribed policy or authorization. The AP polices sessions and flows based on the configured QoS policy values for the MN.

For QoS reservations, TSPEC uses WMM AC values and PMIPv6 QoS uses corresponding DSCP values in Traffic Class (TC). IEEE 802.11 QoS Access Class AC_VO, AC_VI are used for QoS reservations. AC_BE, AC_BK should not be used in reservations.

When WMM-AC specifications that do not contain TCLAS are used, it is only possible to have one reservation per Traffic Class / access category (AC). PMIPv6 QoS will not contain any flow specific attributes like Traffic Selector.

4.3 Bandwidth

Bandwidth parameters that need to be mapped between IEEE 802.11 and PMIP QoS are shown in Table 4.

MN <--> AP(IEEE 802.11)	MAG <--> LMA (PMIPv6)
Mean Data Rate, DL	Guaranteed-DL-Bit-Rate
Mean Data Rate, UL	Guaranteed-UL-Bit-Rate
Peak Data Rate, DL	Aggregate-Max-DL-Bit-Rate
Peak Data Rate, UL	Aggregate-Max-UL-Bit-Rate

Table 4: Bandwidth Parameters for Admission Controlled Flows

In PMIPv6 QoS [RFC 7222], services using a sending rate smaller than or equal to Guaranteed Bit Rate (GBR) can in general assume

that congestion related packet drops will not occur [TS 23.203]. If the rate offered by the service exceeds this threshold, there are no guarantees provided. IEEE 802.11 radio networks do not offer such a guarantee, but [WMM 1.2.0] notes that the application (service) requirements are captured in TSPEC by the MSDU (MAC Service Data Unit) and Mean Data Rate. The TSPEC should contain Mean Data Rate and it is RECOMMENDED that it be mapped to the GBR parameters, Guaranteed-DL-Bit-Rate and Guaranteed-UL-Bit-Rate in PMIPv6 QoS [RFC 7222].

IEEE 802.11 TSPEC requests do not require all fields to be completed. [WMM 1.2.0] specifies a list of TSPEC parameters that are required in the specification. Peak Data Rate is not required in WMM, however for MNs and APs that are capable of specifying the Peak Data Rate, it should be mapped to MBR (Maximum Bit Rate) in PMIPv6 QoS. The AP should use the MBR parameters, Aggregate-Max-DL-Bit-Rate and Aggregate-Max-UL-Bit-Rate to police these flows on the backhaul segment between MAG and LMA.

During the QoS reservation procedure, if the MN requests Mean Data Rate, or Peak Data Rate in excess of values authorized in PMIPv6 QoS, the AP should deny the request in ADDTS Response. The AP may set the reject cause code to REJECTED_WITH_SUGGESTED_CHANGES and send a revised TSPEC with Mean Data Rate and Peak Data Rate set to acceptable GBR and MBR respectively in PMIPv6 QoS.

5. Security Considerations

This document describes mapping of PMIPv6 QoS parameters to IEEE 802.11 QoS parameters. Thus, the security in the WLAN and PMIPv6 signaling segments and the functional entities that map the two protocols need to be considered. 802.11 [802.11-2012] provides the means to secure management frames that are used for ADDTS and DELTS. PMIPv6 [RFC 5213] specification recommends using IPSec and IKEv2 to secure protocol messages. The security of the node(s) that implement the QoS mapping functionality should be considered in actual deployments.

The QoS mappings themselves do not introduce additional security concerns.

6. IANA Considerations

No IANA assignment of parameters are required.

7. Acknowledgements

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APPENDIX A: LMA Initiated QoS Service Flow with IEEE 802.11aa

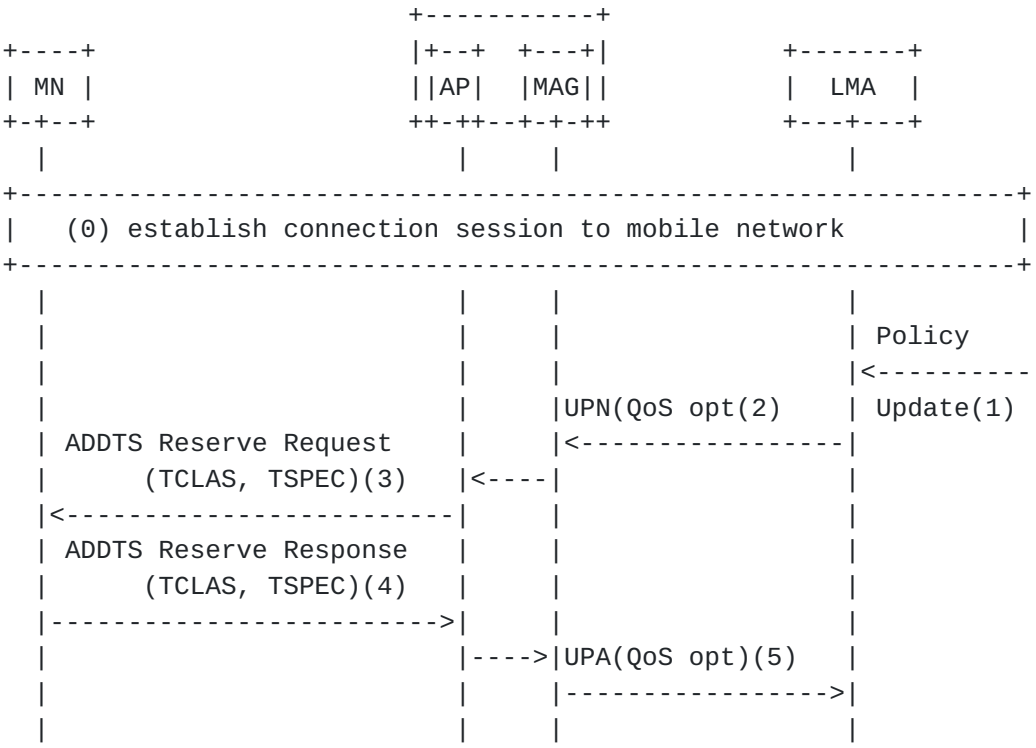


Figure 5: LMA initiated QoS service request with 802.11aa

In this use case shown in Figure 5, the LMA initiates the QoS service request and IEEE 802.11aa is used to setup QoS reservation in the Wi-Fi segment.

(0) MN sets up best effort connectivity session. This allows the MN to perform application level signaling and setup.

(1) The policy server sends a QoS reservation request to the LMA. This is usually sent in response to an application that requests the policy server for higher QoS for some of its flows.

The LMA reserves resources for the flow requested.

(2) LMA sends PMIP UPN (Update Notification) [RFC 7077], as outlined in section 3.2.1, to the MAG with notification reason set to QOS_SERVICE_REQUEST and acknowledgement requested flag set to value of 1. The operational code in QoS option SHOULD be set to ALLOCATE and the Traffic Selector identifies the flow for QoS.

The LMA QoS parameters include Guaranteed-DL-Bit-Rate/Guaranteed-UL-Bit-Rate and Aggregate-Max-DL-Bit-

Rate/Aggregate-Max-UL-Bit-Rate for the flow. The reserved bandwidth for flows are accounted separately from the non-reserved session bandwidth.

(3) If there are sufficient resources to satisfy the request, the AP /MAG sends an ADDTS Reserve Request (IEEE 802.11aa) specifying the QoS reserved for the traffic stream including TSPEC and TCLAS element mapped from PMIP QoS Traffic Selector to identify the flow.

PMIPv6 parameters are mapped to TCLAS (Table 1) and TSPEC (Table 4). If there are insufficient resources at the AP/WLC, the MAG will not send and ADDTS message and will continue processing of step (5).
Higher level StreamId in IEEE 802.11aa should be encoded as discussed in section 3.2.2.

(4) MN accepts the QoS reserved in the network and replies with ADDTS Reserve Response.

(5) The MAG (AP/WLC) replies with UPA confirming the acceptance of QoS options and operational code set to RESPONSE. The AP/WLC polices flows based on the new QoS.

If there are insufficient resources at the AP in step (3), the MAG sends a response with UPA status code set to CANNOT_MEET_QOS_SERVICE_REQUEST (130).