IEEE P802.11  
Wireless LANs

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| PDT MAC on L4S | | | | |
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Abstract

This document proposes draft spec text for L4S support in 802.11bn.

It resolves following two CIDs:

* 3949, 707

**Revisions:**

* Rev 0: Initial version of the document.
* Rev 1: Updates based on offline feedback
* Rev 2: Added email addresses of co-authors
* Rev 3:
* Added passed L4S motion and reference to SFD & motions deck
* For MLME primitive, moved parameters definition to a Table to be consistent with MLME style
* Few other editorial changes.
* Rev 4:
* Edits to address comments received during the TGbn call. Main changes are highlighted in blue.
* Added Support for L4S capability in the Extended Capabilities field
* Text clarifications to clarify that the functionality is on the AP side + added a note for this as well.
* Some clarificatory editorial changes.
* Rev 5:
  + Editorial fixes from Greg
  + Changed MIB variable to dot11L4SImplemented

**Introduction**

Interpretation of a Motion to Adopt.

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGbe Draft. The abstract, revision information, introduction, explanation of the proposed changes and references sections are not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGbe Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGbn Editor: Editing instructions preceded by “TGbn Editor” are instructions to the TGbn editor to modify existing material in the TGbn draft. As a result of adopting the changes, the TGbn editor will execute the instructions rather than copy them to the TGbn Draft.***

**Relevant passing motion:**

[Motion #431]

**Move to add to the TGbn SFD the following:**

* Define in 11bn an optional mechanism for L4S support on the AP as below.
  + Define an MLME primitive that provides congestion notification from the MAC layer to the higher layer at the AP, to enable the upper layer to mark ECN bits on subsequent DL packets for L4S congestion signaling.
  + Enhance the MA-UNITDATA.request primitive to provide an indication whether the MSDU carries the packet of L4S flow.

NOTE - The conditions and criteria based on which the MAC layer determines to signal L4S congestion experienced notification to the upper layer is implementation specific and is outside the scope of this specification.

CIDs and proposed resolution

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 3949 | Binita Gupta | 37 | 67.05 | L4S architecture is defined by IETF to provide low queuing delays, low packet loss, and finer rate adaptation for latency-sensitive applications such as video collaboration, multiplayer games etc. L4S uses ECN field in the IP header to signal early occurrence of congestion to the sender via the receiver, so that sender can adjust its data rate.  In 802.11 MAC Tx queues at the AP can build up leading to congestion being experienced at the MAC layer. In such a scenario, the L4S ECN marking can be performed to signal congestion to the sender for rate adaptation. An MLME interface can be defined to notify congestion to the upper layer for L4S ECN marking. | Define MLME interface at the AP to notify the upper layer when congestion is experienced in the MAC layer transmit queues. Based on this notification the upper layer can perform ECN marking in the IP header. Also, enhance MA-UNITDATA MAC SAP to provide indication of L4S MSDUs to enable MAC layer to implement DualQ AQM for L4S traffic. | Revised.  Agree in principle. Added L4S related text and MLME primitive changes.  TGbn editor, please make changes tagged with CID #3949. |
| 707 | Jay Yang | 6.3.7 | 25.04 | L4S primitive is missing, please add it. | please add some L4S primitive to support L4S function. | Revised  Agree in principle. Same resolution as for CID #3949. |

**Text to be adopted begins here.**

***TGbn editor: please add the following new clause (CID #3949)***

**37.x Support for L4S**

**37.x.1 General**

Low Latency, Low Loss, and Scalable Throughout (L4S) architecture is defined in the IETF (RFCs 9330, 9331, 9332) with the purpose of providing low queuing delays, low packet loss, and fine-grained rate adaptation for latency-sensitive flows.

L4S uses the explicit congestion notification (ECN) field in the IP header to signal early and frequently the occurrence of network congestion to the receiving application. The receiving application relays congestion information back to the sender (e.g. in TCP acknowledgement packets or RTCP reports) and the sender adjusts its sending data rate accordingly. This early congestion notification and fine-grained rate adaptation by the sender minimizes queuing delay and packet drops due to congestion.

In 802.11, MAC layer transmit queues can build up when the ingress rate exceeds the egress rate and when medium access delays occur because of a high level of channel contention. When congestion is experienced at the MAC layer of the AP due to downlink transmit queue build-up, L4S ECN marking can be supported to signal the congestion experienced back to the sender to trigger the sender to adapt its data rate. An MLME interface is defined on the AP to notify the upper layer when congestion is experienced for L4S MSDUs in the MAC layer downlink transmit queues. Based on this notification, the upper layer at the AP can perform ECN congestion experienced (CE) marking in the IP header.

Note: Proposed enhancements for L4S traffic handling are for the AP side only.

**37.x.2 L4S AP operation**

An AP that supports L4S operation described in this clause has dot11L4SImplemented equal to true, is called an L4S AP and shall set the L4S field in the Extended Capabilities field of the Extended Capabilities element to 1 in Beacon, Probe Response and (Re)Association Response frames.

An L4S AP shall be capable of identifying L4S MSDUs received from the MAC SAP based on the L4S field in the MA-UNITDATA.request primitive (see 5.2.4.2 MA-UNITDATA.request). The L4S field is used in addition to the priority and/or SCSID fields of the MA-UNITDATA.request for handling of the corresponding MSDU.

An L4S AP should support buffering of L4S MSDUs in shallow queue(s) as per the recommendations in IETF RFC 9330, RFC 9331 and RFC 9332. The specific implementation of queuing for L4S MSDUs is beyond the scope of this standard.

The L4S AP shall initiate the MLME-L4S-CONGESTION-EXPERIENCED.Indication primitive (see 6.5.xx.2 (MLME-L4S-CONGESTION-EXPERIENCED.Indication)) to signal to its upper layer that congestion is being experienced in the downlink transmit queues at the MAC layer for L4S MSDUs by setting the Congestion Experienced parameter to true and providing the MSDU Congestion Marking Probability. Upon receiving the MLME-L4S-CONGESTION-EXPERIENCED.Indication primitive, the upper layer performs ECN CE marking in the IP header of subsequent packets to signal congestion experienced by setting ECN = 11. The upper layer takes into consideration the MSDU Congestion Marking Probability value provided by the MAC layer when performing ECN CE marking.

If the congestion for L4S MSDUs is no longer experienced in the downlink transmit queues at the MAC layer, then the L4S AP shall initiate another MLME-L4S-CONGESTION-EXPERIENCED.Indication primitive (see 6.5.xx.2 (MLME-L4S-CONGESTION-EXPERIENCED.Indication)) to signal to the upper layer that the congestion for L4S MSDUs has cleared (i.e. congestion is no longer experienced) by setting the Congestion Experienced parameter to false.

NOTE — The conditions and criteria based on which the MAC layer at the AP determines to signal the notifications (via the MLME-L4S-CONGESTION-EXPERIENCED.Indication primitive) for congestion experienced and clearing of congestion for L4S MSDUs to the upper layer is implementation specific and is outside the scope of this specification. Section 5 of RFC 9331 provides general requirements for a network node to support L4S and can be adapted for implementation in the MAC.

﻿**5.2.4 MA-UNITDATA.request**

***TGbn editor: please make following changes in this clause (CID #3949)***

5.2.4.1 Function

﻿5.2.4.2 Semantics of the service primitive

The parameters of the primitive are as follows:

MA-UNITDATA.request(

source address,

destination address,

routing information,

data,

priority,

drop eligible,

service class,

station vector,

MSDU format,

radio environment request vector,

SCSID,

L4S

)

A table with numbers and words

Description automatically generated

Figure xx1 - ECN field definition ([RFC 9331])

The L4S parameter is a Boolean that indicates whether the corresponding MSDU belongs to an L4S flow. If the MSDU has the ECN bits set to 01 or 11 in the IP header (see Figure xx1 (ECN field definition ([RFC 9331]))) contained within the MSDU then the L4S parameter is set to true, otherwise L4S parameter is set to false. The L4S parameter is present if dot11L4SImplemented is true; and is not present otherwise

**6.5 MLME SAP primitives**

***TGbn editor: please add the following new MLME primitive in this clause (CID #3949)***

**6.5.xx L4S explicit congestion notification**

6.5.xx.1 Introduction

This mechanism supports the notification of congestion experienced at the MAC layer for L4S MSDUs to the higher layer for marking of ECN bits at the IP layer for L4S congestion experienced (CE) signalling.

6.5.xx.2 MLME-L4S-CONGESTION-EXPERIENCED.Indication

﻿6.5.xx.2.1 Function

This primitive provides an indication that congestion is experienced in the downlink transmit queues at the MAC layer of the AP for L4S MSDUs.

6.5.xx.2.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-L4S-CONGESTION-EXPERIENCED.Indication(

Source Address,

Destination Address,

Priority,

SCSID,

Congestion Experienced,

MSDU Congestion Marking Probability,

Congestion Information,

)

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** |
| Source Address | ﻿MAC address | ﻿Any valid individual address | Specifies the SA field of an L4S MSDU that experienced congestion at the MAC layer. |
| Destination Address | ﻿MAC address | ﻿Any valid individual or group address | Specifies the DA field of an L4S MSDU that experienced congestion at the MAC layer. |
| Priority | Integer | As defined in 5.1.1.3 (Interpretation of priority parameter in MAC service primitives) | Specifies the priority corresponding to an L4S MSDU that experienced congestion at the MAC layer. |
| SCSID | Integer |  | Identifies the DL SCS stream (if any) to which the L4S MSDU that experienced congestion belongs. If the L4S MSDU experiencing congestion does not belong to an SCS stream, then SCSID is set to 0. This parameter is present if dot11SCSActivated is true; and is not present otherwise. |
| Congestion Experienced | Boolean | true, false | Specifies whether congestion is experienced in the downlink transmit queues at the MAC layer for L4S MSDU(s).  It is set to true to indicate that the congestion is experienced in the downlink transmit queues at the MAC layer for L4S MSDU(s) belonging to the specified Priority or SCSID (if present and set to nonzero value).  If the congestion is no longer experienced in the downlink transmit queues at the MAC layer for L4S MSDU(s), then this parameter is set to false. |
| MSDU Congestion Marking Probability | Non-negative real number |  | Provides the likelihood with which the upper layer can perform ECN congestion experienced (CE) marking (i.e. setting ECN=11) for subsequent downlink L4S MSDUs belonging to the specified Priority and/or SCSID. This parameter is present if the Congestion Experienced parameter is set to true; and is not present otherwise.  Note: The computation of MSDU Congestion Marking Probability is implementation specific. |
| Congestion Information | Octet string | 0-TBD octets | Provides a container to specify further information related to congestion experienced in the downlink transmit queues at the MAC layer for L4S MSDUs. This parameter is optionally present if the Congestion Experienced parameter is set to true; and is not present otherwise. |

6.5.xx.2.3 ﻿When generated

This primitive is generated by the MAC layer at the AP when congestion is experienced in downlink transmit queues at the MAC layer for L4S MSDUs and the dot11L4SImplemented is true.

6.5.xx.2.4 Effect of receipt

The primitive triggers the upper layer to perform ECN congestion experienced (CE) marking of subsequent L4S MSDUs belonging to the specified Priority and/or SCSID (by setting ECN=11), to signal that the congestion is experienced by L4S traffic at the AP.

﻿**9.4.2.25 Extended Capabilities element**

***TGbn editor: please update Extended Capabilities field Table to add an L4S field as shown below (CID #3949)***

|  |  |  |
| --- | --- | --- |
| **Bit** | **Information** | **Description** |
| … | ﻿ |  |
| <ANA> | ﻿L4S | The L4S field indicates whether the AP supports ECN CE (Congestion Experienced) marking when congestion is experienced for L4S MSDUs in the downlink transmit queues at the MAC layer. This field is set to 1 if the AP has dot11L4SImplemented set to true, otherwise this field is set to 0. |

**Annex C**

**C.3 MIB Detail**

***TGbn editor: Please add the following new MIB variable for L4S (CID #3949)***

Dot11UHRStationConfigEntry ::=

SEQUENCE {

dot11CoRTWTOptionImplemented TruthValue,

dot11NPCAOptionImplemented TruthValue,

dot11DUOOptionImplemented TruthValue,

dot11UHRBSROptionImplemented TruthValue,

dot11DBEOptionActivated TruthValue,

dot11L4SImplemented TruthValue

}

dot11L4SImplemented OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-only

STATUS current

DESCRIPTION

﻿"This is a capability variable.

Its value is determined by device capabilities.

This attribute, when true, indicates that the AP supports L4S capability. If this attribute is false, it indicates that the AP does not support L4S capability.”

::= { dot11UHRStationConfigEntry <ana> }

**Text to be adopted ends here.**

**References:**

1. [11-25/0014r22](https://mentor.ieee.org/802.11/dcn/25/11-25-0014-22-00bn-tgbn-motions-list-part-2.pptx): 11-25-0014-07-00bn-tgbn-motions-list-part-2, Alfred Asterjadhi (Qualcomm Technologies Inc.)
2. [11-24/0209r15](https://mentor.ieee.org/802.11/dcn/24/11-24-0209-15-00bn-specification-framework-for-tgbn.docx): 11-24-0209-15-00bn-specification-framework-for-tgbn, Ross Jian Yu (Huawei)