IEEE P802.11
Wireless LANs

|  |
| --- |
| Resolution for CIDs related to TSPEC (CC36) |
| Date: November, 2021 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Duncan Ho | Qualcomm Inc. | 5665 Morehouse Dr. San Diego CA 92121 USA | +1 (858) 845-3214 | dho@qti.qualcomm.com |
| Alfred Asterjadhi |  |  |  |
| Abdel Karim Ajami |  |  |  |
| Abhishek Patil |  |  |  |
| George Cherian |  |  |  |
| Gaurang Naik |  |  |  |
| Yanjun Sun |  |  |  |
| Jinjing Jiang | Apple Inc. |  |  | jinjing@apple.com |
| Jarkko Kneckt |  |  | jkneckt@apple.com |
| Jerome Henry | Cisco |  |  | jerhenry@cisco.com |
| Dibakar Das | Intel |  |  | Dibakar.das@intel.com |
| Laurent Cariou |  |  | Laurent.cariou@intel.com |
| Dave Cavalcanti |  |  | dave.cavalcanti@intel.com |
| Liwen Chu | NXP |  |  |  |
| Vinko Erceg | Broadcom |  |  | vinko.erceg@broadcom.com |
| Thomas Derham |  |  | thomas.derham@broadcom.com |
| Srinivas Kandala | Samsung |  |  | srini.k1@samsung.com |
| Jonghun Han |  |  | jong\_hun.han@samsung.com |
| Liangxiao | Sony |  |  | Liangxiao.Xin@sony.com |

 Abstract

This submission proposes resolutions for CIDs 4918 and 5950 for TGbe (CC36).

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Clarified the MSDU Deliver Ratio is to specify the MSDU loss requirement. Added the Bandwidth field for p2p (Direct link) and clarified the Medium Time is computed based on the bandwidth indicated in the Bandwidth field.
* Rev 2: Added more co-authors and fixed a few editorials
* Rev 3:
	+ Replaced occurrences of TSPEC element with QoS Characteristics element in sections 9.4.2.121 and 9.6.18.3
	+ Replaced “another EHT STA” with “another STA” in the TX Sharing capability table
	+ Removed the Bandwidth field
	+ Remove Direct link association with Medium Time
	+ Added LinkID field to indicate which link the Direct link request is for
	+ Use a bitmap for TXS capability: 2 bits. One bit for UL infra TXS only and the other bit for p2p TXS only

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. This introduction is 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).***

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Pg/Ln** | **Section** | **Comment** | **Proposed Change** | **Resolution** |
| 4918 | Duncan Ho | 298 | 35.6.2 | TSPEC IE needs to be updated for 11be (e.g., adding new QoS parameters such as packet delivery ratio) | Update the TSPEC for 11be and TSPEC should be included in rTWT Request (could be via SCS descriptor) - adopt the latest revision of 21/619 | **Revised**Agree in principle with the comment. Proposed resolution is to create a new “QoS Characteristics element” IE which includes some additional parameters that are specifically tailored for latency sensitive traffic streams. The new IE also includes mandatory and optional fields to handle different use scenarios.**TGbe editor, please make changes as shown in doc 11-21/01407r3** |
| 5950 | Liuming Lu | 298/25 | 35.6.2.1 | Currently 802.11be has not defined enough parameters of TSPEC element for the latency sensitive traffic. For example Maximum jitter is an important parameter for the identification of the latency sensitive traffic. And the potential support for the future TSN applications needs to be considered for the specification ot the extended parameters of TSPEC element. | Suggest to specify the extended parameters of TSPEC element for the latency sensitive traffic. TSN paramerters can be used as a reference to specify the extended parameters of TSPEC element. | **Revised**Agree in principle with the comment. Proposed resolution is to create a new “QoS Characteristics element” IE which includes some additional parameters that are specifically tailored for latency sensitive traffic streams. The new IE also includes mandatory and optional fields to handle different use scenarios.**TGbe editor, please make changes as shown in doc 11-21/01407r3** |

# Discussion

802.11be is supposed to support low-latency traffic effectively. As a result, there were mechanisms introduced to support such feature. For example, modified SCS and Restricted TWT.

Section “35.3.20 Multi-link SCS procedure” in draft D1.1 specifies that the TSPEC element can be carried in an SCS Request and Response frame. The TSPEC element it refers to was defined in the 802.11 baseline (802.11REVme). However, the TSPEC element was designed more than 16 years ago and it does not contain enough information for the purpose of supporting low-latency traffic for 802.11be. Further, the TSPEC element also contains some parameters that are no longer relevant or useful.

Both CIDs 4918 and 5950 complained about the same issue and to resolve these CIDs, we propose the following:

* Create a new element (QoS Characteristics element) to contain all the needed QoS parameters and the basic idea of a STA conveying (MLD-level) QoS parameters to the AP in the SCS Req/Resp remains unchanged (SCS Req/Resp includes the QoS Characteristics element in lieu of the TSPEC element)
* These fields are borrowed from the TSPEC (some with minor modifications)
	+ Direction, TID, UP, min service interval, max service interval, min data rate, and delay bound, Max MSDU size, service start time, mean data rate, burst size, and medium time
* These are the new fields added: MSDU lifetime, MSDU delivery ratio, and MSDU Count Exponent
* The new element consists of **one** control field, **4** mandatory fields, and **9** optional fields
	+ Control field: Direction, TID, UP, and a bitmap that controls the optional fields
	+ Mandatory fields: min service interval, max service interval, min data rate, and delay bound
	+ Optional fields: max MSDU size, service start time, mean data rate, burst size, MSDU lifetime, MSDU delivery ratio, MSDU Count Exponent, and medium time
* Major updates to the field definitions:
	+ The min/max service intervals, min data rate, and delay bound are now defined per direction (i.e., UL, DL, or Direct link (p2p)). The value 0 can be used in some cases to indicate the parameter is not specified even a field is mandatorily present
* Added normative AP behavior in section 35.3.21 Multi-link SCS procedure regarding how some of these fields are used
* Split the “Triggered TXOP Sharing support” capability into two cases: 1) infra UL only 2) p2p and infra UL for more flexibility
* Added normative AP behavior regarding the use of Trigger frames, TWT and Restricted TWT
* EHT STAs are expected to use this new QoS Characteristics element to convey QoS info.

In this way, there is flexibility for the STA which parameters to include (depending on the STA’s capability of supporting different levels of QoS).

# Proposed Text Change

***TGbe editor: Add an entry to the end of Table 9-123 as follows:***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element**  | **Element ID** | **Element ID Extension** | **Extensible** | **Fragmentable** |
| QoS Characteristics element (see 9.4.2.xxx QoS Characteristics element) | **255** | **ANA** | **Yes** | **Yes** |

***TGbe editor: add this new subclause under 9.4.2***

9.4.2.xxx QoS Characteristics element

The QoS Characteristics element contains a set of parameters that define the characteristics and QoS expectations of a traffic flow, in the context of a particular non-AP EHT STA, for use by the EHT AP and the non-AP EHT STA in support of QoS traffic transfer using the procedures defined in 11.25.2 (SCS procedures) and 35.7 (Restricted TWT).

The element information format comprises the items as defined in this subclause, and the structure is defined in Figure 9-xxx (QoS Characteristics element format).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|    | Element ID | Length | Element ID extension | Control Info | Minimum Service Interval | Maximum Service Interval | Minimum Data Rate | Delay Bound |
| Octets: | 1 | 1 | 1 | 4 | 4 | 4 | 3 | 3 |
|  | Maximum MSDU Size | Service Start Time | Mean Data Rate | Burst Size | MSDU Lifetime | MSDU Delivery Ratio | MSDU Count Exponent | Medium Time |  |
| Octets: | 0 or 2 | 0 or 4 | 0 or 3 | 0 or 4 | 0 or 2 | 0 or 1 | 0 or 1 | 0 or 1 |  |
| Figure 9-xxx – QoS Characteristics element format |  |

The structure of the Control Info field is defined in Figure 9-yyy (Control Info field format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 B5 | B6 B8 | B9 B24 | B25 B28 | B29 B31 |
|  | Direction  | TID | User-Priority | Presence Bitmap of Additional Parameters | LinkID | Reserved |
| Bits: | 2 | 4 | 3 | 16 |  | 7 |
|  | Figure 9-yyy – Control Info field format |

The Element ID, Length, and Extended Element ID fields are defined in 9.4.2.1 (General).

The subfields of the Control Info field are defined as follows:

* The Direction subfield specifies the direction of data described by this element as defined in Table 9-158 (Direction subfield encoding).

|  |
| --- |
| * Direction subfield encoding
 |
| Bit 5 | Bit 6 | Usage |
| 0 | 0 | Uplink, defined as follows: * MSDUs or A‑MSDUs are sent from the non-AP STA to the AP.
 |
| 1 | 0 | Downlink, defined as follows: * MSDUs or A‑MSDUs are sent from the AP to the non-AP STA.
 |
| 0 | 1 | Direct link (MSDUs or A‑MSDUs are sent from the non-AP STA to another non-AP STA). |
| 1 | 1 | Reserved. |

* The TID subfield contains the TID value of the data frames that are described by this element. The TID subfield is set to the same value as the User Priority field. The values 8~15 are reserved.
* The User Priority subfield contains the user priority value (0~7) of the data frames that are described by this element. When the TCLAS element is present in the SCS Request frame containing this element, the User Priority subfield is set to the User Priority value specified in the TCLAS element.
* The Presence Bitmap of Additional Parameters subfield contains a bitmap where the ith entry of the bitmap is set to 1 if the ith field starting from the Maximum MSDU Size field is present in this element. For each field starting from the Maximum MSDU Size field, the value 0 is reserved.
* The LinkID subfield contains the link identifier of the link for which the direct link transmissions are going to occur. This field is reserved if the Direction subfield is equal to any value but 2 (Direct link).

The Minimum Service Interval field contains the following:

* If the Direction subfield is set to 0 (Uplink), the Minimum Service Interval field contains an unsigned integer that specifies the minimum interval, in microseconds, between the start of two consecutive service periods that are allocated to the STA for UL frame exchanges and the value 0 is reserved.
* If the Direction subfield is set to 1 (Downlink), the Minimum Service Interval field contains an unsigned integer that specifies the minimum interval, in microseconds, between the start of two consecutive service periods that are allocated for DL frame exchange sequences and the value 0 indicates that this parameter is unspecified.
* If the Direction subfield is set to 2 (Direct link) the Minimum Service Interval field contains an unsigned integer that specifies the minimum interval, in microseconds, between the start of two consecutive service periods that are allocated to the STA for direct link frame exchanges and the value 0 is reserved.

The Maximum Service Interval field contains the following:

* If the Direction subfield is set to 0 (Uplink), the Maximum Service Interval field contains an unsigned integer that specifies the maximum interval, in microseconds, between the start of two consecutive service periods that are allocated to the STA for UL frame exchanges and the value 0 is reserved.
* If the Direction subfield is set to 1 (Downlink), the Maximum Service Interval field contains an unsigned integer that specifies the maximum interval, in microseconds, between the start of two consecutive service periods that are allocated for DL frame exchange sequences and the value 0 indicates that this parameter is unspecified.
* If the Direction subfield is set to 2 (Direct link) the Maximum Service Interval field contains an unsigned integer that specifies the maximum interval, in microseconds, between the start of two consecutive service periods that are allocated to the STA for direct link frame exchanges and the value 0 is reserved.
* The value of this field is greater than or equal to the value of the Minimum Service Interval field.

The Minimum Data Rate field contains an unsigned integer that specifies the lowest data rate specified at the MAC SAP, in kbps, for transport of MSDUs or A-MSDUs belonging to the traffic flow described by this element.

* If the Direction subfield is set to 0 (Uplink) or 1 (Downlink), the value 0 is reserved.
* If the Direction subfield is set to 2 (Direct link), the value 0 indicates that this parameter is unspecified.

The Delay Bound field contains an unsigned integer that specifies the maximum amount of time, in microseconds, allowed to transport an MSDU or A-MSDU belonging to the traffic flow described by this element, measured between the time marking the arrival of the MSDU, or the first MSDU of the MSDUs constituting an A-MSDU, at the local MAC sublayer from the local MAC SAP and the time of completion of the successful transmission or retransmission of the MSDU or A-MSDU to the destination. The completion time of the MSDU or A-MSDU transmission includes the relevant acknowledgment frame transmission time, if present.

* If the Direction subfield is set to 0 (Uplink) or 2 (Direct link), the value 0 indicates that this parameter is unspecified.
* If the Direction subfield is set to 1 (Downlink), the value 0 is reserved.

The Maximum MSDU Size field contains an unsigned integer that specifies the maximum size, in octets, of MSDUs or A‑MSDUs belonging to the traffic flow described by this element.

The Service Start Time field contains an unsigned integer that specifies the time, in micro-seconds, when the first service period starts. The Service Start Time indicates to the AP the time when the STA expects to exchange frames corresponding to the TID specified in this element. The field represents the four lower order octets of the TSF timer at the start of the service period.

The Mean Data Rate field indicates the average data rate specified at the MAC SAP, in kbps, for transport of MSDUs or A-MSDUs belonging to the traffic flow within the bounds of this element.

The Burst Size field is 4 octets long and contains an unsigned integer that specifies the maximum burst, in octets, of the MSDUs or A-MSDUs belonging to the traffic flow that arrive at the MAC SAP at the peak data rate.

The MSDU Lifetime field contains an unsigned integer that specifies the maximum amount of time, in units of milliseconds, since the arrival of the MSDU at the MAC data service interface beyond which the MSDU is not useful and may be discarded at the MSDU transmitter. The amount of time specified in this field is larger than or equal to the amount of time specified in the Delay Bound field, if present.

The MSDU Delivery Ratio field specifies the MSDU loss requirement and is encoded as follows:

* The 4 LSBs of the MSDU Delivery Ratio field indicate the percentage of MSDUs that are expected to be delivered within the delay bound specified in the Delay Bound field and its encoding is defined in Table 9-xxx. The 4 MSBs of the MSDU Delivery Ratio field are reserved.

|  |
| --- |
| Table 9-xxx MSDU Delivery Ratio field values |
| Value | MSDU delivery ratio |
| 0 | Not specified |
| 1 | 95% |
| 2 | 96% |
| 3 | 97% |
| 4 | 98% |
| 5 | 99% |
| 6 | 99.9% |
| 7 | 99.99% |
| 8 | 99.999% |
| 9 | 99.9999% |
| 10 - 15 | Reserved |

The MSDU Count Exponent field contains an unsigned integer that specifies the exponent from which the number of incoming MSDUs used for computing the MSDU delivery ratio is obtained. The number of incoming MSDUs is equal to 10MSDU Count Exponent.

The Medium Time field contains an unsigned integer that specifies the medium time, in units of 256 microseconds per second, requested by the STA as the average medium time needed in each second .

|  |
| --- |
|  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

***TGbe editor: Modify 9.4.2.121 as follows:***

**9.4.2.121 SCS Descriptor element**

***TGbe editor: Modify Figure 9-541 (SCS Descriptor element format) as follows***:

 zero or more zero or one

 TCLAS Elements QoS Characteristics

 Element

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Element ID | Length | SCSID | Request Type | Intra- Access Category Priority Element (optional) | TCLASElements (optional) | TCLASProcessing Element (optional) | QoS Characteristics Element (optional) | Optional Subelements |

 Octets: 1 1 1 1 0 or 3 variable 0 or 3 variable variable

### Figure 9-541—SCS Descriptor element format

***Insert the following paragraph after the 7th paragraph (“The TCLAS Processing Element field is present when more than...”):***

The QoS Characteristics Element field contains zero or one QoS Characteristic element to describe the traffic characteristics and QoS expectations of traffic flows that belong to this SCS stream, as defined in 9.4.2.xxx (QoS Characteristics element). Zero or one QoS Characteristics element is present when the Request Type field is equal to “Add” or “Change” and no QoS Characteristics element is present when the Request Type field is equal to “Remove”.

***TGbe editor: Modify 9.6.18.3 as follows:***

**9.6.18.3 SCS Response frame format**

The SCS Descriptor List field contains zero or more SCS Descriptor elements, as defined in 9.4.2.121 (SCS Descriptor element). If included, each SCS Descriptor element contains a QoS Characteristics element to describe the traffic characteristics and QoS expectations of traffic flows that belong to this SCS stream. Zero or more SCS Descriptor elements are present when the Status Code field value is equal to “Success” and no SCS Descriptor element is present otherwise.

***TGbe editor: replace all occurrences of “TSPEC” with “QoS Characteristics” and delete all occurrences of “bidirectional link” in this section 35.3.21.***

**35.3.21 Multi-link SCS procedure**

***TGbe editor: insert the following after the 10th paragraph and before the NOTE:***

A non-AP EHT STA with dot11EHTTXOPSharingTFOptionImplemented equal to true may send an SCS request that contains a QoS Characteristics element whose Direction field is set to 2 (Direct Link) only if the EHT AP sets the Triggered TXOP Sharing Mode 2 Support subfield in the EHT Capabilities element it transmits to 1.

The QoS Characteristics element is a reference for the EHT AP's scheduling. An EHT AP should schedule for transmission downlink frames such that the delay bound and minimum data rate requested are met for the downlink Data frames if the Direction subfield of the QoS Characteristics element indicates downlink. An EHT AP should enable the transmission of uplink frames from the EHT STA with an interval that falls between the requested minimum and maximum service intervals and the AP should meet the minimum data rate requested if the Direction subfield of the QoS Characteristics element indicates uplink. An EHT AP should enable the transmission of direct link frames from the EHT STA to another STA on the link specified in the LinkID subfield of the Control Info field with an interval that falls between the requested minimum and maximum service intervals.

The transmission of uplink Data frames should be enabled by using Basic Trigger frames or alternatively by using MU RTS TXS Trigger frames if both EHT STAs have dot11EHTTXOPSharingTFOptionImplemented equal to true. The transmission of direct link frames should be enabled by using MU RTS TXS Trigger frames if both EHT STAs have set the Triggered TXOP Sharing Mode 2 Support field in their transmitted EHT Capabilities elements to 1.

If the EHT STA is a TWT scheduled STA or TWT requesting STA (see 26.8 TWT operation) and there are negotiated TWT SPs for the TID specified in the QoS Characteristics element with the EHT AP, the EHT AP should ensure that the selected interval aligns with negotiated TWT wake intervals.

If the EHT STA is an r-TWT scheduled STA (see 35.7 Restricted TWT) and the negotiated r-TWT SPs for the TID specified in the QoS Characteristics element are trigger-enabled r-TWTs, the EHT AP should ensure that the trigger frames are scheduled at the start of the TWT SPs.

The EHT AP may discard a DL data frame if the lifetime of the frame has exceeded the value specified by the MSDU Lifetime field.

***TGbe editor: modify the NOTE as follows:***

NOTE—A QoS Characteristics element provided by a non-AP EHT STA is used by a receiving EHT AP to facilitate the creation of a schedule for contention based channel access (EDCA) or MU operation. How the AP uses the information provided by the non-AP STA QoS Characteristics element that do not have corresponding normative requirements is beyond the scope of the standard.

**9.4.2.295c.2 EHT MAC Capabilities Information field(#1126)**

***TGbe editor: modify this section as follows:***

The format of the EHT MAC Capabilities Information field is defined in [Figure 9-788eu (EHT MAC Capabilities Information field format](#bookmark116).

 B0 B1 B2 B3 B B5 B6 B15

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NSEP Priority Access Supported | EHT OMControl Support | Triggered TXOP Sharing Mode 1 Support | Triggered TXOP Sharing Mode 2 Support |  Restricted TWT Support | SCS Traffic Description Support | Reserved |

Bits: 1 1 1 1 1 1 15

**Figure 9-788eu—EHT MAC Capabilities Information field format**

**Table 9-322aq—Subfields of the EHT MAC Capabilities Information field**

|  |  |  |
| --- | --- | --- |
| Triggered TXOP Sharing Mode 1 Support | Indicates support for transmitting or responding to a TXOP sharing trigger frame with Triggered TXOP Sharing Mode field equal to 1 that does not solicit TB PPDU. | For an EHT AP:Set to 1 to indicate that the AP is capable of transmitting a modified MU-RTS frame that allocates time to a STA to transmit non-TB PPDUs to the EHT AP (i.e., with Triggered TXOP Sharing Mode field equal to 1. (see 35.2.1.3 (Triggered TXOP sharing procedure))).Set to 0 otherwise.For a non-AP EHT STA:Set to 1 to indicate that the non-AP STA is capable of responding to a modified MU-RTS frame that allocates time to a STA to transmit non-TB PPDUs to the EHT AP (i.e., with Triggered TXOP Sharing Mode field equal to 1. (see 35.2.1.3 (Triggered TXOP sharing procedure))). Set to 0 otherwise. |
| Triggered TXOP Sharing Mode 2 Support | Indicates support for transmitting or responding to a TXOP sharing trigger frame with Triggered TXOP Sharing Mode field equal to 2 that does not solicit TB PPDU. | For an EHT AP:Set 1 to indicate that the AP is capable of transmitting a modified MU-RTS frame that allocates time to a STA to transmit non-TB PPDUs to other STAs (i.e., with Triggered TXOP Sharing Mode field equal to 1or 2 (see 35.2.1.3 (Triggered TXOP sharing procedure))) Set to 0 otherwise.For a non-AP EHT STA:Set to 1 to indicate that the non-AP STA is capable of responding to a modified MU-RTS frame that allocates time to a STA to transmit non-TB PPDUs to the other STAs (i.e., with Triggered TXOP Sharing Mode field equal to 1 or 2. (see 35.2.1.3 (Triggered TXOP sharing procedure))).Set to 0 otherwise. |
| SCS Traffic Description Support | Indicates support for transmission and reception of SCS Descriptor elements containing a QoS Characteristics element. | Set to 1 by an EHT AP that supports transmission of SCS Response frames containing SCS Descriptor element with a QoS Characteristics element and dot11SCSActivated is true.Set to 1 by a non-AP EHT STA that supports transmission of SCS Request frames containing SCS Descriptor element with a QoS Characteristics element and dot11SCSActivated is true. Set to 0 otherwise. |

**35.2.1.3.1 General**

The Triggered TXOP sharing procedure allows an AP to allocate a portion of the time within an obtained TXOP to only an associated non-AP EHT STA for transmitting one or more non-TB PPDUs.

An EHT STA with dot11EHTTXOPSharingTFOptionImplemented equal to true shall set either of the following two bits in the EHT Capabilities element to 1: the Triggered TXOP Sharing Mode 1 Support subfield or the Triggered TXOP Sharing Mode 2 Support subfield.

An EHT STA with dot11EHTTXOPSharingTFOptionImplemented equal to shall follow the rules defined in 35.2.2 (MU-RTS trigger/CTS frame exchange procedure for EHT STAs) when transmitting or responding to an MU-RTS TXS Trigger frame and the additional rules defined in 35.2.1.3.2 (AP behavior) and 35.2.1.3.3 (Non-AP STA behavior).

An EHT STA that uses information from a received MU-RTS TXS Trigger frame as the most recent basis to update its NAV should not reset its NAV after the NAVTimeout has expired (see 10.3.2.4 (Setting and resetting the NAV)) unless the STA receives a CF-End frame that satisfies the conditions in 26.2.5 (Truncation of TXOP).

Do you agree to the resolution provided in doc 11-21/1407r3 for CIDs 4918 and 5950?