IEEE P802.11  
Wireless LANs

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| --- | --- | --- | --- | --- |
| **Specification framework for TGbe** | | | | |
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Abstract

This document provides the framework from which the draft TGbe amendment will be developed. The document provides an outline of each the functional blocks that will be a part of the final amendment. The document is intended to reflect the working consensus of the group on the broad outline for the draft specification. As such it is expected to begin with minimal detail reflecting agreement on specific techniques and highlighting areas on which agreement is still required. It may also begin with an incomplete feature list with additional features added as they are justified. The document will evolve over time until it includes sufficient detail on all the functional blocks and their inter-dependencies so that work can begin on the draft amendment itself.

# Revision history

|  |  |  |
| --- | --- | --- |
| Revision | Date | Changes |
| 0 | July 15, 2019 | Initial draft version for task group review |
| 1 | July 18, 2019 | Revised draft version based on the inputs from task group members |
| 2 | July 18, 2019 | Further revised draft version based on the inputs from task group members |
| 3 | October 9, 2019 | Incorporated motions 1, 6, 10, and 11 approved in the September 2019 interim. |
| 4 | October 9, 2019 | Incorporated motion 9 approved in the September 2019 interim. |
| 5 | November 17, 2019 | Incorporated motions 14-38, 40-49 approved in the November 2019 plenary. |
| 6 | November 27, 2019 | Further revised draft version based on [the input from a task group member](http://www.ieee802.org/11/email/stds-802-11-tgbe/msg00322.html). |
| 7 | January 26, 2020 | Incorporated motions 50-63, 65-76, and 78-110 approved in the January 2020 interim. |
| 8 | February 11, 2020 | Move motions 91 and 92 from Section 2.4.5 to Section 2.3 based on [an input from a task group member](http://www.ieee802.org/11/email/stds-802-11-tgbe/msg00478.html). |
| 9 | May 6, 2020 | Update the reference of Motion 71 to the contribution 19/1822r4.  Update the reference of Motion 75 to the contribution 20/0117r1.  Replace “GLK” with “GTK” in Section 1. |
| 10 | June 17, 2020 | Incorporated motions 111-114 approved on June 11, 2020. |
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| 14 | September 5, 2020 | Incorporated motions 124, 125, and 126 approved on September 3, 2020. |
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| 17 | November 4, 2020 | Incorporated motions 137, 139, and 141 approved on November 4, 2020. |
| 18 | November 5, 2020 | Fixed the typo of Motion 137, #SP284 |
| 19 | November 9, 2020 | Incorporated motion 142 approved on November 9, 2020. |
| 20 | November 10, 2020 | Fixed the title of the document. |
| 21 | December 3, 2020 | Incorporated motion 144 approved on December 2, 2020. |
| 22 | January 6, 2021 | Incorporated motions 146 and 148 approved on January 6, 2021. |
| 23 | January 17, 2021 | Incorporated motion 150 approved on January 14, 2021. |

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# Abbreviations and acronyms

BIGTK beacon integrity group temporal key

BPSK binary phase shift keying

BU bufferable unit

BSS basic service set

BW bandwidth

CCA clear channel assessment

DL downlink

DS distribution system

EHT extremely high throughput

EP emergency preparedness

GTK group temporal key

HE high efficiency

IGTK integrity group temporal key

LLC logical link control

L-LTF Non-HT Long Training field

L-SIG Non-HT SIGNAL field

L-STF Non-HT Short Training field

LTF long training field

MAC medium access protocol

MCS modulation and coding scheme

MLD multi-link device

MU multi-user

MU-MIMO multi-user multiple input, multiple output

NDP null data PPDU

NS national security

OFDM orthogonal frequency division multiplexing

PHY physical layer

PN packet number

PPDU PHY protocol data unit

PSDU PHY service data unit

RA receiver address

RL-SIG Repeated Non-HT SIGNAL field

RU resource unit

RX receive or receiver

SAP service access point

STA station

SU single user

SU-MIMO single user multiple input, multiple output

TA transmitter address

TID traffic identifier

TX transmit or transmitter

TXOP transmission opportunity

UL Uplink

U-SIG Universal SIGNAL field

WM wireless medium

# EHT PHY



## General

This section describes the functional blocks in the EHT PHY.

802.11be AP is mandatory to support the following:

* 160 MHz operating channel width in 6 GHz band
* 80 MHz operating channel width in 5 GHz band
* 20 MHz operating channel width in 2.4 GHz band

NOTE – “soft AP” is TBD.

[Motion 124, #SP178, [1] and [2]]

It is mandatory for a non-AP STA to support 80 MHz operating channel width in 5 and 6 GHz bands.

* Except for 20 MHz only client (if defined in EHT).

[Motion 124, #SP179, [1] and [2]]

802.11be defines 20 MHz-only client in 2.4/5 GHz band only.

[Motion 124, #SP180, [1] and [2]]

## Subcarriers and resource allocation

### Wideband and noncontiguous spectrum utilization

802.11be defines only PPDU with contiguous signal bandwidth, including 20 MHz, 40 MHz, 80 MHz, 160 MHz, and 320 MHz.

* NOTE – Noncontiguous 80+80 MHz and 160+160 MHz are not defined.

[Motion 137, #SP288, [3] and [4]]

802.11be supports 320 MHz and 160+160 MHz PPDU.

[Motion 10, [5] and [6]]

802.11be supports defining 320 MHz channels as any two adjacent 160 MHz channels.

[Motion 119, #SP115, [7] and [8]]

802.11be supports 240 MHz and 160+80 MHz transmission.

* Whether 240/160+80 MHz is formed by 80 MHz channel puncturing of 320/160+160 MHz is TBD.

[Motion 16, [9] and [10]]

No 240 MHz channelization is defined in 802.11be.

* NOTE – 240/160+80 MHz entry in BW field is TBD.

[Motion 119, #SP116, [7] and [11]]

There is no 240/160+80 MHz PPDU BW entry in the BW field of U-SIG in 802.11be.

* The 240 MHz transmission is defined as 320 MHz PPDU with 80 MHz punctured.

[Motion 122, #SP165, [12] and [13]]

240/160+80 MHz bandwidth is constructed from three 80 MHz channels which include primary 80 MHz.

[Motion 17, [9] and [14]]

802.11be reuses 802.11ax tone plan for 20/40 MHz PPDU and, with the exception of pilot locations, for 80/160/80+80 MHz in non-OFDMA PPDU. For 320 MHz and 160+160 MHz PPDU, 802.11be uses duplicated EHT160.

[Motion 33, [9] and [15]]

[Motion 118, [16] and [17]]

802.11be 240/160+80 MHz transmission consists of 3x80 MHz segments while the tone plan of each 80 MHz segment is the same as EHT80.

[Motion 35, [9] and [15]]

[Motion 118, [16] and [17]]

240/160+80 MHz transmission is subjected to 320/160+160 MHz PPDU mask plus additional puncturing mask.

320/160+160 MHz transmission is subjected to 320/160+160 MHz PPDU mask, additional puncturing mask can be applied according to the puncturing patterns and MRUs.

Details of the masks are TBD.

[Motion 119, #SP117, [7] and [18]]

802.11be supports the following toneplan for 802.11be 80 MHz OFDMA.

* 80 MHz OFDMA = 40 MHz DUP, Table 27-8 in 802.11ax D6.0 right/left shifted by 256 tones.



Figure 1 – Tone plan for 80 MHz OFDMA

* NOTE –
  + The 80MHz OFDMA design applies to any RU < 996 for all modes of transmission, SU, DL MU, TB PPDU, with and without puncturing.
  + Non-OFDMA full BW 80 MHz segment uses 996 RU design.
  + Any punctured 80 MHz segment uses the OFDMA tone plan.
  + For each 80 MHz segment in 160 MHz, 240 MHz or 320 MHz: if it is punctured or used for OFDMA the 80 MHz OFDMA tone plan is used, if it’s used for non-OFDMA and non-punctured the 996 RU tone plan is used.

[Motion 112, #SP42, [19] and [20]]

In 160+80 MHz BSS, the 160 MHz and 80 MHz should be non-adjacent.

[Motion 111, #SP0611-01, [19] and [21]]

A 160 MHz tone plan is duplicated for the non-OFDMA tone plan of 320/160+160 MHz PPDU.

* The 160 MHz tone plan is TBD.

[Motion 18, [9] and [22]]

The 802.11be 320/160+160 MHz non-OFDMA tone plan uses duplicated tone plan of EHT160.

[Motion 34, [9] and [15]]

[Motion 118, [16] and [17]]

12 and 11 null tones are placed at the left and right edges in each 160 MHz segment for the non-OFDMA tone plan of 320/160+160 MHz PPDU.

[Motion 19, [9] and [22]]

802.11be uses the same subcarrier spacing for the data portion of EHT PPDU as 802.11ax data portion.

[Motion 11, [5] and [6]]

A power scale factor per subcarrier (as in 802.11ax) is defined for pre-EHT modulated fields.

* This is only for EHT-TB PPDU.

[Motion 146, #SP344, [23] and [24]]

### Support for large bandwidth

802.11be supports that 80 MHz and 160 MHz operating STA shall be able to participate in a higher BW DL and UL OFDMA transmission.

* STA shall be able to decode the preamble and its assigned RU (some restrictions TBD).
* No capability bit as in 802.11ax.

[Motion 115, #SP75, [16] and [25]]

EHT defines frequency domain aggregation of aggregated PPDUs. Aggregated PPDU consists of multiple PPDUs.

* The PPDU format combination limits to EHT and HE.
* Other combinations are TBD.
* For the PPDU using HE format, the PPDU BW TBD.
* The number of PPDUs is TBD.
* A-PPDU will be R2 feature.

[Motion 112, #SP48, [19] and [26]]

802.11be supports the design of allowing multiplexing STAs of different amendments in one transmission with OFDMA using frequency domain A-PPDU.

* STAs of different amendments may include HE, EHT
  + Post-EHT STA is TBD;
  + The BW allocated to different STAs that can be mixed in one transmission is TBD.
* This feature is targeted for R2.

[Motion 122, #SP156, [12] and [27]]

### Single RU

For a single RU less than or equal to 242 tones (i.e., RU26, RU52, RU106, RU242), the BCC can be supported.

* Mandatory or Optional for BCC, TBD.
* Only for modulation up to 256 QAM (with or without DCM – if defined in 802.11be).
* Only for NSS ≤ 4.

[Motion 112, #SP13, [19] and [28]]

### Multiple RU

#### **General**

802.11be shall allow more than one RUs to be assigned to a single STA.

Coding and interleaving schemes for multiple RUs assigned to a single STA are TBD.

Maximum number of RUs (>1) assigned to a single STA is also TBD.

[Motion 6, [5] and [29]]

Small-size RUs can only be combined with small-size RUs and large-size RUs can only be combined with large-size RUs.

RUs with equal to or more than 242 tones are defined as large-size RUs.

RUs with less than 242 tones are defined as small-size RUs.

[Motion 76, [30] and [31]]

In 802.11be, there is only one PSDU per STA for each link.

[Motion 91, [30] and [32]]

#### **Small-size RUs**

Combination of small-size RUs shall not cross 20 MHz channel boundary.

* The combination that includes RU106 plus center 26-tone RU case is TBD.

[Motion 69, [30] and [31]]

Only allowed small-size RU combinations are RU106+RU26 and RU52+RU26.

[Motion 78, [30] and [31]]

For 20 MHz and 40 MHz PPDU, within 20 MHz boundary, any contiguous RU26 and RU106 can be combined.

[Motion 79, [30] and [31]]

For 20 MHz and 40 MHz PPDU, combination of RU52 and RU26 are allowed only in locations shown in rows marked by RU78.



Figure 2 – Allowed combination of RU52+RU26 for 20 MHz and 40 MHz PPDU

[Motion 80, [30] and [31]]

[Motion 118, [16] and [17]]

For 80 MHz PPDU, combination of RU52 and RU26 are allowed only in locations shown in rows marked by RU78.



Figure 3 – Allowed combination of RU52+RU26 for 80 MHz PPDU

[Motion 81, [30] and [31]]

[Motion 118, [16] and [17]]

802.11be supports the following RU106+RU26 combinations as shown in the row marked RU132 for each 80 MHz segment in 80 MHz, 160 MHz, 240 MHz, and 320 MHz bandwidth.



Figure 4 – Allowed combination of RU106+RU26 for each 80 MHz segment in 80, 160, 240, and 320 MHz bandwidth

[Motion 112, #SP21, [19] and [33]]

[Motion 118, [16] and [17]]

802.11be supports the following mandatory RU combinations for small-size RUs:

* {RU26+RU52, RU106+RU26} for non-AP STA only and in OFDMA only.

[Motion 115, #SP71, [16] and [34]]

The 26-tone RU indices for an 80 MHz EHT PPDU in both DL and UL, a 160 MHz EHT PPDU, and a 320 MHz EHT PPDU are given as follows.

**26-tone RU indices for an 80 MHz EHT PPDU in both DL and UL**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **RU type** | **RU index and subcarrier range** | | | | |
| 26-tone RU | RU 1 [–499: –474] | RU 2 [–473: –448] | RU 3 [–445: –420] | RU 4 [–419: –394] | RU 5 [–392: –367] |
| RU 6 [–365: –340] | RU 7 [–339: –314] | RU 8 [–311: –286] | RU 9 [–285: –260] |  |
| RU 10 [–252: –227] | RU 11 [–226: –201] | RU 12 [–198: –173] | RU 13 [–172: –147] | RU 14 [–145: –120] |
| RU 15 [–118: –93] | RU 16 [–92: –67] | RU 17 [–64: –39] | RU 18 [–38: –13] | RU 19 [Not Defined] |
| RU 20 [13: 38] | RU 21 [39: 64] | RU 22 [67: 92] | RU 23 [93: 118] | RU 24 [120: 145] |
| RU 25 [147: 172] | RU 26 [173: 198] | RU 27 [201: 226] | RU 28 [227: 252] |  |
| RU 29 [260: 285] | RU 30 [286: 311] | RU 31 [314: 339] | RU 32 [340: 365] | RU 33 [367: 392] |
| RU 34 [394: 419] | RU 35 [420: 445] | RU 36 [448: 473] | RU 37 [474: 499] |  |

**26-tone RU indices for a 160 MHz EHT PPDU**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| RU type | RU index and subcarrier range | | | | |
| 26-tone RU | RU 1  [–1011: –986] | RU 2  [–985: –960] | RU 3  [–957: –932] | RU 4  [–931: –906] | RU 5  [–904: –879] |
| RU 6  [–877: –852] | RU 7  [–851: –826] | RU 8  [–823: –798] | RU 9  [–797: –772] |  |
| RU 10  [–764: –739] | RU 11  [–738: –713] | RU 12  [–710: –685] | RU 13  [–684: –659] | RU 14  [–657: –632] |
| RU 15  [–630: –605] | RU 16  [–604: –579] | RU 17  [–576: –551] | RU 18  [–-550: –525] | RU 19  [Not defined] |
| RU 20  [–499: –474] | RU 21  [–473: –448] | RU 22  [–445: –420] | RU 23  [–419: –394] | RU 24  [–392: –367] |
| RU 25  [–365: –340] | RU 26  [–339: –314] | RU 27  [–311: –286] | RU 28  [–285: –260] |  |
| RU 29  [–252: –227] | RU 30  [–226: –201] | RU 31  [–198: –173] | RU 32  [–172: –147] | RU 33  [–145: –120] |
| RU 34  [–118: –93] | RU 35  [–92: –67] | RU 36  [–64: –39] | RU 37  [–38: –13] |  |
| RU 38  [13: 38] | RU 39  [39: 64] | RU 40  [67: 92] | RU 41  [93: 118] | RU 42  [120: 145] |
| RU 43  [147: 172] | RU 44  [173: 198] | RU 45  [201: 226] | RU 46  [227: 252] |  |
| RU 47  [260: 285] | RU 48  [286: 311] | RU 49  [314: 339] | RU 50  [340: 365] | RU 51  [367: 392] |
| RU 52  [394: 419] | RU 53  [420: 445] | RU 54  [448: 473] | RU 55  [474: 499] | RU 56  [Not defined] |
| RU 57  [525: 550] | RU 58  [551: 576] | RU 59  [579: 604] | RU 60  [605: 630] | RU 61  [632: 657] |
| RU 62  [659: 684] | RU 63  [685: 710] | RU 64  [713: 738] | RU 65  [739: 764] |  |
| RU 66  [772: 797] | RU 67  [798: 823] | RU 68  [826: 851] | RU 69  [852: 877] | RU 70  [879: 904] |
| RU 71  [906: 931] | RU 72  [932: 957] | RU 73  [960: 985] | RU 74  [986: 1011] |  |

**26-tone RU indices for a 320 MHz EHT PPDU**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| RU type | RU index and subcarrier range | | | | |
| 26-tone RU | RU 1  [–2035: –2010] | RU 2  [–2009: –1984] | RU 3  [–1981: –1956] | RU 4  [–1955: –1930] | RU 5  [–1928: –1903] |
| RU 6  [–1901: –1876] | RU 7  [–1875: –1850] | RU 8  [–1847: –1822] | RU 9  [–1821: –1796] |  |
| RU 10  [–1788: –1763] | RU 11  [–1762: –1737] | RU 12  [–1734: –1709] | RU 13  [–1708: –1683] | RU 14  [–1681: –1656] |
| RU 15  [–1654: –1629] | RU 16  [–1628: –1603] | RU 17  [–1600: –1575] | RU 18  [–1574: –1549] | RU 19  [Not defined] |
| RU 20  [–1523: –1498] | RU 21  [–1497: –1472] | RU 22  [–1469: –1444] | RU 23  [–1443: –1418] | RU 24  [–1416: –1391] |
| RU 25  [–1389: –1364] | RU 26  [–1363: –1338] | RU 27  [–1335: –1310] | RU 28  [–1309: –1284] |  |
| RU 29  [–1276: –1251] | RU 30  [–1250: –1225] | RU 31  [–1222: –1197] | RU 32  [–1196: –1171] | RU 33  [–1169: –1144] |
| RU 34  [–1142: –1117] | RU 35  [–1116: –1091] | RU 36  [–1088: –1063] | RU 37  [–1062: –1037] |  |
| RU 38  [–1011: –986] | RU 39  [–985: –960] | RU 40  [–957: –932] | RU 41  [–931: –906] | RU 42  [–904: –879] |
| RU 43  [–877: –852] | RU 44  [–851: –826] | RU 45  [–823: –798] | RU 46  [–797: –772] |  |
| RU 47  [–764: –739] | RU 48  [–738: –713] | RU 49  [–710: –685] | RU 50  [–684: –659] | RU 51  [–657: –632] |
| RU 52  [–630: –605] | RU 53  [–604: –579] | RU 54  [–576: –551] | RU 55  [–550: –525] | RU 56  [Not defined] |
| RU 57  [–499: –474] | RU 58  [–473: –448] | RU 59  [–445: –420] | RU 60  [–419: –394] | RU 61  [–392: –367] |
| RU 62  [–365: –340] | RU 63  [–339: –314] | RU 64  [–311: –286] | RU 65  [–285: –260] |  |
| RU 66  [–252: –227] | RU 67  [–226: –201] | RU 68  [–198: –173] | RU 69  [–172: –147] | RU 70  [–145: –120] |
| RU 71  [–118: –93] | RU 72  [–92: –67] | RU 73  [–64: –39] | RU 74  [–38: –13] |  |
| RU 75  [13: 38] | RU 76  [39: 64] | RU 77  [67: 92] | RU 78  [93: 118] | RU 79  [120: 145] |
| RU 80  [147: 172] | RU 81  [173: 198] | RU 82  [201: 226] | RU 83  [227: 252] |  |
| RU 84  [260: 285] | RU 85  [286: 311] | RU 86  [314: 339] | RU 87  [340: 365] | RU 88  [367: 392] |
| RU 89  [394: 419] | RU 90  [420: 445] | RU 91  [448: 473] | RU 92  [474: 499] | RU 93  [Not defined] |
| RU 94  [525: 550] | RU 95  [551: 576] | RU 96  [579: 604] | RU 97  [605: 630] | RU 98  [632: 657] |
| RU 99  [659: 684] | RU 100  [685: 710] | RU 101  [713: 738] | RU 102  [739: 764] |  |
| RU 103  [772: 797] | RU 104  [798: 823] | RU 105  [826: 851] | RU 106  [852: 877] | RU 107  [879: 904] |
| RU 108  [906: 931] | RU 109  [932: 957] | RU 110  [960: 985] | RU 111  [986: 1011] |  |
| RU 112  [1037: 1062] | RU 113  [1063: 1088] | RU 114  [1091: 1116] | RU 115  [1117: 1142] | RU 116  [1144: 1169] |
| RU 117  [1171: 1196] | RU 118  [1197: 1222] | RU 119  [1225: 1250] | RU 120  [1251: 1276] |  |
| RU 121  [1284: 1309] | RU 122  [1310: 1335] | RU 123  [1338: 1363] | RU 124  [1364: 1389] | RU 125  [1391: 1416] |
| RU 126  [1418: 1443] | RU 127  [1444: 1469] | RU 128  [1472: 1497] | RU 129  [1498: 1523] | RU 130  [Not defined] |
| RU 131  [1549: 1574] | RU 132  [1575: 1600] | RU 133  [1603: 1628] | RU 134  [1629: 1654] | RU 135  [1656: 1681] |
| RU 136  [1683: 1708] | RU 137  [1709: 1734] | RU 138  [1737: 1762] | RU 139  [1763: 1788] |  |
| RU 140  [1796: 1821] | RU 141  [1822: 1847] | RU 142  [1850: 1875] | RU 143  [1876: 1901] | RU 144  [1903: 1928] |
| RU 145  [1930: 1955] | RU 146  [1956: 1981] | RU 147  [1984: 2009] | RU 148  [2010: 2035] |  |

[Motion 144, #SP332, [35] and [36]]

Indices for small-size MRUs in an OFDMA 80 MHz EHT PPDU, an OFDMA 160 MHz EHT PPDU, and an OFDMA 320 MHz EHT PPDU are given as follows.

**Indices for small-size MRUs in an OFDMA 80 MHz EHT PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** | **Note** |
| RU52+RU26 | MRU 1 | 52-tone RU 2 + 26-tone RU 2 | Not supported in BW ≥ 80 MHz |
| MRU 2 | 52-tone RU 2 + 26-tone RU 5 | - |
| MRU 3 | 52-tone RU 3 + 26-tone RU 8 | - |
| MRU 4 | 52-tone RU 6 + 26-tone RU 11 | - |
| MRU 5 | 52-tone RU 6 + 26-tone RU 14 | - |
| MRU 6 | 52-tone RU 7 + 26-tone RU 17 | Not supported in BW ≥ 80 MHz |
| MRU 7 | 52-tone RU 10 + 26-tone RU 21 | Not supported in BW ≥ 80 MHz |
| MRU 8 | 52-tone RU 10 + 26-tone RU 24 | - |
| MRU 9 | 52-tone RU 11 + 26-tone RU 27 | - |
| MRU 10 | 52-tone RU 14 + 26-tone RU 30 | - |
| MRU 11 | 52-tone RU 14 + 26-tone RU 33 | - |
| MRU 12 | 52-tone RU 15 + 26-tone RU 36 | Not supported in BW ≥ 80 MHz |
| RU106+RU26 | MRU 1 | 106-tone RU 1 + 26-tone RU 5 | - |
| MRU 2 | 106-tone RU 2 + 26-tone RU 5 | Not supported in BW ≥ 80 MHz |
| MRU 3 | 106-tone RU 3 + 26-tone RU 14 | Not supported in BW ≥ 80 MHz |
| MRU 4 | 106-tone RU 4 + 26-tone RU 14 | - |
| MRU 5 | 106-tone RU 5 + 26-tone RU 24 | - |
| MRU 6 | 106-tone RU 6 + 26-tone RU 24 | Not supported in BW ≥ 80 MHz |
| MRU 7 | 106-tone RU 7 + 26-tone RU 33 | Not supported in BW ≥ 80 MHz |
| MRU 8 | 106-tone RU 8 + 26-tone RU 33 | - |

**Indices for small-size MRUs in an OFDMA 160 MHz EHT PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** | **Note** |
| RU52+RU26 | MRU 1 | 52-tone RU 2 + 26-tone RU 2 | Not supported in BW ≥ 80 MHz |
| MRU 2 | 52-tone RU 2 + 26-tone RU 5 | - |
| MRU 3 | 52-tone RU 3 + 26-tone RU 8 | - |
| MRU 4 | 52-tone RU 6 + 26-tone RU 11 | - |
| MRU 5 | 52-tone RU 6 + 26-tone RU 14 | - |
| MRU 6 | 52-tone RU 7 + 26-tone RU 17 | Not supported in BW ≥ 80 MHz |
| MRU 7 | 52-tone RU 10 + 26-tone RU 21 | Not supported in BW ≥ 80 MHz |
| MRU 8 | 52-tone RU 10 + 26-tone RU 24 | - |
| MRU 9 | 52-tone RU 11 + 26-tone RU 27 | - |
| MRU 10 | 52-tone RU 14 + 26-tone RU 30 | - |
| MRU 11 | 52-tone RU 14 + 26-tone RU 33 | - |
| MRU 12 | 52-tone RU 15 + 26-tone RU 36 | Not supported in BW ≥ 80 MHz |
| MRU 13 | 52-tone RU 18 + 26-tone RU 39 | Not supported in BW ≥ 80 MHz |
| MRU 14 | 52-tone RU 18 + 26-tone RU 42 | - |
| MRU 15 | 52-tone RU 19 + 26-tone RU 45 | - |
| MRU 16 | 52-tone RU 22 + 26-tone RU 48 | - |
| MRU 17 | 52-tone RU 22 + 26-tone RU 51 | - |
| MRU 18 | 52-tone RU 23 + 26-tone RU 54 | Not supported in BW ≥ 80 MHz |
| MRU 19 | 52-tone RU 26 + 26-tone RU 58 | Not supported in BW ≥ 80 MHz |
| MRU 20 | 52-tone RU 26 + 26-tone RU 61 | - |
| MRU 21 | 52-tone RU 27 + 26-tone RU 64 | - |
| MRU 22 | 52-tone RU 30 + 26-tone RU 67 | - |
| MRU 23 | 52-tone RU 30 + 26-tone RU 70 | - |
| MRU 24 | 52-tone RU 31 + 26-tone RU 73 | Not supported in BW ≥ 80 MHz |
| RU106+RU26 | MRU 1 | 106-tone RU 1 + 26-tone RU 5 | - |
| MRU 2 | 106-tone RU 2 + 26-tone RU 5 | Not supported in BW ≥ 80 MHz |
| MRU 3 | 106-tone RU 3 + 26-tone RU 14 | Not supported in BW ≥ 80 MHz |
| MRU 4 | 106-tone RU 4 + 26-tone RU 14 | - |
| MRU 5 | 106-tone RU 5 + 26-tone RU 24 | - |
| MRU 6 | 106-tone RU 6 + 26-tone RU 24 | Not supported in BW ≥ 80 MHz |
| MRU 7 | 106-tone RU 7 + 26-tone RU 33 | Not supported in BW ≥ 80 MHz |
| MRU 8 | 106-tone RU 8 + 26-tone RU 33 | - |
| MRU 9 | 106-tone RU 9 + 26-tone RU 42 | - |
| MRU 10 | 106-tone RU 10 + 26-tone RU 42 | Not supported in BW ≥ 80 MHz |
| MRU 11 | 106-tone RU 11 + 26-tone RU 51 | Not supported in BW ≥ 80 MHz |
| MRU 12 | 106-tone RU 12 + 26-tone RU 51 | - |
| MRU 13 | 106-tone RU 13 + 26-tone RU 61 | - |
| MRU 14 | 106-tone RU 14 + 26-tone RU 61 | Not supported in BW ≥ 80 MHz |
| MRU 15 | 106-tone RU 15 + 26-tone RU 70 | Not supported in BW ≥ 80 MHz |
| MRU 16 | 106-tone RU 16 + 26-tone RU 70 | - |

**Indices for small-size MRUs in an OFDMA 320 MHz EHT PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** | **Note** |
| RU52+RU26 | MRU 1 | 52-tone RU 2 + 26-tone RU 2 | Not supported in BW ≥ 80 MHz |
| MRU 2 | 52-tone RU 2 + 26-tone RU 5 | - |
| MRU 3 | 52-tone RU 3 + 26-tone RU 8 | - |
| MRU 4 | 52-tone RU 6 + 26-tone RU 11 | - |
| MRU 5 | 52-tone RU 6 + 26-tone RU 14 | - |
| MRU 6 | 52-tone RU 7 + 26-tone RU 17 | Not supported in BW ≥ 80 MHz |
| MRU 7 | 52-tone RU 10 + 26-tone RU 21 | Not supported in BW ≥ 80 MHz |
| MRU 8 | 52-tone RU 10 + 26-tone RU 24 | - |
| MRU 9 | 52-tone RU 11 + 26-tone RU 27 | - |
| MRU 10 | 52-tone RU 14 + 26-tone RU 30 | - |
| MRU 11 | 52-tone RU 14 + 26-tone RU 33 | - |
| MRU 12 | 52-tone RU 15 + 26-tone RU 36 | Not supported in BW ≥ 80 MHz |
| MRU 13 | 52-tone RU 18 + 26-tone RU 39 | Not supported in BW ≥ 80 MHz |
| MRU 14 | 52-tone RU 18 + 26-tone RU 42 | - |
| MRU 15 | 52-tone RU 19 + 26-tone RU 45 | - |
| MRU 16 | 52-tone RU 22 + 26-tone RU 48 | - |
| MRU 17 | 52-tone RU 22 + 26-tone RU 51 | - |
| MRU 18 | 52-tone RU 23 + 26-tone RU 54 | Not supported in BW ≥ 80 MHz |
| MRU 19 | 52-tone RU 26 + 26-tone RU 58 | Not supported in BW ≥ 80 MHz |
| MRU 20 | 52-tone RU 26 + 26-tone RU 61 | - |
| MRU 21 | 52-tone RU 27 + 26-tone RU 64 | - |
| MRU 22 | 52-tone RU 30 + 26-tone RU 67 | - |
| MRU 23 | 52-tone RU 30 + 26-tone RU 70 | - |
| MRU 24 | 52-tone RU 31 + 26-tone RU 73 | Not supported in BW ≥ 80 MHz |
| MRU 25 | 52-tone RU 34 + 26-tone RU 76 | Not supported in BW ≥ 80 MHz |
| MRU 26 | 52-tone RU 34 + 26-tone RU 79 | - |
| MRU 27 | 52-tone RU 37 + 26-tone RU 82 | - |
| MRU 28 | 52-tone RU 38 + 26-tone RU 85 | - |
| MRU 29 | 52-tone RU 38 + 26-tone RU 88 | - |
| MRU 30 | 52-tone RU 39 + 26-tone RU 91 | Not supported in BW ≥ 80 MHz |
| MRU 31 | 52-tone RU 42 + 26-tone RU 95 | Not supported in BW ≥ 80 MHz |
| MRU 32 | 52-tone RU 42 + 26-tone RU 98 | - |
| MRU 33 | 52-tone RU 43 + 26-tone RU 101 | - |
| MRU 34 | 52-tone RU 46 + 26-tone RU 104 | - |
| MRU 35 | 52-tone RU 46 + 26-tone RU 107 | - |
| MRU 36 | 52-tone RU 47 + 26-tone RU 110 | Not supported in BW ≥ 80 MHz |
| MRU 37 | 52-tone RU 50 + 26-tone RU 113 | Not supported in BW ≥ 80 MHz |
| MRU 38 | 52-tone RU 50 + 26-tone RU 116 | - |
| MRU 39 | 52-tone RU 51 + 26-tone RU 119 | - |
| MRU 40 | 52-tone RU 54 + 26-tone RU 122 | - |
| MRU 41 | 52-tone RU 54 + 26-tone RU 125 | - |
| MRU 42 | 52-tone RU 55 + 26-tone RU 128 | Not supported in BW ≥ 80 MHz |
| MRU 43 | 52-tone RU 58 + 26-tone RU 132 | Not supported in BW ≥ 80 MHz |
| MRU 44 | 52-tone RU 58 + 26-tone RU 135 | - |
| MRU 45 | 52-tone RU 59 + 26-tone RU 138 | - |
| MRU 46 | 52-tone RU 62 + 26-tone RU 141 | - |
| MRU 47 | 52-tone RU 62 + 26-tone RU 144 | - |
| MRU 48 | 52-tone RU 63 + 26-tone RU 147 | Not supported in BW ≥ 80 MHz |
| RU106+RU26 | MRU 1 | 106-tone RU 1 + 26-tone RU 5 | - |
| MRU 2 | 106-tone RU 2 + 26-tone RU 5 | Not supported in BW ≥ 80 MHz |
| MRU 3 | 106-tone RU 3 + 26-tone RU 14 | Not supported in BW ≥ 80 MHz |
| MRU 4 | 106-tone RU 4 + 26-tone RU 14 | - |
| MRU 5 | 106-tone RU 5 + 26-tone RU 24 | - |
| MRU 6 | 106-tone RU 6 + 26-tone RU 24 | Not supported in BW ≥ 80 MHz |
| MRU 7 | 106-tone RU 7 + 26-tone RU 33 | Not supported in BW ≥ 80 MHz |
| MRU 8 | 106-tone RU 8 + 26-tone RU 33 | - |
| MRU 9 | 106-tone RU 9 + 26-tone RU 42 | - |
| MRU 10 | 106-tone RU 10 + 26-tone RU 42 | Not supported in BW ≥ 80 MHz |
| MRU 11 | 106-tone RU 11 + 26-tone RU 51 | Not supported in BW ≥ 80 MHz |
| MRU 12 | 106-tone RU 12 + 26-tone RU 51 | - |
| MRU 13 | 106-tone RU 13 + 26-tone RU 61 | - |
| MRU 14 | 106-tone RU 14 + 26-tone RU 61 | Not supported in BW ≥ 80 MHz |
| MRU 15 | 106-tone RU 15 + 26-tone RU 70 | Not supported in BW ≥ 80 MHz |
| MRU 16 | 106-tone RU 16 + 26-tone RU 70 | - |
| MRU 17 | 106-tone RU 17 + 26-tone RU 79 | - |
| MRU 18 | 106-tone RU 18+ 26-tone RU 79 | Not supported in BW ≥ 80 MHz |
| MRU 19 | 106-tone RU 19+ 26-tone RU 88 | Not supported in BW ≥ 80 MHz |
| MRU 20 | 106-tone RU 20 + 26-tone RU 88 | - |
| MRU 21 | 106-tone RU 21 + 26-tone RU 98 | - |
| MRU 22 | 106-tone RU 22 + 26-tone RU 98 | Not supported in BW ≥ 80 MHz |
| MRU 23 | 106-tone RU 23 + 26-tone RU 107 | Not supported in BW ≥ 80 MHz |
| MRU 24 | 106-tone RU 24 + 26-tone RU 107 | - |
| MRU 25 | 106-tone RU 25 + 26-tone RU 116 | - |
| MRU 26 | 106-tone RU 26 + 26-tone RU 116 | Not supported in BW ≥ 80 MHz |
| MRU 27 | 106-tone RU 27 + 26-tone RU 125 | Not supported in BW ≥ 80 MHz |
| MRU 28 | 106-tone RU 28 + 26-tone RU 125 | - |
| MRU 29 | 106-tone RU 29 + 26-tone RU 135 | - |
| MRU 30 | 106-tone RU 30 + 26-tone RU 135 | Not supported in BW ≥ 80 MHz |
| MRU 31 | 106-tone RU 31 + 26-tone RU 144 | Not supported in BW ≥ 80 MHz |
| MRU 32 | 106-tone RU 32 + 26-tone RU 144 | - |

[Motion 144, #SP333, [35] and [36]]

#### **Large-size RUs**

For the OFDMA transmission in 320/160+160 MHz, for one STA large size RU aggregation is allowed only within primary 160 MHz or secondary 160 MHz, respectively.

* Note that primary 160 MHz is composed of primary 80 MHz and secondary 80 MHz and secondary 160 MHz is 160 MHz channel other than the primary 160 MHz in 320/160+160 MHz.

Exception: 3×996 is supported.

3×996+484 RU combinations are TBD.

[Motion 87, [30] and [37]]

For the OFDMA transmission in contiguous 240 MHz, for one STA large size RU aggregation is allowed only within 160 MHz which is composed of two adjacent 80 MHz channels.

For the OFDMA transmission in noncontiguous 160+80 MHz, for one STA large size RU aggregation is allowed only within contiguous 160 MHz or the other 80 MHz, respectively.

2×996+484 RU combinations is TBD.

[Motion 86, [30] and [37]]

In 160 MHz OFDMA the following large RU combinations are supported.

|  |  |  |
| --- | --- | --- |
| **RU size** | **Aggregate bandwidth** | **Notes** |
| 484 + 996 | 120 MHz | 4 options |

[Motion 98, [30] and [38]]

In 80 MHz OFDMA the following large RU combinations are supported.

|  |  |  |
| --- | --- | --- |
| **RU size** | **Aggregate bandwith** | **Notes** |
| 484 + 242 | 60 MHz | 4 options |

[Motion 97, [30] and [38]]

For OFDMA, MRUs allowed in 80 MHz PPDU shall be allowed in each 80 MHz segment of 160 MHz/80 MHz + 80 MHz, 240 MHz/160 MHz + 80 MHz and 320 MHz/160 MHz + 160 MHz PPDU.

[Motion 115, #SP73, [16] and [39]]

For OFDMA, MRUs (996+484) are allowed in the following cases:

* Contiguous 160 MHz in 240 MHz/160 MHz + 80 MHz.
* Primary 160 MHz and secondary 160 MHz in 320 MHz/160 MHz + 160 MHz.

[Motion 115, #SP74, [16] and [39]]

802.11be supports the following mandatory RU combinations:

* Conditioned on device supporting 80, 160, 240 and 320 MHz transmissions.
* BW support for 802.11be AP and non-AP STA is TBD.
* NOTE – Currently in the SFD under OFDMA, 2×996+484 and 3×996+484 are TBD.

|  |  |  |
| --- | --- | --- |
| **Bandwidth** | **RU** | **Mandatory in OFDMA for:** |
| 80 MHz | 484+242 | Non-AP STA only |
| 160 MHz | 996+484 | Non-AP STA only |
| 240 MHz | 2×996+484 | Non-AP STA only |
| 320 MHz | 3×996+484, 3×996 (any 3) | Non-AP STA only |

[Motion 115, #SP72, [16] and [34]]

802.11be supports the mandatory RU combinations for large-size MRUs as shown in the table below:

* Conditioned on device supporting 80 MHz, 160 MHz, 240 MHz, and 320 MHz transmissions.
* Bandwidth support for 802.11be AP and non-AP STA is TBD.

|  |  |  |
| --- | --- | --- |
| **Bandwidth** | **RU** | **Mandatory in non-OFDMA for:** |
| 80 MHz | 484+242 | AP, STA |
| 160 MHz | 996+484 | AP, STA |
| 996+(484+242) | AP, STA |
| 240 MHz | 3×996, 2×996+484, 2×996 (any 2) | AP, STA |
| 320 MHz | 4×996, 3×996+484, 3×996 (any 3) | AP, STA |

[Motion 115, #SP71, [16] and [34]]

In 80 MHz non-OFDMA the following conditional mandatory (conditional on supporting puncturing) large RU combinations are supported.

* Any one of four 242 RUs can be punctured.

|  |  |  |
| --- | --- | --- |
| **RU size** | **Aggregate bandwidth** | **Notes** |
| 484 + 242 | 60 MHz | 4 options |

[Motion 93, [30] and [38]]

In 160 MHz non-OFDMA the following conditional mandatory (conditional on supporting puncturing) large RU combinations are supported.

* Any one of eight 242 RUs can be punctured.
* Any one of four 484 RUs can be punctured.

|  |  |  |  |
| --- | --- | --- | --- |
| **80 MHz RU size** | **80 MHz RU size** | **Aggregate bandwidth** | **Notes** |
| 484 | 996 | 120 MHz | 4 options |
| 484 + 242 | 996 | 140 MHz | 8 options |

[Motion 94, [30] and [38]]

In 240 MHz non-OFDMA the following conditional mandatory (conditional on supporting puncturing) large RU combinations are supported.

* Any one of six 484 RUs can be punctured.
* Any one of three 996 RUs can be punctured.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **80 MHz RU size** | **80 MHz RU size** | **80 MHz RU size** | **Aggregate Bandwidth** | **Notes** |
| 484 | 996 | 996 | 200 MHz | 6 options |
| - | 996 | 996 | 160 MHz | 3 options |

[Motion 95, [30] and [38]]

In 320 MHz non-OFDMA the following conditional mandatory (conditional on supporting puncturing) large RU combinations are supported.

* Any one of eight 484 RUs can be punctured.
* Any one of four 996 RUs can be punctured.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **80 MHz RU size** | **80 MHz RU size** | **80 MHz RU size** | **80 MHz RU size** | **Aggregate bandwidth** | **Notes** |
| 484 | 996 | 996 | 996 | 280 MHz | 8 options |
| - | 996 | 996 | 996 | 240 MHz | 4 options |

[Motion 96, [30] and [38]]

MRU 996×2 shall not straddle two 160 MHz channels.

[Motion 122, #SP164, [12] and [13]]

The table below defines 12 options for MRU 996×2+484 in 320 MHz BSS.

* 240/160+80 MHz BW entry is TBD.
* NOTE – Shaded area in the table is punctured.



[Motion 122, #SP166, [12] and [13]]

Indices for small-size MRUs in an OFDMA 20 MHz EHT PPDU are given as follows.

|  |  |  |
| --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** |
| RU52+RU26 | MRU 1 | 52-tone RU 2 + 26-tone RU 2 |
| MRU 2 | 52-tone RU 2 + 26-tone RU 5 |
| MRU 3 | 52-tone RU 3 + 26-tone RU 8 |
| RU106+RU26 | MRU 1 | 106-tone RU 1 + 26-tone RU 5 |
| MRU 2 | 106-tone RU 2 + 26-tone RU 5 |

[Motion 144, #SP312, [35] and [40]]

Indices for small-size MRUs in an OFDMA 40 MHz EHT PPDU are given as follows.

|  |  |  |
| --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** |
| RU52+RU26 | MRU 1 | 52-tone RU 2 + 26-tone RU 2 |
| MRU 2 | 52-tone RU 2 + 26-tone RU 5 |
| MRU 3 | 52-tone RU 3 + 26-tone RU 8 |
| MRU 4 | 52-tone RU 6 + 26-tone RU 11 |
| MRU 5 | 52-tone RU 6 + 26-tone RU 14 |
| MRU 6 | 52-tone RU 7 + 26-tone RU 17 |
| RU106+RU26 | MRU 1 | 106-tone RU 1 + 26-tone RU 5 |
| MRU 2 | 106-tone RU 2 + 26-tone RU 5 |
| MRU 3 | 106-tone RU 3 + 26-tone RU 14 |
| MRU 4 | 106-tone RU 4 + 26-tone RU 14 |

[Motion 144, #SP313, [35] and [40]]

Indices for large-size MRUs in an 80 MHz EHT PPDU and in a non-OFDMA 80 MHz EHT PPDU are given as follows.

|  |  |  |
| --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** |
| RU484+RU242 | MRU 1 | RU484+RU242; [empty-RU242 RU242 RU484] |
| MRU 2 | RU484+RU242; [RU242 empty-RU242 RU484] |
| MRU 3 | RU484+RU242; [RU484 empty-RU242 RU242] |
| MRU 4 | RU484+RU242; [RU484 RU242 empty-RU242] |

[Motion 144, #SP314, [35] and [40]]

Indices for large-size MRUs in a 160 MHz EHT PPDU and in a non-OFDMA 160 MHz EHT PPDU are given as follows.

|  |  |  |
| --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** |
| RU996+RU484 | MRU 1 | RU996+RU484; [empty-RU484 RU484 RU996] |
| MRU 2 | RU996+RU484; [RU484 empty-RU484 RU996] |
| MRU 3 | RU996+RU484; [RU996 empty-RU484 RU484] |
| MRU 4 | RU996+RU484; [RU996 RU484 empty-RU484] |
| RU996+RU484+  RU242 (Only for non-OFDMA) | MRU 1 | RU996+RU484+RU242; [empty-RU242 RU242 RU484 RU996] |
| MRU 2 | RU996+RU484+RU242; [RU242 empty-RU242 RU484 RU996] |
| MRU 3 | RU996+RU484+RU242; [RU484 empty-RU242 RU242 RU996] |
| MRU 4 | RU996+RU484+RU242; [RU484 RU242 empty-RU242 RU996] |
| MRU 5 | RU996+RU484+RU242; [RU996 empty-RU242 RU242 RU484] |
| MRU 6 | RU996+RU484+RU242; [RU996 RU242 empty-RU242 RU484] |
| MRU 7 | RU996+RU484+RU242; [RU996 RU484 empty-RU242 RU242] |
| MRU 8 | RU996+RU484+RU242; [RU996 RU484 RU242 empty-RU242] |

[Motion 144, #SP315, [35] and [41]]

Indices for large-size MRUs in a 320 MHz EHT PPDU and in a non-OFDMA 320 MHz EHT PPDU are given as follows.

|  |  |  |
| --- | --- | --- |
| **MRU type** | **MRU index** | **MRU combination** |
| 2×RU996  +RU484 | MRU 1 | 2×RU996+RU484; [empty-RU484 RU484 RU996 RU996 empty-RU996] |
| MRU 2 | 2×RU996+RU484; [RU484 empty-RU484 RU996 RU996 empty-RU996] |
| MRU 3 | 2×RU996+RU484; [RU996 empty-RU484 RU484 RU996 empty-RU996] |
| MRU 4 | 2×RU996+RU484; [RU996 RU484 empty-RU484 RU996 empty-RU996] |
| MRU 5 | 2×RU996+RU484; [RU996 RU996 empty-RU484 RU484 empty-RU996] |
| MRU 6 | 2×RU996+RU484; [RU996 RU996 RU484 empty-RU484 empty-RU996] |
| MRU 7 | 2×RU996+RU484; [empty-RU996 empty-RU484 RU484 RU996 RU996] |
| MRU 8 | 2×RU996+RU484; [empty-RU996 RU484 empty-RU484 RU996 RU996] |
| MRU 9 | 2×RU996+RU484; [empty-RU996 RU996 empty-RU484 RU484 RU996] |
| MRU 10 | 2×RU996+RU484; [empty-RU996 RU996 RU484 empty-RU484 RU996] |
| MRU 11 | 2×RU996+RU484; [empty-RU996 RU996 RU996 empty-RU484 RU484] |
| MRU 12 | 2×RU996+RU484; [empty-RU996 RU996 RU996 RU484 empty-RU484] |
| 3×RU996 | MRU 1 | 3×RU996; [empty-RU996 RU996 RU996 RU996] |
| MRU 2 | 3×RU996; [RU996 empty-RU996 RU996 RU996] |
| MRU 3 | 3×RU996; [RU996 RU996 empty-RU996 RU996] |
| MRU 4 | 3×RU996; [RU996 RU996 RU996 empty-RU996] |
| 3×RU996  +RU484 | MRU 1 | 3×RU996+RU484; [empty-RU484 RU484 RU996 RU996 RU996] |
| MRU 2 | 3×RU996+RU484; [RU484 empty-RU484 RU996 RU996 RU996] |
| MRU 3 | 3×RU996+RU484; [RU996 empty-RU484 RU484 RU996 RU996] |
| MRU 4 | 3×RU996+RU484; [RU996 RU484 empty-RU484 RU996 RU996] |
| MRU 5 | 3×RU996+RU484; [RU996 RU996 empty-RU484 RU484 RU996] |
| MRU 6 | 3×RU996+RU484; [RU996 RU996 RU484 empty-RU484 RU996] |
| MRU 7 | 3×RU996+RU484; [RU996 RU996 RU996 empty-RU484 RU484] |
| MRU 8 | 3×RU996+RU484; [RU996 RU996 RU996 RU484 empty-RU484] |

[Motion 144, #SP316, [35] and [41]]

### RU/MRU restrictions for 20 MHz

Middle 26-tone RUs shall not be allocated to 20 MHz operating STAs for 40 / 80 / 160 / 320 MHz DL / UL OFDMA transmission.

* 80+80 / 160+160 MHz is TBD.

This is for R1.

[Motion 137, #SP271, [3] and [42]]

Middle 26 + 52/106 MRUs shall not be allocated to 20 MHz operating STAs for 40 / 80 / 160 / 320 MHz DL / UL OFDMA transmission.

* 80+80 / 160+160 MHz is TBD.

This is for R1.

[Motion 137, #SP272, [3] and [42]]

242-tone RUs may be allocated to 20 MHz operating STAs for 40 / 80 / 160 / 320 MHz DL OFDMA.

* 80+80 / 160+160 MHz is TBD.
* NOTE 1 – For Downlink OFDMA, receiving 242-tone RUs is optional for 20 MHz operating STAs.
* NOTE 2 – UL OFDMA case is TBD.

This is for R1.

[Motion 137, #SP270, [3] and [42]]

242-tone RUs shall not be allocated to 20 MHz operating STAs for 40 / 80 / 160 / 320 MHz EHT TB PPDU.

This is for R1.

[Motion 144, #SP331, [35] and [43]]

## MU-MIMO

802.11be agrees with the following MU-MIMO support.

* DL MU-MIMO
  + Mandatory support for AP with ≥ 4 antennas.
  + Mandatory support for STA.
  + Mandatory for non-OFDMA on all RU/MRU size ≥ 242 in supported bandwidth.
  + Optional for OFDMA+MU-MIMO operation.
* UL MU-MIMO
  + Mandatory support for AP with ≥ 4 antennas.
  + Mandatory support for STA.
  + Mandatory for non-OFDMA on all RU/MRU size ≥ 242 in supported bandwidth.
  + Optional for OFDMA+MU-MIMO operation.

[Motion 124, #SP181, [1] and [2]]

[Motion 137, #SP284, [3] and [44]]

Support of Nss\_total = 4 is mandatory for 802.11be STA in receiving both sounding NDP and DL MU-MIMO, i.e., beamformee STS capability.

[Motion 124, #SP182, [1] and [2]]

The non-AP EHT STA shall support transmitting UL MU-MIMO where the total spatial streams summed across all users is less than or equal to 8 in R1.

* NOTE – It is the same as in 802.11ax.

[Motion 137, #SP283, [3] and [44]]

DL and UL MU-MIMO are disallowed over MCS 15.

[Motion 146, #SP335, [23] and [45]]

## EHT PPDU formats

The format of the EHT MU PPDU is configured as follow:

* L-STF, L-LTF, L-SIG, RL-SIG, U-SIG, EHT-SIG, EHT-STF, EHT-LTF, DATA, PE.
* Additional fields are TBD.

****

NOTE – This PPDU format is used for 802.11be PPDU transmitted to a single user or multiple users. There is no EHT SU PPDU.

There are two modes in the EHT MU PPDU.

* Compressed mode:
  + Non-OFDMA.
  + No RU Allocation subfield in the Common field of the EHT-SIG.
* Non-compressed mode:
  + OFDMA.
  + RU Allocation subfield(s) in the Common field of the EHT-SIG.

[Motion 111, #SP0611-08, [19] and [46]]

[Motion 122, #SP140, [12] and [47]]

For the EHT MU PPDU, only the following GI/LTF combinations are supported.

* 2× LTF + 0.8 µs GI.
* 2× LTF + 1.6 µs GI.
* 4× LTF + 3.2 µs GI.
* 4× LTF + 0.8 µs GI.

[Motion 135, #SP216, [48] and [49]]

The following mandatory/optional support requirements of LTF+GI combinations are supported.

* MU PPDU
  + 2× LTF + 0.8 μs GI (M).
  + 2× LTF + 1.6 μs GI (M).
  + 4× LTF + 3.2 μs GI (M).
  + 4× LTF + 0.8 μs GI (O).
* TB PPDU
  + 2× LTF+1.6 μs GI (M).
  + 4× LTF + 3.2 μs GI (M).
  + 1× LTF + 1.6 μs GI (M).
  + NOTE – 1× LTF + 1.6 μs GI only for non-OFDMA transmission.
* NDP
  + 2× LTF + 0.8 μs GI (M).
  + 2× LTF + 1.6 μs GI (M).
  + 4× LTF + 3.2 μs GI (O).

[Motion 137, #SP281, [3] and [44]]

In the SU transmission and SU-DUP transmission,

* The compressed mode is used.
* The number of non-OFDMA users subfield is set to 0 to indicate one user.
* The User field for a non-MU-MIMO allocation is used.

[Motion 135, #SP238, [48] and [50]]

SU-DUP is indicated by using the specific MCS index of 802.11be MCS table in SU transmission.

* NOTE – Specific MCS means MCS0 + DCM + Nss = 1.

[Motion 135, #SP239, [48] and [50]]

An EHT NDP transmission uses an 802.11ac/802.11ax like method of signaling an NDP.

* L-SIG length along with N\_LTF/N\_STS and the number of EHT-SIG symbols can be used at the receiver to conclude that there are no data symbols.

[Motion 135, #SP234, [48] and [51]]

The number of EHT-LTF in non-OFDMA transmissions is larger than or equal to the initial number of EHT-LTFs determined by the number of total spatial streams.

* The maximum number of EHT-LTFs supported by the receiving STA(s) can be claimed by capability.
* The number of EHT-LTFs is signaled separately from Nss or Nss\_total.
* This feature is optional for receiver.
* The allowed number of extra LTFs is TBD.
* The support for NDP is TBD.

[Motion 137, #SP258, [3] and [52]]

Three PHY capability fields are defined to indicate the maximum supported number of EHT-LTFs of an EHT STA.

* One bit to indicate the support of extra LTFs for non-OFDMA PPDU.
* One field to indicate the maximum number of LTFs supported for data transmission to non-OFDMA single user.
  + NOTE – Larger than or equal to Nss capability.
* One field to indicate the maximum number of LTFs supported for data transmission to multiple users.
  + NOTE – Larger than or equal to beamformee Nss capability.

[Motion 137, #SP259, [3] and [52]]

The allowed values of maximum NLTF receive capability for single-user transmission are 4, 8, and 16.

NOTE – The value of maximum NLTF = 16 is available in R2.

[Motion 141, #SP260, [3] and [52]]

The allowed values of maximum NLTF receive capability for multiple-user transmission are 4, 8, and 16.

* NOTE 1 – This capability is for both OFDMA and non-OFDMA MU-MIMO transmission.
* NOTE 2 – The value of maximum NLTF = 16 is available in R2.

[Motion 141, #SP261, [3] and [52]]

If extra LTF is applied to non-OFDMA transmission, the number of EHT-LTF should be

* chosen from the set [2 4 8], and
* up to 2 times of the initial NLTF for all Nss.

[Motion 137, #SP262, [3] and [52]]

802.11be agrees that

* the number of EHT-LTF in NDP transmissions can be larger than the initial number of EHT-LTF determined by Nss;
* the support of extra LTF in NDP is optional for beamformee;
* the same capability fields for non-OFDMA data transmission to multiple users applies to NDP:
  + The support of extra LTF is claimed by the capability bit of “Extra LTFs support for non-OFDMA PPDU”;
  + The supported maximum number of EHT-LTFs in NDP is claimed by the capability field of “maximum number of LTFs supported for non-OFDMA data transmission to multiple users and NDP”.

[Motion 142, #SP296, [53] and [54]]

The format of the EHT TB PPDU is configured as follow:

* L-STF, L-LTF, L-SIG, RL-SIG, U-SIG, EHT-STF, EHT-LTF, DATA, PE.
* Additional fields are TBD.

****

NOTE – This format is used for a transmission that is a response to a triggering frame from an AP.

[Motion 111, #SP0611-09, [19] and [46]]

[Motion 122, #SP141, [12] and [47]]

UL MU-MIMO in TB PPDU does not support masked LTF mode and it mandates only non-AP STA to support the followings:

* 1× LTF without pilot,
* 2× and 4× LTF with single stream pilot.

[Motion 137, #SP282, [3] and [44]]

The EHT PPDU sent to a single user has the EHT-SIG field.

* A subfield that indicates preamble puncturing pattern can be present in the U-SIG and/or EHT-SIG field.

[Motion 112, #SP39, [19] and [55]]

802.11be supports to define ER preamble (classification and U-SIG decoding of version independent field only for forward compatibility) but not ER PPDU in R1.

* If defined, the ER preamble design shall be defined as in page 3 of 20/1132r0.



[Motion 137, #SP292, [3] and [56]]

## EHT modulation and coding schemes (EHT-MCSs)

### OFDM modulation

802.11be shall define 4096 QAM as one of the optionally supported modulations.

[Motion 111, #SP0611-21, [19] and [57]]

The uniform constellation mapping for 4096 QAM shall be as given in 11-20/0111r0.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Coordinate** | **Bits** | | | | | |
| -63 | 0 | 0 | 0 | 0 | 0 | 0 |
| -61 | 0 | 0 | 0 | 0 | 0 | 1 |
| -59 | 0 | 0 | 0 | 0 | 1 | 1 |
| -57 | 0 | 0 | 0 | 0 | 1 | 0 |
| -55 | 0 | 0 | 0 | 1 | 1 | 0 |
| -53 | 0 | 0 | 0 | 1 | 1 | 1 |
| -51 | 0 | 0 | 0 | 1 | 0 | 1 |
| -49 | 0 | 0 | 0 | 1 | 0 | 0 |
| -47 | 0 | 0 | 1 | 1 | 0 | 0 |
| -45 | 0 | 0 | 1 | 1 | 0 | 1 |
| -43 | 0 | 0 | 1 | 1 | 1 | 1 |
| -41 | 0 | 0 | 1 | 1 | 1 | 0 |
| -39 | 0 | 0 | 1 | 0 | 1 | 0 |
| -37 | 0 | 0 | 1 | 0 | 1 | 1 |
| -35 | 0 | 0 | 1 | 0 | 0 | 1 |
| -33 | 0 | 0 | 1 | 0 | 0 | 0 |
| -31 | 0 | 1 | 1 | 0 | 0 | 0 |
| -29 | 0 | 1 | 1 | 0 | 0 | 1 |
| -27 | 0 | 1 | 1 | 0 | 1 | 1 |
| -25 | 0 | 1 | 1 | 0 | 1 | 0 |
| -23 | 0 | 1 | 1 | 1 | 1 | 0 |
| -21 | 0 | 1 | 1 | 1 | 1 | 1 |
| -19 | 0 | 1 | 1 | 1 | 0 | 1 |
| -17 | 0 | 1 | 1 | 1 | 0 | 0 |
| -15 | 0 | 1 | 0 | 1 | 0 | 0 |
| -13 | 0 | 1 | 0 | 1 | 0 | 1 |
| -11 | 0 | 1 | 0 | 1 | 1 | 1 |
| -9 | 0 | 1 | 0 | 1 | 1 | 0 |
| -7 | 0 | 1 | 0 | 0 | 1 | 0 |
| -5 | 0 | 1 | 0 | 0 | 1 | 1 |
| -3 | 0 | 1 | 0 | 0 | 0 | 1 |
| -1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 0 | 0 | 0 | 1 |
| 5 | 1 | 1 | 0 | 0 | 1 | 1 |
| 7 | 1 | 1 | 0 | 0 | 1 | 0 |
| 9 | 1 | 1 | 0 | 1 | 1 | 0 |
| 11 | 1 | 1 | 0 | 1 | 1 | 1 |
| 13 | 1 | 1 | 0 | 1 | 0 | 1 |
| 15 | 1 | 1 | 0 | 1 | 0 | 0 |
| 17 | 1 | 1 | 1 | 1 | 0 | 0 |
| 19 | 1 | 1 | 1 | 1 | 0 | 1 |
| 21 | 1 | 1 | 1 | 1 | 1 | 1 |
| 23 | 1 | 1 | 1 | 1 | 1 | 0 |
| 25 | 1 | 1 | 1 | 0 | 1 | 0 |
| 27 | 1 | 1 | 1 | 0 | 1 | 1 |
| 29 | 1 | 1 | 1 | 0 | 0 | 1 |
| 31 | 1 | 1 | 1 | 0 | 0 | 0 |
| 33 | 1 | 0 | 1 | 0 | 0 | 0 |
| 35 | 1 | 0 | 1 | 0 | 0 | 1 |
| 37 | 1 | 0 | 1 | 0 | 1 | 1 |
| 39 | 1 | 0 | 1 | 0 | 1 | 0 |
| 41 | 1 | 0 | 1 | 1 | 1 | 0 |
| 43 | 1 | 0 | 1 | 1 | 1 | 1 |
| 45 | 1 | 0 | 1 | 1 | 0 | 1 |
| 47 | 1 | 0 | 1 | 1 | 0 | 0 |
| 49 | 1 | 0 | 0 | 1 | 0 | 0 |
| 51 | 1 | 0 | 0 | 1 | 0 | 1 |
| 53 | 1 | 0 | 0 | 1 | 1 | 1 |
| 55 | 1 | 0 | 0 | 1 | 1 | 0 |
| 57 | 1 | 0 | 0 | 0 | 1 | 0 |
| 59 | 1 | 0 | 0 | 0 | 1 | 1 |
| 61 | 1 | 0 | 0 | 0 | 0 | 1 |
| 63 | 1 | 0 | 0 | 0 | 0 | 0 |

[Motion 111, #SP0611-22, [19] and [57]]

802.11be devices shall mandatorily support the following modulation order:

* Up to 64 QAM for 20 MHz-only non-AP STA (if defined in EHT).
* Up to 256 QAM for all other devices.

[Motion 124, #SP176, [1] and [2]]

802.11be agrees that:

* MCS numbering for BSPK – 1024 QAM is the same as 802.11ax.
* 4096 QAM is defined with R=3/4 and R=5/6.
* MCS numbering for 4096 QAM is 12 and 13.

[Motion 131, #SP209, [58] and [59]]

### DCM

DCM+MCS0 for Nss=1 as defined in 802.11ax is a MCS in 802.11be.

* The detailed MCS number for DCM+MCS0 is TBD.
* This is an R1 feature.

[Motion 122, #SP147, [12] and [60]]

The following MCSs are defined:

* MCS 14: BPSK + ½ rate coding + DCM + Dup.
* MCS 15: BPSK + ½ rate coding + DCM.

NOTE – These MCSs are only applicable to Nss = 1.

[Motion 137, #SP250, [3] and [61]]

The followings are the requirements to support DCM+MCS0:

* Mandatory in
  + RU 26, 52, 106, and 242 for 20 MHz-only STAs.
  + RU 26, 52, 106, 242, 484, and 996 for non-20 MHz-only STAs.
* Conditional mandatory in
  + RU 2×996 when STA supports 160 MHz.
  + RU 2×996 and 4×996 when STA supports 320 MHz.
* Optional in
  + MRU 52+26, 106+26, 484+242, 996+484, 996+484+242, and 3×996.
* Not supported in
  + MRU 2×996+484, 3×996+484.

[Motion 137, #SP279, [3] and [44]]

802.11be agrees to define a DUP mode for non-punctured 80 MHz, 160 MHz and 320 MHz PPDUs transmitted to a single user, limited to {MCS0+DCM, Nss=1}.

* 80 DUP = 40 (RU 484) duplicated.
* 160 DUP = 80 (RU 996) duplicated.
* 320 DUP = 160 (RU 2×996) duplicated.
* PAPR reduction scheme is TBD.
* Additional diversity scheme is TBD.
* This is an R1 feature.

The mode defined above is limited to 6 GHz.

* NOTE – Whether to further limit this to LPI mode is TBD.

The duplication in the mode defined above is done only on the data tones of the payload portion and that EHT-STF/LTF are based on the total bandwidth.

In this mode,

* For 80 MHz PPDU, the EHT-STF, EHT-LTF, and pilot are the same as transmitting both RU1 and RU2 of 484-tone RU.
* For 160/320 MHz PPDU, the EHT-STF, EHT-LTF and pilot are the same as the non-OFDMA 160/320 MHz PPDU.

PAPR reduction scheme is TBD.

NOTE – Pre-EHT modulated fields are TBD.

[Motion 122, #SP162, [12] and [62]]

[Motion 122, #SP163, [12] and [62]]

[Motion 122, #SP170, [12] and [63]]

The optional Dup+DCM mode for 6 GHz band LPI channel is supported.

[Motion 137, #SP280, [3] and [44]]

The PAPR reduction scheme for the DUP mode consists of flipping the sign of data tones only, as shown in red as follows:

* BW80 and BW160 PPDU data-tone processing:
  + Pre-DCM frequency domain signal: 𝒙
  + DCM-encoded frequency domain signal: 𝒚 = [𝒙 𝒙𝐷𝐶𝑀 ]
  + DUP freq-domain signal: [𝒚 −𝒙 𝒙𝐷𝐶𝑀 ]
* BW320 PPDU data-tone processing:
  + Pre-DCM frequency domain signal split into two halves:
    - 𝒙𝐿 over lower 𝑁𝑆𝐷/2 subcarriers, 𝒙𝑈 over upper 𝑁𝑆𝐷/2 subcarriers.
  + DCM-encoded frequency domain signal: 𝒚 = [𝒙𝐿 𝒙𝐿,𝐷𝐶𝑀 𝒙𝑈 𝒙𝑈,𝐷𝐶𝑀]
  + DUP frequency domain signal: [𝒚 −𝒙𝐿 −𝒙𝐿,𝐷𝐶𝑀 𝒙𝑈 𝒙𝑈,𝐷𝐶𝑀 ]

[Motion 135, #SP210, [48] and [64]]

## EHT preambles

### L-STF, L-LTF, L-SIG, and RL-SIG

For EHT PPDU, L-STF, L-LTF, and L-SIG shall be transmitted at the beginning of the EHT PPDU.

For EHT PPDU, the first symbol after L-SIG shall be BPSK modulated.

[Motion 1, [5] and [65]]

The LENGTH field in L-SIG set to a value *N* such that mod(*N*, 3) = 0.

[Motion 29, [9] and [66]]

Phase rotation is applied to the legacy preamble part of EHT PPDU.

Coefficients applied to each 20 MHz channel are TBD.

Application to the other fields is TBD.

[Motion 41, [9] and [67]]

Phase rotation is applied to legacy preamble, RL-SIG, U-SIG, and EHT-SIG in EHT PPDU.

[Motion 112, #SP30, [19] and [68]]

802.11be supports the following phase rotation sequence for legacy preamble, RL-SIG, U-SIG, and EHT-SIG in 320/160+160 MHz PPDU:

* + [1 -1 -1 -1 1 -1 -1 -1 -1 1 1 1 -1 1 1 1]

[Motion 115, #SP81, [16] and [69]]

802.11be reuses the phase rotation sequence defined in 802.11ax for 20/40/80/160/80+80 MHz PPDU.

[Motion 112, #SP31, [19] and [68]]

EHT PPDU shall have a RL-SIG field, which is a repeat of the L-SIG field, immediately following the L-SIG field.

[Motion 49, [9] and [70]]

The extra 4 subcarriers are applied to L-SIG and RL-SIG.

The indices for extra subcarriers are [-28, -27, 27, 28].

The extra subcarriers are BPSK modulated.

The coefficients [-1 -1 -1 1] as in 802.11ax are mapped to the extra subcarriers.

[Motion 107, [30] and [46]]

### U-SIG

There shall be a 2 OFDM symbol long, jointly encoded U-SIG in the EHT preamble immediately after the RL-SIG.

* The U-SIG will contain version independent fields. The intent of the version independent content is to achieve better coexistence among future 802.11 generations.
* In addition, the U-SIG can have some version dependent fields.
* The size of the U-SIG for the case of an extended range mode (if such a mode were to be adopted) is TBD.
* The U-SIG will be sent using 52 data tones and 4 pilot tones per 20 MHz.

[Motion 27, [9] and [71]]

The U-SIG is modulated in the same way as the HE-SIG-A field of 802.11ax.

* Extended range SU mode is TBD.

[Motion 45, [9] and [72]]

The U-SIG includes version-independent bits followed by Version-dependent bits.



Figure 5 – U-SIG

* Version-independent bits have static location and bit definition across different generations/PHY versions.
* Version-dependent bits may have variable bit definition in each PHY version.

[Motion 47, [9] and [73]]

The U-SIG shall contain the following version-independent fields:

* PHY version identifier: 3 bits.
* UL/DL flag: 1 bit.

[Motion 42, [9] and [72]]

PHY version identifier field shall be one of the version-independent fields in the U-SIG.

* The purpose is to simplify autodetection for future 802.11 generations, i.e., the value of this field is used to identify the exact PHY version starting with 802.11be.
* Exact location of this field is TBD.

[Motion 28, [9] and [74]]

The U-SIG field includes the following bits in version-independent bits portion:

* BSS color, the number of bits TBD.
* TXOP duration, the number of bits TBD.

[Motion 48, [9] and [73]]

The U-SIG shall contain bandwidth information, carried as a version independent field.

* This field may also convey some puncturing information.
* The number of bits for this field is TBD.

[Motion 88, [30] and [75]]

802.11be supports that U-SIG in each 80 MHz shall carry puncturing channel info for at least the specific 80 MHz where it is transmitted.

* NOTE – Within each 80 MHz segment, U-SIG is duplicated in every non-punctured 20 MHz.
* Whether bandwidth/puncturing info can be different for different 80 MHz is TBD.
* Whether bandwidth and puncturing info in U-SIG are carried as a combined or a separate field is TBD.

[Motion 111, #SP0611-10, [19] and [76]]

802.11be signaling in U-SIG for bandwidth/puncturing information in every non-punctured 20 MHz of an 80 MHz segment shall allow even an OBSS or unassociated device to decode the puncturing pattern of at least the specific 80 MHz that contains the 20 MHz.

[Motion 113, [19] and [77]]

802.11be supports punctured channel information field in U-SIG to be ‘5 bits + 1 reserved bit adjacent to it’ in the version-dependent section.

* Non-OFDMA: use a 5-bit bandwidth dependent table to signal the puncturing pattern of the entire PPDU bandwidth.
* OFDMA: 4 bits to indicate which 20 MHz is punctured in the current 80 MHz.
  + 1 bit out of the 5 bits is not used for the OFDMA case.
* 1 reserved bit for possible future expansion (e.g., more puncturing patterns in R2) of non-OFDMA puncturing modes.
* Interpretation of the field shall be dependent on the transmission being OFDMA vs. non-OFDMA.

[Motion 135, #SP233, [48] and [78]]

U-SIG of TB PPDU does not have punctured channel indication.

[Motion 135, #SP222, [48] and [79]]

802.11be supports bandwidth field which does not include puncturing information.

[Motion 112, #SP29, [19] and [77]]

In addition to four entries for 20/40/80/160MHz, there exists two entries in U-SIG BW field for 320 MHz:

* 320-1 if PPDU channel center frequency is 31, 95, 159.
* 320-2 if PPDU channel center frequency is 63, 127, 191.

[Motion 135, #SP237, [48] and [80]]

The preamble puncture indication field in U-SIG of an OFDMA transmission in an EHT MU PPDU indicates the preamble puncturing patterns of only the 80 MHz where the U-SIG is being sent.

[Motion 131, #SP194, [58] and [81]]

Regarding preamble puncture flexibility for OFDMA, up to one hole per 80 MHz segments is supported. If punctured, the puncture pattern of each segment shall be one of the followings:

* X212
* 1X12
* 12X2
* 121X
* XX12
* 12XX
* 1XX2

NOTE – Left-to-right represents low-to-high 20MHz channels.

[Motion 131, #SP195, [58] and [81]]

For non-AP STA, it is mandatory to support the following:

* In OFDMA Rx, any preamble puncturing pattern allowed by Motion 131, #SP195.
* In non-OFDMA Tx and Rx, any preamble puncturing pattern needed to support mandatory MRU for non-OFDMA as specified in subclause 36.3.2.3.3 in D0.1.

For AP, it is mandatory to support the following:

* In OFDMA Tx and non-OFDMA Tx and Rx, any preamble puncturing pattern that needs to be supported for mandatory MRU in non-OFDMA as specified in subclause 36.3.2.3.3 in D0.1.

[Motion 137, #SP278, [3] and [44]]

Within one EHT PPDU, the bandwidth field in U-SIG shall indicate the same PPDU bandwidth across different 80MHz segments.

[Motion 122, #SP142, [12] and [82]]

The U-SIG shall contain a PPDU type field, carried as a version-dependent field.

* Number of bits for this field is TBD.

[Motion 89, [30] and [75]]

A subfield for indication of compressed mode is included in U-SIG as version-dependent field.

[Motion 124, #SP183, [1] and [83]]

The following subfields exist in U-SIG of an EHT PPDU sent to multiple users:

* EHT-SIG MCS.
* Number of EHT-SIG Symbols.

[Motion 59, [30] and [84]]

The following subfield exists in U-SIG or EHT-SIG of an EHT PPDU sent to multiple users:

* GI+EHT-LTF Size.

[Motion 100, [30] and [84]]

The following subfields exist in U-SIG and/or EHT-SIG of an EHT PPDU sent to single user:

* MCS
* NSTS
* GI+EHT-LTF Size
* Coding

[Motion 99, [30] and [84]]

The following subfields exist in U-SIG and/or EHT-SIG of an EHT PPDU sent to single user:

* LDPC Extra Symbol
* Beamformed
* Pre-FEC Padding Factor
* PE Disambiguity

[Motion 111, #SP0611-11, [19] and [85]]

A subfield for preamble puncturing pattern information that separates from the BW field is included in U-SIG and/or EHT-SIG for the 802.11be PPDU transmitted to a single user.

[Motion 111, #SP0611-12, [19] and [86]]

802.11be STA can recognize the preamble puncturing pattern it needs by using the BW field and puncturing information of U-SIG and/or EHT-SIG field in multiple user transmission.

* Details for how to convey the puncturing information is TBD.

[Motion 111, #SP0611-18, [19] and [87]]

802.11be supports that preamble of primary 20 MHz channel shall not be punctured in any PPDU (except TB PPDU).

[Motion 111, #SP0611-13, [19] and [76]]

The following indication shall be the same considering symbol alignment within each segment from PHY point of view, if the fields are present in U-SIG:

* Number of EHT-SIG symbols
* GI+EHT-LTF Size
* Number of EHT-LTF symbols
* PE related parameters

[Motion 111, #SP0611-14, [19] and [88]]

The Number of EHT-SIG Symbols field always exists in U-SIG of a PPDU that is not an EHT TB PPDU.

* The field is not reinterpreted as the number of MU-MIMO users.

[Motion 122, #SP138, [12] and [89]]

The bitwidth of the Number of EHT-SIG Symbols field is 5 in U-SIG of a PPDU that is not an EHT TB PPDU.

[Motion 122, #SP139, [12] and [89]]

A STA only needs to process up to one 80 MHz segment of the pre-EHT preamble (up to and including EHT-SIG) to get all the assignment information for itself.

* No 80 MHz segment change is needed while processing L-SIG, U-SIG, and EHT-SIG.

[Motion 111, #SP0611-15, [19] and [90]]

Information in U-SIG is allowed to vary from one 80 MHz to the next in an EHT PPDU of bandwidth > 80 MHz.

* NOTE –
  + - Each STA still needs to decode only one 80 MHz segment in U-SIG.
    - Within each 80MHz, U-SIG is still duplicated in every non-punctured 20 MHz.
    - SST operation using TWT is one potential applicable scenario, other scenarios are TBD (Needs MAC discussion).

[Motion 111, #SP0611-16, [19] and [90]]

The punctured channel information in U-SIG for the DL OFDMA case is a 4-bit bitmap that tells which 20 MHz channel is punctured in the relevant 80 MHz.

* Information may vary from one 80 MHz to another.
* The information is located in the 4 LSBs of the overall 5-bit punctured channel indication field. MSB is reserved.
* The LSB to the 4th bit of the field apply from the lowest frequency 20 MHz channel to the highest frequency 20 MHz channel.

[Motion 137, #SP290, [3] and [91]]

The puncture bitmap indication for a 20/40 MHz OFDMA transmission is 1111.

* All the other values of the puncture bitmap indication shall be Validate.

[Motion 150, #SP365, [92] and [93]]

802.11be supports the 5-bit punctured channel information in U-SIG for the non-OFDMA case to use the BW dependent table as shown below.

* The table tells, for a specific PPDU BW, the mapping of the “Punctured channel indication” field value to the non-OFDMA puncturing pattern being used in the PPDU.

|  |  |  |  |
| --- | --- | --- | --- |
| PPDU BW | Cases |  | Value |
| 80 MHz | No puncturing | [1 1 1 1] | 0 |
| 20 MHz punctured | [x 1 1 1] | 1 |
| [1 x 1 1] | 2 |
| [1 1 x 1] | 3 |
| [1 1 1 x] | 4 |
| 160 MHz | No puncturing | [1 1 1 1 1 1 1 1] | 0 |
| 20 MHz punctured | [x 1 1 1 1 1 1 1] | 1 |
| [1 x 1 1 1 1 1 1] | 2 |
| [1 1 x 1 1 1 1 1] | 3 |
| [1 1 1 x 1 1 1 1] | 4 |
| [1 1 1 1 x 1 1 1] | 5 |
| [1 1 1 1 1 x 1 1] | 6 |
| [1 1 1 1 1 1 x 1] | 7 |
| [1 1 1 1 1 1 1 x] | 8 |
| 40 MHz punctured | [x x 1 1 1 1 1 1] | 9 |
| [1 1 x x 1 1 1 1] | 10 |
| [1 1 1 1 x x 1 1] | 11 |
| [1 1 1 1 1 1 x x] | 12 |
| 320 MHz | No puncturing | [1 1 1 1 1 1 1 1] | 0 |
| 40 MHz punctured | [x 1 1 1 1 1 1 1] | 1 |
| [1 x 1 1 1 1 1 1] | 2 |
| [1 1 x 1 1 1 1 1] | 3 |
| [1 1 1 x 1 1 1 1] | 4 |
| [1 1 1 1 x 1 1 1] | 5 |
| [1 1 1 1 1 x 1 1] | 6 |
| [1 1 1 1 1 1 x 1] | 7 |
| [1 1 1 1 1 1 1 x] | 8 |
| 80 MHz punctured | [x x 1 1 1 1 1 1] | 9 |
| [1 1 x x 1 1 1 1] | 10 |
| [1 1 1 1 x x 1 1] | 11 |
| [1 1 1 1 1 1 x x] | 12 |
| 320-80-40 | [x x x 1 1 1 1 1] | 13 |
| [x x 1 x 1 1 1 1] | 14 |
| [x x 1 1 x 1 1 1] | 15 |
| [x x 1 1 1 x 1 1] | 16 |
| [x x 1 1 1 1 x 1] | 17 |
| [x x 1 1 1 1 1 x] | 18 |
| [x 1 1 1 1 1 x x] | 19 |
| [1 x 1 1 1 1 x x] | 20 |
| [1 1 x 1 1 1 x x] | 21 |
| [1 1 1 x 1 1 x x] | 22 |
| [1 1 1 1 x 1 x x] | 23 |
| [1 1 1 1 1 x x x] | 24 |

[Motion 142, #SP302, [53] and [94]]

The U-SIG and U-SIG overflow contents (other than NDP and TB packets) are shown in the table below.



* Ordering of fields is TBD.
* TxOP/BSS Color bits are TBD.
* Reserved bits will be reduced if these fields get more bits.

[Motion 135, #SP236, [48] and [51]]

A 2-bit combined “PPDU type and compression mode” field is used to signal the following:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **DL/UL**  **(1 bit)** | **PPDU type and**  **compression mode (2 bits)** | **Note** |
| **TB PPDU** | UL | 0 | No EHT-SIG |
| **DL OFDMA** | DL | 0 | EHT-SIG, RU allocation, [1 2 1 2] |
| **UL SU/SU DUP/NDP** | UL | 1 | EHT-SIG, No RU allocation, [1 1 1 1] |
| **DL SU/SU DUP/NDP** | DL | 1 | EHT-SIG, No RU allocation, [1 1 1 1] |
| **DL non-OFDMA MU-MIMO** | DL | 2 | EHT-SIG, No RU allocation, [1 2 1 2] |

* Other values are reserved.

[Motion 137, #SP291, [3] and [91]]

One reserved bit in EHT-SIG is used to indicate beamformed in an EHT sounding NDP.

* This is for R1.

If the Beamformed field in EHT-SIG of an EHT sounding NDP is 1, then the receiver of the EHT sounding NDP should not perform channel smoothing when generating the compressed beamforming feedback report.

[Motion 142, #SP299, [53] and [95]]

For 80 MHz NDP or each 80 MHz segment of > 80 MHz bandwidth NDP,

* If not punctured, non-OFDMA 80 MHz tone plan is used.
* If punctured, OFDMA 80 MHz tone plan is used.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **RU & Tone Indices** | **1x LTF Tones** | **2x LTF Tones** | **4x LTF Tones** |
| Non-punctured | RU996,  [–500:–3, 3:500] | A = [–500:4:–4, 4:4:500] | A = [–500:2:–4, 4:2:500] | A = [–500:–3, 3:500] |
| 1st 2 0MHz punctured | RU242+484,  [–253:–12, 12:253, 259:500] | B1 = [–252:4:–12, 12:4:252, 260:4:500] | B1 = [–252:2:–12, 12:2:252, 260:2:500] | B1 = [–253:–12, 12:253, 259:500] |
| 2nd 20 MHz punctured | RU242+484,  [–500:–259, 12:253, 259:500] | B2 = [–500:4:–260, 12:4:252, 260:4:500] | B2 = [–500:2:–260, 12:2:252, 260:2:500] | B2 = [–500:–259, 12:253, 259:500] |
| 3rd 20 MHz punctured | RU242+484,  [–500:–259,  –253:–12, 259:500] | B3 = [–500:4:–260,  –252:4:–12, 260:4:500] | B3 = [–500:2:–260,  –252:2:–12, 260:2:500] | B3 = [–500:–259,  –253:–12, 259:500] |
| 4th 20 MHz punctured | RU242+484,  [–500:–259,  –253: –12, 12:253] | B4 = [–500:4:–260,  –252:4:–12, 12:4:252] | B4 = [–500:2:–260,  –252:2:–12, 12:2:252] | B4 = [–500:–259,  –253:–2, 12:253] |
| 1st 40 MHz punctured | RU484,  [12:253, 259:500] | C1 = [12:4:252, 260:4:500] | C1 = [12:2:252, 260:2:500] | C1 = [12:253, 259:500] |
| 2nd 40 MHz punctured | RU484,  [–500:–259,  –253:–12] | C2 = [–500:4:–260,  –252:4:–12] | C2 = [–500:2:–260,  –252:2:–12] | C2 = [–500:–259,  –253:–12] |

[Motion 131, #SP201, [58] and [96]]

The U-SIG in NDP carries the puncturing information for the entire PPDU bandwidth.

* The same 5-bit field as the other non-OFDMA PPDUs.

[Motion 142, #SP306, [53] and [97]]

Two different kinds of reserved bits in the EHT preamble are required.

* Validate
  + Reserved bits with Terminate as Rx behavior for an R1 device.
* Disregard
  + Reserved bits with Don’t Care or Ignore as Rx behavior for an R1 device.

[Motion 144, #SP321, [35] and [98]]

There are 3 validate bits in the U-SIG as follows.

* 1 below Punctured Channel Indication field.
* 1 below the PPDU Type And Compression mode field.
* 1 more to tell R1 devices to terminate processing in certain R2 transmissions (which still use an R1 PPDU type and R1 puncturing pattern).
  + NOTE – Definitions of R1 and R2 devices are TBD.

[Motion 144, #SP322, [35] and [98]]

The following rules about any new potential entries of RU allocation table in R2 are defined.

* Values greater than 303
  + For any states of the RU allocation subfield that are defined as reserved in R1, R1 device can assume that “Field value modulo 8 +1” tells the number of R2 users.
* When reserved values < 303 are used, R1 devices will terminate reception.

[Motion 144, #SP323, [35] and [98]]

### EHT-SIG

There shall be a variable MCS and variable length EHT-SIG, immediately after the U-SIG, in an EHT PPDU sent to multiple users.

[Motion 43, [9] and [72]]

EHT-SIG support the following MCSs:

* MCS 0, MCS 1, MCS 3, and ‘MCS0+DCM’.

[Motion 135, #SP215, [48] and [49]]

802.11be does not have Doppler bit in EHT-SIG for R1.

* No midamble support in R1.

[Motion 135, #SP217, [48] and [49]]

802.11be shall not support STBC.

[Motion 135, #SP218, [48] and [49]]

The EHT-SIG (immediately after the U-SIG) in an EHT PPDU sent to multiple users shall have a common field and user-specific field(s).

* Special case compressed modes (e.g., full bandwidth MU-MIMO) are TBD.

[Motion 44, [9] and [72]]

The EHT-SIG common field in the uncompressed mode has the following coding structure for various bandwidth:

* In case of 20/40/80 MHz, just 1 code block is present.
* In case of 160/320 MHz, 2 code blocks are present.
  + 1st code block has fixed size (U-SIG overflow + 2 RUA fields).
  + 2nd code block includes all remaining RU allocation subfields (2 RUA fields in 160 MHz, 6 RUA fields in 320 MHz).

[Motion 135, #SP214, [48] and [49]]

A 3-bit subfield for the indication of the number of non-OFDMA users is included in EHT-SIG Common field of an EHT MU PPDU for the compressed mode.

[Motion 124, #SP184, [1] and [83]]

The EHT-SIG Common field is encoded together with the first User field for the non-OFDMA compressed modes.

* Applicable only if EHT-SIG field exists.

[Motion 135, #SP213, [48] and [49]]

The Common field of EHT SIG in EHT PPDU that is sent to multiple user includes the CRC and tail bits.

* The number of bits for CRC is TBD.
* The number of tail bits is 6.
* The configuration of the Common field is TBD.

[Motion 119, #SP107, [7] and [99]]

The EHT-SIG Common field includes the following:

* U-SIG overflow
  + Repeated in each content channel to be friendly to 20 MHz operating devices.
* Total number of non-OFDMA users (3 bits for 1–8 users)
  + Only present in the non-OFDMA compressed mode.
  + Repeated in each content channel (just like 802.11ax where the number of MU-MIMO users in the compressed mode was carried in HE-SIG-A).
* RU allocation subfields (RUA)
  + Only present in the uncompressed mode.
  + Contents are sent parallelized into two content channels.

[Motion 135, #SP212, [48] and [49]]

There is STA-ID related information in the EHT PPDU preamble sent to a single user and multiple users. TB PPDU is TBD.

[Motion 111, #SP0611-19, [19] and [76]]

The user-specific field of EHT SIG in EHT PPDU that is sent to multiple user consists of the user block field(s) that is made up of 2 user fields except for the last user block.

* The last user block may have one or two user field(s).
* The user block field includes the CRC and tail bits. The number of bits for CRC is 4. The number of tail bits is 6.

[Motion 119, #SP108, [7] and [99]]

The User field in EHT PPDU that is sent to multiple user includes the subfield that indicates the number of spatial streams for each user.

* For MU-MIMO allocation
  + Spatial configuration
    - Indicates the number of spatial streams for a user in MU-MIMO allocation.
* For non-MU-MIMO allocation
  + NSTS

[Motion 119, #SP120, [7] and [100]]

Design of the EHT-SIG User field is shown as follows:

* The ordering of the fields is also shown below.
* User field for a non-MU-MIMO allocation:

|  |  |
| --- | --- |
| **Subfield** | **Number of bits** |
| STA-ID | 11 |
| MCS | 4 |
| Reserved | 1 |
| NSTS | 4 |
| Beamformed | 1 |
| Coding | 1 |

* User field for an MU-MIMO allocation:

|  |  |
| --- | --- |
| **Subfield** | **Number of bits** |
| STA-ID | 11 |
| MCS | 4 |
| Coding | 1 |
| Spatial Configuration | 6 |

[Motion 135, #SP211, [48] and [49]]

The meaning of the coding bit in MU-MIMO per-user field for RU > 242 is reserved.

[Motion 135, #SP219, [48] and [101]]

The DUPed transmission in EHT is signaled using a value of the MCS field in EHT-SIG user field of the SU transmission.

[Motion 135, #SP235, [48] and [51]]

The EHT-SIG of the EHT sounding NDP is always modulated with BPSK R = 1/2, and has only one symbol.

* The EHT-SIG of the EHT sounding NDP contains 16-bit U-SIG overflow bits, 4-bit CRC, and 6-bit tail.
* This is for R1.

[Motion 137, #SP287, [3] and [102]]

For an EHT sounding NDP:

* The Number of EHT-SIG symbols field indicates one symbol.
* The EHT-SIG MCS field is set to MCS 0.
* This is for R1.

[Motion 142, #SP297, [53] and [95]]

Pre-FEC padding factor + PE disambiguity + LDPC extra symbol segment indication are repurposed to signal NSS (4 bits) in an EHT sounding NDP.

* Indicating 1SS–8SS in R1.
* The other 8 entries are reserved for R2.
* This is for R1.

[Motion 142, #SP298, [53] and [95]]

The 802.11ax encoding table for the SR field in HE SU/MU PPDU is reused for the SR field in the EHT-SIG of EHT MU PPDU.

[Motion 150, #SP379, [92] and [103]]

The Spatial Configuration subfield of the user field for MU-MIMO allocation consists of 6 bits.

[Motion 119, #SP122, [7] and [100]]

The Spatial Configuration subfield is defined as follows.







[Motion 119, #SP123, [7] and [100]]

The Nsts subfield of the User field for non-MU-MIMO allocation that consists of four bits. This subfield can indicate 1 to 16 streams that consists of four bits.

[Motion 119, #SP121, [7] and [100]]

An RU Allocation subfield is present in the Common field of the EHT-SIG field of an EHT PPDU sent to multiple users.

* Compressed modes are TBD.
* Contents of the RU Allocation subfield are TBD.

[Motion 57, [30] and [84]]

N RU allocation subfields are present in an EHT-SIG content channel,

* where N is the number of RU allocation subfield in common field of EHT-SIG content channel,
* N = 1 if a 20 MHz or 40 MHz EHT PPDU sent to multiple users is used,
* N = 2 if an 80 MHz EHT PPDU sent to multiple users is used,
* N = TBD for other cases.
* The compressed modes are TBD.

[Motion 112, #SP46, [19] and [104]]

The number of RU Allocation subfields, when present, in a Common field in the EHT-SIG field of EHT PPDU sent to multiple users is 4 and 8 in each content channel for 160 MHz and 320 MHz PPDU, respectively.

[Motion 122, #SP132, [12] and [105]]

The RU Allocation subfield in the EHT-SIG field of an EHT-PPDU sent to multiple users includes the RU allocation for multiple RUs as well as single RU.

[Motion 112, #SP45, [19] and [106]]

An RU Allocation subfield that is present in the Common field of the EHT-SIG field of an EHT PPDU sent to multiple users (except EHT TB PPDU), indicates RU assignment, including the size of the RU(s) and their placement in the frequency domain, to be used in the EHT modulated fields of the PPDU in the frequency domain.

* Compressed modes are TBD.

[Motion 112, #SP43, [19] and [107]]

There exists at least one compressed mode in which RU Allocation subfield does not exist in the Common field of the EHT-SIG field of an EHT PPDU sent to multiple users.

* Signaling method is TBD.

[Motion 58, [30] and [84]]

The minimum RU size for EHT to support MU-MIMO shall be 242-tone RU.

[Motion 112, #SP44, [19] and [107]]

The RU Allocation subfield includes large size of RU aggregation for OFDMA transmission as follows:

* For 80 MHz
  + 484 + 242
* For 160 MHz
  + 484 + 996
* For 320 MHz
  + 3x996
* Other cases are TBD.
* NOTE – Specific RU allocation indication is TBD.

[Motion 115, #SP57, [16] and [108]]

For non-compressed mode, each RU Allocation subfield in an EHT-SIG content channel corresponding to a 20 MHz frequency segment indicates the RU assignment, including the size of the RU(s) and their placement in the frequency domain, to be used in the EHT modulated fields of the EHT PPDU sent to multiple users in the frequency domain, also indicates information needed to compute the number of users allocated to each RU.

[Motion 115, #SP84, [16] and [109]]

The mapping from the TBD-bit RU Allocation subfield to the RU assignment contains the following entries:

* Other entries TBD.
* Compressed mode TBD.
* NOTE – Not all the 106+26-tone and 52+26 tone MRU are applicable when PPDU bandwidth is greater than or equal to 80 MHz.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Order** | **#1** | | **#2** | | **#3** | **#4** | **#5** | **#6** | **#7** | | **#8** | **#9** | **Number of entries** |
| TBD | 26 | | 26 | | 26 | 26 | 26 | 26 | 26 | | 26 | 26 | 1 |
| TBD | 26 | | 26 | | 26 | 26 | 26 | 26 | 26 | | 52 | | 1 |
| TBD | 26 | | 26 | | 26 | 26 | 26 | 52 | | | 26 | 26 | 1 |
| TBD | 26 | | 26 | | 26 | 26 | 26 | 52 | | | 52 | | 1 |
| TBD | 26 | | 26 | | 52 | | 26 | 26 | 26 | | 26 | 26 | 1 |
| TBD | 26 | | 26 | | 52 | | 26 | 26 | 26 | | 52 | | 1 |
| TBD | 26 | | 26 | | 52 | | 26 | 52 | | | 26 | 26 | 1 |
| TBD | 26 | | 26 | | 52 | | 26 | 52 | | | 52 | | 1 |
| TBD | 52 | | | | 26 | 26 | 26 | 26 | 26 | | 26 | 26 | 1 |
| TBD | 52 | | | | 26 | 26 | 26 | 26 | 26 | | 52 | | 1 |
| TBD | 52 | | | | 26 | 26 | 26 | 52 | | | 26 | 26 | 1 |
| TBD | 52 | | | | 26 | 26 | 26 | 52 | | | 52 | | 1 |
| TBD | 52 | | | | 52 | | 26 | 26 | 26 | | 26 | 26 | 1 |
| TBD | | 52 | | | 52 | | 26 | 26 | 26 | | 52 | | 1 |
| TBD | | 52 | | | 52 | | 26 | 52 | | | 26 | 26 | 1 |
| TBD | | 52 | | | 52 | | 26 | 52 | | | 52 | | 1 |
| TBD | | 26 | | 26 | 26 | 26 | 26 | 106 | | | | | 1 |
| TBD | | 26 | | 26 | 52 | | 26 | 106 | | | | | 1 |
| TBD | | 52 | | | 26 | 26 | 26 | 106 | | | | | 1 |
| TBD | | 52 | | | 52 | | 26 | 106 | | | | | 1 |
| TBD | | 106 | | | | | 26 | 26 | 26 | | 26 | 26 | 1 |
| TBD | | 106 | | | | | 26 | 26 | 26 | | 52 | | 1 |
| TBD | | 106 | | | | | 26 | 52 | | | 26 | 26 | 1 |
| TBD | | 106 | | | | | 26 | 52 | | | 52 | | 1 |
| TBD | | 52 | | | 52 | | -- | 52 | | | 52 | | 1 |
| TBD | | Punctured 242-tone RU | | | | | | | | | | | 1 |
| TBD | | Unassigned 242-tone RU | | | | | | | | | | | 1 |
| TBD | | 242-tone RU; contributes zero User fields to the User Specific field in the same EHT-SIG content channel as this RU Allocation subfield and is not unallocated | | | | | | | | | | | 1 |
| TBD | | 484-tone RU; contributes zero User fields to the User Specific field in the same EHT-SIG content channel as this RU Allocation subfield and is not unallocated | | | | | | | | | | | 1 |
| TBD | | 996-tone RU; contributes zero User fields to the User Specific field in the same EHT-SIG content channel as this RU Allocation subfield and is not unallocated | | | | | | | | | | | 1 |
| TBD | | 106 | | | | | 26 | 106 | | | | | 1 |
| TBD | | 242 | | | | | | | | | | | 8 |
| TBD | | 484 | | | | | | | | | | | 8 |
| TBD | | 996 | | | | | | | | | | | 8 |
| TBD | | 2×996 | | | | | | | | | | | 8 |
| TBD | 26 | | | 26 | 26 | 26 | 26 | 52+26 | | | | 26 | 1 |
| TBD | 26 | | | 26+52 | | | 26 | 26 | 26 | | 26 | 26 | 1 |
| TBD | 26 | | | 26+52 | | | 26 | 26 | 26 | | 52 | | 1 |
| TBD | 26 | | | 26+52 | | | 26 | 52 | | | 26 | 26 | 1 |
| TBD | 26 | | | 26 | 52 | | 26 | 52+26 | | | | 26 | 1 |
| TBD | 26 | | | 26+52 | | | 26 | 52+26 | | | | 26 | 1 |
| TBD | 26 | | | 26+52 | | | 26 | 52 | | | 52 | | 1 |
| TBD | 52 | | | | 26 | 26 | 26 | 52+26 | | | | 26 | 1 |
| TBD | 52 | | | | 52 | | 26 | 52+26 | | | | 26 | 1 |
| TBD | 52 | | | | 52+26 | | | 52 | | 52 | | | 1 |
| TBD | 26 | | 26 | | 26 | 26 | 26+106 | | | | | | 1 |
| TBD | 26 | | 26+52 | | | | 26 | 106 | | | | | 1 |
| TBD | 26 | | 26 | | 52 | | 26+106 | | | | | | 1 |
| TBD | 26 | | 26+52 | | | | 26+106 | | | | | | 1 |
| TBD | 52 | | | | 26 | 26 | 26+106 | | | | | | 1 |
| TBD | 52 | | | | 52 | | 26+106 | | | | | | 1 |
| TBD | 106+26 | | | | | | | 26 | 26 | | 26 | 26 | 1 |
| TBD | 106+26 | | | | | | | 26 | 26 | | 52 | | 1 |
| TBD | 106+26 | | | | | | | 52 | | | 26 | 26 | 1 |
| TBD | 106 | | | | | | 26 | 52+26 | | | | 26 | 1 |
| TBD | 106+26 | | | | | | | 52+26 | | | | 26 | 1 |
| TBD | 106+26 | | | | | | | 52 | | | 52 | | 1 |
| TBD | 106+26 | | | | | | | 106 | | | | | 1 |
| TBD | 106 | | | | | | 26+106 | | | | | | 1 |

* STA ID 2046 is indicating unallocated RU for smaller than 242-tone RU.
* Whether STA ID 2046 can be used to indicated unallocated RU for equal or larger than 242-tone RU or not is TBD.

NOTE – Punctured RU 242 shall be used when the preamble portion of corresponding 20 MHz is punctured.

[Motion 115, #SP58, [16] and [110]]

[Motion 119, #SP103, [7] and [111]]

[Motion 119, #SP104, [7] and [111]]

[Motion 119, #SP105, [7] and [111]]

[Motion 119, #SP106, [7] and [112]]

[Motion 122, #SP134, [12] and [113]]

[Motion 122, #SP135, [12] and [113]]

[Motion 122, #SP136, [12] and [114]]

[Motion 131, #SP200, [58] and [115]]

RU996+484 is not supported in two contiguous 80 MHz segments that cross two 160 MHz channels.

[Motion 122, #SP137, [12] and [114]]

No entry in the RU allocation subfield table is defined for 4×996 RU.

[Motion 131, #SP131, [12] and [116]]

The RU Allocation subfield corresponding to RU242 in large-size MRU combinations of 484+242 is set to x (TBD) to indicate the zero users.

* x is a value corresponding to the entry of “242-tone RU; contributes zero User fields to the User Specific field in the same EHT-SIG content channel as this RU Allocation subfield and is not punctured” in RU Allocation subfield table.

The RU Allocation subfield corresponding to RU484 in large-size MRU combinations of 484+242, 996+484, 2×996+484, and 3×996+484 is set to y (TBD) to indicate the zero users.

* y is a value corresponding to the entry of “484-tone RU; contributes zero User fields to the User Specific field in the same EHT-SIG content channel as this RU Allocation subfield and is not punctured” in RU Allocation subfield table.

The RU Allocation subfield corresponding to RU996 in large-size MRU combinations of 996+484, 2×996+484, 3×996+484, 3×996, and 2×996 is set to z to indicate the zero users.

* z is a value corresponding to the entry of “996-tone RU; contributes zero User fields to the User Specific field in the same EHT-SIG content channel as this RU Allocation subfield and is not punctured” in RU Allocation subfield table.

[Motion 137, #SP289, [3] and [115]]

802.11be agrees to the following RU table.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **RU Table Index (9-bits)** | | | | | | | | |  | **Lowest to highest frequency order** | | | | | | | | |  |
| **Category** | **b8** | **b7** | **b6** | **b5** | **b4** | **b3** | **b2** | **b1** | **b0** |  | **#1** | **#2** | **#3** | **#4** | **#5** | **#6** | **#7** | **#8** | **#9** | **No. of entries** |
| Small RU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 26 | 26 | 26 | 26 | 26 | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 26 | 26 | 26 | 26 | 26 | 52 | | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 26 | 26 | 52 | | 26 | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 26 | 26 | 52 | | 26 | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 26 | 26 | 52 | | 26 | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 26 | 26 | 52 | | 26 | 52 | | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 52 | | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 52 | | 26 | 26 | 26 | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 52 | | 26 | 26 | 26 | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 52 | | 26 | 26 | 26 | 52 | | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 52 | | 52 | | 26 | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 52 | | 52 | | 26 | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 52 | | 52 | | 26 | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 52 | | 52 | | 26 | 52 | | 52 | | 1 |
| Small RU | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |  | 26 | 26 | 26 | 26 | 26 | 106 | | | | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 26 | 26 | 52 | | 26 | 106 | | | | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 52 | | 26 | 26 | 26 | 106 | | | | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 52 | | 52 | | 26 | 106 | | | | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |  | 106 | | | | 26 | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 106 | | | | 26 | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 106 | | | | 26 | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 106 | | | | 26 | 52 | | 52 | | 1 |
| Small RU | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |  | 52 | | 52 | | - | 52 | | 52 | | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |  | 106 | | | | 26 | 106 | | | | 1 |
| Punctured /Zero User Field | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |  |  | | | | | | | | | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |  |  | | | | | | | | | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |  |  | | | | | | | | | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |  |  | | | | | | | | | 1 |
|  | 0 | 0 | 0 | 0 | 1 | 1110-1111 | | | |  | **Reserved** | | | | | | | | | **2** |
| Small  M-RU | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |  | 26 | 26 | 26 | 26 | 26 | 52+26 | | | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 26 | 26 | 52 | | 26 | 52+26 | | | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 52 | | 26 | 26 | 26 | 52+26 | | | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 52 | | 52 | | 26 | 52+26 | | | 26 | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |  | 26 | 52+26 | | | 26 | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 26 | 52+26 | | | 26 | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 26 | 52+26 | | | 26 | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 26 | 52+26 | | | 26 | 52 | | 52 | | 1 |
| Small  M-RU | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |  | 26 | 26 | 26 | 26 | 106+26 | | | | | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 26 | 26 | 52 | | 106+26 | | | | | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 52 | | 26 | 26 | 106+26 | | | | | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 52 | | 52 | | 106+26 | | | | | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |  | 106+26 | | | | | 26 | 26 | 26 | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 106+26 | | | | | 26 | 26 | 52 | | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 106+26 | | | | | 52 | | 26 | 26 | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 106+26 | | | | | 52 | | 52 | | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Small  M-RU | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |  | 106+26 | | | | | 106 | | | | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |  | 106+26 | | | | | 52+26 | | | 26 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |  | 106 | | | | 106+26 | | | | | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |  | 26 | 52+26 | | | 106+26 | | | | | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |  | 106 | | | | 26 | 52+26 | | | 26 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |  | 26 | 52+26 | | | 26 | 106 | | | | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |  | 26 | 52+26 | | | 26 | 52+26 | | | 26 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |  | 52 | | 52+26 | | | 52 | | 52 | | 1 |
|  | 0 | 0 | 0 | 1 | 1 | 1000-1111 | | | |  | **Reserved** | | | | | | | | | **8** |
| Large RU | 0 | 0 | 1 | 0 | 0 | 0 | y2 | y1 | y0 |  | 242 | | | | | | | | | 8 |
| 0 | 0 | 1 | 0 | 0 | 1 | y2 | y1 | y0 | 484 | | | | | | | | | 8 |
| 0 | 0 | 1 | 0 | 1 | 0 | y2 | y1 | y0 | 996 | | | | | | | | | 8 |
| 0 | 0 | 1 | 0 | 1 | 1 | y2 | y1 | y0 | 2x996 | | | | | | | | | 8 |
| Large  M-RU | 0 | 0 | 1 | 1 | 0 | 0 | y2 | y1 | y0 |  | []-242-484 | | | | | | | | | 8 |
| 0 | 0 | 1 | 1 | 0 | 1 | y2 | y1 | y0 | 242-[]-484 | | | | | | | | | 8 |
| 0 | 0 | 1 | 1 | 1 | 0 | y2 | y1 | y0 | 484-[]-242 | | | | | | | | | 8 |
| 0 | 0 | 1 | 1 | 1 | 1 | y2 | y1 | y0 | 484-242-[] | | | | | | | | | 8 |
| Large  M-RU | 0 | 1 | 0 | 0 | 0 | 0 | y2 | y1 | y0 |  | []-484-996 | | | | | | | | | 8 |
| 0 | 1 | 0 | 0 | 0 | 1 | y2 | y1 | y0 | 484-[]-996 | | | | | | | | | 8 |
| 0 | 1 | 0 | 0 | 1 | 0 | y2 | y1 | y0 | 996-[]-484 | | | | | | | | | 8 |
| 0 | 1 | 0 | 0 | 1 | 1 | y2 | y1 | y0 | 996-484-[] | | | | | | | | | 8 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 | 1 | 0 | 1 | 0 | 0 | y2 | y1 | y0 |  | []-996-996-996 | | | | | | | | | 8 |
| 0 | 1 | 0 | 1 | 0 | 1 | y2 | y1 | y0 | 996-[]-996-996 | | | | | | | | | 8 |
| 0 | 1 | 0 | 1 | 1 | 0 | y2 | y1 | y0 | 996-996-[]-996 | | | | | | | | | 8 |
| 0 | 1 | 0 | 1 | 1 | 1 | y2 | y1 | y0 | 996-996-996-[] | | | | | | | | | 8 |
| Large  M-RU | 0 | 1 | 1 | 0 | 0 | 0 | y2 | y1 | y0 |  | []-484-996-996-996 | | | | | | | | | 8 |
| 0 | 1 | 1 | 0 | 0 | 1 | y2 | y1 | y0 | 484-[]-996-996-996 | | | | | | | | | 8 |
| 0 | 1 | 1 | 0 | 1 | 0 | y2 | y1 | y0 | 996-[]-484-996-996 | | | | | | | | | 8 |
| 0 | 1 | 1 | 0 | 1 | 1 | y2 | y1 | y0 | 996-484-[]-996-996 | | | | | | | | | 8 |
| 0 | 1 | 1 | 1 | 0 | 0 | y2 | y1 | y0 | 996-996-[]-484-996 | | | | | | | | | 8 |
| 0 | 1 | 1 | 1 | 0 | 1 | y2 | y1 | y0 | 996-996-484-[]-996 | | | | | | | | | 8 |
| 0 | 1 | 1 | 1 | 1 | 0 | y2 | y1 | y0 | 996-996-996-[]-484 | | | | | | | | | 8 |
| 0 | 1 | 1 | 1 | 1 | 1 | y2 | y1 | y0 | 996-996-996-484-[] | | | | | | | | | 8 |
| Large  M-RU | 1 | 0 | 0 | 0 | 0 | 0 | y2 | y1 | y0 |  | []-484-996-996 | | | | | | | | | 8 |
| 1 | 0 | 0 | 0 | 0 | 1 | y2 | y1 | y0 | 484-[]-996-996 | | | | | | | | | 8 |
| 1 | 0 | 0 | 0 | 1 | 0 | y2 | y1 | y0 | 996-[]-484-996 | | | | | | | | | 8 |
| 1 | 0 | 0 | 0 | 1 | 1 | y2 | y1 | y0 | 996-484-[]-996 | | | | | | | | | 8 |
| 1 | 0 | 0 | 1 | 0 | 0 | y2 | y1 | y0 | 996-996-[]-484 | | | | | | | | | 8 |
| 1 | 0 | 0 | 1 | 0 | 1 | y2 | y1 | y0 | 996-996-484-[] | | | | | | | | | 8 |
|  | 1 | 0 | 0 | 110 000 - 111 111 | | | | | |  | **Reserved** | | | | | | | | | **16** |
|  | 1 | 0 | 1 | 000 000 - 111 111 | | | | | |  | **Reserved** | | | | | | | | | **64** |
|  | 1 | 1 | 000 0000 - 111 1111 | | | | | | |  | **Reserved** | | | | | | | | | **128** |
|  |  |  |  |  |  |  |  |  |  |  | Note: 'y2y1y0' - Number of MU-MIMO users | | | | | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  | **Table size** | | | | | | | | | **512** |
|  |  |  |  |  |  |  |  |  |  |  | **Reserved entries** | | | | | | | | | **218** |
|  |  |  |  |  |  |  |  |  |  |  | **Total entries used** | | | | | | | | | **294** |

[Motion 139, #SP175, [3] and [117]]

For the PPDU transmitted to MU, the User field having TBD bits is contained in the user-specific field of EHT-SIG.

* The User field indicates user information assigned to each RU similar to that used in HE MU PPDU.
* Detailed descriptions are TBD.

[Motion 85, [30] and [118]]

In BW ≤ 160 MHz, the EHT-SIG content channel for multiple user transmission is configured as follows:

* An EHT-SIG content channel is composed of a 20 MHz frequency segment.
* EHT-SIG content channels carry EHT-SIG common information and user-specific information.
* The EHT-SIG field consists of two EHT-SIG content channels in each 80 MHz.

The content channels (i.e., CC1 and CC2) per each 80 MHz may carry different information.

* + Where, SST operation using TWT is one potential applicable scenario, other scenarios are TBD.

[Motion 111, #SP0611-17, [19] and [87]]

EHT-SIG may carry different content in each 80 MHz.

* For PPDU bandwidth larger than 80 MHz.
* SST operation using TWT is one applicable scenario, other scenarios are TBD.

[Motion 112, #SP1, [19] and [119]]

### STF

EHT PPDU has EHT-STF immediately after EHT-SIG.

* If EHT PPDU does not have EHT-SIG, EHT-STF is positioned immediately after U-SIG.

[Motion 112, #SP8, [19] and [120]]

802.11be supports 1× EHT-STF and 2× EHT-STF:

* 1× EHT-STF is used in EHT SU/MU PPDU.
  + Whether SU and MU PPDU format is the same is TBD.
* 2× EHT-STF is used in EHT TB PPDU.
* TBD for any new EHT PPDU formats.

[Motion 112, #SP9, [19] and [120]]

802.11be reuses 1× HE-STF and 2× HE-STF in 20/40/80/160/80+80 MHz PPDU.

[Motion 112, #SP10, [19] and [120]]

1× and 2× 320/160+160 MHz EHT-STF sequences are designed by repeating 1× and 2× 80 MHz HE-STF sequences, respectively.

* Additional coefficients for phase rotation are TBD.

[Motion 115, #SP56, [16] and [121]]

1× EHT-STF sequence for contiguous 320 MHz PPDU

* *EHTS*-2032:16:2032 = {*M*, 1, -*M*, 0, -*M*, 1, -*M*, 1×(0, *M*, 1, -*M*, 0, -*M*, 1, -*M*) , -1×(0, *M*, 1, -*M*, 0, -*M*, 1, -*M*), -1×(0, *M*, 1, -*M*, 0, -*M*, 1, -*M*)} × (1+j) / sqrt(2)

1× EHT-STF sequence for non-contiguous 160+160 MHz PPDU

* Low 160 MHz: *EHTS*-1008:16:1008 = {*M*, 1, -*M*, 0, -*M*, 1, -*M*, 0, *M*, 1, -*M*, 0, -*M*, 1, -*M* }×(1+j) / sqrt(2)
* High 160 MHz: *EHTS*-1008:16:1008 = {-*M*, -1, *M*, 0, *M*, -1, *M*, 0, -*M*, -1, *M*, 0, *M*, -1, *M* }×(1+j) / sqrt(2)

where *M* = {-1, -1, -1, +1, +1, +1, -1, +1, +1, +1, -1, +1, +1, -1, +1}.

[Motion 115, #SP82, [16] and [121]]

2× EHT-STF sequence for contiguous 320 MHz PPDU

* *EHTS*-2040:8:2040 = {*M*, -1, *M*, -1, -*M*, -1, *M*, 0, -*M*, 1, *M*, 1, -*M*, 1, -*M*, 1×(0, *M*, -1, *M*, -1, -*M*, -1, *M*, 0, -*M*, 1, *M*, 1, -*M*, 1, -*M*), -1×(0, *M*, -1, *M*, -1, -*M*, -1, *M*, 0, -*M*, 1, *M*, 1, -*M*, 1, -*M*), -1×(0, *M*, -1, *M*, -1, -*M*, -1, *M*, 0, -*M*, 1, *M*, 1, -*M*, 1, -*M*)}×(1+j) / sqrt(2)
  + *EHTS*-2040 = *EHTS*-1032 = *EHTS*-1016 = *EHTS*-8 = *EHTS*8 = *EHTS*1016 = *EHTS*1032 = *EHTS*2040 = 0

2× EHT-STF sequence for non-contiguous 160+160 MHz PPDU

* Low 160 MHz: *EHTS*-1016:8:1016 = {*M*, -1, *M*, -1, -*M*, -1, *M*, 0, -*M*, 1, *M*, 1, -*M*, 1, -*M*, 0, *M*, -1, *M*, -1, -*M*, -1, *M*, 0, -*M*, 1, *M*, 1, -*M*, 1, -*M* }×(1+j) / sqrt(2)
  + *EHTS*-1016 = *EHTS*-8 = *EHTS*8 = *EHTS*1016 = 0
* High 160 MHz: *EHTS*-1016:8:1016 = {-*M*, 1, -*M*, 1, *M*, 1, -*M*, 0, *M*, -1, -*M*, -1, *M*, -1, *M*, 0, -*M*, 1, -*M*, 1, *M*, 1, -*M*, 0, *M*, -1, -*M*, -1, *M*, -1, *M*}×(1+j) / sqrt(2)
  + *EHTS*-1016 = *EHTS*-8 = *EHTS*8 = *EHTS*1016 = 0

where *M* = {-1, -1, -1, +1, +1, +1, -1, +1, +1, +1, -1, +1, +1, -1, +1}

[Motion 115, #SP83, [16] and [121]]

### LTF

802.11be shall include 1× EHT-LTF and 2× EHT-LTF.

[Motion 74, [30] and [122]]

802.11be shall include 4× EHT-LTF.

[Motion 75, [30] and [123]]

802.11be supports EHT-LTF for 16 spatial streams.

[Motion 83, [30] and [124]]

802.11be supports reusing 1/2/4× HE-LTF sequences for 1/2/4× EHT-LTF sequences in 20/40/80 MHz PPDU transmission.

[Motion 112, #SP11, [19] and [125]]

802.11be supports reusing 1/2/4× HE-LTF sequences for 1/2/4× EHT-LTF sequences in 80+80/160 MHz.

[Motion 112, #SP41, [19] and [125]]

P-matrix based modulation of EHT-LTFs is adopted for all spatial multiplexing modes (both UL and DL) defined in EHT.

* All spatial streams are active during EHT-LTFs on every non-zero LTF tone.
* Applicable to multi-AP transmission modes as well.

[Motion 111, #SP0611-20, [19] and [126]]

In a 320 MHz transmission using 1× EHT-LTF, the 1× EHT-LTF sequence is given as below.

*EHTLTF*-2036,2036= {*LTF*80MHz\_1st\_1x, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, *LTF*80MHz\_2nd\_1x, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, *LTF*80MHz\_3rd\_1x, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, *LTF*80MHz\_4th\_1x}

*LTF*80MHz\_1st\_1x = { *LTF*80MHz\_left\_1x, 0, *LTF*80MHz\_right\_1x}

*LTF*80MHz\_2nd\_1x = { *LTF*80MHz\_left\_1x, 0, *LTF*80MHz\_right\_1x}

*LTF*80MHz\_3rd\_1x = { -*LTF*80MHz\_left\_1x, 0, -*LTF*80MHz\_right\_1x}

*LTF*80MHz\_4th\_1x = { -*LTF*80MHz\_left\_1x, 0, -*LTF*80MHz\_right\_1x}

*LTF*80MHz\_left\_1x and *LTF*80MHz\_right\_1x are used as it is in 802.11ax.

[Motion 122, #SP146, [12] and [127]]

The 2× 320 MHz LTF sequence is given as follows.

LTF80\_2x = [ +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 0 0 0 0 0 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1];

LTF320\_2x = [ [C(1)×LTF80\_2x(1:245), C(2)×LTF80\_2x(246:500), 0, C(3)×LTF80\_2x(502:756), C(4)×LTF80\_2x(757:1001)], zeros(1,23), [C(5)×LTF80\_2x(1:245), C(6)×LTF80\_2x(246:500), 0, C(7)×LTF80\_2x(502:756), C(8)×LTF80\_2x(757:1001)], zeros(1,23), [C(9)×LTF80\_2x(1:245), C(10)×LTF80\_2x(246:500), 0, C(11)×LTF80\_2x(502:756), C(12)×LTF80\_2x(757:1001)], zeros(1,23), [C(13)×LTF80\_2x(1:245), C(14)×LTF80\_2x(246:500), 0, C(15)×LTF80\_2x(502:756), C(16)×LTF80\_2x(757:1001)] ];

C = [+1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 -1 -1].

[Motion 137, #SP286, [3] and [128]]

The 4× 320 MHz EHT-LTF sequences are given as follows.

LTF320M\_4x =

[ C(1)×**LTF80M\_4x\_left**, zeros(1,5), C(2)×**LTF80M\_4x\_right**, zeros(1,23), ...

C(3)×**LTF80M\_4x\_left**, zeros(1,5), C(4)×**LTF80M\_4x\_right**, zeros(1,23), ...

C(5)×**LTF80M\_4x\_left**, zeros(1,5), C(6)×**LTF80M\_4x\_right**, zeros(1,23), ...

C(7)×**LTF80M\_4x\_left**, zeros(1,5), C(8)×**LTF80M\_4x\_right** ];

where,

C = [ 1 1 1 -1 -1 -1 -1 1],

**LTF80M\_4x\_left** = [+1 -1 -1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 -1 +1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 -1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 +1 -1 -1 -1 -1 -1 -1 -1 -1 +1 -1 -1 +1 -1 -1 +1 +1 +1 -1 +1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 +1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 -1 +1 -1 +1 -1 -1 +1 +1 +1 +1 +1 -1 +1 +1 -1 -1 +1 +1 +1 -1 +1 +1 -1 +1 +1 -1 -1 +1 +1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 +1 -1 -1 +1 +1 -1 -1 -1 +1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 -1 +1 -1 +1 +1 -1 -1 -1 +1 +1 -1 -1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 +1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 +1 +1 -1 -1 +1 +1 +1 -1 -1 -1 +1 -1 -1 +1 +1 -1 -1 -1 +1 -1 +1 -1 -1 +1 +1 +1 +1 +1 -1 -1 -1 -1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 -1 -1 -1 +1 -1 +1 +1 -1 -1 -1 +1 -1 -1],

**LTF80M\_4x\_right** = [ -1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 -1 +1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 -1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 -1 -1 +1 +1 -1 -1 -1 +1 +1 -1 +1 -1 -1 +1 -1 -1 -1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 -1 +1 +1 +1 -1 -1 -1 +1 -1 -1 +1 +1 -1 +1 +1 +1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 -1 -1 -1 -1 -1 +1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 -1 +1 +1 -1 -1 +1 +1 +1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 +1 -1 +1 -1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 +1 +1 -1 -1 +1 -1 +1 -1 +1 +1 +1 +1 +1 -1 -1 -1 +1 +1 -1 -1 -1 -1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 +1 -1 -1 -1 +1 +1 -1 +1 +1 -1 +1 +1 +1 +1 +1 +1 +1 +1 -1 -1 -1 -1 +1 +1 -1 +1 -1 +1 -1 +1 -1 +1 -1 -1 +1 -1 +1 -1 -1 -1 -1 -1 -1 +1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 +1 -1 -1 -1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 -1 -1 +1 -1 +1 +1 -1 -1 +1 +1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 +1 +1 -1 +1 -1 +1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 +1 -1 +1 +1 +1 -1 -1 +1 +1 +1 -1 +1 +1 -1 +1 +1 +1 +1 -1 ]

[Motion 137, #SP285, [3] and [129]]

### Preamble puncture

CCA minimum bandwidth resolution is 20 MHz.

Preamble puncturing resolution is 20 MHz.

[Motion 90, [30] and [32]]

802.11be shall support a preamble puncture mechanism for an EHT PPDU transmitted to multiple STAs.

[Motion 30, [9] and [130]]

802.11be shall support a preamble puncture mechanism for an EHT PPDU transmitted to a single STA.

[Motion 31, [9] and [130]]

## Data field

### Scrambler

The following generator polynomial to generate the PPDU synchronous scrambler is used for EHT PPDU:

* The 11 bits used for the scrambler initialization are randomly assigned by the transmitter.
* The polarity of the pilot subcarrier is derived from the same sequence as 802.11ax.

[Motion 112, #SP16, [19] and [131]]

802.11be supports using the first 11 LSB bits in SERVICE field for 802.11be scrambling seed initialization and keeping the remaining 5 bits as reserved.



Figure 6 – SERVICE field

[Motion 124, #SP172, [1] and [132]]

802.11be supports using the first 7 LSB bits of the SERVICE field in MU-RTS to scramble the CTS data and fill in the first 7 LSB bits of the SERVICE field of the CTS, when MU-RTS is transmitted using an EHT PPDU.

[Motion 124, #SP173, [1] and [132]]

802.11be supports to disallow the 7 LSB bits of the SERVICE field in MU-RTS transmitted using an EHT PPDU to be all zeros.

[Motion 124, #SP174, [1] and [132]]

### Pilot subcarriers

802.11be supports the following pilot indices for 26/52/106/242/484 RU in 80/160/320 MHz PPDU:

* in a OFDMA/non-OFDMA with puncturing 80MHz EHT PPDU
  + [Pilot indices in 40 MHz]-256, [Pilot indices in 40 MHz]+256
* in a OFDMA/non-OFDMA with puncturing 160MHz EHT PPDU
  + [Pilot indices in 80 MHz]-512, [Pilot indices in 80 MHz]+512
* in a OFDMA/non-OFDMA with puncturing 320MHz EHT PPDU
  + [Pilot indices in 160 MHz]-1024, [Pilot indices in 160 MHz]+1024

[Motion 116, [16] and [133]]

802.11be supports the following pilot indices for n×996RUs (n ≥ 1):

* In a OFDMA/non-OFDMA 80 MHz EHT PPDU
  + Pilot indices of 996-tone RU: P996 = {-468, -400, -334, -266, -220, -152, -86, -18, 18, 86, 152, 220, 266, 334, 400, 468}
* In a OFDMA/non-OFDMA 160 MHz EHT PPDU
  + Pilot indices of 996-tone RU: {P996 -512}, {P996 + 512}
  + Pilot indices of 2×996-tone RU: {P996 -512, P996 + 512}
* In a OFDMA/non-OFDMA 320 MHz EHT PPDU
  + Pilot indices of 996-tone RU: {P996 -1536}, {P996 -512}, {P996 + 512}, {P996 + 1536}
  + Pilot indices of 2×996-tone RU: {P996 -1536, P996 -512}, {P996 + 512, P996 + 1536}
  + Pilot indices of 4×996-tone RU: {P996 -1536, P996 -512, P996 + 512, P996 + 1536}

[Motion 115, #SP78, [16] and [134]]

802.11be supports that pilot subcarriers for small/large RU combinations includes the pilot subcarriers of each RU.

[Motion 115, #SP80, [16] and [134]]

All 802.11be PPDUs use single stream pilots in the data section for SU, DL/UL OFDMA as well as DL/UL MU-MIMO transmissions.

[Motion 122, #SP143, [12] and [135]]

802.11be pilot values are shifted on pilot tones in the data section from symbol to symbol for each RU, which is the same as 802.11ax.

[Motion 122, #SP144, [12] and [135]]

802.11be supports to define the following pilot mapping and values.

* For all size of RUs under 2×996-tone RU, pilot mapping and values of 802.11ax are reused.
* For 3×996-tone RU, pilot mapping and values for 996-tone RU are triplicated.
* For 4×996-tone RU, pilot mapping and values for 2×996-tone RU are duplicated.
* Pilot mapping and values of RU combinations follow each RU’s.

[Motion 122, #SP145, [12] and [135]]

For small multi-RUs 106+26 and 52+26, a modulo 6 is used for the pilot polarity rotation.

P*n* = {Ψ(*n*) mod 6, Ψ(*n*+1) mod 6, Ψ(*n*+2) mod 6, Ψ(*n*+3) mod 6, Ψ(*n*+4) mod 6, Ψ(*n*+5) mod 6}

[Motion 137, #SP273, [3] and [136]]

The 6 initial pilot values for 52+26 and 106+26 multi-RU are given as follows:

ψ0= 1, ψ1= 1, ψ2= 1, ψ3= –1, ψ4= –1, ψ5= 1

[Motion 137, #SP274, [3] and [136]]

### Segment parser

802.11be uses 80 MHz segment parser with proportional round robin scheme.

[Motion 111, #SP0611-07, [19], [137], and [138]]

802.11be uses 80 MHz segment parser with the following parameters for the proportional round robin scheme:

|  |  |  |  |
| --- | --- | --- | --- |
| **RU aggregation** | **Nsd\_total** | **Proportional ratio (m1:m2:m3:m4)** | **Leftover bits (per symbol)** |
| 484+996 | 1448 | 1s:2s | 44×N bpscs on RU996 |
| 484+2×996 | 2428 | 1s:2s:2s | 44×N bpscs on RU996 |
| 484+3×996 | 3408 | 1s:2s:2s:2s | 44×N bpscs on RU996 |
| 2×996 | 1960 | 1s:1s | 0 |
| 3×996 | 2940 | 1s:1s:1s | 0 |
| 4×996 | 3920 | 1s:1s:1s:1s | 0 |

where

[Motion 111, #SP2, [19] and [139]]

The same proportional round robin is applied to left-over bits.

* The same ratios are used in the entire segment parsing process except the ratios of those already filled segment becomes 0.



Leftover bits

To 1st RU

To 2nd RU

Figure 7 – Propotional round robin parser

[Motion 111, #SP3, [19] and [139]]

802.11be uses 80 MHz segment parser with the following parameters for (242+484)+996:

|  |  |  |  |
| --- | --- | --- | --- |
| **RU aggregation** | **Nsd\_total** | **Proportional ratio (m1:m2:m3:m4)** | **Leftover bits (per symbol)** |
| (242+484)+996 | 1682 | 3s:4s | 44×N bpscs on RU996 |

where

[Motion 115, #SP70, [16] and [140]]

802.11be supports the following DCM scheme for RU/MRU size > 80 MHz.

* Use segment parser to distribute coded bits to each 80 MHz segment.
* Within each 80 MHz, perform DCM mapping using per 80 MHz Nsd\_k, k is the index of 80 MHz segment.
* This is for R1.

[Motion 122, #SP150, [12] and [141]]

## Coding

### BCC and LDPC coding

In 802.11be, for LDPC encoding each PSDU only uses one encoder.

[Motion 92, [30] and [32]]

Mandatory support requirement of LDPC in 802.11be is the same as in 802.11ax.

[Motion 124, #SP177, [1] and [2]]

For the combined multiple RU with the combined RU size less than 242 tones, the BCC can be supported.

* Mandatory or Optional for BCC, TBD.
* Only for modulation up to 256 QAM (with or without DCM – if defined in 802.11be).
* Only for NSS ≤ 4.

[Motion 112, #SP12, [19] and [28]]

In case of small size MRU transmission, 802.11be supports applying a common BCC encoder and joint bit interleaver for the combined RU.

[Motion 112, #SP14, [19] and [28]]

### EHT padding process

802.11be uses the same two-step padding procedure as in 802.11ax, i.e.,

* Pre-FEC padding to one of the four pre-FEC padding boundaries.
* Post-FEC padding to the OFDM symbol boundary.

[Motion 137, #SP263, [3] and [142]]

The NSD,short is defined in the following table.

* For EHT PPDU of X MHz modulated with MCS0+DCM+EHT DUP, uses the NSD,short values for RU size corresponding to X/2 MHz and with DCM = 1.
* X = 80, 160, or 320.

|  |  |  |
| --- | --- | --- |
| RU size | NSD,short | |
| DCM = 0 | DCM = 1 |
| 26 | 6 | 2 |
| 52 | 12 | 6 |
| 52+26 | 18 | 8 |
| 106 | 24 | 12 |
| 106+26 | 30 | 14 |
| 242 | 60 | 30 |
| 484 | 120 | 60 |
| 484+242 | 180 | 90 |
| 996 | 240 | 120 |
| 996+484 | 360 | 180 |
| 996+(484+242) | 420 | 210 |
| 2×996 | 492 | 246 |
| 2×996+484 | 612 | - |
| 3×996 | 732 | 366 |
| 3×996+484 | 852 | - |
| 4×996 | 984 | 492 |

[Motion 137, #SP264, [3] and [142]]

The TPE value for EHT sounding NDP is given as follows:

* 4 µs for BW ≤ 160MHz and Nss ≤ 8,
* 8 µs, otherwise.

[Motion 137, #SP265, [3] and [142]]

The duration of the PE field in EHT MU PPDU may take value of 20 µs for any modes with constellation > 1024 or NSS > 8 or RU > 2×996.

[Motion 137, #SP268, [3] and [142]]

The EHT nominal packet padding has two capability bits that are defined as follows.

|  |  |
| --- | --- |
| **Nominal packet padding** | **Encoding** |
| 0 | Set to 0 if the nominal packet padding is 0 μs for all constellations, *NSS* and RU allocations the STA supports. |
| 1 | Set to 1 if the nominal packet padding is 8 μs for all constellations, *NSS* and RU allocations the STA supports. |
| 2 | Set to 2 if the nominal packet padding is 16 μs for all constellations, *NSS* and RU allocations the STA supports. |
| 3 | Set to 3 if the nominal packet padding is 16 μs for all modes with constellation ≤ 1024, *NSS ≤* 8and RU ≤ 2×996, and 20 µs for all other modes the STA supports. |

[Motion 137, #SP269, [3] and [142]]

## Interleaving for RUs and aggregated RUs

For LDPC coding, for combined RUs sent to a user with RU size less than 242-tone, a single tone mapper shall be used.

[Motion 82, [30] and [143]]

For aggregated RUs and PPDU BW larger than 80 MHz, a separate LDPC tone mapper is applied in each 80 MHz segment.

[Motion 111, #SP0611-06, [19] and [137]]

802.11be supports the following BCC interleaver parameters for RU78:

* NOTE – The parameters are defined without considering DCM.

|  |  |
| --- | --- |
| **RU78** | **Parameters** |
| Nsd | 72 |
| Ncol | 18 |
| Nrow | 4×N bpscs |

[Motion 115, #SP66, [16] and [144]]

802.11be supports the following BCC interleaver parameters for RU132:

* NOTE – The parameters are defined without considering DCM.

|  |  |
| --- | --- |
| **RU132** | **Parameters** |
| Nsd | 126 |
| Ncol | 21 |
| Nrow | 6×N bpscs |

[Motion 115, #SP67, [16] and [144]]

802.11be supports the following BCC interleaver parameters for RU52+RU26:

* NOTE – The parameters are defined without considering DCM.

|  |  |
| --- | --- |
| **RU52+RU26** | **Parameters** |
| Nrot | 18 |

[Motion 115, #SP68, [16] and [144]]

802.11be supports the following BCC interleaver parameters for RU106+RU26:

* NOTE – The parameters are defined without considering DCM.

|  |  |
| --- | --- |
| **RU106+RU26** | **Parameters** |
| Nrot | 31 |

[Motion 115, #SP69, [16] and [144]]

The following BCC interleaver and LDPC DTM parameters are defined for DCM.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | NSD | | BCC NCOL | | BCC NROT | | LDPC DTM | |
| No DCM | DCM | No DCM | DCM | No DCM | DCM | No DCM | DCM |
| RU78 | 72 | 36 | 18 | **12** | 18 | - | 4 | **3** |
| RU132 | 126 | 63 | 21 | 21 | 31 | - | 6 | 3 |
| RU726 | 702 | 351 | - | - | - | - | 18 | 9 |

* This is for R1.

[Motion 122, #SP149, [12] and [141]]

802.11be supports one padding bit is added after 2 × NDBPS coded bit when BCC is used for RU132 with DCM.

* This is for R1.

[Motion 122, #SP151, [12] and [141]]

802.11be supports define DCM for RU/M-RU size ≤ 996×2 plus RU 996×3 and 996×4.

* This is for R1.

[Motion 122, #SP148, [12] and [141]]

802.11be supports joint interleaving for BCC and joint tone mapper for LDPC for RU and aggregated RU size ≤ 80 MHz.

[Motion 111, #SP0611-02, [19] and [145]]

The segment parser bit distribution sequence starts from the lowest frequency location to the highest frequency, just like in 802.11ac/802.11ax.

[Motion 111, #SP0611-03, [19] and [145]]

802.11be supports the following LDPC tone mapper parameters:

* For RU52+RU26: D\_TM = 4.
* For RU106+RU26: D\_TM = 6.
* Existing RUs: identical to 802.11ax.

[Motion 111, #SP0611-04, [19] and [145]]

802.11be supports the following LDPC tone mapper parameters:

* For RU484+RU242: D\_TM = 18.

[Motion 111, #SP0611-05, [19] and [145]]

## Beamforming

802.11be supports defining a compressed beamforming feedback in 802.11be for following cases:

* Number of streams: 1–16
* Number of antennas: 2–16
* NOTE – Compressed beamforming feedback is the same as defined in 802.11ax except for the new parameter values of Nc and Nr.

[Motion 111, #SP0611-23, [19] and [146]]

## Sounding feedback parameters

The Ng values are the same as defined in 802.11ax.

* NOTE – This is for R1.

[Motion 135, #SP223, [48] and [147]]

The Ng mandatory/optional support requirement is the same as in 802.11ax.

* NOTE – This is for R1.

[Motion 135, #SP224, [48] and [147]]

## Sounding to mixed bandwidth STAs

The followings are defined for the sounding to STAs of mixed bandwidths.

* Beamformer can group STAs of mixed bandwidths in one NDPA and NDP with NDP bandwidth larger or equal to the STA’s operating bandwidth.
* Beamformee supports receiving NDP of bandwidth wider than its operating bandwidth.
* 20 MHz operating STA participating in 320 MHz NDP is TBD.
* 40 MHz operating STA is excluded.

[Motion 144, #SP318, [35] and [148]]

The beamformee support of receiving NDP with bandwidth wider than the STA’s operating BW is

* mandatory for STAs with operating BW ≥ 80 MHz.
* optional for STAs with operating BW = 20 MHz.

[Motion 144, #SP319, [35] and [148]]

It is mandatory for beamformee to support all partial bandwidth feedback modes aligned with the large RU/MRU.

[Motion 144, #SP320, [35] and [148]]

## Spectral mask

The following mask for 320 MHz transmission is supported in EHT PPDU.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BW(MHz)** | **0 dBr** | **–20 dBr** | **–28 dBr** | **–40 dBr** |
| 802.11be 320 | ±159.5 | ±160.5 | ±320 | ±480 |

PSD

0

dBr

-

20

dBr

-

28

dBr

-

40

dBr

159.5

160.5

320

480

-

159.5

-

160.5

-

320

-

480

Freq

[

MHz

]

Figure 8 – Spectral mask for a 320 MHz EHT PPDU

[Motion 137, #SP251, [3] and [149]]

The following spectral mask for 320 MHz non-HT DUP PPDU is supported.

* 0 dBr: 159 MHz
* –20 dBr: 161 MHz
* –28 dBr: 320 MHz
* –40 dBr: 480 MHz
* NOTE 1 – Separate transmit spectral mask for non-HT DUP.
* NOTE 2 – Spectral mask for non-HT DUP PPDU puncturing case is TBD.

[Motion 137, #SP254, [3] and [150]]

A 100 kHz resolution bandwidth is supported for spectrum measurement in 802.11be.

* It is the same as 802.11ax.

[Motion 137, #SP252, [3] and [149]]

For 802.11be puncturing mask, a 0.5 MHz transition band is used at the first slope from 0 dBr to –20 dBr, starting at the punctured band edge.

* [N×10, N×10+0.5] at the right edge of transmission band.
* [N×10-0.5, N×10] at the left edge of transmision band.
* NOTE 1 – This is for EHT PPDU.
* NOTE 2 – It is the same as 802.11ax.

[Motion 137, #SP253, [3] and [149]]

The rule of edge channel puncturing is given as follows.

* When the lowest and/or the highest subchannel(s) is/are punctured in an EHT PPDU, an additional subchannel edge mask as in the figure below shall be applied at the lower edge of the lowest occupied subchannel and at the higher edge of the highest occupied subchannel.
  + M is the separation in MHz between the lower edge of the lowest occupied subchannel and the higher edge of the highest occupied subchannel in the EHT PPDU.



Figure 9 – Subchannel edge mask for the edge channel puncturing

[Motion 137, #SP255, [3] and [151]]

The rule of middle subchannel (≥ 40 MHz) puncturing is given as follows.

* When there are two or more contiguous 20 MHz subchannels are punctured in an EHT PPDU, an additional subchannel edge mask as in the figure below shall be applied at the lower edge of the lowest punctured subchannel(s) and at the higher edge of the highest punctured subchannel(s).
* M is the contiguous occupied bandwidth adjacent to the punctured subchannel(s).
* The lower edge and higher edge each has its own M which can be different.
* NOTE – For a frequency that both subchannel edge mask have value greater than –25 dBr and less than –20 dBr, the higher value of the two subchannel edge mask shall be taken as the overall mask value.



Figure 10 – Subchannel edge mask for the middle subchannel puncturing

[Motion 137, #SP256, [3] and [151]]

The rule of the middle 20 MHz channel puncturing is given as follows.

* When the puncturing includes only one 20 MHz subchannel and the punctured 20 MHz subchannel is not at the edge of the EHT PPDU, an additional mask as in the figure below shall be applied at the punctured 20 MHz subchannel.



Figure 11 – Subchannel edge mask for the middle 20 MHz channel puncturing

[Motion 137, #SP257, [3] and [151]]

## Spectral flatness requirements

The requirements for spectral flatness maximum deviation in 802.11be are defined as follows.

* For non-puncturing case, it is the same as 802.11ax.
  + ±4dB for inner tones, +4/–6dB for edge tones.
  + Inner tone set for 320 MHz TBD.
* For puncturing case, +4/–6dB for all populated tones.

[Motion 150, #SP362, [92] and [152]]

The requirements for spectral flatness for EHT modes are defined in the following table.

* Red text portion is TBD

Maximum transmit spectral flatness derivation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bandwidth of EHT transmission (MHz)** | **Averaging subcarrier indices (inclusive)** | **Tested subcarrier indices (inclusive)** | **Maximum deviation (dB)** **(Full bandwidth non-OFDMA)** | **Maximum deviation (dB)**  **(punctured cases)** |
| 20 | –84 to –2 and  +2 to +84 | –84 to –2 and +2 to +84 | ±4 | N/A |
| –122 to –85 and  +85 to +122 | +4/–6 |
| 40 | –168 to –3 and  +3 to +168 | –168 to –3 and +3 to +168 | ±4 |
| –244 to –169 and  +169 to +244 | +4/–6 |
| 80 | –344 to –3 and  +3 to +344 | –344 to –3 and +3 to +344 | ±4 | +4/–6 |
| –500 to –345 and  +345 to +500 | +4/–6 | +4/–6 |
| 160 | –696 to –515,  –509 to –12,  +12 to +509, and  +515 to +696 | –696 to –515,  –509 to –12,  +12 to +509, and  +515 to +696 | ±4 | +4/–6 |
| –1012 to –697 and  +697 to +1012 | +4/–6 | +4/–6 |
| 320 | –1400 to –1036,  –1012 to –515,  –509 to –12,  +12 to +509,  +515 to +1012, and +1036 to +1400 | –1400 to –1036,  –1012 to –515,  –509 to –12, +12 to +509,  +515 to +1012, and  +1036 to +1400 | ±4 | +4/–6 |
| –2036 to –1539, –1533 to –1401, +1401 to +1533, and  +1539 to +2036 | +4/–6 | +4/–6 |

[Motion 150, #SP363, [92] and [153]]

The requirements for spectral flatness for non-HT duplicate are defined in the following table.

Maximum transmit spectral flatness derivation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bandwidth of transmission (MHz)** | **Averaging subcarrier indices (inclusive)** | **Tested subcarrier indices (inclusive)** | **Maximum deviation (dB) (Full bandwidth)** | **Maximum deviation (dB) (Punctured)** |
| 40 | –42 to –33,  –31 to –6,  +6 to +31, and  +33 to +42 | –42 to –33, –1 to –6, +6 to +31, and +33 to +42 | ±4 | N/A |
| –58 to –43 and +43 to +58 | +4/–6 |
| 80 | –84 to –70,  –58 to –33,  –31 to –6,  +6 to +31,  +33 to +58, and  +70 to +84 | –84 to –70, –58 to –33, –31 to –6,  +6 to +31, +33 to +58, and  +70 to +84 | ±4 | +4/–6 |
| –122 to –97, –95 to –85, +85 to 95, and +97 to +122 | +4/–6 | +4/–6 |
| 160 | –172 to –161,  –159 to –134,  –122 to –97,  –95 to –70,  –58 to –44,  +44 to +58,  +70 to +95,  +97 to +122,  +134 to +159, and  +161 to +172 | –172 to –161, –159 to –134,  –122 to –97, –95 to –70,  –58 to –44, +44 to +58,  +70 to +95, +97 to +122,  +134 to +159, and +161 to +172 | ±4 | +4/-6 |
| –250 to –225, –223 to –198,  –186 to –173, –43 to –33,  –31 to –6, +6 to +31, +33 to +43, +173 to +186, +198 to +223,  and +225 to +250 | +4/-6 | +4/-6 |
| 320 | –348 to –326,  –314 to –300,  –212 to –198,  –186 to –161,  –159 to –134,  –122 to –97,  –95 to –84,  +84 to +95,  +97 to +122,  +134 to +159,  +161 to +186,  +198 to +212,  +300 to +314, and +326 to +348 | –348 to –326, –314 to –300,  –212 to –198,–186 to –161,  –159 to –134, –122 to –97,  –95 to –84, +84 to +95,  +97 to +122, +134 to +159,  +161 to +186, +198 to +212,  +300 to +314, and +326 to +348 | ±4 | +4/–6 |
| –506 to –481, –479 to –454,  –442 to –417, –415 to –390,  –378 to –353, –351 to –349,  –299 to –289, –287 to –262,  –250 to –225, –223 to –213,  –83 to –70, –58 to –33, –31 to –6, +6 to +31, +33 to +58, +70 to +83, +213 to +223, +225 to +250,  +262 to +287, +289 to +299,  +349 to +351, +353 to +378,  +390 to +415, +417 to +442,  +454 to +479, and +481 to +506 | +4/–6 | +4/–6 |

[Motion 150, #SP364, [92] and [153]]

## CCA sensitivity

802.11be defines start of packet CCA check (PD) for the primary 20 MHz channel up to 320 MHz.

* Start of a PPDU for which its power measured within the primary 20 MHz channel is at or above –82 dBm.

[Motion 137, #SP275, [3] and [154]]

802.11be does not define CCA on secondary channels. It defines only per 20 MHz check up to 320 MHz.

* CCA threshold for detection of WLAN signal in a non-primary channel is –72 dBm.
* ED threshold is -62 dBm.

[Motion 137, #SP276, [3] and [154]]

## Local oscillator requirements

For 320 MHz transmission, the power measured at the location of the RF local oscillator using resolution bandwidth 78.125 kHz shall not exceed the maximum of –32 dB relative to the total transmit power and –20 dBm, or equivalently max(P-32, –20).

[Motion 150, #SP375, [92] and [155]]

## EVM requirements

802.11be supports –38 dB as the Tx EVM requirement for 802.11be 4096 QAM.

[Motion 112, #SP20, [19] and [156]]

An EVM requirement for 1024 QAM is –35 dB.

[Motion 150, #SP376, [92] and [155]]

The same EVM requirements for BPSK, BPSK-DCM, and BPSK-DCM-DUP in EHT MU PPDU are supported.

* An EVM requirement for BPSK-DCM-DUP in EHT MU PPDU is –5 dB.
* An EVM requirement for BPSK-DCM-DUP in EHT TB PPDU is N/A.

[Motion 150, #SP377, [92] and [155]]

## Minimum input level sensitivity

The minimum sensitivity levels for 4096 QAM and BPSK-DCM-DUP are defined as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Modulation** | **Rate** | **20 MHz** | **40 MHz** | **80 MHz** | **160 MHz** | **320 MHz** |
| 4096-QAM | 3/4 | –49 | –46 | –43 | –40 | –37 |
| 4096-QAM | 5/6 | –46 | –43 | –40 | –37 | –34 |
| BPSK-DCM | 1/2 | –82 | –79 | –76 | –73 | –70 |
| BPSK-DCM-DUP | 1/2 | N/A | N/A | –78 | –75 | –72 |

[Motion 150, #SP378, [92] and [155]]

# EHT MAC



## General

This section describes the functional blocks in the EHT MAC.

The 802.11be amendment shall define mechanism(s) for an AP to assist a STA that communicates with another STA.

[Motion 22, [9] and [157]]

802.11be supports defining a procedure for an AP to share time resource obtained in a TXOP for peer to peer (STA-TO-STA) frame exchanges.

* Whether it is in R1 or R2 is TBD.

[Motion 111, #SP0611-24, [19] and [158]]

## TXOP

### Bandwidth signaling

802.11be supports defining a MAC mechanism to protect TXOP for PPDUs with > 160 MHz and/or PPDUs with preamble puncturing.

[Motion 111, #SP0611-26, [19] and [159]]

802.11be supports indicating BW larger than 160 MHz through scrambler sequence in non-HT or non-HT duplicated frames.

[Motion 115, #SP102, [16] and [160]]

### Preamble puncturing

802.11be supports transmitting the MU-RTS/RTS and CTS frames in a non-HT duplicate PPDU on 20 MHz subchannels which are not punctured.

[Motion 111, #SP0611-27, [19] and [161]]

### AP assisted SU PPDU transmission

In R1, 802.11be shall define a mechanism for an AP to transmit a modified MU-RTS Trigger frame that allocates time within a TXOP for transmitting one or more non-TB PPDUs.

* The time allocation starts after the end of transmission of the MU-RTS frame.
* It is TBD whether the AP can optionally not solicit CTS.
* This is an optional mechanism for non-AP and AP STAs.

NOTE – The non-TB PPDUs may be transmitted by the non-AP STA to AP or to a peer of a peer-to-peer link.

[Motion 146, #SP354, [23] and [162]]

## Priority access support for NS/EP services

The 802.11be amendment shall define mechanism(s) in support of priority access to a non-AP STA for national security (NS)/emergency preparedness (EP) priority service.

NOTE – A non-AP STA for NS/EP priority service is a regular non-AP STA authorized to NS/EP service.

[Motion 50, [30] and [163]]

The NS/EP priority service if supported by a non-AP STA, shall use an action frame to indicate the need for priority access to its associated AP STA and to be included in Release 1 specification.

NOTE 1 – The identification of the need is outside the scope of this specification.

NOTE 2 – The container of the TID is TBD.

[Motion 115, #SP90, [16] and [164]]

[Motion 126, [1] and [165]]

The Priority Service Information shall be defined in EHT MAC Capability Information element to exchange the NS/EP priority service capability information between AP STA and non-AP STA.

NOTE – It is an R1 feature.

[Motion 131, #SP207, [58] and [165]]

## Sounding

The following rules are defined for EHT sounding.

* In NTB sounding, the beamformer shall not poll the sounding feedback.
* In a TB sounding sequence initiated by NDPA and NDP, an EHT AP shall not poll a beamformee more than once.

[Motion 144, #SP325, [35] and [166]]

# Coexistence and regulatory rules



## General

This section describes the functional blocks that support coexistence. It additionally describes, if needed, adaption to regulatory rules specific to 6 GHz spectrum.

## Coexistence feature #1

Description for coexistence feature #1

# Wideband and noncontiguous spectrum utilization



## General

This section describes features related to the support of wider bandwidth and utilization of noncontiguous spectrum.

## Subchannel selective transmission

802.11be supports extending the SST mechanism so that an 80 MHz/160 MHz (20 MHz TBD) operating STA can operate in the secondary 160 MHz channel in R2.

[Motion 119, #SP129, [7] and [167]]

## A-control subfield

802.11be supports indicating the channel availability up to 320 MHz channel in the A-control subfield.

* NOTE – The detailed solution is TBD.

[Motion 119, #SP128, [7] and [168]]

802.11be supports to indicate the channel availability of 320 MHz channel by carrying two BQR Control subfields in A-control subfield in R2.

[Motion 124, #SP171, [1] and [169]]

The followings apply for BQR Control subfields in A-Control subfield in R2.

* When there are two BQR control subfields in A-Control subfield, the 1st BQR Control is used to indicate the primary 16 0MHz, the 2nd BQR Control is used to indicate the secondary 160 MHz.
* When there is one BQR control subfield in A-Control subfield, the BQR Control is used to indicate the primary 160 MHz.

[Motion 135, #SP220, [48] and [170]]

## Operating mode indication

A new Control ID in A-Control is defined for EHT Operating mode (OM) that enables indication of 320 MHz, Tx NSTS larger than 8, and Rx NSS larger than 8.

* Signaling TBD.

[Motion 137, #SP277, [3] and [171]]

# Multi-link operation

## General

This section describes features related to multi-link operation.

Multi-link device (MLD): A device that has more than one affiliated STA and has one MAC SAP to LLC, which includes one MAC data service.

NOTE 1 – The device can be logical.

NOTE 2 – It is TBD for a MLD to have only one STA.

NOTE 3 – Whether the WM MAC address of each STA affiliated with the MLD is the same or different is TBD.

[Motion 23, [9] and [172]]

AP multi-link device (AP MLD): A MLD, where each STA affiliated with the MLD is an AP.

Non-AP multi-link device (non-AP MLD): A MLD, where each STA affiliated with the MLD is a non-AP STA.

[Motion 24, [9] and [172]]

The support of the following MLO features is mandatory for 802.11be AP and 802.11be STA.

* Discovery procedure, setup procedures, security procedures, default mapping (all TIDs mapped to all links, all setup links enabled), TIM indicating BUs at MLD level, BA at MLD level, power save per link, power state change indications per link, and BSS parameter critical update procedure.
* NOTE – The above does not preclude other functionalities being added to the list.

[Motion 142, #SP303, [53] and [173]]

## Multi-link discovery

### Discovery procedures and RNR

802.11be shall define mechanism(s) for an AP of an AP MLD to advertise complete or partial information of other links:

* Partial information to prevent frame bloating.
* For example, frames exchanged during ML setup are expected to carry complete information while Beacon frame is expected to carry partial information.
* The exact set of elements/fields that constitute partial information is TBD.

[Motion 115, #SP93, [16] and [174]]

All APs that are part of the same MLD as a reporting AP and that are collocated with the reporting AP shall be reported in the RNR element that is included in the beacons and the broadcast probe responses transmitted by the reporting AP when the reporting AP is either not part of a multiple BSSID set or corresponds to a transmitted BSSID in a multiple BSSID set.

* NOTE 1 – An AP is not included if it is not discoverable.
* NOTE 2 – RNR provides basic information (e.g., operating class, channel, BSSID, short SSID).

[Motion 115, #SP95, [16] and [175]]

802.11be agrees to include in a TBTT Information field of the RNR, corresponding to a reported AP that is part of the same MLD as the reporting AP, an indication that the reported AP is part of the same MLD as the reporting AP when the reporting AP is either not part of a multiple BSSID set or corresponds to a transmitted BSSID in a multiple BSSID set.

* NOTE – Signaling of that indication is TBD.

[Motion 115, #SP96, [16] and [175]]

All APs that are part of the same MLD as a non-transmitted BSSID and that are collocated with the non-transmitted BSSID shall be reported in the RNR element that is included in the beacons and the broadcast probe responses transmitted by the transmitted BSSID that is in the same Multiple BSSID set as the non-transmitted BSSID.

If a reporting AP is part of an AP MLD and is in the same collocated set as APs affiliated with another AP MLD for which there are no affiliated APs operating on the same channel as the reporting AP, each AP of the other AP MLD shall be reported in the RNR element that is included in the beacons and the broadcast probe responses transmitted by the reporting AP if at least one AP of the other AP MLD is in the same multiple BSSID set as an AP affiliated with the AP MLD of the reporting AP, unless the APs of the other AP MLDs are already reported in beacons and the broadcast probe responses transmitted by an AP in the same collocated set as the reporting AP on the same channel as the reporting AP.

[Motion 119, #SP127, [7] and [176]]

802.11be agrees to define a mechanism for a STA of a non-AP MLD to send a probe request frame to an AP belonging to an AP MLD, which enables to request a probe response from the AP that includes the complete set of capabilities, parameters and operation elements of other APs affiliated to the same MLD as the AP.

* The complete information is defined as all elements that would be provided if the reported AP was transmitting that same frame (exceptions TBD).
* It is TBD if the AP is mandated or not to respond with the requested information.
* NOTE 1 – Such a directed probe request requesting complete MLO information for one or more APs of the MLD is referred to as an ML probe request.
* NOTE 2 – A probe response sent in response to an ML probe request containing complete MLO Information for the requested AP(s) is referred to as an ML probe response.

[Motion 115, #SP97, [16] and [175]]

[Motion 119, #SP109, [7] and [177]]

802.11be agrees to add MLD-index to the TBTT Information field of the RNR element, which is used to indicate the ID of the AP MLD in which the reported AP is if the reported AP in an AP MLD.

* MLD-Index is set to BSSID Index of a non-transmitted BSSID if the reported AP is the in the same MLD as the non-transmitted BSSID and the reporting AP is the same multiple BSSID set as the non-transmitted BSSID.
* MLD-Index is set to zero if the reported AP is in the same MLD as the reporting AP.
* MLD-Index of the AP MLD in which the reported AP is shall be unique in the frame sent by the reporting AP.

[Motion 124, #SP185, [1] and [178]]

802.11be agrees to carry Link ID in the TBTT Information field of the RNR element, which is used to indicate the identifier of the reported AP if the reported AP is in an AP MLD.

* The link identifier (Link ID) uniquely identifies a link (tuple consisting of Operational Class, Channel, BSSID) within an MLD.

[Motion 124, #SP186, [1] and [178]]

### ML element structure

802.11be defines mechanism(s) to include MLO information that a STA of an MLD provides in its management, frames, during discovery and ML setup, as described below:

* MLD (common) Information
  + Information common to all the STAs of the MLD.
* Per-link information
  + Capabilities and Operational parameter of other STAs of the MLD other than the advertising STA.

[Motion 115, #SP91, [16] and [174]]

802.11be supports that the MLO framework should follow an inheritance model when advertising complete information of other link(s):

* NOTE – Inheritance mechanism is similar to that defined in 802.11ax for multiple BSSID feature.

[Motion 115, #SP92, [16] and [174]]

802.11be agrees to define a new Multi-Link element (MLE) to report/describe multiple STAs of an MLD with at least the following characteristics:

* MLD-level information may be included.
* A STA profile subelement is included for each reported STA (if any) and is made of a variable number of elements describing this STA.

NOTE 1 – A control field for the element is not considered as MLD-level information.

NOTE 2 – Name can be changed.

[Motion 115, #SP98, [16] and [179]]

802.11be supports that, for the ML element, an inheritance model is defined to prevent frame bloating when advertising complete information of other links.

* Define the inheritance mechanism, similar to 802.11ax, so that the value of an element of a reported STA that is not present in a STA profile of a ML element in a frame sent by a reporting STA is the same as the element of the reporting STA, present elsewhere in the frame.
* Define the inheritance mechanism, similar to 802.11ax, so that the value of an element of a reported STA that is not present in a STA profile of a ML element, if any, included in a nontransmitted BSSID profile of a nontransmitted BSSID in a multiple BSSID element in a frame sent by a reporting STA is the same as the element of the nontransmitted BSSID, present elsewhere in the frame or as the element of the reporting STA, present elsewhere in the frame.
* NOTE 1 – An “element of a STA” refers in the text above to the instance of the element describing the capabilities/operation/functionalities of that STA, in a frame where multiple instances of the element can be found for other STAs.
* NOTE 2 – Some elements may not be inherited, signaling TBD.

[Motion 115, #SP99, [16] and [179]]

An AP shall not include a RNR element in a STA profile subelement of a Multi-Link element.

An AP shall not include a MBSSID element in a STA profile subelement of a Multi-Link element.

An ML element shall not be included in a STA profile subelement of another Multi-Link element.

NOTE – It is an R1 feature.

[Motion 131, #SP193, [58] and [180]]

802.11be agrees to include a Control field in Multi-Link element to indicate the presence of certain fields.

[Motion 119, #SP124, [7] and [181]]

A common Multi-Link element is defined in R1 to carry information for various multi-link operations. The element carrying a Type field is used for differentiating various formats of the element.

[Motion 137, #SP245, [3] and [182]]

In R1, the Type field is carried as the first subfield in the Multi-Link Control field of the Multi-Link element.

[Motion 137, #SP246, [3] and [182]]

The following two entries for the Type field in the Multi-Link element is defined in R1:

1. Basic

* NOTE – It is the Multi-Link element as used in D0.1.

1. ML probe request

* NOTE – It is used for soliciting MLD probe response.

NOTE – Other Types are TBD.

[Motion 137, #SP267, [3] and [183]]

### Usage and rules of ML information element in the context of discovery

The Multi-Link element when included in a Beacon or non-ML Probe Response frame should carry only MLD-level/common information.

* NOTE 1 – Exact name for the element is TBD.
* NOTE 2 – Whether the Multi-Link element is always present in the Beacon and non-ML Probe Response frames or is optionally present is TBD.
* NOTE 3 – MLD-Level/Common information includes at least MLD Address, and other information (TBD).

[Motion 119, #SP111, [7] and [177]]

### Information request

802.11be agrees to define the following mechanism:

* A STA of a non-AP MLD can request a peer AP of AP MLD a part of complete information of other APs of the same AP MLD.
* The signaling for requesting the part of complete information is TBD.
* NOTE – As an example, the part of complete information may be information that is not included on the beacon frame sent from the peer AP.

[Motion 131, #SP190, [58] and [184]]

## Multi-link setup

### Procedure

A MLD has a MAC address that singly identifies the MLD management entity.

For example, the MAC address can be used in multi-link setup between a non-AP MLD and an AP MLD.

[Motion 40, [9] and [172]]

[Motion 111, #SP0611-28, [19] and [185]]

802.11be supports that if different affiliated APs of an AP MLD have different MAC addresses, then different affiliated non-AP STAs of a non-AP MLD with more than one affiliated STA have different MAC addresses.

[Motion 112, #SP38, [19] and [185]]

The value of the RA/TA fields sent over-the-air in the MAC header of a frame is the MAC address of the STA affiliated with the MLD corresponding to that link.

[Motion 108, [30] and [186]]

The MAC address of each affiliated AP within an AP MLD shall be different from each other unless the affiliated APs cannot perform simultaneous TX/RX operation (e.g., due to near band in-device interference), in which case the MAC address properties are TBD.

NOTE – It is TBD whether we allow the operation of an AP MLD without simultaneous TX/RX operation.

[Motion 109, [30] and [186]]

802.11be supports that a non-AP MLD may update its ability to perform simultaneous transmission and reception on a pair of setup links after multi-link setup.

* This update for any pair of setup links can be announced by non-AP MLD on any enabled link.

NOTE 1 – Specific signaling for update indication is TBD.

NOTE 2 – Limitations on dynamic updating is TBD.

[Motion 112, #SP4, [19] and [187]]

A MLD that supports multiple links can announce whether it can support transmission on one link concurrent with reception on the other link for each pair of links.

NOTE 1 – The two links are on different channels.

NOTE 2 – Whether to define a capability of announcing the support transmission on one link concurrent with transmission on the other link is TBD.

[Motion 38, [9] and [188]]

If a MLD can support transmission on link 1 concurrent with reception on link 2, but cannot support transmit on link 2 concurrent with reception on link1, this pair of links will be non-STR.

[Motion 122, #SP167, [12] and [189]]

A MLD can indicate capability to support exchanging frames simultaneously on a set of affiliated STAs to another MLD.

[Motion 26, [9] and [190]]

802.11be defines a multi-link setup signaling exchange executed over one link initiated by a non-AP MLD with an AP MLD as follows:

* Capability for one or more links can be exchanged during the multi-link setup.
* The AP MLD serves as the interface to the DS for the non-AP MLD after successful multi-link setup.

NOTE 1 – The link identification is TBD.

NOTE 2 – Details for non-infrastructure mode of operation TBD.

[Motion 25, [9] and [190]]

The Listen Interval field in the (Re)Association Request frame sent by a non-AP MLD shall apply to the MLD level, and not to the STA level in R1.

[Motion 135, #SP241, [48] and [191]]

The AP MLD aging function shall not cause the buffered BUs to be discarded after any period that is shorter than that indicated by the non-AP MLD for which the BUs are buffered in the Listen Interval field of its (Re)Association Request frame in R1.

* This is independent of MSDU lifetime, which is also used to discard the frames.
* The exact specification of the aging function is beyond the scope of this standard.

[Motion 135, #SP242, [48] and [191]]

The existing Listen Interval field in the (Re)Association Request frame is reused for the non-AP MLD in R1.

[Motion 135, #SP243, [48] and [191]]

The value of the Listen Interval field sent by the non-AP MLD is in units of the maximum value of beacon intervals corresponding to the links that the non-AP MLD intends to setup in R1.

[Motion 137, #SP247, [3] and [192]]

In R1, an AP MLD may delete buffer for the implementation dependent reasons, including the use of an aging function and availability of buffers where the aging function is based on the listen interval indicated by the non-AP MLD in its (Re)Association Request frame.

[Motion 137, #SP248, [3] and [192]]

802.11be supports the following:

* Existing frames are reused for discovering APs that are affiliated with AP MLD.
* Association Request and Association Response frames are reused for multi-link setup.
* NOTE – After association, new signaling to query AP link specific parameters or AP MLD parameters by using Protected Management Frames (PMF) encrypted Management frames is TBD.

[Motion 115, #SP76, [16] and [193]]

802.11be shall define a mechanism to teardown an existing multi-link setup agreement.

[Motion 70, [30] and [194]]

802.11be supports the following:

* Reuse disassociation frame for multi-link teardown.
* Reuse authentication frame for multi-link SAE exchange and multi-link Open System authentication.

[Motion 115, #SP88, [16] and [195]]

Between two MLDs, 802.11be supports using the MLD MAC addresses to derive PMK under SAE method and PTK in 802.11be SFD.

[Motion 112, #SP40, [19] and [196]]

TGbe shall define a multi-link resetup mechanism to resetup with another AP MLD or changing configuration of existing multi-link setup with an AP MLD.

* Reassociation Request/Response frame is used for this purpose.

[Motion 115, #SP86, [16] and [197]]

When a non-AP MLD that has multi-link setup with current AP MLD sends a Reassociation Request frame to a new AP MLD, AP MLD MAC address of the current AP MLD is used in Current AP Address field of the frame.

[Motion 115, #SP87, [16] and [197]]

When a STA of a non-AP MLD that has multi-link setup with current AP MLD sends a Reassociation Request frame to a new AP that is not affiliated with an AP MLD, AP MLD MAC address of the current AP MLD is used in Current AP Address field of the frame.

* NOTE – Only the STA that sends the Reassociation Request frame can associate with the new AP.

[Motion 115, #SP94, [16] and [197]]

A multi-radio non-AP MLD that is operating on a pair of links on which it is STR capable shall be capable of operating with channel aggregation on that pair of links.

A regular AP MLD (that corresponds to an AP MLD that is not a soft-AP MLD) shall be an STR AP MLD

NOTE – Channel aggregation is used here to refer to the simultaneous transmission and reception of PPDUs overlapping in time on different links.

[Motion 150, #SP366, [92] and [198]]

### ML transition

After a successful multi-link (re)setup between a non-AP MLD and an AP MLD, the non-AP MLD is in associated state and is (re)associated with the AP MLD, and the non-AP MLD to the AP MLD mapping is provided to the DS by the AP MLD.

* For each setup link, the corresponding non-AP STA affiliated with the non-AP MLD is in the same associated state as the non-AP MLD and is associated with the corresponding AP affiliated with the AP MLD, without providing the corresponding non-AP STA to the corresponding AP mapping to the DS, and enables the functionalities between a non-AP STA and its associated AP unless the functionalities have been extended to MLD level and specified otherwise.

After a successful multi-link tear down between a non-AP MLD and an AP MLD, the non-AP MLD is in unassociated state and is disassociated with the AP MLD.

* All the non-AP STAs affiliated with the non-AP MLD are in the unassociated state.

NOTE – A non-AP MLD needs to perform successful multi-link (re)setup with AP MLD before the non-AP MLD is allowed to send/receive MSDU(s) via the AP MLD to the DS.

[Motion 131, #SP192, [58] and [199]]

Define ML transition\* as follows:

* A non-AP MLD movement from being associated with one AP MLD in one ESS to be reassociated with another AP MLD within the same ESS.
* A non-AP MLD movement from being associated with one AP MLD in one ESS to become a non-AP STA that is reassociated with an AP within the same ESS.
* A non-AP STA movement from being associated with one AP in one ESS to become a non-AP MLD that is reassociated with an AP MLD with the same ESS.

Define fast ML transition\* as follows:

* A ML transition\* that establishes the state necessary for data connectivity before the reassociation rather than after the reassociation.

NOTE 1 – \* the name can be changed.

NOTE 2 – It is an R1 feature.

[Motion 131, #SP196, [58] and [200]]

802.11be supports to reuse existing frame exchange of over-the-air fast BSS transition (FT) for fast ML transition in R1.

[Motion 131, #SP197, [58] and [200]]

For a non-AP MLD and an AP MLD in a FT initial mobility domain operation, use non-AP MLD address as S1KH-ID and S0KH-ID and AP MLD address as R1KH-ID. Use AP MLD address and non-AP MLD address to compute PMKID, PTK, and PTKName.

For a non-AP MLD and a target AP MLD in an over-the-air FT operation, use non-AP MLD address as S1KH-ID and AP MLD address as R1KH-ID. Use AP MLD address and non-AP MLD address to compute PMKID, PTK, and PTKName.

NOTE – It is an R1 feature.

[Motion 131, #SP203, [58] and [201]]

For a non-AP MLD and an AP MLD in a FT initial mobility domain operation, different GTK/IGTK/BIGTK of different setup links are delivered in one FT 4-way handshake.

For a non-AP MLD and a target AP MLD in an over-the-air FT operation, different GTK/IGTK/BIGTK of different setup links are delivered in FTE of reassociation response of the over-the-air FT protocol.

NOTE – It is an R1 feature.

[Motion 131, #SP204, [58] and [201]]

The following applies for R1:

* For a multi-link transition from a legacy AP to an AP MLD, the MAC address of the non-AP STA that is associated with the legacy AP shall be used as the MLD MAC address of the non-AP MLD that is reassociated with the AP MLD.
* For a multi-link transition from an AP MLD to a legacy AP, the non-AP MLD MAC address of the non-AP MLD that is associated with the AP MLD shall be used as the MAC address of the non-AP STA that is reassociated with the legacy AP.
* NOTE – Tear down of previous association and have a new association is not a multi-link transition.

[Motion 135, #SP221, [48] and [202]]

### Security

After multi-link setup between two MLDs, different GTK/IGTK/BIGTK in different links with different PN spaces are used.

* GTK/IGTK/BIGTK in different links can be delivered in one 4-way handshake.

[Motion 71, [30] and [203]]

802.11be supports that after multi-link setup between two MLDs, the same PMK and the same PTK across links are used with the same PN space for a PTKSA.

[Motion 111, #SP0611-29, [19] and [204]]

In R1, the followings are supportedfor the cases <To DS =0, From DS = 1> and <To DS = 1, From DS = 0> for individually addressed Data frames:

1. replacing Addresses A1 and A2 with MLD MAC Addresses for AAD computation,
2. replacing Address A3 (only in case when A3 is set to BSSID) with MLD MAC Address for AAD computation,
3. using MLD MAC address in A2 for constructing Nonce.

[Motion 144, #SP329, [35] and [205]]

In R1, the followings are supported for the case <To DS =1, From DS = 1> for individually addressed Data frames:

1. replacing Addresses A1 and A2 with MLD MAC Addresses for AAD computation,
2. replacing Addresses A3 and A4 (only in case when A3 and A4 both are set to BSSID) with MLD MAC Addresses for AAD computation,
3. Using MLD MAC address in A2 for constructing Nonce.

[Motion 144, #SP330, [35] and [205]]

### Usage and rules of ML Information element

802.11be supports the following:

* An AP that is part of an AP MLD that supports SAE authentication shall include the MLD address in beacon and probe response frames it transmits.
* EHT MLD shall indicate its MLD MAC address during authentication request/response exchange.

[Motion 115, #SP89, [16] and [195]]

An EHT MLD shall indicate its MLD MAC address during ML setup.

[Motion 112, #SP32, [19] and [206]]

802.11be supports that a non-AP MLD may initiate multi-link setup with an AP MLD to setup more than one link with subset of APs affiliated with the AP MLD. This is for R1.

[Motion 122, #SP133, [12] and [207]]

During multi-link setup, a non-AP MLD includes in a Multi-Link element included in Association Request frame the complete information of affiliated non-AP STAs corresponding to the links requested for setup.

NOTE – It is an R1 feature.

[Motion 131, #SP202, [58] and [208]]

During multi-link setup, when an AP MLD accepts the association request of a non-AP MLD, the AP MLD provides in a Multi-Link element included in Association Response frame the complete information of affiliated APs corresponding to the links that are accepted by the AP MLD and requested by the non-AP MLD.

NOTE – It is an R1 feature.

[Motion 131, #SP205, [58] and [208]]

802.11be defines mechanism(s) for multi-link operation that enables the following:

* Indication of capabilities and operating parameters for multiple links of an AP MLD.
* Negotiation of capabilities and operating parameters for multiple links during a single setup signaling exchange.

[Motion 32, [9] and [209]]

802.11be supports a mechanism for multi-link operation:

* An AP affiliated with an AP MLD can indicate the capabilities and operational parameters for one or more STAs of the multi-link device.
* A non-AP STA affiliated with a non-AP MLD can indicate the capabilities for one or more non-AP STAs of the non-AP MLD.
* Specific information of capabilities and operational parameters of multi-link device is TBD.

[Motion 21, [9] and [210]]

A new element will be defined as a container to advertise and exchange capability information for multi-link setup.

[Motion 68, [30] and [211]]

802.11be supports that an STA of an MLD can provide MLD-level information that is common to all STAs affiliated with the MLD and per-link information that is specific to the STA on each link in management frames during multi-link setup.

* The specific information is TBD.

[Motion 115, #SP65, [16] and [193]]

802.11be supports that each STA of an MLD may independently select and manage its operational parameters unless specified otherwise in the 802.11be standard.

[Motion 112, #SP33, [19] and [212]]

## TID-to-link mapping and link management

### Default mode and enablement

At any point in time, a TID shall always be mapped to at least one link that is set up, unless admission control is used.

[Motion 101, [30] and [213]]

A link, that is setup as part of a multi-link setup, is defined as Enabled if that link can be used for frame exchange and at least one TID is mapped to that link.

NOTE – Frame exchange on a link is subject to the power state of the corresponding non-AP STA.

[Motion 105, [30] and [214]]

Management frames are allowed on all enabled links, following baseline.

[Motion 102, [30] and [213]]

If a TID is mapped in UL to a set of enabled links for a non-AP MLD, then the non-AP MLD can use any link within this set of enabled links to transmit data frames from that TID.

If a TID is mapped in DL to a set of enabled links for a non-AP MLD, then:

* The non-AP MLD can retrieve buffered BUs corresponding to that TID on any links within this set of enabled links.
* The AP MLD can use any link within this set of enabled links to transmit data frames from that TID, subject to existing restrictions for transmissions of frames that apply to those enabled links.
* An example of restriction is if the STA is in doze state.

[Motion 103, [30] and [213]]

802.11be supports adjusting the setting of More Data subfield to fit MLD scenario.

[Motion 112, #SP51, [19] and [215]]

802.11be define mechanism(s) for multi-link operation that enables the following:

* An operational mode for concurrently exchanging frames on more than one link for one or more TID(s).
* An operational mode for restricting exchanging frames of one or more TID(s) to be on one link at a time.

[Motion 9, [5] and [216]]

802.11be supports setting the More Data subfield as follows:

* When AP MLD transmit a BU in one link to a non-AP MLD, if there is at least one additional buffered BU of any TID or management frames that is mapped to this link by TID-to-link mapping or default mapping for the same non-AP MLD, the More Data subfield is set to 1, otherwise the More Data subfield is set to 0.

[Motion 112, #SP52, [19] and [215]]

### TID-to-link mapping

802.11be defines a directional-based TID-to-link mapping mechanism among the setup links of a MLD.

* By default, after the multi-link setup, all TIDs are mapped to all setup links.
* The multi-link setup may include the TID-to-link mapping negotiation.
  + TID-to-link mapping can have the same or different link-set for each TID unless a non-AP MLD indicates that it requires to use the same link-set for all TIDs during the multi-link setup phase.

NOTE – Such indication method by the non-AP MLD is TBD (implicit or explicit).

* The TID-to-link mapping can be updated after multi-link setup through a negotiation, which can be initiated by any MLD.
  + Format TBD.

NOTE – When the responding MLD cannot accept the update, it can reject the TID-to- link mapping update.

[Motion 54, [30] and [217]]

In R1, 802.11be defines a directional-based TID-to-link mapping mechanism among the setup links of a MLD.

* By default, after the multi-link setup, all TIDs are mapped to all setup links.
* The multi-link setup may include the TID-to-link mapping negotiation.
  + TID-to-link mapping can have the same or different link set for each TID unless a non-AP MLD indicates that it requires to use the same link set for all TIDs during the multi-link setup phase.
    - NOTE – Such indication method by the non-AP MLD is TBD (implicit or explicit).
* The TID-to-link mapping can be updated after multi-link setup through a negotiation, which can be initiated by any MLD.
  + Format TBD.
    - NOTE – When the responding MLD cannot accept the update, it can reject the TID-to-link mapping update.
* The support of the TID-to-link mapping negotiation is optional.

[Motion 144, #SP311, [35] and [218]]

### Individual addressed data delivery

After multi-link setup, the following is enabled to deliver individual addressed QoS traffic of a TID without BA negotiation across links, where the TID is mapped, in R1.

* For transmitter:
  + Expand Table 10-5—Transmitter sequence number spaces to have a new entry Indexed by <destined MLD Address, TID>.
  + Continue to transmit the failed QoS Data frame until the retry counter is met.
  + Cannot transmit other QoS Data frame from the same TID in any link until the current frame finish transmission or dropped.
* For receiver:
  + Maintain at least the most recent record of <peer MLD address, TID, sequence number>.
  + Drop the frame with retry bit set and record match.

[Motion 122, #SP158, [12] and [219]]

### Retransmission

The established block ack agreement allows the QoS Data frames of the TID, aggregated within the A-MPDUs, to be exchanged between the two MLDs on any available link.

NOTE – QoS Data frames that are not fragments might be retransmitted on any available link.

[Motion 61, [30] and [220]]

[Motion 115, #SP85, [16] and [221]]

## Multi-link block ack

### Procedures

A single block ack agreement is negotiated between two MLDs for a TID that may be transmitted over one or more links.

NOTE – The format of the setup frames is TBD.

[Motion 36, [9] and [222]]

Setup a block ack agreement for multi-link operation by using ADDBA Request and ADDBA Response frames.

[Motion 67, [30] and [223]]

For each block ack agreement, there exists one receive reordering buffer based on MPDUs in the MLD which is the recipient of the QoS Data frames for that block ack agreement.

The receive reordering buffer operation is based on the Sequence Number space that is shared between the two MLDs.

[Motion 62, [30] and [220]]

The receive status of QoS Data frames of a TID received on a link shall be signaled on the same link and may be signaled on other available link(s).

[Motion 63, [30] and [220]]

802.11be supports allowing an EHT STA to use HE SU PPDU to carry the solicited block ack if the transmit time of HE SU PPDU is less than the PPDU duration of a non-HT PPDU containing the Control frame sent at the primary rate.

[Motion 115, #SP63, [16] and [224]]

802.11be supports allowing an EHT SU PPDU to carry the solicited BA if the transmit time of EHT SU PPDU is less than the PPDU duration of a non-HT PPDU containing the Control frame sent at the primary rate and the soliciting PPDU is EHT PPDU.

[Motion 115, #SP64, [16] and [224]]

802.11be shall define mechanism for multi-link operation that enables the following:

* A STA of a recipient MLD shall provide receive status for MPDUs received on the link that it is operating on and may provide (if available) information on successful reception of MPDUs received by another STA of that MLD.

[Motion 114, [19] and [225]]

An originator MLD of a block ack agreement:

* shall update the receive status for an MPDU corresponding to the block ack agreement if the received status indicates successful reception.
* shall not update the receive status for an MPDU corresponding to the block ack agreement that has been already positively acknowledged.

[Motion 112, #SP26, [19] and [226]]

802.11be shall disallow static fragmentation in MLO.

[Motion 150, #SP372, [92] and [227]]

### Sharing and extension of SN space

Sequence numbers are assigned from a common sequence number space shared across multiple links of a MLD, for a TID that may be transmitted to a peer MLD over one or more links.

[Motion 37, [9] and [222]]

After the BA agreement of a TID between two MLDs, the common reordering buffer of the TID are applied on all setup links.

[Motion 112, #SP27, [19] and [228]]

For each block ack agreement between two MLDs, there exists one transmit buffer control to submit MPDUs for transmission across links.

* TBD for separate transmit buffer control.

[Motion 112, #SP6, [19] and [229]]

802.11be extends the negotiated Block Ack buffer size to be smaller than or equal to 1024 and define 512-bit and 1024-bit block ack bitmap in R1.

[Motion 112, #SP7, [19] and [229]]

802.11be extends Table 26-1 in 802.11ax D6.0 as shown below:

|  |  |  |
| --- | --- | --- |
| **Negotiated buffer size** | **Bitmap in compressed block ack** | **Bitmap in multi-STA block ack** |
| 1–64 | 64 | 32 or 64 |
| 65–128 | 64 or 256 | 32, 64, 128 |
| 129–256 | 64 or 256 | 32, 64, 128, or 256 |
| 257–512 | 64 or 256 or 512 | 32, 64, 128, 256, 512 |
| 513–1024 | 64 or 256 or 512 or 1024 | 32, 64, 128, 256, 512, or 1024 |

[Motion 112, #SP25, [19] and [230]]

For an M-BlockAck frame, add support for 512/1024 bitmap lengths by:

* Including new block ack bitmap lengths (of 512 and 1024 bits), where the length of the BA Bitmap field is signaled in the Per AID TID Info field addressed to an EHT STA.
* The M-BA frame containing these Per AID TID Info fields is not sent as a response to an HE TB PPDU generated by at least one HE STA.

[Motion 112, #SP22, [19] and [231]]

For a Compressed BlockAck frame, use some of the reserved values of the Fragment Number field of the BlockAck frame to indicate the added bitmap lengths (512 and 1024).

[Motion 112, #SP23, [19] and [231]]

802.11be uses B3 equal to 1, B2 B1 equal to 0 and B0 equal to 0 in Fragment Number field to indicate 512 BA bitmap length and to use B3 equal to 1, B2-B1 equal to 1 and B0 equal to 0 in Fragment Number field to indicate 1024 block ack bitmap length in compressed BA and multi-STA BA.

[Motion 112, #SP24, [19] and [232]]

[Motion 133, [58]]

802.11be support to design a mechanism for the originator of a BlockAck negotiation of a TID to indicate to the recipient the range of reported received status of a solicited block ack in R2.

* If supported by the recipient, it is supported for all negotiated buffer sizes.

[Motion 146, #SP349, [23] and [233]]

## Power save

### Traffic indication

An AP of an AP MLD may transmit on a link a frame that carries an indication of buffered data for transmission on other enabled link(s).

[Motion 52, [30] and [234]]

An AP MLD can recommend a non-AP MLD to use one or more enabled links.

* The AP’s indication could be carried in a broadcast or a unicast frame.

[Motion 106, [30] and [235]]

A bit in a partial virtual bitmap of a TIM element that corresponds to a non-AP MLD is set to 1 if any individually addressed BUs for the non-AP MLD are buffered by the AP MLD.

[Motion 115, #SP61, [16] and [236]]

When a non-AP MLD made a multi-link setup with an AP MLD, one AID is assigned to the non-AP MLD across all links.

[Motion 115, #SP62, [16] and [236]]

A non-AP MLD shall have the same U-APSD Flag value for each AC across all links that multi-link is setup. This is for R1.

[Motion 122, #SP157, [12] and [237]]

In R1, the WNM sleep interval of a non-AP MLD is applied at the MLD level and not at the link level.

[Motion 137, #SP244, [3] and [238]]

### Power state indication

For a link setup between an AP MLD and a non-AP MLD, a non-AP STA operating on that link can send to an AP operating on that link an indication that (an)other non-AP STA(s) within the same non-AP MLD that has(have) transition to doze state is(are) in awake state.

[Motion 84, [30] and [239]]

### BSS parameter update

A non-AP MLD monitors and performs basic operations (such as traffic indication, BSS parameter updates) on one or more link(s).

[Motion 104, [30] and [240]]

A non-AP MLD shall maintain a record of the most recently received change sequence number for each reported APs in the AP MLD with which it has multi-link setup.

[Motion 115, #SP101, [16] and [241]]

An AP in an AP MLD shall provide BSS specific parameters update indication for one or more other APs in the same AP MLD.

* The detail for BSS specific parameters update indication is TBD.

[Motion 115, #SP59, [16] and [242]]

802.11be supports that an AP within an AP MLD shall include in the Beacon and Probe Response frames it transmits the Change Sequence fields that indicate changes of system information for the transmitting AP and other APs within the same AP MLD, where the change sequence field value for each AP is initialized to 0, and is incremented when there is a critical update to the operational parameters for that AP.

* TBD field(s) to carry the change sequence(s) of the transmitting AP and of non-transmitted BSSIDs (if any).
* The change sequence information for another AP of the MLD shall be carried in a field in the TBTT Information field of the Reduced Neighbor Report element corresponding to that AP.
* A TBD subfield in the Capability Information field of the Beacon frame shall provide an early indication of an update to change sequence information in the RNR for any AP of the reporting AP’s MLD.
  + NOTE – For an AP corresponding to nontransmitted BSSID in a multiple BSSID set, the early indication is carried in the Nontransmitted BSSID Capability field (which has the same structure as the Capability Information field) and signals the update to change sequence information in RNR for APs corresponding to the MLD to which the nontransmitted BSSID is affiliated with.
* The critical updates are defined in 11.2.3.15 (TIM Broadcast) and the additional update can be added if needed.
* The field is at most 1 octet in length and the value carried in the field is modulo of the maximum value.
* NOTE – It is optional for non-AP MLD to decode the subfield in the Capability Information field carrying the early indication.

[Motion 115, #SP77, [16] and [243]]

[Motion 131, #SP191, [58] and [244]]

In R1, an AP of an MLD shall provide early indication (in the Capability Information field) in Beacon frame(s) until (and including) the next DTIM Beacon frame when there is a change to the change sequence value for any other AP of that MLD reported in the RNR.

[Motion 137, #SP266, [3] and [245]]

If an AP corresponding to a nontransmitted BSSID in a multiple BSSID set is affiliated with an AP MLD, then the AP corresponding to the transmitted BSSID in the same Multiple BSSID set shall include in the Beacon and Probe Response frames it transmits the Change Sequence fields that indicate changes of system information for that AP corresponding to a nontransmitted BSSID and other APs within the AP MLD to which that AP corresponding to the nontransmitted BSSID is affiliated with, where the change sequence field value for each AP is initialized to 0, and is incremented when there is a critical update to the operational parameters for that AP.

[Motion 146, #SP336, [23] and [246]]

For the AP corresponding to nontransmitted BSSID in a multiple BSSID set, that is part of an MLD, the early indication shall be carried in the Nontransmitted BSSID Capability field (for that nontransmitted BSSID) in the Beacon frame(s) transmitted by the transmitted BSSID until (and including) the next DTIM Beacon frame of the nontransmitted BSSID when there is a change to the change sequence value for any other AP of that MLD reported in the RNR.

[Motion 146, #SP337, [23] and [246]]

### TWT

Individual TWT agreement(s) could be set up on a setup link for more than one setup link.

[Motion 115, #SP60, [16] and [242]]

### Other procedures

For each of the enabled links, frame exchanges are possible when the corresponding non-AP STA of the enabled link is in the awake state.

NOTE 1 – A link is enabled when that link can be used to exchange frames subject to STA power states.

NOTE 2 – When a link is disabled (i.e., not enabled) by an MLD the frame exchanges are not possible.

[Motion 51, [30] and [234]]

Each non-AP STA affiliated with a non-AP MLD that is operating on an enabled link maintains its own power state/mode.

[Motion 110, [30] and [214]]

Not every STA operating in PS mode in a non-AP MLD is required to receive the beacon frames periodically.

* This is an exemption besides the existing ones, such as individual TWT agreement, WNM sleep mode and NonTIM mode.

[Motion 112, #SP55, [19] and [247]]

The MLD Max Idle Period of an AP MLD applies at the MLD level and not at the STA level.

The MLD Max Idle Period of an AP MLD indicates, for a non-AP MLD, the time period during which a non-AP MLD can be inactive (i.e., refrain from transmitting frames to the AP MLD on any of the setup links) without the Multi-link setup to be torn down.

A non-AP MLD is considered inactive if none of the APs of the AP MLD have received a Data frame, PS-Poll frame, or Management frame (protected or unprotected) of a frame exchange sequence initiated by a STA from the non-AP MLD for a time period greater than or equal to the time specified by the MLD Max Idle Period of the AP MLD.

If the non-AP MLD is inactive for a duration greater than the MLD Max Idle Period, then the AP MLD may tear down the multi-link setup for that non-AP MLD.

[Motion 115, #SP100, [16] and [248]]

802.11be define a ML (multi-link) SM power save mode in R2 as follows.

* A non-AP MLD that is in ML SM PS mode can use only one link and one active receive chain for receiving and responding to an initial frame sent by the AP, and addressed to it.
* The non-AP MLD becomes available on other links after responding to the initial frame.
  + How and which device determines the “other links” is TBD.
* The non-AP MLD may become unavailable on any of the “other links” if one of the followings is satisfied:
  + The TXOP on the “other link” has ended.
  + Other TBD condition to deal with the case when the non-AP MLD does not receive any frame addressed to it on the “other links”.
* This is an optional feature for both AP and non-AP MLD.

[Motion 146, #SP343, [23] and [249]]

In R1, if an AP (AP 1) of an AP MLD includes a (extended) Channel Switch Announcement element and a Max Channel Switch Time element (if present) or includes a Quiet element and a Quiet Channel element (if present) in a Beacon frame or Probe Response frame it transmits, then another AP (AP 2) of the AP MLD shall include in the Beacon and Probe Response frames it transmits (or if another AP (AP 2) of the AP MLD corresponds to a nontransmitted BSSID, then the transmitted BSSID in the same multiple BSSID set as AP 2 shall include in the Beacon and Probe Responses frame it transmits) the (extended) Channel Switch Announcement element and Max Channel Switch Time element or the Quiet element and Quiet Channel element in the per-STA profile corresponding to AP 1 in a Multi-link element.

* The timing fields in the Quiet element, Quiet Channel element, (extended) Channel Switch Announcement element shall be applied in reference to the most recent TBTT and BI indicated in the corresponding element(s) of AP 1 and not to the TBTT and BI of the other AP (AP 2) of the AP MLD.
* NOTE – The CSA/eCSA/Max Channel Switch Time elements will be included in every beacon and probe response frames on all links of the AP MLD from right after the time AP 1 includes the elements in its beacons until the intended channel switch time.

[Motion 146, #SP347, [23] and [250]]

In R1, if any STA (STA 2) of a non-AP MLD receives a management frame with a field corresponding to an AP (AP 1) of the AP MLD with which the non-AP MLD is associated, and if the non-AP MLD has an affiliated STA (STA 1) that is associated with that AP (AP 1), then that affiliated STA (STA 1) shall follow the procedure (if any) corresponding to receiving such field from its associated AP (AP 1), as if that element was received by the affiliated STA (STA 1) from its associated AP (AP 1).

* NOTE 1 – Management frames from AP 2 that would carry such information include Beacon, Probe Response, and (Re)Association Response frames.
* NOTE 2 – The timing fields (when present) in such an element are applied with reference to AP 1.

[Motion 146, #SP348, [23] and [250]]

## Multi-link group addressed frame delivery

For R1, each AP affiliated with an STR AP MLD shall follow the baseline rules for scheduling Beacon frame transmissions.

[Motion 112, #SP37, [19] and [251]]

802.11be supports the following group addressed frames delivery mechanism in R1:

* An AP MLD should not cause a STA affiliated to a non-STR non-AP MLD to transmit an MPDU that overlaps with group addressed frames in a constrained link if another STA affiliated to the same non-STR non-AP MLD is expected to be receiving group addressed frames.

[Motion 122, #SP155, [12] and [252]]

802.11be supports the following loopback prevention mechanism of the group addressed frame in the MLO in R1.

* An AP MLD that broadcasts the group addressed MPDU received from a non-AP MLD with which it has done multi-link setup shall set the SA field of the broadcast group addressed MPDU to the MLD MAC address of the non-AP MLD.
* A non-AP MLD filters out the group addressed MPDU with the SA field set to the MLD MAC address of the non-AP MLD.

[Motion 131, #SP199, [58] and [253]]

802.11be agrees that each AP in an AP MLD shall independently transmit all bufferable group addressed Management frames after every DTIM beacon in R1.

[Motion 131, #SP206, [58] and [254]]

The followings are supported in R1:

* If a non-AP MLD intends to receive group addressed data frame, the non-AP MLD shall follow the baseline rules to receive the group address data frames on any one link that the non-AP MLD selects to receive group addressed data frames.
* A group addressed data frame that is expected to be received by the non-AP MLD shall be scheduled for transmission in all the links setup with the non-AP MLD.

[Motion 144, #SP327, [35] and [255]]

For a NSTR link pair of a non-AP MLD, if the non-AP MLD successfully obtains a TXOP on one link before the TBTT of the other link, then it should end its TXOP before the TBTT of the other link if it intends to receive Beacon frames on the other link.

NOTE – The non-STR MLD may not do so if it is not aware of the TSF of the other link.

[Motion 146, #SP342, [23] and [256]]

In R1, an AP affiliated with an AP MLD shall indicate if each AP in the same AP MLD has buffered group addressed frames by using the existing TIM element.

* If the AP is not part of a multiple BSSID set or if the AP is part of a multiple BSSID set and is a transmitted BSSID, then the indication is in the DTIM beacon sent by the AP and is based on the latest information about the other APs that it has when the AP schedules the DTIM beacon.
* If the AP is a nontransmitted BSSID in a multiple BSSID set, then the indication is in the DTIM beacon corresponding to that nontransmitted BSSID sent by the transmitted BSSID of the same multiple BSSID set as the AP and is based on the latest information about the other APs that the transmitted BSSID has when it schedules the DTIM beacon.

[Motion 146, #SP353, [23] and [257]]

## Multi-link channel access

### STR: General

802.11be shall allow the following asynchronous multi-link channel access:

* Each of STAs belonging to a MLD performs a channel access over their links independently in order to transmit frames.
* Downlink and uplink frames can be transmitted simultaneously over the multiple links.

[Motion 20, [9] and [258]]

An STR AP MLD with two or more affiliated EHT APs:

* shall be capable to receive a PPDU on each affiliated EHT AP independently to the transmit/reception status on the other affiliated EHT APs;
* shall be capable to transmit concurrent PPDUs simultaneously to the same non-AP MLD by at least two affiliated EHT APs on at least two affiliated EHT APs of the AP MLD;
* shall support asynch channel access across all the affiliated EHT APs links.
* NOTE – All APs affiliated with an AP MLD are EHT APs.

[Motion 142, #SP309, [53] and [259]]

### Non-STR: General

802.11be supports the following cases in R1:

* STR AP MLD with STR non-AP MLD.
* STR AP MLD with non-STR non-AP MLD.
* NOTE – All the other cases are TBD.

[Motion 111, #SP0611-30, [19] and [260]]

802.11be supports the following constrained multi-link operation:

* When a STA in a non-STR MLD receives an RTS addressed to itself, if the NAV of the STA indicates idle but another STA in the same MLD is either a TXOP holder or a TXOP responder, the STA may not respond with a CTS frame.

[Motion 111, #SP0611-32, [19] and [261]]

### Capability signaling

802.11be shall allow a MLD that has constraints to simultaneously transmit and receive on a pair of links to operate over this pair of links.

* Signaling of these constraints is TBD.

[Motion 46, [9] and [262]]

The common info part of the basic Multi-Link element transmitted by a non-AP MLD in a (Re)Association Request frame shall include a field that indicates the maximum number of affiliated STAs in the non-AP MLD that support simultaneous exchange of Data frames (*n*).

* A field value that corresponds to *n* = 1 indicates that the non-AP MLD is a single radio MLD.
* A field value that corresponds to *n* = 2 or more indicates that the non-AP MLD is a multi-radio MLD.

[Motion 146, #SP340, [23] and [263]]

The common part of the basic Multi-Link element transmitted by an MLD contains an EMLSR Mode subfield and an EMLMR Support subfield.

[Motion 146, #SP341, [23] and [263]]

### End PPDU alignment

802.11be supports the following PPDU transmission restriction for the constrained multi-link operation:

* If an AP MLD intends to align the ending time of DL PPDUs carrying a frame soliciting an immediate response simultaneously sent to the same non-STR non-AP MLD on multiple links, the AP MLD shall ensure that the difference between the ending times of transmitting DL PPDUs is less than or equal to 8 μs ((aSIFSTime + aSignalExtension)/2).
  + Where the reference of the ending time of the PPDU is not including the Signal Extension field.

[Motion 111, #SP0611-31, [19] and [264]]

[Motion 122, #SP152, [12] and [265]]

802.11be supports the following Trigger frame transmission rule in the MLO:

* An AP in the AP MLD shall not send a Trigger frame with the CS Required subfield set to 1 to a STA in a non-STR non-AP MLD, when at least one PPDU from other STAs affiliated to the same non-STR non-AP MLD is scheduled for transmission before (aSIFSTime + aSignalExtention – aRxTxTurnaroundTime) has expired after the PPDU containing the Trigger frame.
  + NOTE 1 – In the above, aRxTxTurnaroundTime is 4 μs.
  + NOTE 2 – The ending time of a first PPDU that carrying a frame soliciting an immediate response frame cannot be earlier more than aRxTxTurnaroundTime of the ending time of a second PPDU containing a Trigger frame with the CS Required subfield set to 1.
  + NOTE 3 – The AP STA still follows the CS Required rule defined in 802.11ax.

[Motion 122, #SP153, [12] and [266]]

802.11be supports the following Trigger frame transmission rule in the MLO in R1:

* When an AP MLD triggers simultaneously TB PPDUs from more than one STAs affiliated to the same non-STR non-AP MLD and allows the frames in the TB PPDUs to solicit control response frames from the AP MLD, then the UL Length subfield values in the soliciting Trigger frames shall be set to the same value.

[Motion 122, #SP154, [12] and [266]]

An AP MLD shall align the end of DL PPDUs (that contain QoS data soliciting an immediate UL response) that are sent simultaneously on multiple links to the same non-STR non-AP MLD, in such a way that the response to any of the PPDUs will not overlap with any of the DL PPDUs in R1.An exception is that a high priority DL PPDU sent on one link may not be aligned with another DL PPDU sent on the other link.

[Motion 122, #SP159, [12] and [267]]

802.11be supports that the padding procedures of 802.11ax can be used when transmitting a Trigger frame to extend the frame length to meet the ending time requirement of the PPDU carrying the Trigger frame in the MLO.

* NOTE – The Padding field in the Trigger frame is also included in the padding procedure.

[Motion 122, #SP168, [12] and [268]]

In R1, after two PPDUs with end time alignment (and the PPDUs carrying the expected response frames are also with end time alignment) are transmitted by a NSTR MLD on link 1 and link 2 respectively, STA 1 affiliated with this NSTR MLD may use an IFS greater than SIFS between the ending time of PPDU carrying the successful response frame and a following PPDU within a TXOP on link 1 when PHY-RXSTART.indication is received but FCS is not correct for response frame on link 2.

* STA 1 shall transmit the following PPDU only if the ED CS mechanism indicates that the medium is idle;
* The concrete value for the IFS greater than SIFS is TBD, with an upper limit of PIFS;
* The response frames are frames sent from STAs affiliated with the peer MLD in the TXOP in response to the frames carried in the previous PPDUs.

[Motion 146, #SP346, [23] and [269]]

### Start PPDU alignment

A non-STR MLD that intends to align the start time of the PPDUs sent on more than one link shall ensure that EDCA count down procedure is completed on all the links.

* NOTE 1 – The above restriction only applies to the case when the non-STR MLD is the TXOP initiator.
* NOTE 2 – Whether to extend this mechanism to STR MLD is TBD.
* NOTE 3 – This is an R1 feature.

[Motion 135, #SP240, [48] and [270]]

An STA that is affiliated with a non-STR MLD shall follow the channel access procedure described below.

1. The STA may initiate transmission on a link when the medium is idle and one of the following conditions is met:
2. The backoff counter of the STA reaches zero on a slot boundary of that link.
3. The backoff counter of the STA is already zero, and the backoff counter of another STA of the affiliated MLD reaches zero on a slot boundary of the link that the other STA operates.
4. When the backoff counter of the STA reaches zero, it may choose to not transmit and keep its backoff counter at zero.
5. If the backoff counter of the STA has already reached zero, it may perform a new backoff procedure. CW[AC] and QSRC[AC] is left unchanged.

[Motion 142, #SP310, [53] and [271]]

### STA ID indication

802.11be supports that the STA ID field in a downlink EHT SU PPDU sent from an EHT AP to an EHT STA identifies the recipient EHT STA.

* NOTE – The size and encoding of the STA ID field in the downlink EHT SU PPDU is TBD.

[Motion 122, #SP160, [12] and [272]]

802.11be supports that the STA ID field in an uplink EHT SU PPDU sent from an EHT STA to an EHT AP identifies the transmitter EHT STA.

* NOTE – The size and encoding of the STA ID field in the uplink EHT SU PPDU is TBD.

[Motion 122, #SP161, [12] and [272]]

### Blindness

In R1, if during a transmission of a STA (STA-1) of a non-STR non-AP MLD, another STA (STA-2) of the same MLD cannot detect its medium state when required (due to STA-1’s UL transmission interference), STA-2 shall start a MediumSyncDelay timer at the end of STA-1’s transmission, unless the STA-2 ended a transmission at the same time.

* The MediumSyncDelay timer expires after a duration value that is either assigned by AP or a default value in the specification or if at least either of the following events happens:
  + any received PPDU with a valid MPDU,
  + a received PPDU whose corresponding RXVECTOR parameter TXOP\_DURATION is not UNSPECIFIED,

whichever happens first.

* STA-2 shall perform CCA until the MediumSyncDelay timer expires. Additional TBD exceptions may be considered.

NOTE – It is TBD whether STA-2 is required to start the MediumSyncDelay timer if the transmission of STA-1 is shorter than TBD duration.

[Motion 150, #SP373, [92] and [273]]

## Multi-BSSID operation

An AP of an AP MLD can correspond to a transmitted BSSID or a nontransmitted BSSID in a multiple BSSID set on a link.

[Motion 112, #SP34, [19] and [274]]

APs belonging to the same multiple BSSID set cannot be part of the same AP MLD.

* NOTE – APs within a multiple BSSID set are, by definition, operating on the same channel.

[Motion 112, #SP35, [19] and [274]]

APs belonging to the same co-hosted BSSID set cannot be part of the same AP MLD.

* NOTE – APs within a co-hosted BSSID set are, by definition, operating on the same channel.

[Motion 112, #SP36, [19] and [274]]

802.11be supports that each AP of an AP MLD is independently configured to operate as transmitted or nontransmitted BSSID of a multiple BSSID set or as an AP of a co-hosted BSSID set or not part of either a multiple BSSID set or co-hosted BSSID set.

[Motion 112, #SP50, [19] and [275]]

## Quality of service for latency sensitive traffic

An MLD AP may offer differentiated quality of service over different links.

[Motion 112, #SP49, [19] and [276]]

802.11be supports to define a mechanism so that an EHT AP MLD can provide information about traffic conditions of each link (e.g., DL transmit Delay, BSS load).

* Signaling details is TBD.

[Motion 119, #SP110, [7] and [277]]

## Multi-link single radio operation

Single-link/radio (TBD) non-AP MLD: A non-AP MLD that supports operation on more than one link but can only receive, or transmit frames on one link at a time.

[Motion 119, #SP118, [7] and [278]]

[Motion 119, #SP125, [7] and [279]]

An AP MLD shall be able to serve a single radio non-AP MLD.

[Motion 142, #SP308, [53] and [259]]

802.11be supports the multi-link operation for a non-AP MLD that is defined as follows to be included in R1.

* A non-AP MLD that can: 1) transmit or receive data/management frames to another MLD on one link at a time, and 2) listening on one or more links.
  + The “listening” operation includes CCA as well as receiving initial control messages (e.g., RTS/MU-RTS).
  + The initial control message may have one or more additional limitations: spatial stream, MCS (data rate), PPDU type, frame type.
  + Link switch delay may be indicated by the non-AP MLD.

[Motion 119, #SP126, [7] and [280]]

## Enhanced multi-link operation mode

802.11be shall define a mechanism that in R1 a non-AP MLD indicates maximum number of spatial streams that it is capable of transmitting or receiving at a time, while operating in any of the links within the specified set of links in which the enhanced multi-link operation mode is applied.

* Each STA in the non-AP MLD operating in any of the links within the specified set of links shall support the indicated maximum number of spatial streams.
* The enhanced multi-link operation mode is optional mechanism.

NOTE – The name of the enhanced multi-link operation mode can be changed.

[Motion 124, #SP187, [1] and [281]]

## Soft AP for MLD operation

802.11be defines mechanisms to support the operation of a Non-STR AP MLD in R1. The mechanisms are limited to instantiate a Non-STR Non-AP MLD as a Soft AP that could utilize all its links under TBD conditions. The exact language to govern such scope is TBD.

[Motion 125, [1] and [282]]

# Multi-band and multichannel aggregation and operation



## General

This section describes features related to multi-band and multichannel aggregation and operation.

## Feature #1

Description for feature #1

# Spatial stream and MIMO protocol enhancement



## General

This section describes features related to 16 spatial stream operation and MIMO protocol enhancement.

## 16 spatial stream operation

802.11be supports a maximum of 16 spatial streams (total across all the scheduled STAs) for MU-MIMO.

[Motion 65, [30] and [283]]

802.11be defines a maximum of 16 spatial streams for SU-MIMO.

[Motion 66, [30] and [283]]

For an EHT MU-MIMO transmission, the maximum number of spatial streams allocated to each MU-MIMO scheduled non-AP STA is limited to 4.

[Motion 112, #SP15, [19] and [284]]

The maximum number of users that can be spatially multiplexed in EHT for DL transmissions is 8 per RU/MRU.

* Applicable to all transmission modes in 802.11be.

[Motion 112, #SP47, [19] and [285]]

## Feedback

The following feedback tone sets are supported:

* 20/40 MHz: Reuse 802.11ax feedback tone sets for 802.11be.
* 80 MHz
  + Ng = 4: Reuse the 802.11ax feedback tones of Ng = 4 for 802.11be.
  + Ng = 16: Redefine the feedback tones of Ng = 16 for 802.11be as [–500:16:–260, –252:16: –12, –4, 4, 12:16:252, 260:16:500].
* 160 / 320 MHz: Duplicate the feedback tone set of 80 MHz.
* Full bandwidth sounding feed back the entire tone set.

[Motion 142, #SP300, [53] and [286]]

802.11be supports thatthe partial BW CSI feedback request uses 20 MHz (RU242) granularity.

NOTE – Feedback request granularity change does not impact the CSI computation scheme. For example, CQI feedback computation is still based on RU26.

[Motion 135, #SP232, [48] and [96]]

The following feedback tone indices table with RU242 granularity for both Ng = 4 and Ng = 16 is supported:

* If feedback request does not cover the entire 80 MHz segment, use the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **RU242 index** | **20 MHz** | **40 MHz** | **80 MHz** | **160 MHz** | **320 MHz** |
| **1** | Ng = 4:  [–122, –120:4:–4, –2, 2, 4:4:120, 122];  Ng = 16:  [–122, –116:16:–4,  –2, 2, 4:16:116, 122] | [–244:Ng:–4] | [–500:Ng:–260] | [–1012:Ng:–772] | [–2036:Ng:–1796] |
| **2** |  | [4:Ng:244] | [–252:Ng:–12] | [–764:Ng:–524] | [–1788:Ng:–1548] |
| **3** |  |  | [12:Ng:252] | [–500:Ng:–260] | [–1524:Ng:–1284] |
| **4** |  |  | [260:Ng:500] | [–252:Ng:–12] | [–1276:Ng:–1036] |
| **5** |  |  |  | [12:Ng:252] | [–1012:Ng:–772] |
| **6** |  |  |  | [260:Ng:500] | [–764:Ng:–524] |
| **7** |  |  |  | [524:Ng:764] | [–500:Ng:–260] |
| **8** |  |  |  | [772:Ng:1012] | [–252:Ng:–12] |
| **9** |  |  |  |  | [12:Ng:252] |
| **10** |  |  |  |  | [260:Ng:500] |
| **11** |  |  |  |  | [524:Ng:764] |
| **12** |  |  |  |  | [772:Ng:1012] |
| **13** |  |  |  |  | [1036:Ng:1276] |
| **14** |  |  |  |  | [1284:Ng:1524] |
| **15** |  |  |  |  | [1548:Ng:1788] |
| **16** |  |  |  |  | [1796:Ng:2036] |

* If feedback request covers the entire 80 MHz segment, feedback the entire 80 MHz segment feedback tone set using the following tables:
  + Feedback tone table for Ng = 4

|  |  |  |  |
| --- | --- | --- | --- |
| **RU996 index** | **80 MHz** | **160 MHz** | **320 MHz** |
| **1** | [–500:4:–4, 4:4:500] | [–1012:4:–516,  –508:4:–12] | [–2036:4:–1540,  –1532:4:–1036] |
| **2** |  | [12:4:508, 516:4:1012] | [–1012:4:–516,  –508:4:–12] |
| **3** |  |  | [12:4:508, 516:4:1012] |
| **4** |  |  | [1036:4:1532, 1540:4:2036] |

* + Feedback tone table for Ng = 16

|  |  |  |  |
| --- | --- | --- | --- |
| **RU996 index** | **80 MHz** | **160 MHz** | **320 MHz** |
| **1** | [–500:16:–260,  –252:16:–12,  –4, 4, 12:16:252, 260:16:500] | [–1012:16:–772,  –764:16:–524,  –516, –508,  –500:16:–260,  –252:16:–12] | [–2036:16:–1796,  –1788:16:–1548, –1540, –1532,  –1524:16: –1284,  –1276:16: –1036] |
| **2** |  | [12:16:252, 260:16:500,  508, 516, 524:16:764, 772:16:1012] | [–1012:16:–772,  –764:16:–524, –516, –508,  –500:16:–260, –252:16:–12] |
| **3** |  |  | [12:16:252, 260:16:500, 508, 516, 524:16:764, 772:16:1012] |
| **4** |  |  | [1036:16:1276, 1284:16:1524,  1532, 1540, 1548:16:1788, 1796:16:2036] |

[Motion 142, #SP301, [53] and [286]]

[Motion 144, #SP324, [35] and [287]]

# Multi-AP operation



## General

This section describes features related to multi-AP operation.

## Setup

An EHT AP supporting the multi-AP coordination can send a frame (e.g., Beacon or other Management frame) including capabilities of Multi-AP transmission schemes.

NOTE – Multi-AP transmission schemes are TBD (e.g., coordinated OFDMA).

[Motion 72, [30] and [288]]

An EHT AP which obtains a TXOP and initiates the multi-AP coordination is the sharing AP.

An EHT AP which is coordinated for the multi-AP transmission by the sharing AP is the shared AP.

NOTE – The name of the sharing AP and the shared AP can be modified.

[Motion 73, [30] and [288]]

802.11be supports the following:

* Sharing AP and shared AP may not have the same primary 20 MHz channel.
* The primary 20 MHz channel of the shared AP shall be within the BSS operating channel width of the sharing AP.
* The primary 20 MHz channel of the sharing AP shall be within the BSS operating channel width of the shared AP.

[Motion 119, #SP113, [7] and [289]]

802.11be supports defining the modes of AP coordination that share frequency resources with one or more APs within the AP candidate set only for 20 MHz channels allocated by a sharing AP to a shared AP within the BSS operating channel of the shared AP.

* NOTE – 20 MHz channels allocated by a sharing AP within the 20 MHz channels on which the sharing AP gained channel access.

[Motion 119, #SP114, [7] and [289]]

## Channel sounding

802.11be shall provide a joint NDP sounding scheme as optional mode for multiple-AP systems.

* Sequential sounding scheme that each AP transmits NDP independently and sequentially without overlapped sounding period of each AP can also be used in multi-AP systems.

[Motion 14, [9] and [290]]

Joint NDP sounding scheme for multi-AP system with less or equal to total 8 antennas at AP has all antennas active on all LTF tones and uses 802.11ax P matrix across OFDM symbols.

[Motion 15, [9] and [290]]

Multiple APs can sequentially use an 802.11ax-like sounding sequence to collect CSI from the in-BSS STAs and OBSS STAs.

* The sounding sequence of each AP is similar to the 802.11ax sounding protocol with multiple STAs (NDPA + NDP + BFRP TF + CSI report).

[Motion 112, #SP18, [19] and [291]]

In sequential channel sounding sequence for multi-AP, the NDPA frame and BFRP TF frame will include ID info for OBSS STA.

* The details of the NDPA, BFRP TF and the ID info are TBD.

[Motion 112, #SP19, [19] and [291]]

In sequential channel sounding sequence for multi-AP, 802.11be supports the following:

* STA can process the NDPA frame and the BFRP Trigger frame received from the OBSS AP.
* If polled by the BFRP trigger frame from the OBSS AP, the STA responds with the corresponding channel state information (CSI) to the OBSS AP

NOTE 1 – Details of the CSI report are TBD.NOTE 2 – The OBSS AP belongs to the multi-AP set serving the STA and the details regarding formulation of the multi-AP set are TBD.NOTE 3 – This feature is for R2.

[Motion 119, #SP119, [7] and [292]]

## Coordinated transmission

802.11be shall define an AP candidate set\* as follows:

* An AP candidate set is a set of APs that can initiate or participate in multi-AP coordination.
* An AP in an AP candidate set can participate as a shared AP in multi-AP coordination initiated by a sharing AP in the same AP candidate set.
* At least one AP in an AP candidate set shall be capable of being a sharing AP.
* NOTE – The name\* can be changed.

[Motion 55, [30] and [293]]

[Motion 124, #SP188, [1] and [294]]

Define a procedure for an AP to share its frequency/time resources of an obtained TXOP with a set of APs.

* Set of APs is TBD.

[Motion 56, [30] and [295]]

An AP that intends to use the resource (i.e., frequency or time) shared by another AP shall be able to indicate its resource needs to the AP that shared the resource.

[Motion 53, [30] and [296]]

In all modes of operation wherein an AP shares its frequency/time resource of an obtained TXOP with a set of APs:

* Define a mechanism for the sharing AP to optionally solicit feedback from one or more APs from the AP candidate set to learn the resource needs and the intent to participate in a coordinated AP transmission.

[Motion 111, #SP0611-33, [19] and [295]]

In all modes of operation wherein an AP shares its frequency resource with a set of APs, the AP shall share its frequency resource in multiples of 20 MHz channels with a set of APs in an obtained TXOP.

* PPDU format of the transmission on the shared resource is TBD.

[Motion 111, #SP0611-34, [19] and [295]]

Coordinated OFDMA is supported in 11be, and in a coordinated OFDMA, both DL OFDMA and its corresponding UL OFDMA acknowledgement are allowed.

[Motion 60, [30] and [297]]

802.11be will adopt coordinated UL MU-MIMO as a multi-AP coordination scheme for UL transmissions in R2.

* NOTE – Not for joint reception.

[Motion 124, #SP189, [1] and [298]]

802.11be believes the hidden node problem in multi-AP environments (e.g. coordinated AP transmission) should be addressed.

[Motion 131, #SP208, [58] and [299]]

## Other Multi-AP coordination schemes

802.11be supports introducing a coordinated spatial reuse operation in 802.11be.

* Whether it is in R1 or R2 is TBD.

[Motion 111, #SP0611-35, [19] and [300]]

802.11be supports adding to 802.11be SFD “Joint transmission for single and multi user” under the multi-AP topic.

* NOTE – This feature is for R2

[Motion 111, #SP0611-36, [19] and [301]]

802.11be supports adding “Multi-AP Coordinated BF” to 802.11be SFD as one of the multi-AP coordination schemes.

* NOTE – This feature is for R2.

[Motion 112, #SP17, [19] and [302]]

# Link adaptation and retransmission protocols



## General

This section describes features related to enhanced link adaptation and retransmission protocols.

## Feature #1

Description for feature #1

# Low latency



## General

This section describes features related to low latency.

## EDCA queue

802.11be shall define a mechanism that differentiates low latency traffic from regular traffic and prioritizes the transmission of low latency traffic in R1.

[Motion 135, #SP225, [48] and [303]]

## Protected TWT enhancement

In R1, there exists a mode where an EHT AP may announce restricted service periods (SPs) such that:

* Any non-AP EHT STA that supports following the announced restricted SPs, and associated to the AP, shall end its TXOP before the start of the restricted SP(s).
* Non-AP EHT STAs are allowed to ignore the quiet intervals (which are advertised in Quiet elements by the AP) if they overlap with the restricted SP.
* An EHT AP may announce quiet intervals with Quiet elements that overlap with restricted SPs and the abovementioned exception applies. The rules on transmitting Quiet elements for restricted SPs are TBD.
* The support for the restricted SPs is optional for the non-AP EHT STA.
* The support for this mode is optional for the EHT AP.
* NOTE – Such restricted SPs are intended to provide more predictable latency performance for latency sensitive traffic.

[Motion 148, #SP345, [23] and [304]]

In R1, there exists a mode, known as restricted TWT, where EHT STAs use TWT setup procedure as baseline to set up a restricted SP agreement.

* The name “restricted TWT” is TBD.

[Motion 150, #SP371, [92] and [305]]

# Frame Format

## General

This section describes features related to frame format.

## EHT Operation element

802.11be supports defining an EHT Operation element with the following fields to indicate 320/160+160 MHz BSS bandwidth:

* Channel Width field
* CCFS field

[Motion 111, #SP0611-25, [19] and [306]]

802.11be supports that in 6 GHz band, an EHT AP may announce different BSS operating bandwidth to non-EHT STAs than the BSS operating bandwidth it announces to EHT STAs when EHT bandwidth covers disallowed 20 MHz channels and/or when the announced EHT bandwidth is not supported by non-EHT amendments. The advertised BSS operating bandwidth to EHT STA shall include the advertised BSS operating bandwidth to non-EHT STA.

[Motion 112, #SP53, [19] and [176]]

802.11be supports defining an EHT operation element to indicate the channel configuration for EHT STA, which does not need to combine with the indication of CCFS0 and CCFS1 in HE

operation elements at 6 GHz.

[Motion 112, #SP54, [19] and [307]]

5 bits of Channel Width field in the EHT Operation element is used for indicating the channel width for EHT BSS as follows:

* 0: 20
* 1: 40
* 2: 80
* 3: 160
* 4: 320
* 5~7: reserved

[Motion 144, #SP317, [35] and [308]]

The EHT operating mode change is announced by adding the additional fields (EHT Channel Width, Additional EHT Rx Nss) to the Operating Mode Notification element.

[Motion 144, #SP328, [35] and [309]]

## Trigger frame

802.11be reuses the trigger type of 802.11ax.

* All the Per User Info fields in a Trigger frame other than MU-BAR trigger shall have the same size.

[Motion 135, #SP226, [48] and [310]]

The same Trigger frame can be used to solicit the TB PPDU from both the HE STA(s) and EHT STA(s).

[Motion 135, #SP228, [48] and [311]]

A Trigger frame includes the signalling that indicates TB PPDU format to be used.

* The fields between Common Info field and User Info field that includes the signalling is TBD.

[Motion 135, #SP230, [48] and [312]]

The UL HE SIG-A2 Reserved field is used to carry the information of the Trigger frame for soliciting EHT TB PPDU.

* The field name can be revised in Trigger frame for soliciting EHT TB PPDU.

[Motion 135, #SP227, [48] and [310]]

802.11be has one unified RU allocation table (for both SU and MU) for the RU allocation field in the User Info field of the Trigger frame in R1.

[Motion 135, #SP229, [48] and [311]]

An AP may allocate an RA-RU to solicit a response in an EHT TB PPDU.

[Motion 135, #SP231, [48] and [312]]

An EHT AP shall set the UL Length subfield of a Trigger frame to the value given by the following equation with *m* = 2 if the Trigger frame is to solicit EHT TB PPDU:



For an EHT STA:

* if the EHT STA is solicited to transmit HE TB PPDU, then the LENGTH field in L-SIG field shall be equal to UL length in the Trigger frame for an HE TB PPDU;
* if the EHT STA is solicited to transmit EHT TB PPDU, then the Length field in L-SIG field shall be equal to UL length in the Trigger frame + 2 for an EHT TB PPDU.

This is for R1.

[Motion 144, #SP326, [35] and [313]]

In the User Info Field of the Trigger frame, the following bits indicate the following:

* B0 of the RU Allocation subfield indicates Primary/Secondary 80 MHz Channel for RU/MRU 80 MHz, for P160.
  + NOTE 1 – This is the same as in 802.11ax.
  + NOTE 2 – For RUs/MRUs > 80 MHz, B0 is used to indicate a specific MRU and does not have a primary/secondary meaning.
* PS160 (B39) indicates Primary/Secondary 160 MHz for RU/MRU 160 MHz.
  + NOTE 3 – For RUs/MRUs > 160 MHz, PS160 is used to indicate a specific MRU and does not have a primary/secondary meaning.
* For S160, the definition of B0 is TBD, for RU/MRU ≤ 80MHz.

[Motion 146, #SP350, [23] and [314]]

The following entries are included in the RU Allocation table of the Trigger frame.

|  |  |  |
| --- | --- | --- |
| **B7-B1 of**  **the RU Allocation subfield** | **MRU** | **MRU Index** |
| 69 | RU996x4 | RU1 |
| 70–75 | MRU26+52 | MRU1 to MRU6, respectively |
| 76 | Reserved |  |
| 77–80 | MRU26+52 | MRU8 to MRU11, respectively |
| 81 | Reserved |  |
| 82–86 | MRU26+106 | MRU1 to MRU5, respectively |
| 87–88 | Reserved |  |
| 89 | MRU26+106 | MRU8 |
| 90–93 | MRU484+242 | MRU1 to MRU4, respectively |

[Motion 150, #SP355, [92] and [314]]

The following entries are included in the RU allocation table of the Trigger frame.



* B0 and B7–B1 indicate MRU within 160 MHz.
* PS160 indicates which 160 MHz.

[Motion 146, #SP351, [23] and [314]]

The following entries are included in the RU allocation table of the Trigger frame.



* B0 and B7–B1 indicate MRU within 160 MHz.
* PS160 indicates which 160 MHz.

[Motion 146, #SP352, [23] and [314]]

The following entries are included in the RU Allocation table of the Trigger frame.



[Motion 150, #SP356, [92] and [314]]

The following entries are included in the RU Allocation table of the Trigger frame.



[Motion 150, #SP357, [92] and [314]]

The following entries are included in the RU Allocation table of the Trigger frame.



[Motion 150, #SP358, [92] and [314]]

Design of the RU Allocation table of the Trigger frame is shown as follows.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RU Allocation subfield** | | | **BW subfield** | **RU size** | **RU index 802.11ax** | **RU index 802.11be** | **PHY RU index 802.11be** | **Details:  1) RU numbering in the context of the 80 MHz segment where the RU starts. 2) RU numbering starts with 1, as in 802.11ax RU allocation numbers** |
| **PS160** | **B0** | **B7–B1** |
| 0–3: 80 MHz segment where the RU is located | | 0–8 | 20 MHz, 40 MHz, 80 MHz, 160 MHz, 320 MHz | 26 | RU1 – RU9 | | 37×N + RU index 802.11be | 26-tone RU: - 802.11ax:  1, ..., 37, RU19 is the DC RU in 80 MHz - 802.11be:  1, ..., 18 for lower 40 MHz and 20–37 in upper 40 MHz. RU19 does not exist. |
| 9–17 | 40 MHz, 80 MHz, 160 MHz, 320 MHz | RU10 – RU18 | |
| 18 | 80 MHz, 160 MHz,  320 MHz | RU19 | reserved |
| 19–36 | 80 MHz, 160 MHz,  320 MHz | RU20 – RU37 | |
| 37–40 | 20 MHz, 40 MHz,  80 MHz, 160 MHz,  320 MHz | 52 | RU1– RU4 | | 16×N + RU index 802.11be | Same numbering for 802.11ax and 802.11be |
| 41–44 | 40 MHz, 80 MHz,  160 MHz, 320 MHz | RU5 – RU8 | |
| 45–52 | 80 MHz, 160 MHz,  320 MHz | RU9 – RU16 | |
| 53, 54 | 20 MHz, 40 MHz,  80 MHz, 160 MHz,  320 MHz | 106 | RU1 – RU2 | | 8×N + RU index 802.11be |
| 55, 56 | 40 MHz, 80 MHz,  160 MHz, 320 MHz | RU3 – RU4 | |
| 57–60 | 80 MHz, 160 MHz,  320 MHz | RU5 – RU8 | |
| 61 | 20 MHz, 40 MHz,  80 MHz, 160 MHz,  320 MHz | 242 | RU1 | | 4×N + RU index 802.11be |
| 62 | 40 MHz, 80 MHz,  160 MHz, 320 MHz | RU2 | |
| 63, 64 | 80 MHz, 160 MHz,  320 MHz | RU3 – RU4 | |
| 65 | 40 MHz, 80 MHz,  160 MHz, 320 MHz | 484 | RU1 | | 2×N + RU index 802.11be |
| 66 | 80 MHz, 160 MHz,  320 MHz | RU2 | |
| 67 | 80 MHz, 160 MHz,  320 MHz | 996 | RU1 | | N + RU index 802.11be |
| **160 MHz segment where the RU is located** | 0 | 68 | reserved | | | | reserved |
| 1 | 160 MHz, 320 MHz | 2×996 | RU1 | | LU160 + RU index 802.11be |
| 0 | 0 | 69 | reserved | | | | reserved | reserved |
| 0 | 1 |
| 1 | 0 |
| 1 | 1 | 320 MHz | 4×996 | reserved | RU1 | RU1 | RU1 |
| 0–3: 80 MHz segment where the RU is located | | 70–72 | 20 MHz, 40 MHz,  80 MHz, 160 MHz,  320 MHz | RU52 + RU26 | reserved | MRU1 – MRU3 | 12×N + RU index 802.11be | - MRU1:  RU2 (26T) + RU2 (52T) - reserved for BW ≥ 80 MHz - MRU2:  RU5 (26T) + RU2 (52T) - MRU3:  RU8 (26T) + RU3 (52T) |
| 73–75 | 40 MHz, 80 MHz,  160 MHz, 320 MHz | reserved | MRU4 – MRU6 | - MRU4:  RU11 (26T) + RU6 (52T) - MRU5:  RU14 (26T) + RU6 (52T) - MRU6:  RU17 (26T) + RU7 (52T) - reserved for BW ≥ 80 MHz |
| 76–81 | 80 MHz, 160 MHz,  320 MHz | reserved | MRU7 –MRU12 | - MRU7:  RU21 (26T) + RU10 (52T) - reserved - MRU8:  RU24 (26T) + RU10 (52T) - MRU9:  RU27 (26T) + RU11 (52T) - MRU10:  RU30 (26T) + RU14 (52T) - MRU11:  RU33 (26T) + RU14 (52T) - MRU12:  RU36 (26T) + RU15 (52T) - reserved |
| 82–83 | 20 MHz, 40 MHz,  80 MHz, 160 MHz,  320 MHz | RU106 + RU26 | reserved | MRU1 – MRU2 | 8×N + RU index 802.11be | - MRU1:  RU5 (26T) + RU1 (106T)  - MRU2:  RU5 (26T) + RU2 (106T) - reserved for BW ≥ 80 MHz |
| 84–85 | 40 MHz, 80 MHz,  160 MHz, 320 MHz | reserved | MRU3 – MRU4 | - MRU3:  RU14 (26T) + RU3 (106T) - reserved for BW ≥ 80 MHz - MRU4:  RU14 (26T) + RU4 (106T) |
| 86–89 | 80 MHz, 160 MHz,  320 MHz | reserved | MRU5 –MRU8 | - MRU5:  RU24 (26T) + RU5 (106T) - MRU6:  RU24 (26T) + RU6 (106T) - reserved - MRU7:  RU33 (26T) + RU7 (106T) - reserved - MRU8:  RU33 (26T) + RU8 (106T) |
| 90–93 | 80 MHz, 160 MHz,  320 MHz | RU484 + RU242 | reserved | MRU1 –MRU4 | 4×N + RU index 802.11be | - MRU1:  RU2 (242T) + RU2 (484T) - MRU2:  RU1 (242T) + RU2 (484T) - MRU3:  RU4 (242T) + RU1 (484T) - MRU4:  RU3 (242T) + RU1 (484T) |
| **160 MHz segment where the RU is located** | 0 | 94–95 | 160 MHz, 320 MHz | RU996 + RU484 | reserved | MRU1 – MRU2 | 4×LU160 + RU index 802.11be | - MRU1:  RU2 (484T) + RU2 (996T) - MRU2:  RU1 (484T) + RU2 (996T) |
| 1 | MRU3 –MRU4 | - MRU3:  RU4 (484T) + RU1 (996T) - MRU4:  RU3 (484T) + RU1 (996T) |
| 0 | 96–99 | 160 MHz, 320 MHz | RU996 + RU484 + RU242 | reserved | MRU1 – MRU4 | 8×LU160 + RU index 802.11be | - MRU1:  RU2 (242T) + RU2 (484T) + RU2 (996T) - MRU2:  RU1 (242T) + RU2 (484T) + RU2 (996T) - MRU3:  RU4 (242T) + RU1 (484T) + RU2 (996T) - MRU4:  RU3 (242T) + RU1 (484T) + RU2 (996T) |
| 1 | MRU5 – MRU8 | - MRU5:  RU6 (242T) + RU4 (484T) + RU1 (996T) - MRU6:  RU5 (242T) + RU4 (484T) + RU1 (996T) - MRU7:  RU8 (242T) + RU3 (484T) + RU1 (996T) - MRU8:  RU7 (242T) + RU3 (484T) + RU1 (996T) |
| 0 | 0 | 100–103 | 320 MHz | RU2×996 + RU484 | reserved | MRU1 – MRU4 | RU index 802.11be | - MRU1:  RU2 (484T) + RU2 (996T) + RU3 (996T) - MRU2:  RU1 (484T) + RU2 (996T) + RU3 (996T) - MRU3:  RU4 (484T) + RU1 (996T) + RU3 (996T) - MRU4:  RU3 (484T) + RU1 (996T) + RU3 (996T) |
| 0 | 1 | MRU5 – MRU6 | - MRU5:  RU6 (484T) + RU1 (996T) + RU2 (996T) - MRU6:  RU5 (484T) + RU1 (996T) + RU2 (996T)  2 reserved entries for B7:B1 = 102, 103 |
| 1 | 0 | MRU7 – MRU8 | 2 reserved entries for B7:B1 = 100, 101  - MRU7:  RU4 (484T) + RU3 (996T) + RU4 (996T) - MRU8:  RU3 (484T) + RU3 (996T) + RU4 (996T) |
| 1 | 1 | MRU9 – MRU12 | - MRU9:  RU6 (484T) + RU2 (996T) + RU4 (996T) - MRU10:  RU5 (484T) + RU2 (996T) + RU4 (996T)  - MRU11:  RU8 (484T) + RU2 (996T) + RU3 (996T) - MRU12:  RU7 (484T) + RU2 (996T) + RU3 (996T) |
| 0 | 0 | 104 | 320 MHz | RU3×996 | reserved | MRU1 | - MRU1:  RU2 (996T) + RU2 (2×996T) |
| 0 | 1 | MRU2 | - MRU2:  RU1 (996T) + RU2 (2×996T) |
| 1 | 0 | MRU3 | - MRU3:  RU4 (996T) + RU1 (2×996T) |
| 1 | 1 | MRU4 | - MRU4:  RU3 (996T) + RU1 (2×996T) |
| 0 | 0 | 105–106 | 320 MHz | RU3×996 + RU484 | reserved | MRU1 – MRU2 | - MRU1:  RU2 (484T) + RU2 (996T) + RU2 (2×996T) - MRU2:  RU1 (484T) + RU2 (996T) + RU2 (2×996T) |
| 0 | 1 | MRU3 – MRU4 | - MRU3:  RU4 (484T) + RU1 (996T) + RU2 (2x996T) - MRU4:  RU3 (484T) + RU1 (996T) + RU2 (2×996T) |
| 1 | 0 | MRU5 – MRU6 | - MRU5:  RU6 (484T) + RU4 (996T) + RU1 (2×996T) - MRU6:  RU5 (484T) + RU4 (996T) + RU1 (2×996T) |
| 1 | 1 | MRU7 – MRU8 | - MRU7:  RU8 (484T) + RU3 (996T) + RU1 (2×996T) - MRU8:  RU7 (484T) + RU3 (996T) + RU1 (2×996T) |
|  | | 107–127 | reserved | | | | | |

[Motion 150, #SP359, [92] and [315]]

B0 bit in the S160 is defined as follows.

* B0 == 0 → Lower 80 MHz
* B0 == 1 → Upper 80 MHz

[Motion 150, #SP360, [92] and [315]]

The formula and tables for the parameter 𝑁 in the Trigger Frame RU Allocation table are defined as follows.

* *N* = 2×X1+X0
* For UL BW ≤ 80MHz → PS160, B0, X0 and X1 are 0.
* For UL BW = 160MHz PS160 and X1 = 0. X0 is specified in the following table.

|  |  |  |
| --- | --- | --- |
| **160 MHz channelization** | **Primary 80 MHz (B0 = 0)** | **Secondary 80 MHz (B0 = 1)** |
| [P80 S80] | X0 = 0 | X0 = 1 |
| [S80 P80] | X0 = 1 | X0 = 0 |

* For UL BW = 320 MHz X0 and X1 are specified in the following table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **320 MHz channelization** | **Primary 160 MHz (PS160 = 0)** | | **Secondary 160MHz (PS160 = 1)** | |
| Primary  80 MHz (B0 = 0) | Secondary  80 MHz (B0 = 1) | Lower 80 MHz  (B0 = 0) | Higher 80 MHz  (B0 = 1) |
| [P80 S80 S160] | [X1 X0] = [0 0] | [X1 X0] = [0 1] | [X1 X0] = [1 0] | [X1 X0] = [1 1] |
| [S80 P80 S160] | [X1 X0] = [0 1] | [X1 X0] = [0 0] | [X1 X0] = [1 0] | [X1 X0] = [1 1] |
| [S160 P80 S80] | [X1 X0] = [1 0] | [X1 X0] = [1 1] | [X1 X0] = [0 0] | [X1 X0] = [0 1] |
| [S160 S80 P80] | [X1 X0] = [1 1] | [X1 X0] = [1 0] | [X1 X0] = [0 0] | [X1 X0] = [0 1] |

[Motion 150, #SP361, [92] and [315]]

The UL BW Extension field of the Tigger frame in R1 is defined as follows.

|  |  |  |  |
| --- | --- | --- | --- |
| **UL BW**  **(2 bits)** | **Bandwidth for HE TB PPDU (MHz)** | **UL BW Extension (2 bits)** | **Bandwidth for EHT TB PPDU (MHz)** |
| 0 | 20 | 0 | 20 |
| 0 | 20 | 1 | reserved |
| 0 | 20 | 2 | reserved |
| 0 | 20 | 3 | reserved |
| 1 | 40 | 0 | 40 |
| 1 | 40 | 1 | reserved |
| 1 | 40 | 2 | reserved |
| 1 | 40 | 3 | reserved |
| 2 | 80 | 0 | 80 |
| 2 | 80 | 1 | reserved |
| 2 | 80 | 2 | reserved |
| 2 | 80 | 3 | reserved |
| 3 | 160 | 0 | reserved |
| 3 | 160 | 1 | 160 |
| 3 | 160 | 2 | 320 -1 |
| 3 | 160 | 3 | 320 -2 |

[Motion 150, #SP383, [92] and [316]]

In R1, an 1-bit HE/EHT indication in the common part of the Trigger frame is used to indicate to the EHT STA whether to transmit an HE or EHT TB PPDU within the primary 160 MHz.

* Use B54 (the first bit) of UL HE-SIG-A2 Reserved field to carry this HE/EHT indication.

NOTE – The EHT STA shall not transmit an HE TB PPDU on the secondary 160 MHz.

[Motion 150, #SP384, [92] and [316]]

## NDPA and EHT MIMO Control field

There is at least one reserved bit in EHT NDPA STA Info Subfield and EHT MIMO Control field.

* NOTE – If needed, this reserved bit may be used for codebook size expansion or other purpose.

[Motion 137, #SP249, [3] and [317]]

The following two rules are supported:

* NDPA shall not request feedback on a RU242 that is signaled as punctured in the U-SIG of the NDP that follows it.
* Partial BW Info field (naming TBD) of the MIMO Control field is the same as the one in NDPA.

[Motion 142, #SP307, [53] and [97]]

The design of an EHT NDPA frame is based on the VHT/ HE NDPA frame.

* The EHT NDPA frame will have the same Type/Subtype subfield in the FC field of the VHT/HE NDPA frame.

[Motion 137, #SP293, [3] and [318]]

The length of an EHT STA Info field in the NDPA frame is 4 bytes.

[Motion 137, #SP294, [3] and [319]]

A new EHT NDPA variant using the encoding value 11 for B0-B1 is created in the Sounding Dialog Token field.

[Motion 137, #SP295, [3] and [320]]

The design of STA Info field is shown as follows.

* Partial BW Info field (naming is TBD) can be 7–9 bits [the figure will be modified accordingly if the field size is different from 9 bits]
* The codebook size may be increased, and the location of the Nc and Codebook Size fields are TBD.



[Motion 142, #SP304, [53] and [97]]

A 9-bit to signal NDPA partial BW info field is defined as follows.



* 1 bit indicates bitmap resolution for 20 MHz or 40 MHz
  + Set to 0 for 20 MHz for NDP BW < 320MHz.
  + Set to 1 for 40 MHz for NDP BW = 320MHz.
* 8-bit bitmap to indicate the request for each resolution size.

[Motion 150, #SP367, [92] and [321]]

The design of the EHT MIMO Control Field Design is shown as follows.

* The size of codebook information may be increased.
* Reserved bits (number and location) may change.
* Sounding Dialogue Token and Feedback Segment related bits are TBD.
* Partial BW Info field (naming is TBD) can be 7–9 bits [the figure will be modified accordingly if the field size is different from 9 bits].



[Motion 142, #SP305, [53] and [97]]

## Enhanced Trigger frame

In a Trigger frame that solicits an EHT TB PPDU, a Special User Info field is placed immediately after the Common Info field and the Special User Info field carries the following non-derived subfields of the U-SIG in the TB PPDU:

* PHY Version ID (3 bits)
* PPDU Bandwidth Extension field (2 bits)
* Spatial Reuse 1 (4 bits)
* Spatial Reuse 2 (4 bits)
* U-SIG Reserved bits (12 bits)

The length of the Special User Info field is the same as that of the other User Info fields in the Trigger frame.

[Motion 150, #SP368, [92] and [322]]

If the Special User Info field is not present in the Trigger frame, then the User Info field is the HE format and the EHT STA transmits an HE TB PPDU.

In R1, if the Special User Info field is present in the Trigger frame, the User Info field is the EHT Format and the EHT STA transmits an EHT TB PPDU.

[Motion 150, #SP369, [92] and [322]]

The Special User Info field (that carries the non-derived subfields of the U-SIG) is identified by using the value 2007 in the AID12 subfield.

* An EHT AP shall not use the value 2007 as an association identifier (AID) for any STA.

[Motion 150, #SP370, [92] and [322]]

There are two SR fields (4 bits each, total 8 bits), with granularity of half PPDU BW, but no smaller than 20 MHz, in the U-SIG of TB PPDU.

* Values in SR fields are defined as the same as in 802.11ax.

[Motion 150, #SP374, [92] and [323]]

B25 in a User Info Field addressed to an EHT STA within a Trigger frame is reserved and is set to zero in R1.

* NOTE – In 802.11ax B25 is the DCM bit, which is not needed in 802.11be.

[Motion 150, #SP381, [92] and [324]]

B39 in a User Info field addressed to an EHT STA within a Trigger frame is the Primary/Secondary 160 (PS160) subfield.

* NOTE – The PS160 subfield, along with B7-B0 of the RU Allocation subfield, specify the RU/MRU.

[Motion 150, #SP380, [92] and [324]]

Four bits of a User Info field addressed to an EHT STA within a Trigger frame for the Spatial Stream Allocation subfield are used to indicate the starting spatial stream, and two bits are used to indicate the number of per-user spatial streams.

* NOTE – This supports up to a total of sixteen spatial streams with up to four spatial streams per-user.



[Motion 150, #SP382, [92] and [324]]

## EHT Capabilities element

802.11be agrees to define PPE Thresholds field in EHT Capabilities element.

* The existence of the PPET Thresholds field is indicated by the PPET Thresholds Present subfield in the EHT PHY Capabilities Information field.

[Motion 146, #SP334, [23] and [325]]

The max supported HE BW capability indicated in the HE Capabilities element by an EHT STA is no more than the max supported EHT BW capability indicated in the EHT Capabilities element by the EHT STA.

* When the max supported EHT BW capability indicated in the EHT Capabilities element by an EHT STA is no more than 160 MHz, the max supported HE BW capability indicated in the HE Capabilities element by the EHT STA is the same as the max supported EHT BW capability indicated in the EHT Capabilities element.
* When the max supported EHT BW capability indicated in the EHT Capabilities element by an EHT STA is 320 MHz, the max supported HE BW capability indicated in the HE Capabilities element by the EHT STA is 160 MHz.

[Motion 146, #SP338, [23] and [326]]

At any BW+MCS allowed by HE, the max supported HE Nss capability indicated in the HE Capabilities element (Nss for transmitting HE PPDU) by an EHT STA/AP is no more than the max supported EHT Nss capability indicated in the EHT Capabilities element (Nss for transmitting EHT PPDU) by the EHT STA.

* When the max supported EHT Nss capability indicated in the EHT Capabilities element by an EHT STA at a BW+MCS is no more than 8, the max supported HE Nss capability indicated in the HE Capabilities element by the EHT STA is the same as the max supported EHT Nss capability indicated in the EHT Capabilities element at the BW+MCS.
* When the max supported EHT Nss capability indicated in the EHT Capabilities element by an EHT STA at a BW+MCS is more than 8, the max supported HE Nss capability indicated in the HE Capabilities element by the EHT STA at the BW is 8 at the BW+MCS.

[Motion 146, #SP339, [23] and [326]]

# Security

## General

This section describes features related to security.

An EHT RSNA STA shall support GCMP-256.

[Motion 119, #SP130, [7] and [327]]

# Bibliography

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| --- | --- |
| [1] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r8,* September 2020. |
| [2] | Bin Tian (Qualcomm), “Discussion on 11be PHY capabilities,” *20/0975r0,* July 2020. |
| [3] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *20/1755r11,* November 2020. |
| [4] | Rui Cao (NXP), “Discussions on EHT non-contigeous PPDU,” *20/1100r1,* October 2020. |
| [5] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r0,* October 2019. |
| [6] | Alice Chen (Qualcomm), “320MHz channelization and tone plan,” *19/0797r1,* September 2019. |
| [7] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r6,* August 2020. |
| [8] | Ron Porat (Broadcom), “320 Channelization,” *20/0953r0,* June 2020. |
| [9] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework,” *19/1755r1,* November 2019. |
| [10] | Eunsung Park (LGE), “Tone plan discussion,” *19/1066r3,* November 2019. |
| [11] | Xiaogang Chen (Intel), “240MHz transmission,” *20/0954r0,* June 2020. |
| [12] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r7,* August 2020. |
| [13] | Xiaogang Chen (Intel), “240MHz transmission,” *20/0954r3,* July 2020. |
| [14] | Eunsung Park (LGE), “Discussion on 240MHz bandwidth,” *19/1889r2,* November 2019. |
| [15] | Bin Tian (Qualcomm), “Further thoughts on 11be tone plan,” *19/1521r2,* November 2019. |
| [16] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r5,* July 2020. |
| [17] | Ron Porat (Broadcom), “Tone plan related corrections,” *20/0955r1,* June 2020. |
| [18] | Eunsung Park (LGE), “Consideration on 240MHz,” *20/0960r0,* June 2020. |
| [19] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r4,* June 2020. |
| [20] | Ron Porat (Broadcom), “80MHz OFDMA tone plan,” *20/0666r2,* May 2020. |
| [21] | Sigurd Schelstraete (Quantenna/ON Semiconductor), “240 MHz channelization,” *20/0479r0,* March 2020. |
| [22] | Eunsung Park (LGE), “Non-OFDMA tone plan for 320MHz,” *19/1492r3,* November 2019. |
| [23] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r14,* January 2021. |
| [24] | Yan Zhang (NXP), “Proposed draft text: mathematical description of signals,” *20/1337r6,* December 2020. |
| [25] | Ron Porat (Broadcom), “Mandatory larger BW support,” *20/0796r1,* June 2020. |
| [26] | Rui Cao (NXP), “Aggregated PPDU for large BW,” *20/0693r1,* May 2020. |
| [27] | Xiaogang Chen (Intel), “Forward compatible OFDMA,” *20/0674r3,* July 2020. |
| [28] | Junghoon Suh (Huawei), “Small size MRU with different MCS and BCC,” *20/0470r1,* April 2020. |
| [29] | Jianhan Liu (MediaTek), “Enhanced resource allocation schemes for 11be,” *19/1126r1,* September 2019. |
| [30] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework,” *19/1755r2,* January 2020. |
| [31] | Jianhan Liu (MediaTek), “Multiple RU combinations for EHT,” *19/1907r2,* January 2020. |
| [32] | Bin Tian (Qualcomm), “Preamble puncturing and RU aggregation,” *19/1869r2,* January 2020. |
| [33] | Ron Porat (Broadcom), “Small RU combinations,” *20/0667r1,* April 2020. |
| [34] | Ron Porat (Broadcom), “Mandatory M-RU support,” *20/0791r5,* June 2020. |
| [35] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r13,* December 2020. |
| [36] | Myeongjin Kim (Samsung), “RU allocation subfield design for EHT trigger frame follow up,” *20/1845r3,* November 2020. |
| [37] | Eunsung Park (LGE), “Multiple RU aggregation,” *20/0023r2,* January 2020. |
| [38] | Ron Porat (Broadcom), “Multi-RU support,” *19/1908r4,* January 2020. |
| [39] | Jianhan Liu (MediaTek), “MRU support in 11be,” *20/0793r2,* June 2020. |
| [40] | Myeongjin Kim (Samsung), “RU allocation subfield design for EHT trigger frame,” *20/0828r6,* October 2020. |
| [41] | Myeongjin Kim (Samsung), “RU allocation subfield design for EHT tiigger frame,” *20/0828r7,* November 2020. |
| [42] | Eunsung Park (LGE), “RU restriction for 20MHz operation,” *20/1441r3,* October 2020. |
| [43] | Eunsung Park (LGE), “RU restriction for 20MHz operation,” *20/1441r5,* November 2020. |
| [44] | Bin Tian (Qualcomm), “TBDs of 11be PHY capabilities,” *20/1656r0,* October 2020. |
| [45] | Ron Porat (Broadcom), “MU-MIMO over MCS15,” *20/1879r0,* November 2020. |
| [46] | Dongguk Lim (LGE), “11be PPDU format,” *20/0019r1,* January 2020. |
| [47] | Wook Bong Lee (Samsung), “Thoughts on U-SIG contents,” *20/0959r1,* July 2020. |
| [48] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *20/1755r10,* October 2020. |
| [49] | Sameer Vermani (Qualcomm), “Open issues on preamble design,” *20/1238r4,* September 2020. |
| [50] | Dongguk Lim (LGE), “Signaling for various transmission modes of MU-PPDU,” *20/1515r2,* October 2020. |
| [51] | Sameer Vermani (Qualcomm), “Open issues on preamble design,” *20/1238r7,* October 2020. |
| [52] | Rui Cao (NXP), “EHT NLTF design,” *20/1375r2,* October 2020. |
| [53] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r12,* November 2020. |
| [54] | Rui Cao (NXP), “EHT NLTF design,” *20/1375r3,* November 2020. |
| [55] | Dongguk Lim (LGE), “11be PPDU format,” *20/0019r4,* May 2020. |
| [56] | Bin Tian (Qualcomm), “Thoughts on extended range preamble,” *20/1132r0,* September 2020. |
| [57] | Sigurd Schelstraete (Quantenna/ON Semiconductor), “4096 QAM Straw Polls,” *20/0480r0,* March 2020. |
| [58] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r9,* September 2020. |
| [59] | Yujin Noh (Newracom), “PDT-PHY-Parameters-for-EHT-MCSs,” *20/1290r1,* August 2020. |
| [60] | Jianhan Liu (MediaTek), “DCM for range extension in 6GHz LPI band,” *20/0986r1,* July 2020. |
| [61] | Jianhan Liu (MediaTek), “On TBD MCSs,” *20/1377r1,* October 2020. |
| [62] | Ron Porat (Broadcom), “6GHz LPI range extension,” *20/0965r3,* July 2020. |
| [63] | Ron Porat (Broadcom), “6GHz LPI range extension,” *20/0965r4,* August 2020. |
| [64] | Ron Porat (Broadcom), “DUP mode PAPR reduction,” *20/1191r1,* September 2020. |
| [65] | Ross Yu (Huawei), “Preamble structure,” *19/1099r2,* September 2019. |
| [66] | Dongguk Lim (LGE), “Further discussion for 11be preamble,” *19/1486r9,* November 2019. |
| [67] | Eunsung Park (LGE), “Phase rotation for 320MHz,” *19/1493r1,* November 2019. |
| [68] | Eunsung Park (LGE), “Phase rotation proposal follow-up,” *20/0699r0,* May 2020. |
| [69] | Eunsung Park (LGE), “Phase rotation proposal follow-up,” *20/0699r1,* May 2020. |
| [70] | Xiaogang Chen (Intel), “11be preamble structure,” *19/1516r4,* November 2019. |
| [71] | Sameer Vermani (Qualcomm), “Forward compatibility for WiFi preamble design,” *19/1519r5,* November 2019. |
| [72] | Sameer Vermani (Qualcomm), “Further ideas on EHT preamble design,” *19/1870r4,* November 2019. |
| [73] | Rui Cao (Marvell), “EHT preamble design,” *19/1540r7,* November 2019. |
| [74] | Dongguk Lim (LGE), “Further discussion for 11be preamble,” *19/1486r8,* November 2019. |
| [75] | Sameer Vermani (Qualcomm), “PPDU types and U-SIG content,” *20/0049r2,* January 2020. |
| [76] | Wook Bong Lee (Samsung), “SU PPDU SIG contents considerations,” *20/0285r5,* April 2020. |
| [77] | Wook Bong Lee (Samsung), “Further discussion on bandwidth and puncturing information,” *20/0606r2,* May 2020. |
| [78] | Sameer Vermani (Qualcomm), “Open issues on preamble design,” *20/1238r6,* October 2020. |
| [79] | Alice Chen (Qualcomm), “U-SIG design for TB PPDU,” *20/1546r0,* September 2020. |
| [80] | Ron Porat (Broadcom), “BW320 signaling,” *20/1467r0,* September 2020. |
| [81] | Ross Yu (Huawei), “Preamble puncture discussion in EHT PPDU,” *20/1150r2,* August 2020. |
| [82] | Ross Yu (Huawei), “Bandwidth indication for EHT PPDU,” *20/0969r3,* July 2020. |
| [83] | Dongguk Lim (LGE), “Consideration on compressed mode in 11be,” *20/1064r1,* August 2020. |
| [84] | Mengshi Hu (Huawei), “Preamble structure and SIG contents,” *20/0029r3,* January 2020. |
| [85] | Dongguk Lim (LGE), “11be PPDU format,” *20/0019r3,* April 2020. |
| [86] | Dongguk Lim (LGE), “Signaling of preamble puncturing in SU transmission,” *20/0524r2,* April 2020. |
| [87] | Dongguk Lim (LGE), “Consideration for EHT-SIG transmission,” *20/0020r3,* April 2020. |
| [88] | Ross Yu (Huawei), “Multi-segment EHT-SIG design discussion,” *20/0545r1,* April 2020. |
| [89] | Ross Yu (Huawei), “EHT-SIG compression format,” *20/0783r4,* July 2020. |
| [90] | Sameer Vermani (Qualcomm), “U-SIG structure and preamble processing,” *20/0380r0,* March 2020. |
| [91] | Sameer Vermani (Qualcomm), “Open issues on preamble design,” *20/1238r10,* October 2020. |
| [92] | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r15,* January 2021. |
| [93] | Ross Yu (Huawei), “Preamble puncture bitmap indication for 20 and 40 MHz OFDMA transmission,” *20/1984r1,* January 2021. |
| [94] | Sameer Vermani (Qualcomm), “Open Issues on preamble design,” *20/1238r11,* November 2020. |
| [95] | Ross Yu (Huawei), “SIG contents discussion for EHT sounding NDP,” *20/1317r3,* October 2020. |
| [96] | Bin Tian (Qualcomm), “EHT punctured NDP and partial bandwidth feedback,” *20/1161r0,* August 2020. |
| [97] | Sameer Vermani (Qualcomm), “NDPA and MIMO control field design for EHT,” *20/1436r6,* November 2020. |
| [98] | Sameer Vermani (Qualcomm), “Reserved bit behavior for EHT,” *20/1829r0,* November 2020. |
| [99] | Dongguk Lim (LGE), “Consideration on user-specific field in EHT-SIG,” *20/0930r1,* June 2020. |
| [100] | Dongguk Lim (LGE), “Consideration on user-specific field in EHT-SIG,” *20/0930r3,* July 2020. |
| [101] | Ron Porat (Broadcom), “Coding bit in MU-MIMO,” *20/1310r0,* August 2020. |
| [102] | Ross Yu (Huawei), “SIG contents discussion for EHT sounding NDP,” *20/1317r1,* September 2020. |
| [103] | Alice Chen (Qualcomm), “Spatial reuse fields in EHT preamble,” *21/0065r0,* January 2021. |
| [104] | Dongguk Lim (LGE), “Evaluation of signaling overhead for EHT-SIG,” *20/0738r2,* May 2020. |
| [105] | Dongguk Lim (LGE), “Management of RU allocation field,” *20/0839r2,* July 2020. |
| [106] | Dongguk Lim (LGE), “Signaling of RU allocation in 11be,” *20/0652r0,* April 2020. |
| [107] | Ross Yu (Huawei), “Further discussion on RU allocation subfield in EHT-SIG,” *20/0609r3,* May 2020. |
| [108] | Dongguk Lim (LGE), “Signaling of RU allocation follow-up,” *20/0798r1,* May 2020. |
| [109] | Dongguk Lim (LGE), “Management of RU allocation field,” *20/0839r1,* June 2020. |
| [110] | Ross Yu (Huawei), “Further discussion on RU allocation subfield in EHT-SIG,” *20/0609r7,* June 2020. |
| [111] | Ross Yu (Huawei), “RU allocation subfield in EHT-SIG follow up II,” *20/0922r2,* June 2020. |
| [112] | Ron Porat (Broadcom), “On 52 plus 26 M-RU,” *20/0925r1,* June 2020. |
| [113] | Jianhan Liu (MediaTek), “Zero user RUs for Per-80MHz resource unit allocation signaling,” *20/1102r1,* July 2020. |
| [114] | Ross Yu (Huawei), “Multi-RU indication in RU allocation subfield,” *20/0970r1,* July 2020. |
| [115] | Myeongjin Kim (Samsung), “RU allocation subfield design in EHT-SIG follow up,” *20/0985r6,* August 2020. |
| [116] | Dongguk Lim (LGE), “Signaling of RU allocation follow-up,” *20/0798r4,* July 2020. |
| [117] | Ron Porat (Broadcom), “Large M-RU table,” *20/1138r4,* August 2020. |
| [118] | Eunsung Park (LGE), “Consideration on 240/160+80 MHz and preamble puncturing,” *20/0022r1,* January 2020. |
| [119] | Jianhan Liu (MediaTek), “Further discussions on efficient EHT preamble,” *20/0605r0,* April 2020. |
| [120] | Eunsung Park (LGE), “Consideration on EHT-STF,” *20/0585r0,* April 2020. |
| [121] | Eunsung Park (LGE), “EHT-STF sequences,” *20/0782r2,* June 2020. |
| [122] | Dandan Liang (Huawei), “EHT P matrices discussion,” *19/1980r2,* January 2020. |
| [123] | Dandan Liang (Huawei), “EHT-LTFs design for wideband,” *20/0117r1,* January 2020. |
| [124] | Jinmin Kim (LGE), “Consideration of EHT-LTF,” *19/1925r2,* January 2020. |
| [125] | Jinyoung Chun (LGE), “Consideration on EHT-LTF,” *20/0608r0,* April 2020. |
| [126] | Sameer Vermani (Qualcomm), “P-matrix based LTFs for EHT,” *20/0382r0,* March 2020. |
| [127] | Jinyoung Chun (LGE), “1x EHT LTF sequence,” *20/0962r3,* July 2020. |
| [128] | Ron Porat (Broadcom), “2x 320MHz LTF design,” *20/1311r2,* September 2020. |
| [129] | Chenchen Liu (Huawei), “4x EHT-LTF sequences design,” *20/1073r4,* October 2020. |
| [130] | Oded Redlich (Huawei), “Improved preamble puncturing in 802.11be,” *19/1190r3,* November 2019. |
| [131] | Xiaogang Chen (Intel), “EHT PPDU scrambler,” *20/0563r1,* April 2020. |
| [132] | Bin Tian (Qualcomm), “Remaining issues with new 11be scrambler,” *20/1107r0,* July 2020. |
| [133] | Jinyoung Chun (LGE), “Pilot subcarriers for new tone plan,” *20/0838r3,* June 2020. |
| [134] | Jinyoung Chun (LGE), “Pilot subcarriers for new tone plan,” *20/0838r2,* June 2020. |
| [135] | Jinyoung Chun (LGE), “Pilot mapping and sequences for data section in 11be,” *20/0961r0,* July 2020. |
| [136] | Ron Porat (Broadcom), “Pilot polarities for small M-RUs,” *20/1446r0,* September 2020. |
| [137] | Jianhan Liu (MediaTek), “Segment parser and tone interleaver for 11be,” *20/0440r1,* March 2020. |
| [138] | Tianyu Wu (Apple), “Discussions on multi-RU aggregation,” *20/0495r1,* March 2020. |
| [139] | Jianhan Liu (MediaTek), “Update on segment parser and tone interleaver for 11be,” *20/0579r3,* April 2020. |
| [140] | Jianhan Liu (MediaTek), “On TBD segment parser and tone interleaver for specific MRU,” *20/0789r1,* May 2020. |
| [141] | Bin Tian (Qualcomm), “Remaining TBDs for DCM,” *20/1119r0,* July 2020. |
| [142] | Rui Cao (NXP), “EHT pre-FEC padding and packet extension,” *20/1331r0,* September 2020. |
| [143] | Ross Yu (Huawei), “Multiple RU discussion,” *19/1914r4,* January 2020. |
| [144] | Ross Yu (Huawei), “BCC interleaver parameters for multiple RU,” *20/0773r2,* June 2020. |
| [145] | Bin Tian (Qualcomm), “Thoughts on RU aggregation and interleaving,” *20/0394r1,* March 2020. |
| [146] | Wook Bong Lee (Samsung), “Further discussion on feedback overhead reduction,” *19/1495r2,* March 2020. |
| [147] | Genadiy Tsodik (Huawei), “EHT sounding feedback request parameters,” *20/1342r0,* September 2020. |
| [148] | Rui Cao (NXP), “EHT beamformee NDP and partial BW feedback support,” *20/1807r0,* November 2020. |
| [149] | Bin Tian (Qualcomm), “11be spectral mask,” *20/1159r1,* October 2020. |
| [150] | Wook Bong Lee (Samsung), “Spectrum mask requirement for punctured transmission,” *20/1180r2,* October 2020. |
| [151] | Xiaogang Chen (Intel), “Spectrum mask for puncturing,” *20/1165r1,* October 2020. |
| [152] | Lin Yang (Qualcomm), “11be spectral flatness requirements,” *20/1954r3,* December 2020. |
| [153] | Lin Yang (Qualcomm), “11be spectral flatness requirements,” *20/1954r4,* January 2021. |
| [154] | Lin Yang (Qualcomm), “11be CCA levels,” *20/1439r3,* October 2020. |
| [155] | Wook Bong Lee (Samsung), “Considerations on Open Issues PHY requirements,” *21/0012r1,* January 2021. |
| [156] | Qinghua Li (Intel), “Tx EVM requirement for 4k QAM,” *20/0456r0,* March 2020. |
| [157] | Stephane Baron (Canon), “Direct link MU transmissions,” *19/1117r2,* November 2019. |
| [158] | Dibakar Das (Intel), “EHT direct link transmission,” *19/1604r1,* January 2020. |
| [159] | Liwen Chu (NXP), “Protection with more than 160MHz PPDU and puncture operation,” *20/0062r0,* January 2020. |
| [160] | Yunbo Li (Huawei), “Bandwidth indication of 320MHz for non-HT and non-HT duplicate frames,” *20/0616r0,* April 2020. |
| [161] | Yongho Seok (MediaTek), “EHT RTS and CTS procedure,” *19/2125r2,* March 2020. |
| [162] | Dibakar Das (Intel) , “Triggered SU PPDU for 11beR1,” *20/1312r8,* December 2020. |
| [163] | Subir Das (Perspecta Labs), “Priority access support in IEEE 802.11be: what and why?,” *19/1901r4,* January 2020. |
| [164] | Subir Das (Perspecta Labs), “Priority access support options for NS/EP serveices,” *20/0463r3,* June 2020. |
| [165] | Subir Das (Perspecta Labs), “Priority service capability information,” *20/0948r3,* September 2020. |
| [166] | Liwen Chu (NXP), “EHT sounding discussion,” *20/1469r0,* November 2020. |
| [167] | Yongho Seok (MediaTek), “EHT SST operation,” *20/0736r2,* July 2020. |
| [168] | Yunbo Li (Huawei), “BQR for 320MHz,” *20/0712r1,* July 2020. |
| [169] | Yunbo Li (Huawei), “BQR for 320MHz,” *20/0712r3,* August 2020. |
| [170] | Yunbo Li (Huawei), “BQR for 320MHz,” *20/0712r5,* October 2020. |
| [171] | Po-Kai Huang (Intel), “320 MHz and 16 SS OM operation,” *20/0882r0,* October 2020. |
| [172] | Po-Kai Huang (Intel), “Extremely efficient multi-band operation,” *19/0822r9,* November 2019. |
| [173] | Laurent Cariou (Intel), “MLO optional mandatory,” *20/0992r4,* October 2020. |
| [174] | Abhishek Patil (Qualcomm), “MLO: discovery and beacon-bloating,” *20/0356r3,* June 2020. |
| [175] | Laurent Cariou (Intel), “Multi-link discovery part 1,” *20/0389r2,* June 2020. |
| [176] | Liwen Chu (NXP), “EHT BSS with wider bandwidth,” *20/0398r3,* May 2020. |
| [177] | Abhishek Patil (Qualcomm), “MLO: container structure for capability advertisement,” *20/0357r3,* June 2020. |
| [178] | Ming Gan (Huawei), “Discovery mechanism for MLD,” *20/0615r3,* August 2020. |
| [179] | Laurent Cariou (Intel), “Multi-link discovery part 2,” *20/0390r3,* June 2020. |
| [180] | Young Hoon Kwon (NXP), “MLD discovery follow up,” *20/0898r2,* August 2020. |
| [181] | Abhishek Patil (Qualcomm), “MLO: container structure for capability advertisement,” *20/0357r5,* July 2020. |
| [182] | Rojan Chitrakar (Panasonic), “Multi-link element format,” *20/0772r4,* October 2020. |
| [183] | Rojan Chitrakar (Panasonic), “Multi-link element format,” *20/0772r5,* October 2020. |
| [184] | Namyeong Kim (LGE), “MLO: information exchange for link switching,” *20/0411r4,* August 2020. |
| [185] | Po-Kai Huang (Intel), “MLD MAC address and WM address,” *20/0054r3,* March 2020. |
| [186] | Duncan Ho (Qualcomm), “MLA MAC addresses considerations,” *19/1899r7,* January 2020. |
| [187] | Sharan Naribole (Samsung), “MLO constraint indication and operating mode,” *20/0226r5,* April 2020. |
| [188] | Liwen Chu (Marvell), “Multiple link operation capability announcement,” *19/1159r5,* November 2019. |
| [189] | Yunbo Li (Huawei), “Discussion about STR capabilities indication,” *20/0921r1,* August 2020. |
| [190] | Po-Kai Huang (Intel), “Multi-link operation framework,” *19/0773r8,* November 2019. |
| [191] | Ming Gan (Huawei), “Buffer management for multi-link device,” *20/0675r3,* October 2020. |
| [192] | Ming Gan (Huawei), “Buffer management for multi-link device,” *20/0675r6,* October 2020. |
| [193] | Insun Jang (LGE), “Indication of multi-link Information,” *20/0028r5,* June 2020. |
| [194] | Po-Kai Huang (Intel), “Multi-link setup follow up,” *19/1823r3,* January 2020. |
| [195] | Po-Kai Huang (Intel), “Multi-link setup follow up II,” *20/0387r3,* June 2020. |
| [196] | Po-Kai Huang (Intel), “Multi-link security consideration,” *19/1822r9,* May 2020. |
| [197] | Young Hoon Kwon (NXP), “Multi-link association follow up,” *20/0386r4,* June 2020. |
| [198] | Laurent Cariou (Intel), “MLO optional mandatory,” *20/0992r8,* January 2021. |
| [199] | Po-Kai Huang (Intel), “MLD transition,” *20/0669r1,* August 2020. |
| [200] | Po-Kau Huang (Intel), “MLD transition,” *20/0669r3,* August 2020. |
| [201] | Po-Kai Huang (Intel), “MLD transition,” *20/0669r4,* August 2020. |
| [202] | Po-Kai Huang (Intel), “MLD transition,” *20/0669r5,* September 2020. |
| [203] | Po-Kai Huang (Intel), “Multi-link security consideration,” *19/1822r4,* January 2020. |
| [204] | Po-Kai Huang (Intel), “Multi-link security consideration,” *19/1822r7,* March 2020. |
| [205] | Gaurav Patwardhan (HPE), “MLD security considerations,” *20/1545r1,* November 2020. |
| [206] | Xiaofei Wang (InterDigital), “Follow up discussion on multi-link operations,” *20/0119r2,* May 2020. |
| [207] | Insun Jang (LGE), “Indication of multi-link information: follow-up,” *20/0741r2,* July 2020. |
| [208] | Insung Jang (LGE), “Indication of multi-link information: follow-up,” *20/0741r3,* August 2020. |
| [209] | Abhishek Patil (Qualcomm), “Multi-link association setup,” *19/1525r2,* November 2019. |
| [210] | Insun Jang (LGE), “Discussion on multi-link setup,” *19/1509r5,* November 2019. |
| [211] | Yunbo Li (Huawei), “Multi-link association,” *19/1549r5,* January 2020. |
| [212] | Abhishek Patil (Qualcomm), “MLO: BSS color,” *20/0314r1,* May 2020. |
| [213] | Laurent Cariou (Intel), “Multi-link: steps for using a link,” *19/1924r1,* January 2020. |
| [214] | Abhishek Patil (Qualcomm), “Multi-link: link management,” *19/1528r5,* January 2020. |
| [215] | Yunbo Li (Huawei), “Discussion of More Data subfield for multi-link,” *20/0472r2,* May 2020. |
| [216] | Abhishek Patil (Qualcomm), “Multi-link operation: dynamic TID transfer,” *19/1082r3,* September 2019. |
| [217] | Yongho Seok (MediaTek), “Multi-link operation management,” *19/1358r4,* January 2020. |
| [218] | Yongho Seok (MediaTek), “Multi-link operation management,” *19/1358r5,* November 2020. |
| [219] | Po-Kai Huang (Intel), “Multi-link individual addressed data delivery without BA,” *20/0688r1,* August 2020. |
| [220] | Liwen Chu (NXP), “A-MPDU and BA,” *19/1856r3,* January 2020. |
| [221] | Rojan Chitrakar (Panasonic), “Multi-link secured retransmissions,” *20/0434r3,* June 2020. |
| [222] | Rojan Chitrakar (Panasonic), “Multi-link acknowledgment,” *19/1512r6,* November 2019. |
| [223] | Yuchen Guo (Huawei), “BA setup for multi-link aggregation,” *19/1591r5,* January 2020. |
| [224] | Liwen Chu (NXP), “BA consideration,” *20/0061r2,* June 2020. |
| [225] | Abhishek Patil (Qualcomm), “MLO: acknowledgement procedure,” *20/0024r2,* April 2020. |
| [226] | Abhishek Patil (Qualcomm), “MLO: acknowledgement procedure,” *20/0024r3,* May 2020. |
| [227] | Abhishek Patil (Qualcomm), “Fragmentation in MLO,” *20/0702r3,* December 2020. |
| [228] | Yongho Seok (MediaTek), “Multi-link BA clarification,” *20/0460r3,* May 2020. |
| [229] | Po-Kai Huang (Intel), “Multi-link BA,” *20/0053r3,* April 2020. |
| [230] | Po-Kai Huang (Intel), “Multi-link BA,” *20/0053r4,* May 2020. |
| [231] | Duncan Ho (Qualcomm), “MLA: BA format,” *20/0441r3,* April 2020. |
| [232] | Liwen Chu (NXP), “Sequence number and BA operation with large BA buffer size,” *20/0397r4,* May 2020. |
| [233] | Po-Kai Huang (Intel), “11be BA Indication,” *20/0462r1,* December 2020. |
| [234] | Alexander Min (Intel), “Multi-link power save operation,” *19/1544r5,* January 2020. |
| [235] | Abhishek Patil (Qualcomm), “MLO: link management – follow up,” *19/1904r3,* January 2020. |
| [236] | Young Hoon Kwon (NXP), “Multi-link TIM,” *20/0066r3,* May 2020. |
| [237] | Young Hoon Kwon (NXP), “TIM follow up,” *20/0899r1,* August 2020. |
| [238] | Young Hoon Kwon (NXP), “TIM follow up,” *20/0899r3,* October 2020. |
| [239] | Jeongki Kim (LGE), “EHT power saving considering multi-link,” *19/1510r6,* January 2020. |
| [240] | Abhishek Patil (Qualcomm), “Multi-link operation: anchor channel,” *19/1526r3,* January 2020. |
| [241] | Ming Gan (Huawei), “BSS parameter update for Multi-link Operation,” *20/0503r2,* June 2020. |
| [242] | Ming Gan (Huawei), “Power save for multi-link,” *19/1988r3,* June 2020. |
| [243] | Yongho Seok (MediaTek), “Multi-link BSS parameter update,” *20/0337r2,* June 2020. |
| [244] | Abhishek Patil (Qualcomm), “MLO: signaling of critical updates,” *20/0586r7,* August 2020. |
| [245] | Abhishek Patil (Qualcomm), “MLO: signaling of critical updates,” *20/0586r9,* October 2020. |
| [246] | Abhishek Patil (Qualcomm), “MLO: signaling of critical updates,” *20/0586r10,* November 2020. |
| [247] | Ming Gan (Huawei), “Power save for multi-link,” *19/1988r2,* May 2020. |
| [248] | Laurent Cariou (Intel), “MLD max BSS idle period,” *20/0392r2,* March 2020. |
| [249] | Jason Yuchen Guo (Huawei), “Multi link SM power save mode,” *20/0760r5,* December 2020. |
| [250] | Laurent Cariou (Intel), “eCSA for multi link operation,” *20/1140r6,* December 2020. |
| [251] | Duncan Ho (Qualcomm), “MLA: group addressed frames delivery,” *20/0442r1,* May 2020. |
| [252] | Yongho Seok (MediaTek), “Group addressed frame transmission in constrained multi-link operation follow-up,” *20/0672r0,* July 2020. |
| [253] | Yongho Seok (MediaTek), “Group addressed frame transmission in constrained multi-link operation follow-up,” *20/0672r3,* August 2020. |
| [254] | Ming Gan (Huawei), “Group addressed frames delivery for MLO,” *20/0661r4,* September 2020. |
| [255] | Po-Kai Huang (Intel), “Multi-link group addressed data frame delivery follow up,” *20/0903r5,* November 2020. |
| [256] | Jason Yuchen Guo (Huawei), “Multi link group addressed frame delivery for non-STR MLD,” *20/0761r2,* November 2020. |
| [257] | Ming Gan (Huawei), “Group addressed frames delivery for MLO follow up,” *20/0902r4,* December 2020. |
| [258] | Insun Jang (LGE), “Channel access for multi-link operation,” *19/1144r6,* November 2019. |
| [259] | Laurent Cariou (Intel), “MLO optional mandatory,” *20/0992r5,* November 2020. |
| [260] | Duncan Ho (Qualcomm), “MLO: Sync PPDUs,” *20/0026r4,* April 2020. |
| [261] | Yongho Seok (MediaTek), “Constrained multi-link operation,” *19/1959r1,* March 2020. |
| [262] | Sharan Naribole (Samsung), “Multi-link channel access discussion,” *19/1405r7,* November 2019. |
| [263] | Dibakar Das (Intel), “STR capability signaling,” *20/1085r5,* November 2020. |
| [264] | Yongho Seok (MediaTek), “Synchronous multi-link operation,” *19/1305r4,* April 2020. |
| [265] | Yongho Seok (MediaTek), “Synchronous multi-link operation follow-up,” *20/0670r1,* July 2020. |
| [266] | Yongho Seok (MediaTek), “Multi-link triggered uplink access follow-up,” *20/0671r1,* July 2020. |
| [267] | Ming Gan (Huawei), “Sync transmission for non-STR MLD,” *20/0505r1,* August 2020. |
| [268] | Yongho Seok (MediaTek), “RTS and CTS procedure in synchronous multi-link operation,” *20/0577r3,* August 2020. |
| [269] | Yunbo Li (Huawei), “Error recovery for non-STR MLD,” *20/1062r5,* December 2020. |
| [270] | Dmitry Akhmetov (Intel), “Sync ML operations of non-STR device,” *20/0993r7,* September 2020. |
| [271] | Yongho Seok (MediaTek), “UL sync channel access procedure,” *20/1730r3,* November 2020. |
| [272] | Yongho Seok (MediaTek), “STA ID indication for constrained multi-link operation,” *20/0762r1,* August 2020. |
| [273] | Dibakar Das (Intel), “Multi-link hidden terminal-followup,” *20/1009r9,* January 2021. |
| [274] | Abhishek Patil (Qualcomm), “Multi-BSSID operation with MLO,” *20/0358r1,* May 2020. |
| [275] | Abhishek Patil (Qualcomm), “Multi-BSSID operation with MLO,” *20/0358r3,* May 2020. |
| [276] | Chunyu Hu (Facebook), “Prioritized EDCA channel access over latency sensitive links in MLO,” *20/0408r4,* May 2020. |
| [277] | Frank Hsu (MediaTek), “Link latency statistics of multi-band operations in EHT,” *20/0105r6,* June 2020. |
| [278] | Taewon Song (LGE), “Multi-link management,” *19/1943r8,* July 2020. |
| [279] | Taewon Song (LGE), “Multi-link management,” *19/1943r9,* July 2020. |
| [280] | Minyoung Park (Intel), “Enhanced multi-link single radio operation,” *20/0562r7,* July 2020. |
| [281] | Yongho Seok (MediaTek), “Multi-link spatial multiplexing,” *20/0883r6,* August 2020. |
| [282] | Jinjing Jiang (Apple), “Non-STR AP operation,” *20/0755r1,* June 2020. |
| [283] | Wook Bong Lee (Samsung), “16 Spatial Stream Support,” *19/1877r1,* January 2020. |
| [284] | Junghoon Suh (Huawei), “Restrictions for 16 SS based MU-MIMO scheduling,” *20/0067r1,* April 2020. |
| [285] | Ron Porat (Broadcom), “Number of users in MU-MIMO,” *20/0767r0,* May 2020. |
| [286] | Bin Tian (Qualcomm), “EHT punctured NDP and partial bandwidth feedback,” *20/1161r1,* October 2020. |
| [287] | Alice Chen (Qualcomm), “Update on EHT partial BW feedback tone indices table,” *20/1857r0,* November 2020. |
| [288] | Sungjin Park (LGE), “Setup for Multi-AP coordination,” *19/1895r2,* January 2020. |
| [289] | Po-Kai Huang (Intel), “Multi-AP configuration and resource allocation,” *20/0560r0,* April 2020. |
| [290] | Jianhan Liu (MediaTek), “Joint sounding for multi-AP systems,” *19/1593r3,* November 2019. |
| [291] | Feng Jiang (Intel), “Channel sounding for Multi-AP CBF,” *20/0123r0,* January 2020. |
| [292] | Feng Jiang (Intel), “Channel sounding for Multi-AP CBF,” *20/0123r2,* July 2020. |
| [293] | Cheng Chen (Intel), “Multi-AP group formation follow-up,” *19/1931r2,* January 2020. |
| [294] | Cheng Chen (Intel), “AP candidate set follow up,” *20/0596r1,* July 2020. |
| [295] | Lochan Verma (Qualcomm), “Coordinated AP time/frequency sharing in a transmit opportunity in 11be,” *19/1582r2,* January 2020. |
| [296] | Yongho Seok (MediaTek), “Coordinated OFDMA operation,” *19/1788r1,* January 2020. |
| [297] | Liwen Chu (NXP), “Coordinated OFDMA,” *19/1919r3,* January 2020. |
| [298] | Genadiy Tsodik (Huawei), “Discussion on coordinated UL MU-MIMO,” *20/0548r2,* July 2020. |
| [299] | Dennis Sundman (Ericsson), “Hidden node protection in coordinated AP transmissions,” *20/0933r1,* September 2020. |
| [300] | Jason Yuchen Guo (Huawei), “Coordinated spatial reuse operation,” *20/0033r1,* February 2020. |
| [301] | Ron Porat (Broadcom), “Joint transmission for 11be,” *20/0071r1,* April 2020. |
| [302] | Roya Doostnejad (Intel), “Coordinated beamforming for 802.11be,” *20/0099r1,* April 2020. |
| [303] | Liangxiao Xin (Sony) , “EDCA queue for RTA,” *20/1041r2,* August 2020. |
| [304] | Chunyu Hu (Facebook), “Prioritized EDCA channel access - slot management,” *20/1046r10,* December 2020. |
| [305] | Chunyu Hu (Facebook), “Prioritized EDCA channel access - slot management,” *20/1046r12,* January 2021. |
| [306] | Po-Kai Huang (Intel), “320 MHz BSS configuration,” *20/0384r1,* March 2020. |
| [307] | Guogang Huang (Huawei), “Operating bandwidth indication for EHT BSS,” *20/0680r0,* April 2020. |
| [308] | Guogang Huang (Huawei), “Operating bandwidth indication for EHT BSS,” *20/0680r3,* November 2020. |
| [309] | Liwen Chu (NXP), “EHT BSS follow up: EHT (BSS) operating parameter update,” *20/1052r1,* October 2020. |
| [310] | Liwen Chu (NXP), “Trigger consideration,” *20/0764r2,* September 2020. |
| [311] | Ming Gan (Huawei), “Backward compatible EHT trigger frame,” *20/0840r3,* October 2020. |
| [312] | Geonjung Ko (WILUS), “TB PPDU format signaling in trigger frame,” *20/1192r1,* October 2020. |
| [313] | Ross Yu (Huawei), “UL length indication in trigger frame,” *20/1685r3,* November 2020. |
| [314] | Steve Shellhammer (Qualcomm), “Backward compatible trigger frame RU allocation table,” *20/1703r3,* December 2020. |
| [315] | Steve Shellhammer (Qualcomm), “Backward compatible trigger frame RU allocation table,” *20/1703r5,* January 2021. |
| [316] | Ming Gan (Huawei), “Backward compatible EHT trigger frame follow up,” *20/1808r4,* January 2021. |
| [317] | Genadiy Tsodik (Huawei), “EHT sounding feedback request parameters,” *20/1342r1,* October 2020. |
| [318] | Eunsung Jeon (Samsung), “Partial bandwidth feedback for multi-RU,” *20/0950r4,* September 2020. |
| [319] | Chenchen Liu (Huawei), “EHT NDPA frame design discussion,” *20/1015r2,* September 2020. |
| [320] | Cheng Chen (Intel), “EHT NDPA frame design,” *20/1495r2,* October 2020. |
| [321] | Rui Cao (NXP), “EHT NDPA partial BW info design,” *20/1747r2,* January 2021. |
| [322] | Steve Shellhammer (Qualcomm), “Enhanced trigger frame for EHT support,” *20/1429r4,* January 2021. |
| [323] | Ron Porat (Broadcom), “SR field in TB PPDU,” *20/1880r1,* January 2021. |
| [324] | Steve Shellhammer (Qualcomm), “Enhanced trigger frame for EHT support,” *20/1429r6,* January 2021. |
| [325] | Mengshi Hu (Huawei), “EHT PPE thresholds field,” *20/1847r0,* November 2020. |
| [326] | Liwen Chu (NXP), “EHT BSS follow up: EHT BW Nss MCS and HE BW Nss MCS,” *20/0593r1,* October 2020. |
| [327] | Laurent Cariou (Intel), “GCMP for 11be,” *20/0866r0,* July 2020. |