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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. |

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# Abbreviations and acronyms

BPSK binary phase shift keying

BSS basic service set

BW bandwidth

DL downlink

DS distribution system

EHT extremely high throughput

HE high efficiency

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

OFDM orthogonal frequency division multiplexing

PHY physical layer

PPDU PHY protocol data unit

RL-SIG Repeated Non-HT SIGNAL field

RU resource unit

SAP service access point

STA station

SU single user

TID traffic identifier

TXOP transmission opportunity

UL Uplink

U-SIG Universal SIGNAL field

WM wireless medium

# EHT PHY

1.
2.

## General

This section describes the functional blocks in the EHT PHY.

## Channelization and tone plan

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

[Motion 10, [1] and [2]]

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, [3] and [4]]

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

[Motion 17, [3] and [5]]

802.11be reuses 802.11ax tone plan for 20/40/80/160/80+80 MHz PPDU.

For 320 MHz and 160+160 MHz PPDU, 802.11be uses duplicated HE160 for OFDMA tone plan.

[Motion 33, [3] and [6]]

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 HE80 in 802.11ax.

[Motion 35, [3] and [6]]

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, [3] and [7]]

The 802.11be 320/160+160 MHz non-OFDMA tone plan uses duplicated tone plan of HE160.

NOTE – Puncturing design TBD.

[Motion 34, [3] and [6]]

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, [3] and [7]]

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

[Motion 11, [1] and [2]]

## Resource unit

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, [1] and [8]]

## EHT preamble

### 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, [1] and [9]]

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

[Motion 29, [3] and [10]]

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, [3] and [11]]

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, [3] and [12]]

### 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-20MHz.

[Motion 27, [3] and [13]]

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, [3] and [14]]

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



Figure 1 – 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, [3] and [15]]

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

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

[Motion 42, [3] and [14]]

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

* Purpose is to simplify autodetection for future 802.11 generations, i.e., 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, [3] and [16]]

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

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

[Motion 48, [3] and [15]]

### 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, [3] and [14]]

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 BW MU-MIMO) are TBD.

[Motion 44, [3] and [14]]

### Preamble puncture

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

[Motion 30, [3] and [17]]

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

[Motion 31, [3] and [17]]

# EHT MAC

1.

## General

This section describes the functional blocks in the EHT MAC.

## Direct link MU transmission

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

[Motion 22, [3] and [18]]

# Coexistence and regulatory rules

1.

## 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

1.

## General

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

## Feature #1

Description for feature #1

# Multi-band and multichannel aggregation and operation

1.

## General

This section describes features related to multi-band and multichannel aggregation and 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, [3] and [19]]

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, [3] and [19]]

## Multi-link operation

A MLD has a MAC address that 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, [3] and [19]]

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, [3] and [20]]

A MLD can indicate capability to support exchanging frames simultaneously on a set of affiliated STAs to another MLD.

[Motion 26, [3] and [20]]

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, [3] and [21]]

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 2 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, [3] and [22]]

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, [3] and [23]]

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, [3] and [24]]

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.

[Moton 46, [3] and [25]]

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, [1] and [26]]

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, [3] and [27]]

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, [3] and [27]]

# Spatial stream and MIMO protocol enhancement

1.

## General

This section describes features related to 16 spatial stream operation and MIMO protocol enhancement.

## Feature #1

Description for feature #1

# Multi-AP operation

1.

## General

This section describes features related to multi-AP operation.

## Joint NDP 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, [3] and [28]]

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, [3] and [28]]

# Link adaptation and retransmission protocols

1.

## General

This section describes features related to enhanced link adaptation and retransmission protocols.

## Feature #1

Description for feature #1

# Low latency

1.

## General

This section describes features related to low latency.

## Feature #1

Description for feature #1

# Bibliography

|  |  |
| --- | --- |
| [1]  | TGbe, “Compendium of motions related to the contents of the TGbe specification framework document,” *19/1755r0,* October 2019.  |
| [2]  | Alice Chen (Qualcomm), “320MHz channelization and tone plan,” *19/0797r1,* September 2019.  |
| [3]  | TGbe, “Compendium of motions related to the contents of the TGbe specification framework,” *19/1755r1,* November 2019.  |
| [4]  | Eunsung Park (LGE), “Tone plan discussion,” *19/1066r3,* November 2019.  |
| [5]  | Eunsung Park (LGE), “Discussion on 240MHz bandwidth,” *19/1889r2,* November 2019.  |
| [6]  | Bin Tian (Qualcomm), “Further thoughts on 11be tone plan,” *19/1521r2,* November 2019.  |
| [7]  | Eunsung Park (LGE), “Non-OFDMA tone plan for 320MHz,” *19/1492r3,* November 2019.  |
| [8]  | Jianhan Liu (MediaTek), “Enhanced resource allocation schemes for 11be,” *19/1126r1,* September 2019.  |
| [9]  | Ross Yu (Huawei), “Preamble structure,” *19/1099r2,* September 2019.  |
| [10]  | Dongguk Lim (LGE), “Further discussion for 11be preamble,” *19/1486r9,* November 2019.  |
| [11]  | Eunsung Park (LGE), “Phase rotation for 320MHz,” *19/1493r1,* November 2019.  |
| [12]  | Xiaogang Chen (Intel), “11be preamble structure,” *19/1516r4,* November 2019.  |
| [13]  | Sameer Vermani (Qualcomm), “Forward compatibility for WiFi preamble design,” *19/1519r5,* November 2019.  |
| [14]  | Sameer Vermani (Qualcomm), “Further ideas on EHT preamble design,” *19/1870r4,* November 2019.  |
| [15]  | Rui Cao (Marvell), “EHT preamble design,” *19/1540r7,* November 2019.  |
| [16]  | Dongguk Lim (LGE), “Further discussion for 11be preamble,” *19/1486r8,* November 2019.  |
| [17]  | Oded Redlich (Huawei), “Improved preamble puncturing in 802.11be,” *19/1190r3,* November 2019.  |
| [18]  | Stephane Baron (Canon), “Direct link MU transmissions,” *19/1117r2,* November 2019.  |
| [19]  | Po-Kai Huang (Intel), “Extremely efficient multi-band operation,” *19/0822r9,* November 2019.  |
| [20]  | Po-Kai Huang (Intel), “Multi-link operation framework,” *19/0773r8,* November 2019.  |
| [21]  | Insun Jang (LGE), “Discussion on multi-link setup,” *19/1509r5,* November 2019.  |
| [22]  | Liwen Chu (Marvell), “Multiple link operation capability announcement,” *19/1159r5,* November 2019.  |
| [23]  | Abhishek Patil (Qualcomm), “Multi-link association setup,” *19/1525r2,* November 2019.  |
| [24]  | Insun Jang (LGE), “Channel access for multi-link operation,” *19/1144r6,* November 2019.  |
| [25]  | Sharan Naribole (Samsung), “Multi-link channel access discussion,” *19/1405r7,* November 2019.  |
| [26]  | Abhishek Patil (Qualcomm), “Multi-link operation: dynamic TID transfer,” *19/1082r3,* September 2019.  |
| [27]  | Rojan Chitrakar (Panasonic), “Multi-link acknowledgment,” *19/1512r6,* November 2019.  |
| [28]  | Jianhan Liu (MediaTek), “Joint sounding for multi-AP systems,” *19/1593r3,* November 2019.  |