IEEE P802.11
Wireless LANs

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| **Proposed Draft Text: EHT LTF Sequence** |
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Abstract

This submission proposes the draft text on EHT-STF for 802.11be D0.1.

Revisions:

* Rev 0: Initial version of the document.

References:

[1] 802.11-20/0566r48 Compendium of Stras Polls and Potential Changes to the Specification Framework Document

34.3.11.10 EHT-LTF

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

[Motion 74, [26] and [82]]

802.11be shall include 4× EHT-LTF.

[Motion 75, [26] and [83]]

802.11be supports EHT-LTF for 16 spatial streams.

[Motion 83, [26] and [84]]

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, [17] and [85]]

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, [17] and [85]]

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, [17] and [86]]

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, [10] and [87]]

The EHT-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. In an EHT MU PPDU, the transmitter provides training for *NSTS, r, total* space-time streams used for the transmission of the PSDU(s) in the r-th RU. In an HE TB PPDU, the transmitter of user *u* in the *r*-th RU provides training for *NSTS,r,u* space-time streams used for the transmission of the PSDU. For each subcarrier in the r-th RU, the MIMO channel that can be estimated is an *NRX × NSTS,r,total* matrix. An EHT transmission has a preamble that contains EHT-LTF symbols, where the data tones of each EHT-LTF symbol are multiplied by entries belonging to a matrix *PEHT-LTF*, to enable channel estimation at the receiver. When single stream pilot is used in EHT-LTF, the pilot subcarriers of each EHT-LTF symbol are multiplied by the entries of a matrix *RHE-LTF* to allow receivers to track phase and/or frequency offset during MIMO channel estimation using the EHT-LTF. Single stream pilots shall be used 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. This is applicable to multi-AP transmission modes as well

In an EHT MU PPDU with a single RU (the RU having an MU-MIMO allocation or an SU allocation), the number of EHT-LTF symbols, *NEHT-LTF*, is a function of the total number of space-time streams *NSTS* as shown in Table TBD.

In an EHT MU PPDU, *NEHT-LTF* is indicated in the U-SIG field. In an EHT MU PPDU with more than one RU, *NEHT-LTF* may take a value that is greater than or equal to the maximum value of the initial number of EHT-LTF symbols for each RU, where the initial number of EHT-LTF symbols is calculated as a function of *NSTS,r,total* (where *r* is the index of the RU) based on Table TBD.

In an EHT TB PPDU, *NEHT-LTF* is indicated in the Trigger frame that triggers the transmission of the PPDU. In a non-OFDMA EHT TB PPDU, the number of EHT-LTF symbols, *NEHT-LTF*, is a function of the total number of space-time streams, *NSTS*, as shown in Table TBD. For an OFDMA HE TB PPDU NHE-LTF may be greater than or equal to the maximum value of the initial number of EHT-LTF symbols for each RU *r*, which is calculated as a function of *NSTS, r, total*, separately based on Table TBD.

An EHT PPDU supports 3 EHT-LTF types: 1x EHT-LTF, 2x EHT-LTF and 4x EHT-LTF. Table TBD (EHT-LTF type and GI duration combinations for various EHT PPDU formats) defines whether a particular EHT-LTF type and GI duration combination is mandatory, conditional mandatory or optional for each EHT PPDU format.

In an EHT MU PPDU, the combination of EHT-LTF type and GI duration is indicated in U-SIG field. In an EHT TB PPDU, the combination of EHT-LTF type and GI duration is indicated in the Trigger frame that triggers the transmission of the PPDU. If an EHT PPDU is an EHT sounding NDP, the combinations of EHT-LTF types and GI durations are listed in TBD (EHT sounding NDP). If an EHT PPDU is an EHT TB feedback NDP, the combinations of types and GI durations are listed in TBD

The duration of each EHT-LTF symbol excluding GI is *THE-LTF*, defined in Equation (34-xx).

where , , are defined in Table xxx (Timing-related constants).

In a 20 MHz transmission, the 1x EHT-LTF sequence transmitted on subcarriers [–122: 122] is given by Equation (34-xx).

 (34-xx)

In a 20 MHz transmission, the 2x EHT-LTF sequence transmitted on subcarriers [–122: 122] is given by Equation (34-xx).



 (34-xx)

In a 20 MHz transmission, the 4x EHT-LTF sequence transmitted on subcarriers [–122: 122] is given by Equation (34-xx).



–1, –1, +1, –1, +1, –1, +1, +1, +1, –1, +1, +1, +1, –1, –1, +1, –1, –1, –1, –1, –1, +1, +1,

–1, –1, –1, –1, +1, +1, –1, +1, –1, +1, +1, +1, +1, –1, +1, –1, –1, +1, +1, –1, +1, +1, +1,

+1, –1, –1, +1, –1, –1, –1, +1, +1, +1, +1, –1, +1, +1, –1, –1, –1, –1, +1, –1, –1, +1, +1,

–1, +1, –1, –1, –1, –1, +1, –1, +1, –1, –1, –1, –1, –1, –1, +1, +1, –1, –1, –1, –1, –1, +1,

–1, –1, +1, +1, +1, –1, +1, +1, +1, –1, +1, –1, +1, –1, –1, –1, –1, –1, +1, +1, +1, –1, –1,

–1, +1, –1, +1, +1, +1, 0, 0, 0, –1, +1, –1, +1, –1, +1, +1, –1, +1, +1, +1, –1, –1, +1, –1, (34-xx)

–1, +1, –1, +1, –1, +1, +1, +1, –1, +1, +1, +1, –1, –1, +1, –1, –1, –1, –1, –1, +1, +1, –1,

–1, –1, –1, –1, –1, +1, –1, +1, –1, –1, –1, –1, +1, –1, +1, +1, –1, –1, +1, –1, –1, –1, –1,

+1, +1, –1, +1, +1, +1, +1, +1, +1, +1, –1, +1, +1, –1, –1, –1, –1, +1, –1, –1, +1, +1, –1,

+1, –1, –1, –1, –1, +1, –1, +1, –1, –1, +1, +1, +1, +1, –1, –1, +1, +1, +1, +1, +1, –1, +1,

+1, –1, –1, –1, +1, –1, –1, –1, +1, –1, +1, –1, +1, +1

In a 40 MHz transmission, the 1x EHT-LTF sequence transmitted on subcarriers [–244: 244] is given by Equation (34-xx).

 (34-xx)

In a 40 MHz transmission, the 2x EHT-LTF sequence transmitted on subcarriers [–244: 244] is given by Equation (34-xx).

In a 40 MHz transmission, the 4x EHT-LTF sequence transmitted on subcarriers [–244: 244] is given by Equation (34-xx).

In an 80 MHz transmission, the 1x EHT-LTF sequence transmitted on subcarriers [–500: 500] is given by Equation (34-xx).

In an 80 MHz transmission, the 2x EHT-LTF sequence transmitted on subcarriers [–500: 500] is given by Equation (34-xx).

In an 80 MHz transmission, the 4x EHT-LTF sequence transmitted on subcarriers [–500: 500] is given by Equation (34-xx).

In a 160 MHz transmission using a 1x EHT-LTF, the 1x EHT-LTF sequence is given by Equation (34-xx).

where

 means number of 23 consecutive 0s

 shall be used in the lower 80 MHz frequency segment

 shall be used in the upper 80 MHz frequency segment

In a 160 MHz transmission using a 2x EHT-LTF, the 2x EHT-LTF sequence is given by Equation (34-xx).

where

 means number of 23 consecutive 0s

 shall be used in the lower 80 MHz frequency segment

 shall be used in the upper 80 MHz frequency segment

In a 160 MHz transmission using a 4x EHT-LTF, the 4x EHT-LTF sequence is given by Equation (34-XX).

where

 means number of 23 consecutive 0s

 shall be used in the lower 80 MHz frequency segment

 shall be used in the upper 80 MHz frequency segment

For an 80+80 MHz transmission using a 1x EHT-LTF, the lower 80 MHz frequency segment shall use the 80 MHz 1x EHT-LTF sequence, *EHTLTF-500,500* =, and the upper 80 MHz frequency segment shall use the 80 MHz 1x EHT-LTF sequence, EHTLTF-500,500 = .

For an 80+80 MHz transmission using a 2x EHT-LTF, the lower 80 MHz frequency segment shall use the 80 MHz 2x EHT-LTF sequence, *EHTLTF-500,500* =, and the upper 80 MHz frequency segment shall use the 80 MHz 2x EHT-LTF sequence, EHTLTF-500,500 = .

For an 80+80 MHz transmission using a 4x EHT-LTF, the lower 80 MHz frequency segment shall use the 80 MHz 4x EHT-LTF sequence, *EHTLTF-500,500* =, and the upper 80 MHz frequency segment shall use the 80 MHz 4x EHT-LTF sequence, EHTLTF-500,500 = .

In a 320 MHz transmission using a 1x EHT-LTF, the 1x EHT-LTF sequence is given by Equation (34-xx).

 (34-xx)

where

 means number of 23 consecutive 0s

*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}

In a 320 MHz transmission using a 2x EHT-LTF, the 2x EHT-LTF sequence is given by Equation TBD.