IEEE P802.11
Wireless LANs

|  |
| --- |
| **Proposed Draft Text of ‘Pilots’ section in PHY** |
| **Date:** 2020-09-14 |
| **Author(s):** |
| **Name** | **Affiliation** | **Address** | **Phone** | **email** |
| Jinyoung Chun | LG Electronics |  |  | jiny.chun@lge.com |

Abstract

This document is proposed draft text of ‘pilots’ section in PHY

r0: initial draft

r1: comments from email reflector, modified the below things

* R matrix TBD.
* Explicitly listing pilot indices
* Following 11ax wording for a noncontiguous 160+160 MHz transmission

R2: Editorial change by Edward’s comments

# Introduction

This submission proposes the draft text on EHT-STF for 802.11be D0.1. This document is based on the following motions in [1].

* Motion 116
* Motion 115, #SP78
* Motion 115, #SP80
* Motion 122, #SP143
* Motion 122, #SP144
* Motion 122, #SP145

Texts highlighted in yellow are TBD

References:

[1] 802.11-20/0566r62 Compendium of Stras Polls and Potential Changes to the Specification Framework Document

# Proposed text

### xx.3.2 Subcarrier and resource allocation

### xx.3.2.4 Pilot subcarriers

Pilot subcarriers are present in the Data field, and may be present in the EHT-LTF field.

The pilot subcarrier indices for the Data field OFDM symbols are defined in 1.z.x (Pilot subcarriers).

One of three EHT-LTF types is used in the EHT-LTF field of an EHT PPDU: 1x EHT-LTF, 2x EHT-LTF and 4x EHT-LTF. If pilot subcarriers are present in the EHT-LTF field of an EHT PPDU, then, for a 4x EHT-LTF and 2x EHT-LTF, the pilot subcarrier locations in the EHT-LTF field are the same as the pilot subcarrier locations in the Data field. For a 1x EHT-LTF, the pilot subcarrier locations in the EHT-LTF field are the pilot subcarriers locations in the Data field that are multiples of 4.

### xx.3.10 EHT preamble

### xx.3.10.10 EHT-LTF

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 *R*EHT-LTF defined below to allow receivers to track phase and/or frequency offset during MIMO channel estimation using the EHT-LTF. Single stream pilot in EHT-LTF shall be used for SU, DL and UL OFDMA, DL MU-MIMO and UL MU-MIMO transmission using EHT UL MU-MIMO single stream pilot EHT-LTF mode.

*R*EHT-LTF is $\left[\_{}\right]\_{}\left[\_{}\right]\_{}\_{}$$\_{}$TBD.

### xx.3.11 Data field

### xx.3.11.13 Pilot subcarriers

For a user transmitting on the *i*-th 26/52/106/242/484-tone RU in a 20/40MHz PPDU BW, the pilot subcarriers defined in 27.3.12.13 (Pilot subcarriers) shall be followed.

For a user transmitting on the *i*-th 26-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R26\_{i}}$, where $K\_{R26\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-1 (Pilot indices for a 26-tone RU transmission).

**Table xx-1. Pilot indices for a 26-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R26\_{i}}$$ |
| 80MHz, *i* = 1:36 |  {-494, -480}, {-468, -454}, {-440, -426}, {-414, -400}, {-386, -372}, {-360, -346}, {-334, -320}, {-306, -292}, {-280, -266}, {-246, -232}, {-220, -206}, {-192, -178}, {-166, -152}, {-138, -124}, {-112, -98}, {-86, -72}, {-58, -44}, {-32, -18}, {18, 32}, {44, 58}, {72, 86}, {98, 112}, {124, 138}, {152, 166}, {178, 192}, {206, 220}, {232, 246}, {266, 280}, {292, 306}, {320, 334}, {346, 360}, {372, 386}, {400, 414}, {426, 440}, {454, 468}, {480, 494} |
| 160MHz, $i=1: \left(\right)$ | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz , $i=1: \left(\right)$ | {pilot subcarrier indices in 80MHz-1536, pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512, pilot subcarrier indices in 80MHz+1536 } |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-101) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 52-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R52\_{i}}$, where $K\_{R52\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-2 (Pilot indices for a 52-tone RU transmission).

**Table xx-2. Pilot indices for a 52-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$\_{\_{}}$$ |
| 80MHz, *i* = 1:16 | {-494, -480, -468, -454}, {-440, -426, -414, -400}, {-360, -346, -334, -320}, {-306, -292, -280, -266}, {-246, -232, -220, -206}, {-192, -178, -166, -152}, {-112, -98, -86, -72}, {-58, -44, -32, -18}, {18, 32, 44, 58}, {72, 86, 98, 112}, {152, 166, 178, 192}, {206, 220, 232, 246}, {266, 280, 292, 306}, {320, 334, 346, 360}, {400, 414, 426, 440}, {454, 468, 480, 494} |
| 160MHz, $i=1: 32$  | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz, $i=1: $$72$ | {pilot subcarrier indices in 80MHz-1536, pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512, pilot subcarrier indices in 80MHz+1536} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-102) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 106-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R106\_{i}}$, where $K\_{R106\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-3 (Pilot indices for a 106-tone RU transmission).

**Table xx-3. Pilot indices for a 106-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$\_{\_{}}$$ |
| 80MHz, *i* = 1:8 | {-494, -468, -426, -400}, {-360, -334, -292, -266}, {-246, -220, -178, -152}, {-112, -86, -44, -18}, {18, 44, 86, 112}, {152, 178, 220, 246}, {266, 292, 334, 360}, {400, 426, 468, 494} |
| 160MHz, $i=1: $$16$ | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz , $i=1: $$32$ | {pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-103) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 242-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R242\_{i}}$, where $K\_{R242\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-4 (Pilot indices for a 242-tone RU transmission).

**Table xx-4. Pilot indices for a 242-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$\_{\_{}}$$ |
| 80MHz, *i* = 1:4 | {-494, -468, -426, -400, -360, -334, -292, -266}, {-246, -220, -178, -152, -112, -86, -44, -18}, {18, 44, 86, 112, 152, 178, 220, 246}, {266, 292, 334, 360, 400, 426, 468, 494} |
| 160MHz, $i=1: 8$  | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz, $i=1: $$16$ | {pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-104) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 484-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R484\_{i}}$, where $K\_{R484\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-5 (Pilot indices for a 484-tone RU transmission).

**Table xx-5. Pilot indices for a 484-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$\_{\_{}}$$ |
| 80MHz, *i* = 1:2 | {-494, -468, -426, -400, -360, -334, -292, -266, -246, -220, -178, -152, -112, -86, -44, -18}, {18, 44, 86, 112, 152, 178, 220, 246, 266, 292, 334, 360, 400, 426, 468, 494} |
| 160MHz, $i=1: $$4$  | {pilot subcarrier indices in 80MHz-512, pilot subcarrier indices in 80MHz+512} |
| 320MHz, $i=1: $$8$ | {pilot subcarrier indices in 160MHz-1024, pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in from Equation (27-105) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 996-tone RU in 80/160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R996\_{i}}$, where $K\_{R996\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-6 (Pilot indices for a 996-tone RU transmission).

**Table xx-6. Pilot indices for a 996-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R996\_{i}}$$ |
| 80MHz, *i* = 1 | {-468, -400, -334, -266, -220, -152, -86, -18, 18, 86, 152, 220, 266, 334, 400, 468} |
| 160MHz, *i* = 1:2 | {pilot subcarrier indices in 80MHz-512}, {pilot subcarrier indices in 80MHz+512} |
| 320MHz, *i* = 1:4 | {pilot subcarrier indices in 80MHz-1536}, {pilot subcarrier indices in 80MHz-512}, {pilot subcarrier indices in 80MHz+512}, {pilot subcarrier indices in 80MHz+1536} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in Equation (27-106) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 2$×$996-tone RU in 160/320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R2×996\_{i}}$, where $K\_{R2×996\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-7 (Pilot indices for a 2\*996-tone RU transmission).

**Table xx-7. Pilot indices for a 2**$×$**996-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R2×996\_{i}}$$ |
| 160MHz, *i* = 1 | {-980, -912, -846, -778, -732, -664, -598, -530, -494, -426, -360, -292, -246, -178, -112, -44, 44, 112, 178, 246, 292, 360, 426, 494, 530, 598, 664, 732, 778, 846, 912, 980} |
| 320MHz, *i* = 1:2 | {pilot subcarrier indices in 160MHz-1024}, {pilot subcarrier indices in 160MHz+1024} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in Equation (27-107) in 27.3.12.13 (Pilot subcarriers).

For a user transmitting on the *i*-th 4$×$996-tone RU in 320MHz PPDU BW, the pilot subcarriers shall be inserted in subcarriers $k\in K\_{R4×996\_{i}}$, where $K\_{R4×996\_{i}}$ is given by the *i*-th pilot index set in the row of given PPDU BW of Table xx-4 (Pilot indices for a 4$×$996-tone RU transmission).

**Table xx-4 Pilot indices for a 4**$×$**996-tone RU transmission**

|  |  |
| --- | --- |
| PPDU BW (OFDMA/ non-OFDMA) | $$K\_{R4×996\_{i}}$$ |
| 320MHz, *i* = 1 | {-2004, -1936, -1870, -1802, -1756, -1688, -1622, -1554, -1518, -1450, -1384, -1316, -1270, -1202, -1136, -1068, -980, -912, -846, -778, -732, -664, -598, -530, -494, -426, -360, -292, -246, -178, -112, -44, 44, 112, 178, 246, 292, 360, 426, 494, 530, 598, 664, 732, 778, 846, 912, 980, 1068, 1136, 1202, 1270, 1316, 1384, 1450, 1518, 1554, 1622, 1688, 1756, 1802, 1870, 1936, 2004} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* shall be as specified in Equation (yy-yy).

$$P\_{n}^{K\_{R4×996\_{i}}}=\{Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}, $$

$$Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}, $ (yy-yy)

$$Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}, $$

$$Ψ\_{n mod 8}, Ψ\_{\left(n+1\right)mod 8}, Ψ\_{\left(n+2\right)mod 8}, , Ψ\_{\left(n+3\right)mod 8}, $$

$$Ψ\_{\left(n+4\right)mod 8}, Ψ\_{\left(n+5\right)mod 8}, Ψ\_{\left(n+6\right)mod 8}, Ψ\_{\left(n+7\right)mod 8}, $$

$$Ψ\_{\left(n+8\right)mod 8}, Ψ\_{\left(n+9\right)mod 8}, , Ψ\_{\left(n+10\right)mod 8}, Ψ\_{\left(n+11\right)mod 8}, $$

$$Ψ\_{\left(n+12\right)mod 8}, Ψ\_{\left(n+13\right)mod 8}, Ψ\_{\left(n+14\right)mod 8}, Ψ\_{\left(n+15\right)mod 8}\} $$

$$P\_{n}^{k\notin K\_{R4×996\_{i}}}=0$$

where

$Ψ\_{m}$ is defiend in Table 27-43 (The 8 pilot values in a 242-tone RU)

For a noncontiguous 160+160 MHz transmission, each 160MHz frequency segment shall follow the pilot sub-carrier allocation and values defined for 2\*996-tone RU in 160MHz transmission.

For a user transmitting on the combinated RUs in 320MHz PPDU BW, the pilot subcarriers, mapping and values of combinated RUs shall follows the pilot subcarriers, mapping and values of each RU.

The above pilot mapping shall be copied to all space-time streams before the space-time stream cyclic shifts are applied.