IEEE P802.11  
Wireless LANs

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| Proposed Draft Text (PDT-PHY): An update to Preamble: U-SIG | | | | |
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| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Sameer Vermani | Qualcomm |  |  | svverman@qti.qualcomm.com |
| Alice Chen | Qualcomm |  |  | alicel@qti.qualcomm.com |
| Bin Tian | Qualcomm |  |  | btian@qti.qualcomm.com |
| Youhan Kim | Qualcomm |  |  | youhank@qti.qualcomm.com |

Abstract

This submission proposes updates to U-SIG section based on motions after TGbe D0.1

* + - 1. U-SIG
         1. General

The U-SIG field carries information necessary to interpret EHT PPDUs. The integer fields of the U-SIG field are transmitted in unsigned binary format, LSB first, where the LSB is in the lowest numbered bit position.

* + - * 1. Content

The U-SIG field is designed to bring forward compatibility to the EHT preamble via the introduction of version independent fields. These are fields that will be consistent in location and interpretation across multiple 802.11 PHY amendments. 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 which are fields specific to a PHY amendment. The U-SIG includes version independent bits followed by version dependent bits. PHY version identifier field shall be one of the version independent fields in the U-SIG. The purpose of PHY Version Identifier 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.

The size of the U-SIG for EHT MU PPDU and EHT TB PPDU is two symbols. For forward compatibility, EHT R1 defines Extended Range (ER) Preamble while not defining an ER PPDU. This enables an EHT R1 STA to decode and interpret the version independent content in the U-SIG of an ER PPDU which may be introduced in future amendments. The size of U-SIG for an ER preamble is four symbols

The following fields shall be the same in every 80MHz segment, 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

The U-SIG field for an EHT MU PPDU contains the fields listed in Table 34-18 (U-SIG field of an EHT MU PPDU).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 34-18 U-SIG field of an EHT MU PPDU | | | | |
| Two Parts of U-SIG | Bit | Field | Number of bits | Description |
| U-SIG-1 | B0-B2 | PHY Version Identifier | 3 | Differentiate between different PHY amendments. Set to 0 for EHT.  Values 1-7 are reserved. |
|  | B3-B5 | BW | 3 | Set to 0 for 20 MHz  Set to 1 for 40 MHz  Set to 2 for 80 MHz  Set to 3 for 160 MHz  Set to 4 for 320MHz-1  Set to 5 for 320MHz-2  Values 6,7 are reserved. |
|  | B6 | UL/DL | 1 | Indicates whether the PPDU is sent UL or DL. Set to 1 if the PPDU is addressed to an AP. Set to 0 otherwise. See TXVECTOR parameter UPLINK\_FLAG.(#24500) |
|  | B7-B12 | BSS Color | 6 | (#24500)An identifier of the BSS.  See TXVECTOR parameter BSS\_COLOR. |
|  | B13-B19 | TXOP | 7 | Set to 127 to indicate no duration information if TXVECTOR parameter TXOP\_DURATION is UNSPECIFIED.  Set to a value less than 127 to indicate duration information for NAV setting and protection of the TXOP as follows:  If TXVECTOR parameter TXOP\_DURATION is less than 512, then B0 is set to 0 and B1–B6 is set to floor(TXOP\_DURATION/8).  Otherwise, B0 is set to 1 and B1–B6 is set to floor((TXOP\_DURATION – 512) / 128).  where  B0 indicates the TXOP length granularity. Set to 0 for 8 µs; otherwise set to 1 for 128 µs.  B1-B6 indicates the scaled value of the TXOP\_DURATION  (#24368) |
|  | B20-B24 | Disregard | 5 | Disregard and set to 1 |
| B25 | Validate | 1 | Validate and set to 1 |
| U-SIG-2 | B0-B1 | PPDU type &  Compression Mode | 2 | If B6 of U-SIG-1 is set to 1, a value of 0 indicates a TB PPDU.  If B6 of U-SIG-1 is set to 0, a value of 0 indicates a DL OFDMA PPDU.  A value of 1 indicates an EHT SU transmission, or an EHT sounding NDP.  A value of 2 indicates a non-OFDMA DL MU-MIMO transmission. |
| B2 | Validate | 1 | Validate and set to 1. Maybe used for an expanded set of PPDU types or compressed modes in future amendments. |
|  | B3-B7 | Punctured Channel Indication | 5 | If B0-B1 of U-SIG-2 is set to 0, which is the non-OFDMA case, B3-B7 points to the entry of a BW dependent table(defined in Table XXX) to signal the non-OFDMA puncturing pattern of the entire PPDU BW.  If B0-B1 of U-SIG-2 is set to 1 or 2, this is the OFDMA case. B3-B6 is a 4 bits bit-map that tells which 20MHz channel is punctured in the relevant 80MHz segment, where B3 applies to the lowest frequency 20MHz channel and B6 to the highest frequency 20MHz channel. For each of the bits B3-B6, a value of 0 indicates that the corresponding 20MHz channel is punctured, and a value of 1 is used otherwise. Field value may vary from one 80MHz to the other. B7 is reserved and set to 1. |
|  | B8 | Validate | 1 | Validate and set to 1. Maybe used for an expanded set of puncturing modes in future amendments. |
| (#24191) | B9-B10 | EHT-SIG MCS | 2 | Indicated the MCS used for modulating the EHT-SIG.  Set to 0 for MCS0  Set to 1 for MCS1  Set to 2 for MCS3  Set to 3 for ‘MCS0+DCM’  .(#24501) |
| B11-B15 | Number of EHT-SIG symbols | 5 | Indicates the number of EHT-SIG symbols. Set to a value which is “number of EHT-SIG symbols” minus 1. (#24500) |
|  | B16-B19 | CRC | 4 | CRC for bits 0–41 of the U-SIG field (see 27.3.11.7.3 (CRC computation)). Bits 0–41 of the U-SIG field correspond to bits 0–25 of U-SIG1 followed by bits 0–15 of U-SIG2). |
|  | B20-B25 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.  Set to 0. |

Table XXX 5-bit Punctured Channel Indication for the non-OFDMA case in an EHT MU PPDU

|  |  |  |  |
| --- | --- | --- | --- |
| PPDU BW | Cases | Puncturing Pattern | Field 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 |

Note: In the puncturing patterns in the above table, a ‘1’ denotes a non-punctured sub-channel and an ‘x’ denotes a punctured sub-channel. The puncturing granularity for 80MHz and 160MHz PPDU bandwidths is 20MHz, and the puncturing granularity for 320MHz PPDU bandwidth is 40MHz.

The U-SIG field for an EHT TB PPDU contains the fields listed in Table 34-19 (U-SIG field of an EHT TB PPDU).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 34-19 U-SIG field of an EHT TB PPDU | | | | |
| Two Parts of U-SIG | Bit | Field | Number of bits | Description |
| U-SIG-1 | B0-B2 | Version Identifier | 3 | Differentiate between different PHY amendments. Set to 0 for EHT.  Values 1-7 are reserved. |
|  | B3-B5 | BW | 3 | Set to 0 for 20 MHz  Set to 1 for 40 MHz  Set to 2 for 80 MHz  Set to 3 for 160 MHz  Set to 4 for 320MHz-1  Set to 5 for 320MHz-2  Values 6,7 are reserved. |
|  | B6 | UL/DL | 1 | Indicates whether the PPDU is sent UL or DL. Set to 1 if the PPDU is addressed to an AP. Set to 0 otherwise. See TXVECTOR parameter UPLINK\_FLAG.(#24500) |
|  | B7-B12 | BSS Color | 6 | (#24500)An identifier of the BSS.  See TXVECTOR parameter BSS\_COLOR. |
|  | B13-B19 | TXOP | 7 | Set to 127 to indicate no duration information if TXVECTOR parameter TXOP\_DURATION is UNSPECIFIED.  Set to a value less than 127 to indicate duration information for NAV setting and protection of the TXOP as follows:  If TXVECTOR parameter TXOP\_DURATION is less than 512, then B0 is set to 0 and B1–B6 is set to floor(TXOP\_DURATION/8).  Otherwise, B0 is set to 1 and B1–B6 is set to floor((TXOP\_DURATION – 512) / 128).  where  B0 indicates the TXOP length granularity. Set to 0 for 8 µs; otherwise set to 1 for 128 µs.  B1-B6 indicates the scaled value of the TXOP\_DURATION  (#24368) |
| B20-B25 | Disregard | 6 | Disregard and set to 1 |
| U-SIG-2 | B0-B1 | PPDU type &  Compression Mode | 2 | Set to 0 for a TB PPDU |
| B2 | Validate | 1 | Validate and set to 1 |
| B3-B6 | Spatial Reuse 1 | 4 | Indicates whether or not specific spatial reuse modes are allowed in a subband of the PPDU during the transmission of this PPDU, and if PSR spatial reuse is allowed, indicates a value that is used to determine a limit on the transmit power of the PSRT PPDU.  If the Bandwidth field indicates 20 MHz, 40 MHz, then this Spatial Reuse field applies to the first 20 MHz subband.  If the Bandwidth field indicates 80MHz, then this Spatial Reuse field applies to the first 40 MHz subband of the 80 MHz operating band.  If the Bandwidth field indicates 160MHz, then this Spatial Reuse field applies to the first 80 MHz subband of the 160 MHz operating band.  If the Bandwidth field indicates 320MHz-1 or 320MHz-2, then this Spatial Reuse field applies to the first 160 MHz subband of the 320 MHz operating band.  Set to the value of the SPATIAL\_REUSE(1) parameter of the TXVECTOR, which contains a value from Table 27-23 (Spatial Reuse field encoding for an HE TB PPDU) for an HE TB PPDU (see 26.11.6 (SPATIAL\_REUSE) and 26.10 (Spatial reuse operation)). |
|  | B7-B10 | Spatial Reuse 2 | 4 | Indicates whether or not specific spatial reuse modes are allowed in a subband of the PPDU during the transmission of this PPDU, and if PSR spatial reuse is allowed, indicates a value that is used to determine a limit on the transmit power of the PSRT PPDU.  If the Bandwidth field indicates 40 MHz:  This Spatial Reuse field applies to the second 20 MHz subband.  If the STA operating channel width is 20 MHz, then this field is set to the same value as the Spatial Reuse 1 field.  If the STA operating channel width is 40 MHz in the 2.4 GHz band, this field is set to the same value as the Spatial Reuse 1 field.  If the Bandwidth field indicates 80 MHz the this Spatial Reuse field applies to the second 40 MHz subband of the 80 MHz operating band.  If the Bandwidth field indicates 160MHz, then this Spatial Reuse field applies to the second 80 MHz subband of the 160 MHz operating band.  If the Bandwidth field indicates 320MHz-1 or 320MHz-2, then this Spatial Reuse field applies to the second 160 MHz subband of the 320 MHz operating band.  Set to the value of the SPATIAL\_REUSE(1) parameter of the TXVECTOR, which contains a value from Table 27-23 (Spatial Reuse field encoding for an HE TB PPDU) for an HE TB PPDU (see 26.11.6 (SPATIAL\_REUSE) and 26.10 (Spatial reuse operation)). (#24500) |
|  | B11-B15 | Disregard | 5 | Disregard and set to 1 |
|  | B16-B19 | CRC | 4 | CRC for bits 0–41 of the U-SIG field (see 27.3.11.7.3 (CRC computation)). Bits 0–41 of the U-SIG field correspond to bits 0–25 of U-SIG1 followed by bits 0–15 of U-SIG2). |
|  | B20-B25 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.  Set to 0. |

The U-SIG field for an ER preamble contains the fields listed in Table XXX.

Table XXX U-SIG field of an ER preamble

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Two Parts of U-SIG | Bit | Field | Number of bits | Description |
| U-SIG-1 | B0-B2 | Version Identifier | 3 | Differentiates between different PHY amendments.  Note: Expected to take a value other than 0 as EHT does not define an ER PPDU. |
|  | B3-B5 | BW | 3 | Set to 0 for 20 MHz  Set to 1 for 40 MHz  Set to 2 for 80 MHz  Set to 3 for 160 MHz  Set to 4 for 320MHz-1  Set to 5 for 320MHz-2  Values 6,7 are reserved. |
|  | B6 | UL/DL | 1 | Indicates whether the PPDU is sent UL or DL. Set to 1 if the PPDU is addressed to an AP. Set to 0 otherwise. See TXVECTOR parameter UPLINK\_FLAG.(#24500) |
|  | B7-B12 | BSS Color | 6 | (#24500)An identifier of the BSS.  See TXVECTOR parameter BSS\_COLOR. |
|  | B13-B19 | TXOP | 7 | Set to 127 to indicate no duration information if TXVECTOR parameter TXOP\_DURATION is UNSPECIFIED.  Set to a value less than 127 to indicate duration information for NAV setting and protection of the TXOP as follows:  If TXVECTOR parameter TXOP\_DURATION is less than 512, then B0 is set to 0 and B1–B6 is set to floor(TXOP\_DURATION/8).  Otherwise, B0 is set to 1 and B1–B6 is set to floor((TXOP\_DURATION – 512) / 128).  where  B0 indicates the TXOP length granularity. Set to 0 for 8 µs; otherwise set to 1 for 128 µs.  B1-B6 indicates the scaled value of the TXOP\_DURATION (#24368) |
| B20-B25 | Disregard | 6 | Disregard, maybe set to any value by a future amendment. |
| U-SIG-2 | B0-B5 | Disregard | 16 | Disregard, maybe set to any value by a future amendment |
|  | B16-B19 | CRC | 4 | CRC for bits 0–41 of the U-SIG field (see 27.3.11.7.3 (CRC computation)). Bits 0–41 of the U-SIG field correspond to bits 0–25 of U-SIG1 followed by bits 0–15 of U-SIG2). |
|  | B20-B25 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.  Set to 0. |

* + - * 1. CRC computation

The CRC computation defined in this subclause applies to U-SIG, the Common field of EHT-SIG, and the User Block field of EHT-SIG.

The CRC is calculated over bits 0 to 41 of the U-SIG field and over bits 0 to *L* of the EHT-SIG field (*L*= *x* for each Common field where *x* = *N* × TBD, and *L*= TBD for an User Block field that contains one User field and *L* = TBD for an User Block field that contains two User fields). Bits 0 to 41 of the U-SIG field correspond to bits 0–25 of U-SIG-1 followed by bits 0–15 of U-SIG-2).

The value of the CRC field shall be the 1s complement of



where





*G*(*D*) is defined in 19.3.9.4.4 (CRC calculation for HT-SIG)



*mL* is the serial input shown in Figure 34-XXX (CRC calculation)

The CRC field is transmitted from *c4* to *c7* with *c7* first.

Figure 34-XXX (CRC calculation) shows the operation of the CRC. First, the shift register is reset to all 1s. The bits are then passed through the XOR operation at the input. When the last bit has entered, the output is generated by shifting the bits out of the shift register, *c7* first, through an inverter.

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| Figure 34-XXX CRC calculation |

As an example, if bits are given by {1 1 0 1 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 1 0 1 0}, the output bits , where *B*7is output first, are {0 1 1 1}.

* + - * 1. Encoding and modulation

For an EHT MU PPDU and EHT TB PPDU, the U-SIG field is composed of two parts, U-SIG-1 and U-SIG-2, each containing 26 data bits. U-SIG-1 is transmitted before U-SIG-2. The data bits of the U-SIG OFDM symbols shall be BCC encoded at rate, R = 1/2, interleaved, mapped to a BPSK constellation, and have pilots inserted following the steps described in 17.3.5.6 (Convolutional encoder), 27.3.12.8 (BCC interleavers), 17.3.5.8 (Subcarrier modulation mapping), and 17.3.5.9 (Pilot subcarriers), respectively. This process happens on a per-80MHz frequency segment basis as U-SIG field may have different contents in different 80MHz frequency segments, while always having identical content in every 20MHz segment of a given 80MHz segment. For every 80MHz segment in the EHT PPDU, the first and second half of the stream of 104 complex numbers generated by these steps (before pilot insertion) is divided into two groups of 52 complex numbers, where respectively, the first 52 complex numbers form the first OFDM symbol of U-SIG and the second 52 complex numbers form the second OFDM symbol of U-SIG.

For U-SIG in 80 MHz frequency segment *i80FS*, the complex number assigned to the *k-*th data subcarrier of the *n-*th symbol is denoted as . The time domain waveform for the U-SIG field of an EHT MU PPDU and EHT TB PPDU, transmitted on frequency segment *i80FS* and transmit chain *iTX*, shall be as specified in Equation (27-16).(M218)



where

*TSYML* is given in Table 34-xx (Timing-related constants)

*Pk* and *pn* are defined in 17.3.5.10 (OFDM modulation)

is defined in Table XXX (Number of modulated subcarriers and guard interval duration values for EHT PPDU fields)

represents the cyclic shift for transmit chain *iTX* with a value given in XXX (Cyclic shift for pre-EHT modulated fields).

(#24191)For an ER preamble, the U-SIG field is composed of four parts, i.e. U-SIG-1, U-SIG-1-R, U-SIG-2 and U-SIG-2-R, each part containing 26 data bits. These four parts are transmitted sequentially from U-SIG-1 to U-SIG-2-R. The data bits of U-SIG-1 and U-SIG-2 shall be BCC encoded at rate, *R* = 1/2, interleaved, mapped to a BPSK constellation, and have pilots inserted. U-SIG-1-R has the same encoded bits as U-SIG-1 and the encoded bits shall be mapped to a QBPSK constellation without interleaving and have pilots inserted. The constellation mappings of the U-SIG field in an ER preamble is the same as that of the HE-SIG-A field in an HE ER SU PPDU, and is shown in Figure XXX (Data subcarrier constellation of U-SIG symbols). The QBPSK constellation on U-SIG-1R is used to differentiate an ER preamble from an EHT MU PPDU and an EHT TB PPDU. U-SIG-2-R has the same encoded bits as U-SIG-2 and the encoded bits shall be mapped to a BPSK constellation without interleaving and have pilots inserted. BCC encoding, data interleaving, constellation mapping and pilot insertion follow the steps described in 17.3.5.6 (Convolutional encoder), 27.3.12.8 (BCC interleavers), 17.3.5.8 (Subcarrier modulation mapping), and 17.3.5.9 (Pilot subcarriers), respectively.

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| Figure XXX Data subcarrier constellation of U-SIG symbols(#24191) |

For U-SIG in 80 MHz frequency segment *i80FS*, the complex number assigned to the *k-*th data subcarrier of the *n-*th symbol is denoted as . The time domain waveform for the U-SIG field of an EHT ER SU PPDU, transmitted on frequency segment *i80FS* and transmit chain *iTX*, shall be as specified in Equation (27-18).(M215)



where

*Rn* is a phase rotation vector defined as [1, *j*, 1, 1]