IEEE P802.11
Wireless LANs

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| --- |
| D1 Comment Resolution, brianh, part 5 |
| Date: 2011-08-18 |
| Author(s): |
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##### Baseline is 11ac D1.0. Changes indicated by a mixture of Word track-changes and instructions. For equation changes, Latex notation is sometimes used. E.g. a\_{xyz}^b denotes axyzb

MU CIDs addressed: 2562, 2605

PHY CIDs addressed: 2184, 3301 2811, 2285, 2433, 2361

##### MU

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2605 | Hunter, David | 113.30 | 22.2.2 | There doesn't seem to be a specifciation of what a "user" is.  | Supply a specification of a "user", or at least a clear description that tells the implementer how to identify one. There don't seem to be MLME primitives that specify numbers of users, so how do the MAC and PHY determine those (1-4)?  | **Accept in principle. Add a definition for STA and MIB variables to describe the PHY limitations to the MLME. See 11/954r1 with updates in 11/1128r1** | PHY |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2562 | Hunter, David | 14.64 | 6.4.7.1 | It is not clear what a "user" of a PPDU is. Does this mean "transmitting STA"? | Replace "user" with "transmitting STA" or define "user of a PPDU". If "user" is replaced, that change needs to be made throughout the draft text. | **Accept in principle. See 11/1128r1** | MU |

##### Discussion: For reference, CID 2605 in 11/954r1 defines a user as

“user: STA, used in the context of single-user MIMO or MU-MIMO”

But upon reflection, this is wrong since a SU PPDU can transmit to a group address, so really user is closer to “RA”

***After applying 11/954r1, change***

user: Set of STAs indicated by a single RA or a STA, used in the context of single-user MIMO or MU-MIMO, respectively

##### PHY

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2184 | Dehghan, Hossein | 17.30 | 7.3.5.11.2 | "The relationship of channel-list elements (…) is illustrated"This is just one of several possible relationships. | To avoid confusion, state that this is not the only possible allocation of the various channel list elements. | **Accept in principle. See 11/1128r1** | PHY |

##### Discussion: It is true that the allocation of the various channel list elements can vary, yet once the primary channel is allocated, in fact the other aspects then follow directly. So we need to be careful about the language.

##### Change:

The relationship of the channel-list elements to the 40 MHz, 80 MHz and 160 MHz BSS operating channel is illustrated by example in Figure 7-ac1. Note that for an 80+80 MHz BSS the subchannels represented by secondary80 are the same as shown for the 160 MHz channel except that they occur in a non-adjacent 80 MHz channel.



**Figure 7-ac1—Example relationship between the channel-list elements and the operating channel bandwidth**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 3301 | Rosdahl, Jon | 17.65 | 7.3.5.11.3 | If this text is deleted, doesn't corresponding text need to be added somewhere else? | Add some suitable text somewhere in clause 19 | **Accept in principle. See 11/1128r1** | PHY |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2811 | Lindskog, Erik | 17.65 | 7.3.5.11.3 | If this text is deleted, doesn't corresponding text need to be added somewhere else? Ditto 18.3 | Add some suitable text somewhere in clause 19 | **Accept in principle. See 11/1128r1** | PHY |

***Discussion:*** The comments refer to

**2156**

7.3.5.11.3 When generated

*Change section 7.3.5.11.3 as follows:*

This primitive is generated ~~within aCCATime of the occurrence of a change in~~when the status of the channel(s) changes from channel idle to channel busy or from channel busy to channel idle, or when the channellist parameter changes. ~~This includes the period of time when the PHY is receiving data.~~ Refer to specific PHY clauses for details about CCA behavior for a given PHY.

Also 6.5.4.2 has

|  |  |  |
| --- | --- | --- |
| aCCATime | integer | The minimum time (in microseconds) the CCA mechanism has available to assess the medium within every time slot to determine whether the medium is busy or idle. |

Both sections are general: i.e. they seem to apply to both carrier sense and energy detect. Clause 7 is descriptive language but clase 6 seems to be a definition (i.e. closer to normative language).

aCCATime is defined in the PHY subclauses (namely the PHY characteristics table, e.g. 4 us for clause 17/19 and 20 MHz) but aCCATime is not actually used in the clause 17/19 CCA sections (e.g. for preamble detect it just says 4us directly). Clause 15/16 have aCCATime of <15us, but valid signal detect must happen within 5 us. So presumably clause 15/16 intend for aCCATime to apply to energy detect. Meanwhile, neither the missed preamble detect in clause 17 (arguably energy detect) nor true energy detect (clause 15/16/19) mention time at all (so arguably aCCATime is meant to be applicable).

Since the intent to apply aCCATime to ED seems to be there, then it does seem a shame to delete a requirement that clause 15/16/17/19 do seem to expect.

It does have problems:

1. Not backed up by any normative statements, except perhaps the definition in clause 6
2. Yet, inconsistent with clause 6 definition (slot synchronous vs slot asynchronous)
3. Does not account for the secondary PIFS sniff introduced for 40 MHz HT STAs
4. Refers to both the idle->busy transition AND the busy->idle transition. Any changes cannot introduce normative requirements for the busy->idle transition since that implies a well-defined “idle”. In the absence of new thresholds, this would have to be the complement of “busy” and so implementations must provide an infinitely accurate power measurement around -62.0000 and -82.0000 dBm, etc.

We propose to deal with these issues in 11mb since they seem out of scope of 11ac. We’ll just fix up 11ac.

Also the clause 6 definition is back-to-front – aCCATime is defined as a minimum time, but MAC operation requires this to be a maximum. Seems to be a very old error – fix this.

##### Change:

**6.5.4.2 Semantics of the service primitive**

|  |  |  |
| --- | --- | --- |
| aCCATime | integer | For clause 13-21 PHYs, the maximum time (in microseconds) the CCA mechanism has available to assess the medium within every time slot to determine whether the medium is busy or idle; otherwise the maximum time (in microseconds) that the CCA mechanism has available to detect the start of a valid 802.11 transmission within the primary channel and to assess the energy on the medium within the primary, secondary, secondary40 and secondary80 channels that fall inside the operating channel, in order to determine the values of the STATE and channel-list parameters of the PHY-CCA.indication primitive. |

**7.3.5.11.3 When generated**

***Change section 7.3.5.11.3 as follows:***

For clause 13-21 PHYs, this primitive is generated within aCCATime of the occurrence of a change in the status of the channel(s) from channel idle to channel busy or from channel busy to channel idle, or when the channel-list parameter changes; otherwise this primitive is generated when the status of the channel(s) changes from channel idle to channel busy or from channel busy to channel idle, or when the channel-list parameter changes. This includes the period of time when the PHY is receiving data. Refer to specific PHY clauses for details about CCA behavior for a given PHY.

If the STA is an HT STA and the operating channel width is 20 MHz, the PHY maintains the channel busy

indication until the period indicated by the LENGTH field has expired, where the LENGTH field is

— In a valid SIG field if the format of the PPDU is NON\_HT

— In a valid HT-SIG field if the format of the PPDU is HT\_MF or HT\_GF

If the STA is an HT STA and the operating channel width is 40 MHz, the PHY maintains the channel busy

indication until the period indicated by the LENGTH field has expired, where the LENGTH field is

— In a valid SIG field if the format of the PPDU is NON\_HT and the PPDU is received in the primary

20 MHz channel

— In a valid HT-SIG field if the format of the PPDU is HT\_MF or HT\_GF provided that the PPDU is

either a 20 MHz PPDU received in the primary channel or a 40 MHz PPDU

**22.3.19.5 CCA sensitivity**

**22.3.19.5.1 CCA sensitivity for operating classes requiring CCA-ED**

For the operating classes requiring CCA-Energy Detect (CCA-ED), CCA shall also detect a medium busy

condition when CCA-ED detects a channel busy condition.

For improved spectrum sharing, CCA-ED is required in some bands. The behavior class indicating CCA-ED

is given in Table D-2 (Behavior limit sets). The operating classes requiring the corresponding CCA-ED

behavior class are given in Annex E. A STA that is operating within an operating class that requires CCAED

shall operate with CCA-ED. The CCA-ED shall not be required for license-exempt operation in any

band.

CCA-ED shall indicate a channel busy condition when the received signal strength exceeds the CCA-ED

threshold as given by dot11OFDMEDThreshold for the primary 20 MHz channel and the secondary 20 MHz

channel, dot11OFDMEDThreshold+3 dB for the secondary 40 MHz channel, and

dot11OFDMEDThreshold+6 dB for the secondary 80 MHz channel. The CCA-ED thresholds for the operating

classes requiring CCA-ED are subject to the criteria in D.2.5 (CCA-ED threshold).

NOTE—The requirement to issue a CCA signal busy as stated in 22.3.19.5.2 (CCA sensitivity for signals occupying the

primary 20 MHz channel) and 22.3.19.5.3 (CCA sensitivity for signals not occupying the primary 20 MHz channel) is a

mandatory energy detect requirement on all Clause 22 receivers. Support for CCA-ED is an additional requirement that

relates specifically to the sensitivities described in D.2.5 (CCA-ED threshold).

**22.3.19.5.2 CCA sensitivity for signals occupying the primary 20 MHz channel**

The PHY shall issue a PHY-CCA.indication(BUSY, {primary}) if one of the conditions listed in Table 22-

22 (Conditions for CCA BUSY on the primary 20 MHz) is met in an otherwise idle 20 MHz, 40 MHz, 80

MHz, 160 MHz or 80+80 MHz operating channel width. With >90% probability, the PHY shall detect the

start of a PPDU that occupies at least the primary 20 MHz channel under the conditions listed in Table 22-22

(Conditions for CCA BUSY on the primary 20 MHz) within a period of aCCATime (< 4 μs) and hold the CCA signal busy (PHY\_CCA.indicate(BUSY, channel-list)) for the duration of the PPDU.

The receiver shall issue a PHY-CCA.indication(BUSY, {primary}) for any signal that exceeds a threshold equal to 20 dB above the minimum modulation and coding rate sensitivity (-82 + 20 = -62 dBm) in the primary 20 MHz channel within a period of aCCATime after the signal arrives at the receiver’s antenna(s); then the receiver shall not issue a PHY-CCA.indication(BUSY,{secondary}), PHY-CCA.indication(BUSY,{secondary40}), PHY-CCA.indication(BUSY,{secondary80}) or PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.

**Table 22-22—Conditions for CCA BUSY on the primary 20 MHz**

|  |  |
| --- | --- |
| **Operating Channel** | **Width Conditions** |
| 20 MHz, 40 MHz, 80 MHz, 160 MHz or 80+80 MHz | The start of a 20 MHz NON\_HT format PPDU in the primary 20 MHz channel as defined in 17.3.10.6 (CCA requirements).The start of an HT format PPDU under the conditions defined in 19.3.21.5 (CCA sensitivity).The start of a 20 MHz VHT format PPDU in the primary 20 MHz channel at or above -82 dBm. |
| 40 MHz, 80 MHz, 160 MHz or 80+80 MHz | The start of a 40 MHz NON\_HT duplicate or VHT format PPDU in the primary 40 MHz channel at or above -79 dBm.The start of an HT format PPDU under the conditions defined in 19.3.21.5 (CCA sensitivity). |
| 80 MHz, 160 MHz or 80+80 MHz | The start of an 80 MHz NON\_HT duplicate or VHT format PPDU in the primary 80 MHz channel at or above -76 dBm. |
| 160 MHz or 80+80 MHz  | The start of a 160 MHz or 80+80 MHz NON\_HT duplicate or VHT format PPDU at or above -73 dBm. |

**22.3.19.5.3 CCA sensitivity for signals not occupying the primary 20 MHz channel**

The PHY shall issue a PHY-CCA.indication(BUSY, {secondary}) if the conditions for issuing PHY-CCA.indication(BUSY, {primary}) are not present and one of the following conditions are present in an otherwise

idle 40 MHz, 80 MHz, 160 MHz or 80+80 MHz operating channel width:

— Any signal within the secondary 20 MHz channel at or above a threshold of -62 dBm within a period of aCCATime after the signal arrives at the receiver’s antenna(s); then the PHY shall not issue a PHY-CCA.indication(BUSY,{secondary40}), PHY-CCA.indication(BUSY,{secondary80}) or PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.

— A 20 MHz NON\_HT, HT\_MF, HT\_GF or VHT format PPDU detected in the secondary 20 MHz

channel at or above -72 dBm with >90% probability within a period aCCAMidTime (<25 μs).

The PHY shall issue a PHY-CCA.indication(BUSY, {secondary40}) if the conditions for issuing PHYCCA.

indication(BUSY, {primary}) and PHY-CCA.indication(BUSY, {secondary}) are not present and one

of the following conditions are present in an otherwise idle 80 MHz, 160 MHz or 80+80 MHz operating channel

width:

— Any signal within the secondary 40 MHz channel at or above a threshold of -59 dBm within a period of aCCATime after the signal arrives at the receiver’s antenna(s); then the PHY shall not issue a PHY-CCA.indication(BUSY,{secondary80}) or PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.

— A 40 MHz NON\_HT duplicate, HT\_MF, HT\_GF or VHT format PPDU detected in the secondary

40 MHz channel at or above -72 dBm with >90% probability within a period aCCAMidTime

(<25 μs).

— A 20 MHz NON\_HT, HT\_MF, HT\_GF or VHT format PPDU detected in any 20 MHz sub-channel

of the secondary 40 MHz channel at or above -72 dBm with >90% probability within a period

aCCAMidTime (<25 μs).

The PHY shall issue a PHY-CCA.indication(BUSY, {secondary80}) if the conditions for PHY-CCA.indication(

BUSY, {primary}), PHY-CCA.indication(BUSY, {secondary}) and PHY-CCA.indication(BUSY,

{secondary40}) are not present and one of the following conditions are present in an otherwise idle 160 MHz

or 80+80 MHz operating channel width:

— Any signal within the secondary 80 MHz channel at or above a threshold of -56 dBm within a period of aCCATime after the signal arrives at the receiver’s antenna(s) ; then the PHY shall not issue a PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.

An 80 MHz NON\_HT duplicate or VHT format PPDU detected in the secondary 80 MHz channel at

or above -69 dBm with >90% probability within a period aCCAMidTime (<25 μs).

— A 40 MHz NON\_HT duplicate, HT\_MF, HT\_GF or VHT format PPDU detected in any 40 MHz

sub-channel of the secondary 80 MHz channel at or above -72 dBm with >90% probability within a

period aCCAMidTime (<25 μs).

— A 20 MHz NON\_HT, HT\_MF, HT\_GF or VHT format PPDU detected in any 20 MHz sub-channel

of the secondary 80 MHz channel at or above -72 dBm with >90% probability within a period

aCCAMidTime (<25 μs).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2285 | Fischer, Matthew | 116.00 | 22.2.4 | For non-HT format transmission, scrambler/descrambler should follow the procedure described in Section 17.3.5.5.  | as suggested in comment/explanation. | **Accept in principle. See 11/1128r1** | PHY |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 2433 | 155.44 | 22.3.9 | "MODULATION set to OFDM" but a) there is no MODULATION param (NON\_HT\_MOD?) and b) this means there is no restriction for NON\_HT dup on CSDs | Delete "with the MOD para set to OFDM" | A | Agree in principle but superfluous after changes in 11/1128r1.  |

**Discussion:** Since clause 22.2.4 intersection page 116 has no reference to scrambler/descrambler, in email discussions the commenter expressed a broader concern: namely, carefully defining 40/80/160/80+80 non-HT PPDUs in clause 17/19/22 without creating holes/duplication.

In detail, 22.2.4/5 refers to “behavior” defined by clause 17 yet TX/RX procedures still address clause 17 procedures (if only via a redirect). TX/RX PMD requirements are not well defined for non-HT duplicate. CSDs for HT when transmitted out of 5-8 antennas are bounded in clause 19, but for VHT PHYs we can now explicitly list them. CSDs for greater than 8 antennas are not defined. Fix these issues.

***Change:***

**17.3.9.3 Transmit spectrum mask**

The transmit spectrum mask by regulatory domain is defined in Annex D and Annex E.

NOTE 1—In the presence of additional regulatory restrictions, the device needs to meet both the regulatory requirements and the mask defined here, i.e., its emissions need to be no higher at any frequency offset than the minimum of the values specified in the regulatory and default masks.

NOTE 2- For rules regarding TX center frequency leakage levels by VHT STAs, see section 22.3.18.5.2 (Transmit center frequency leakage).

For operation using 20 MHz channel spacing, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset, and the maximum of –40 dBr and –53 dBm/MHz at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in 17-13 (Transmit spectrum mask for 20 MHz transmission). The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

**17.3.9.7.2 Transmitter center frequency leakage**

For VHT STAs, the requirements on transmitter center frequency leakage are defined in 22.3.18.5.2 (Transmit center frequency leakage); otherwise the requirements are defined in the remainder of this subclause.

Certain transmitter implementations may cause leakage of the center frequency component. Such leakage (which manifests itself in a receiver as energy in the center frequency component) shall not exceed –15 dB relative to overall transmitted power or, equivalently, +2 dB relative to the average energy of the rest of the subcarriers. The data for this test shall be derived from the channel estimation phase.

**19.3.20.1 Transmit spectrum mask**

NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause, i.e., its emissions can be no higher at any frequency offset than the minimum of the values specified in the regulatory and default masks.

NOTE 2—The transmit spectral mask figures in this subclause are not drawn to scale.NOTE 3- For rules regarding TX center frequency leakage levels by VHT STAs, see section 22.3.18.5.2 (Transmit center frequency leakage).

For the 2.4 GHz band, when transmitting in a 20 MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset, and the maximum of –45 dBr and –53 dBm/MHz at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 19-17 (Transmit spectral mask for 20 MHz transmission in the 2.4 GHz band). The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

**19.3.20.7.2 Transmit center frequency leakage**

For VHT STAs, the requirements on transmitter center frequency leakage are defined in 22.3.18.5.2 (Transmit center frequency leakage); otherwise the requirements are defined in the remainder of this subclause.

 The transmitter center frequency leakage shall follow 17.3.9.7.2 (Transmitter center frequency leakage) for all transmissions in a 20 MHz channel width. For transmissions in a 40 MHz channel width, the center frequency leakage shall not exceed –20 dB relative to overall transmitted power, or, equivalently, 0 dB relative to the average energy of the rest of the subcarriers. For upper or lower 20 MHz transmissions in a 40 MHz channel, the center frequency leakage (center of a 40 MHz channel) shall not exceed –17 dB relative to overall transmitted power, or, equivalently, 0 dB relative to the average energy of the rest of the subcarriers. The transmit center frequency leakage is specified per antenna.

**22.2.1 Introduction**

The PHY interfaces to the MAC through an extension of the generic PHY service interface defined in 7.3.4 (Basic service and options). The interface includes the TXVECTOR, RXVECTOR, and PHYCONFIG\_VECTOR parameter lists. The TXVECTOR supplies the PHY with per-packet transmit parameters. Using the RXVECTOR, the PHY informs the MAC of the received packet parameters. Using the PHYCONFIG\_VECTOR, the MAC configures the PHY for operation, independent of frame transmission or reception.

**22.2.4 Support for NON\_HT and HT formats**

**22.2.4.1 General**

A VHT STA logically contains Clause 17, 19 and 22 PHYs. The MAC interfaces to the PHYs via the Clause 22 PHY service interface, which in turn interacts with the Clause 17 and 19 PHY service interfaces as shown in Figure 22-XXNEW.





Figure 22-XXNEW: Interaction of Clause 22 primitives with Clause 17 and 19 primitives.

**22.2.4.2 Support for NON\_HT format when NON\_HT\_MODULATION is OFDM**

When a PHY-TXSTART.request(TXVECTOR) primitive with the FORMAT parameter equal to NON\_HT and the NON\_HT\_MODULATION parameter equal to OFDM is issued, the behavior of the VHT PHY is defined in Clause 17 with additional requirements described in section 22.3.9.1 (Transmission of NON\_HT format PPDUs with more than one antenna) and 22.3.18.5.2 (Transmit center frequency leakage) instead of 17.3.9.7.2 (Transmitter center frequency leakage). The Clause 22 TXVECTOR parameters in Table 22-1 (TXVECTOR and RXVECTOR parameters) are mapped to Clause 17 TXVECTOR parameters in Table 17-1 (TXVECTOR parameters) according to Table 22-2 (Mapping of the VHT PHY parameters for NON\_HT operation), and the Clause 17 PHY-TXSTART.request(TXVECTOR) primitive is issued.

When the VHT PHY receives a Clause 22 PHYCONFIG.request(PHYCONFIG\_VECTOR) primitive, the VHT PHY shall issue a Clause 17 PHYCONFIG.request(PHYCONFIG\_VECTOR) primitive but with the OPERATING\_CHANNEL and CHANNEL\_OFFSET parameters discarded from PHYCONFIG\_VECTOR.

In order to transmit a non-HT PPDU on the primary channel, the MAC shall configure dot11CurrentFrequency to dot11CurrentPrimaryChannel before transmission.

As defined in 22.3.21 PLCP receive procedure, once a PPDU is received and detected as a NON\_HT OFDM PPDU, the behavior of the VHT PHY is defined in Clause 17. The RXVECTOR parameters from the Clause 17 PHY-RXSTART.indication primitive are mapped to the Clause 22 RXVECTOR parameters as defined in Table 22-2

(Mapping of the VHT PHY parameters for NON\_HT operation). VHT PHY parameters not listed in the table are not present.

NOTE – When the FORMAT parameter is set to NON\_HT and the NON\_HT\_MODULATION parameter is set to

NON\_HT\_DUP\_OFDM, the behavior of the VHT PHY is defined in Clause 22.

**Table 22-2—Mapping of the VHT PHY parameters for NON\_HT operation**

|  |  |  |
| --- | --- | --- |
| **VHT PHY Parameter** | **5.0 GHz operation defined by Clause 17** | **Parameter List** |
| L\_LENGTH | LENGTH | TXVECTOR/RXVECTOR |
| L\_DATARATE | DATARATE | TXVECTOR/RXVECTOR |
| TXPWR\_LEVEL | TXPWR\_LEVEL | TXVECTOR |
| RSSI | RSSI | RXVECTOR |
| SERVICE | SERVICE | TXVECTOR/RXVECTOR |
| RCPI | RCPI | RXVECTOR |
| CH\_BANDWIDTH\_IN\_NON\_HT | CH\_BANDWIDTH\_IN\_NON\_HT | TXVECTOR/RXVECTOR |
| DYN\_BANDWIDTH\_IN\_NON\_HT | DYN\_BANDWIDTH\_IN\_NON\_HT | TXVECTOR/RXVECTOR |
| OPERATING\_CHANNEL | Discarded1 | PHYCONFIG\_VECTOR |
| CHANNEL\_OFFSET | Discarded1 | PHYCONFIG\_VECTOR |
| 1fc in equation (17-1) is set from dot11CurrentFrequency |

**22.2.4.3 Support for HT formats**

When a PHY-TXSTART.request(TXVECTOR) primitive with the FORMAT parameter equal to HT\_MF or HT\_GF, the behavior of the PHY is defined in Clause 19 with the additional requirements defined in section 22.3.9.2 (Transmission of HT format PPDUs with more than four antennas) and 22.3.18.5.2 (Transmit center frequency leakage) instead of 19.3.20.4 (Transmit center frequency tolerance). The Clause 22 TXVECTOR parameters in Table 22-1 (TXVECTOR and RXVECTOR parameters) are mapped directly to the Clause 19 TXVECTOR parameters in Table 19-1 (TXVECTOR and RXVECTOR parameters), and the Clause 19 PHY-TXSTART.request(TXVECTOR) primitive is issued.

When the VHT PHY receives a Clause 22 PHYCONFIG.request(PHYCONFIG\_VECTOR) primitive, the VHT PHY shall issue a Clause 19 PHYCONFIG.request(PHYCONFIG\_VECTOR) primitive but with the OPERATING\_CHANNEL parameter set to min(40 MHz, dot11CurrentChannelBandwidth) and the CHANNEL\_OFFSET parameter set to CH\_OFFSET\_NONE if dot11CurrentChannelBandwidth is CBW20, to CH\_OFFSET\_ABOVE if fP20,idx > fS20,idx , or to CH\_OFFSET\_BELOW if fP20,idx < fS20,idx,. In order to transmit a CBW40 HT PPDU, the MAC shall configure dot11CurrentSecondaryChannel to fS20,idx. The quantities fP20,idx and fS20,idx are defined in 22.2.3 (Effects of CH\_BANDWIDTH parameter on PPDU format).

As defined in 22.3.21 PLCP receive procedure, once a PPDU is received and detected as an HT\_MF or HT\_GF format PPDU is received, the behavior of the VHT PHY is defined in Clause 19. The RXVECTOR parameters in Table 19-1 (TXVECTOR and RXVECTOR parameters) from the Clause 19 PHY-RXSTART.indication primitive are mapped directly to the RXVECTOR parameters in Table 22-1 (TXVECTOR and RXVECTOR parameters) and a Clause 22 PHY-RXSTART.indication primitive is issued.

**22.3.8.1.1 Cyclic shift definition**

The cyclic shift value for the L-STF, L-LTF, L-SIG and VHT-SIG-A fields of the packet for transmitter

out of total are defined in Table 22-8 (Cyclic shift values for L-STF, L-LTF, L-SIG and VHT-SIGA

fields of the packet).

**Table 22-8—Cyclic shift values for L-STF, L-LTF, L-SIG and VHT-SIG-A fields of the packet**



***TGac Editor: add a new RHS column with first cell merged to existing immediate-LHS cell, second cell merged to existing immediate-LHS cell, third cell containing “>8”, fourth-eleventh cell set to “-” then insert the following as a new row at the end of the above table.***

***Note to reader We’re adding a new row instead of just text in the section like 11n since 22.3.9.1 and 22.3.9.2 refer to this table not the containing section***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| >8 | 0 | -175 | -150 | -125 | -25 | -100 | -50 | -200 | Between -200 and 0 ns inclusive |

**22.3.9 Transmission of NON\_HT and HT format PPDUs with more antennas**

**22.3.9.1 Transmission of 20 MHz NON\_HT format PPDUs with more than one antenna**

When a VHT STA transmits a NON\_HT format PPDU with the MODULATION parameter set to OFDM the STA shall apply the cyclic shifts defined in Table 22-8 (Cyclic shift values for L-STF, L-LTF, L-SIG and VHTSIG-A fields of the packet).

**22.3.9.2 Transmission of HT format PPDUs with more than four antennas**

When a VHT STA transmits an HT\_MF format PPDU, the STA shall apply the cyclic shifts defined in Table 22-8 (Cyclic shift values for L-STF, L-LTF, L-SIG and VHTSIG-A fields of the packet) for the non-HT portion of the PPDU, including the HT-SIG field.

**22.3.10.12 Non-HT duplicate transmission**

When the TXVECTOR parameter FORMAT is set to NON\_HT and the TXVECTOR parameter NON\_HT\_MODULATION is set to NON\_HT\_DUP\_OFDM, the transmitted PPDU shall be a non-HT duplicate. Non-HT duplicate transmission is used to transmit to non-HT OFDM STAs, HT STAs, or VHT STAs that may be present in a part of a 40 MHz, 80 MHz or 160 MHz channel. The VHT-SIG-A, VHT-STF, VHTLTF and VHT-SIG-B fields are not transmitted. The L-STF, L-LTF, and L-SIG fields shall be transmitted in the same way as in the VHT transmission, with the exceptions for the Rate and Length fields listed in 22.3.8.1.4 (L-SIG definition in the L-SIG).

Dk,n is Dk,n is defined to be *dk,n* in 17.3.5.10 (OFDM modulation)

**22.3.18.1 Transmit spectrum mask**

For VHT transmissions using a 20 MHz channel

the transmit spectrum shall have a 0 dBr (dB relative to the maximum

spectral density of the signal) bandwidth not exceeding 18 MHz, -20 dBr at 11 MHz frequency offset,

-28 dBr at 20 MHz frequency offset and the maximum of -40 dBr and -53 dBm/MHz at 30 MHz frequency

offset and above. The spectral density of the transmitted signal shall fall within the spectral mask shown in

Figure 22-16.

For non-HT duplicate or VHT transmissions using a 40 MHz channel, the transmit spectrum shall have a 0 dBr (dB relative to the maximum

spectral density of the signal) bandwidth not exceeding 38 MHz, -20 dBr at 21 MHz frequency offset,

-28 dBr at 40 MHz frequency offset and the maximum of -40 dBr and -56 dBm/MHz at 60 MHz frequency

offset and above. The spectral density of the transmitted signal shall fall within the spectral mask shown in

Figure 22-17.

For non-HT duplicate or VHT transmissions using an 80 MHz channel, the transmit spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 78 MHz, -20 dBr at 41 MHz frequency offset,

-28 dBr at 80 MHz frequency offset and the maximum of -40 dBr and -59 dBm/MHz at 120 MHz frequency

offset and above. The spectral density of the transmitted signal shall fall within the spectral mask shown in

Figure 22-18.

For non-HT duplicate or VHT transmissions using a 160 MHz channel, the transmit spectrum shall have a 0 dBr (dB relative to the maximum

spectral density of the signal) bandwidth not exceeding 158 MHz, -20 dBr at 81 MHz frequency offset,

-28 dBr at 160 MHz frequency offset and the maximum of -40 dBr and -59 dBm/MHz at 240 MHz frequency

offset and above. The spectral density of the transmitted signal shall fall within the spectral mask shown in

Figure 22-19.

**22.3.18.2 Spectral flatness**

In a contiguous non-HT duplicate or VHT transmission having a bandwidth listed in Table 22-19 (Maximum transmit spectral flatness

deviations), of each of the subcarriers with indices listed as tested subcarrier indices shall not deviate

by more than the specified maximum deviation in Table 22-19 (Maximum transmit spectral flatness deviations)

from the average of over subcarrier indices listed as averaging subcarrier indices. Averaging of

is done in the linear domain.

**22.3.18.5.2 Transmit center frequency leakage**

TX LO leakage shall meet the following requirements for all formats and bandwidths except non-contiguous 80+80MHz:

**22.3.18.5.3 Transmitter constellation error**

The relative constellation RMS error, calculated by first averaging over subcarriers, frequency segments,

OFDM frames and spatial streams (see Equation (19-89)) shall not exceed a data-rate dependent value according

to Table 22-20 (Allowed relative constellation error versus constellation size and coding rate). The

number of spatial streams under test shall be equal to the number of utilized transmitting STA antenna (output)

ports and also equal to the number of utilized testing instrumentation input ports. In the test, NSS=NSTS

(no STBC) shall be used. Each output port of the transmitting STA shall be connected through a cable to one

input port of the testing instrumentation. The requirements apply to 20, 40, 80 and 160 MHz VHT continuous transmissions,

as well as non-contiguous 80+80 MHz transmissions.

For non-HT duplicate transmissions, requirements defined in 17.3.9.7.4 (Transmitter constellation error) apply to each 20 MHz subchannel.

**22.3.18.5.4 Transmitter modulation accuracy (EVM) test**

The transmit modulation accuracy test shall be performed by instrumentation capable of converting the transmitted

signals into a streams of complex samples at sampling rate greater than or equal to the bandwidth of

the signal being transmitted; excepting that a) for non-HT duplicate transmissions, each 20 MHz subchannel may be tested independently while all subchannels are being transmitted and b) for non-contiguous transmissions, each frequency segment may

be tested independently while both segments are being transmitted. In this case, transmit modulation accuracy

of each segment shall meet the required value in Table 22-20 (Allowed relative constellation error versus constellation

size and coding rate) using only the subcarriers within the corresponding segment.

***Note to reader: On the receive side, non-HT duplicate PPDUs may be processed as if they are non-HT OFDM PPDUs, so no special PMD RX requirements are needed since the clause 17 behavior is inherited when clause 22RX procedure refers to clause 17 for all NON-HT behavior.***

***Note to editor: CID 2483 may lead to changes nearby this change text. If 2483 includes the word “PPDU” or “PPDUs” as per CID 2483’s proposed resolution, then change PPDU[s] to VHT PPDU[s] instead of the indicated changes below***

**22.3.19.1 Receiver minimum input sensitivity**

The packet error rate (PER) shall be less than 10% for a PSDU length of 4096 octets with the rate-dependent

input levels listed in Table 22-21 (Receiver minimum input level sensitivity). The test in this subclause and

the minimum sensitivity levels specified in Table 22-21 (Receiver minimum input level sensitivity) only ap-

ply to non-STBC modes, 800 ns GI, BCC and VHT PPDUs.

**22.3.19.2 Adjacent channel rejection**

The test in this subclause and the adjacent sensitivity levels specified in Table 22-22 (Minimum required adjacent

and nonadjacent channel rejection levels) only apply to non-STBC modes, 800 ns GI, BCC and VHT PPDUs.

**22.3.19.3 Nonadjacent channel rejection**

The test in this subclause and the nonadjacent sensitivity levels specified in Table 22-22 (Minimum required adjacent

and nonadjacent channel rejection levels) only apply to non-STBC modes, 800 ns GI, BCC and VHT PPDUs.

**22.3.19.4 Receiver maximum input level**

The receiver shall provide a maximum PER of 10% at a PSDU length of 4096 octets, for a maximum input

level of –30 dBm, measured at each antenna for any baseband VHT modulation.

**22.3.20 PLCP transmit procedure**

***Note to editor: Using 11/927r1 as the baseline***

There are two paths for transmit PLCP procedure.

* The first path, for which typical transmit procedures are shown in Figure 22-21, is selected if the FORMAT field of PHY-TXSTART.request(TXVECTOR) is set to VHT. These transmit procedures do not describe the operation of optional features, such as LDPC or STBC.
* The second path is to follow the transmit procedure in Clause 17 if the FORMAT field of PHY-TXSTART.request(TXVECTOR) is set to NON\_HT and the NON\_HT\_MODULATION parameter is set to NON\_HT\_DUP\_OFDM, except that the signal referred to in Clause 17 is instead generated simultaneously on each of the 20 MHz channels that are indicated by the CH\_BANDWIDTH parameter as defined in 22.3.8 (VHT preamble) and 22.3.10.12 (Non-HT duplicate transmission).

Note: For the transmit procedure for NON\_HT format where NON\_HT\_MODULATION is OFDM, see 22.2.4.2 (Support for NON\_HT formats when NON\_HT\_MODULATION is OFDM). For the transmit procedure for HT\_MF and HT\_GF formats, see 22.2.4.3 (Support for HT formats).

**22.6.5.14 PMD\_CBW.indication**

**22.6.5.14.1 Function**

This primitive, generated by the PMD sublayer, provides the bandwidth of the received PPDU to the PLCP and MAC entity.

Note: The bandwidth is typically determined from the PLCP header of HT\_GF (if supported), HT\_MF, and VHT format PPDUs, and by estimation for HT\_GF (if unsupported) and NON\_HT format PPDUs.

**22.6.5.14.2 Semantics of the service primitive**

This primitive shall provide the following parameter: PMD\_CBW.indication(CH\_BANDWIDTH)

CH\_BANDWIDTH represents the channel width (CBW20, CBW40, CBW80, CBW160 or CBW80+80 for 20 MHz, 40 MHz, 80 MHz, 160 MHz or 80+80 MHz respectively) in which the data are transmitted.

**22.6.5.14.3 When generated**

This primitive shall be generated by the PMD when the VHT PHY is in the receive state. This primitive shall be

available continuously to the PLCP that, in turn, shall provide the information to the MAC entity via the CH\_BANDWIDTH parameter and (for NON\_HT format PPDUs) the NON\_HT\_MODULATION parameter.

**22.6.5.14.4 Effect of receipt**

The PLCP sublayer passes the data to the MAC sublayer as part of the RXVECTOR.

**TGac editor: 11/987r2 makes the following changes**

**TGac editor: modify D1.0 P117L4, as follows**

The NON\_HT\_DUP\_OFDM and CH\_BANDWIDTH parameters in the RXVECTOR can be set by the PMD\_NON\_HT\_CH\_BANDWIDTH primitive as in 22.6.

**Assuming those changes, make the following further changes**

The NON\_HT\_MODULATION and CH\_BANDWIDTH parameters in the RXVECTOR can be set by the PMD\_CBW primitive as in 22.6.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2361 | Hart, Brian | 112.37 | 22.2.2 | This seems to be an abuse of "LENGTH". Historically, "LENGTH" meant "LENGTH" = #PSDU octets, and various perversions of it (e.g "L\_LENGTH") were assigned different names. This creates problems: e.g. 22.3.4.8.2 P127L40 refers to "LENGTH" but likely means "PSDU\_LENGTH" | Recommend moving existing PSDU\_LENGTH/VHT to LENGTH/VHT, and renaming existing LENGTH/VHT into SIGB\_LENGTH/VHT. Update language and equations appropriately. Check/fix 22.3.4.8.2 P127L40. ALso P159L35 2x, P158L62 etc | **Accept in principle. See 11/1128r1** | PHY |

***Discussion:*** In 11a/b/g/n, “LENGTH” exactly defines the duration of the PPDU and is added unchanged to the PLCP header (albeit with different units in 11b vs 11a/g/n). Here we are using LENGTH for a parameter that is not placed into the PLCP header unchanged, nor does it exactly define the duration of the PPDU. So naming this parameter “LENGTH” is potentially misleading. Let’s call it APEP\_LENGTH (for AMPDU Pre-EOF Padding)

At the same time “PSDU\_LENGTH” is not transmitted at all in the PLCP header, so calling it “LENGTH” is not so great either. So leave PSDU\_LENGTH unchanged.

***Change wrt D1.1 (D1.1 is used for this change only to minimize the number of exceptions):***

***Apply the following changes only after 11/986r1 is applied:***

***First, change all instances of the case sensitive whole word “LENGTH” to “APEP\_LENGTH” (with or without subscripts; leaving subscripts unchanged) with the following bolded exceptions:***

9.30.1 NDP rules

An RXVECTOR **LENGTH** parameter equal to 0 indicates that the PPDU is an HT NDP.

9.30.2 Transmission of an HT NDP

A STA that transmits an HT NDP shall set the **LENGTH**, SOUNDING, STBC, MCS, and NUM\_EXTEN\_SS

parameters of the TXVECTOR as specified in this subclause.

— **LENGTH** shall be set to 0.

Table 22-3—Mapping of the VHT PHY parameters for NON\_HT operation

|  |  |
| --- | --- |
| VHT PHY Parameter | 5.0 GHz operation defined by Clause 17 |
| L\_LENGTH  | **LENGTH** |

22.3.8.1.4 L-SIG definition

A STA shall not transmit a VHT PPDU if the Length value calculated using Equation (22-20) exceeds 4095 octets. The LSB of the binary expression of the Length value shall be mapped to B5. In a non-HT duplicate PPDU, the Length field is defined in 17.3.4.3 (PLCP **LENGTH** field) using th L\_LENGTH parameter in the TXVECTOR.(#2457)

***Then make the following changes as shown below***

Table 22-1—TXVECTOR and RXVECTOR parameters (continued)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| LENGTH | FORMAT is HT\_MF or HT\_GF | Indicates the length of an HT PSDU in the range of 0 to 65 535 octets. A value of zero indicates an NDP that contains no data symbols after the HT preamble (see 19.3.9 (HT preamble)). | Y  | Y |
|  | ***Define this cell as cell A. Move its contents to cell B. Then delete this row entirely(handled under “otherwise”)*** |  |  |
| Otherwise  | Not present  | N  | N |
| APEP\_LENGTH3 | FORMAT is VHT | ***Cell B*** | MU | O |
| Otherwise | Not present | N | N |
| NOTE 3 – APEP denotes “A-MPDU Pre-EOF Padding” |

***Change (wrt D1.1)***



 APEP\_LENGTH is defined in Table 22-1 (TXVECTOR and RXVECTOR parameters).

***Editorially correct any instances of LENGTH that refer to VHT (i.e. not non-HT or HT) introduced by parallel text changes to APEP\_LENGTH***