IEEE P802.11
Wireless LANs

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| Delete the PMD (Comment Resolution for D3.0) |
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Abstract

This document provides resolutions for CIDs: 6442, 6206

The approach to resolving these CIDS is to delete the PLCP/PMD interface.

**Introduction**

This submission resolves two CIDs and general confusion about the PLCP/PMD split by effectively deleting the PLCP/PMD interface. The rationale is that this is a completely imaginary and useless interface and there are no devices that split their PHY in such a manner. In fact, the MAC is perceived by many in two halves (“upper” and “lower”), but such an architectural split is not in the standard.

The approach taken is to delete the clause 22.6 (VHT PMD sublayer) and any reference to PMD, and to try to convert most uses of PLCP to PHY. Some uses of PLCP cannot be avoided until the entire baseline is scrubbed. For example, PPDU stands for PLCP PDU and PSDU stands for PLCP SDU, and for now the definitions of the PPDU and PSDU will remain unchanged. In the future, we could simply change the definition of PPDU from PLCP PDU to PHY PDU in the 802.11-2012 baseline and leave the acronym unchanged.

In the 802.11-2012 baseline there is still use of PLCP/PMD, since all other PHYs still have such an interface. Occurrences that relate specifically to VHT have for the most part been modified to avoid the PLCP/PMD interface.

**Comments:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Page** | **Clause** | **Comment** | **Proposed Change** | **Resn Status** | **Resolution** |
| 6442 | 180.05 | 22 | Analysis performed as a result of D2.0 comments has revealed that the PMD/PLCP split is unworkable as presented (see e.g. 503r4) | Delineate the responsibilities of the PMD and the PLCP, and then fix the PLCP-PMD SAP | Revised | Revised. PLPC/PMD interface deleted. See changes to the TGac D3.0 in 12/1009r3. |
| 6206 | 195.01 | 22.3 | PMD interface needs work (or deletion) | PLCP and PMD are in same section labelled "VHT PLCP sublayer"; TX diagrams in 22.3.3 don't distinguish PLCP from PMD, etc etc. Also, PPDU is used when a term that includes the preamble is really needed ... ultimately we don't use the PMD very much, and it could be OK to just define the terms PPDU and PhyPDU (and swap some PPDUs -> PhyPDUs) | Revised | Revised. PLPC/PMD interface deleted. See changes to the TGac D3.0 in 12/1009r3. |

**List of Modified Clauses in TGac D3.0**

* **8**
* **22.1.2**
* **22.1.3**
* **22.2.2**
* **22.3**
* **22.4.4**
* **22.6**

**Clause 8 Frame Formats**

**TGac editor: modify TGac D3.0 Table 8-0a as follows:**

NOTE 6—No direct constraint on the maximum duration, but an L\_LENGTH value above 2332 might not be supported by some receivers (see last NOTE in 9.23.4)

**Clause 22.1.2 Scope**

**TGac editor: modify TGac D3.0 P180L2-P181L11 as follows:**

**22.1.2 Scope**

The services provided to the MAC by the VHT PHY consist of the following protocol functions:

a) A function that defines a method of mapping the PSDUs into a framing format (PPDU)

suitable for sending and receiving PSDUs between two or more STAs.

b) A function that defines the characteristics and method of transmitting and receiving

data through a wireless medium between two or more STAs. Depending on the PPDU format, these

STAs support a mixture of VHT, Clause 20 (High Throughput (HT) PHY specification) and Clause

18 (Orthogonal frequency division multiplexing (OFDM) PHY specification) PHYs.

**Clause 22.1.3 VHT PHY Functions**

**TGac editor: modify TGac D3.0 P181L13-41 as follows and renumber appropriately:**

**22.1.3 VHT PHY functions**

**22.1.3.1 General**

The VHT PHY contains two functional entities: the PHY and the physical layer management function (i.e., the PLME). Both of these functions are described in detail in 22.3 (VHT sublayer) and 22.4 (VHT PLME).

The VHT PHY service is provided to the MAC through the PHY service primitives defined in Clause 7

(PHY service specification). The VHT PHY service interface is described in 22.2 (VHT PHY service interface).

**Clause 22.2.2 TXVECTOR and RXVECTOR parameters**

**TGac editor: modify TGac D3.0 Table 22-1 as follows:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Condition** | **Value** | **TXVECTOR** | **RXVECTOR** |
| … |  |  |  |  |
| TIME\_OF\_DEPARTURE\_REQUESTED |  | Boolean value:True indicates that the MAC entity requests that the PHYentity measures and reports time of departure parameters corresponding to the time when the first PPDU energy is sent by the transmitting port.False indicates that the MAC entity requests that the PHYentity neither measures nor reports time of departure parameters.  | O | N |
| … |  |  |  |  |

**Clause 22.3 VHT PLCP sublayer**

**TGac editor: modify TGac D3.0 P195L1-17 as follows:**

**22.3 VHT PHY layer**

**22.3.1 Introduction**

This subclause provides a procedure in which PSDUs are converted to and from PPDUs.

During transmission, a PSDU (in the SU case) or multiple PSDUs (in the MU case) are processed (i.e., scrambled

and coded) and appended to the PHY preamble to create the PPDU. At the receiver, the PHY preamble is processed to aid in demodulation and delivery of the PSDU.

**22.3.2 VHT PPDU format**

A single PPDU format is defined for this PHY: the VHT PPDU format. Figure 22-4 shows the VHT PPDU

format

**TGac editor: modify TGac D3.0 P203L46 as follows:**

**22.3.4.4 Construction of L-SIG**

b) BCC Encoder: Encode the L-SIG symbol of the PHY header by a convolutional encoder at the rate of R=1/2 as described in 22.3.10.5.3 (Binary convolutional coding and puncturing).

**TGac editor: modify TGac D3.0 P216L25 as follows:**

**22.3.7 Mathematical description of signals**

**Table 22-8—Tone scaling factor and guard interval duration values for PHY fields**

**TGac editor: modify TGac D3.0 P263L53-65 as follows:**

**22.3.13 Regulatory requirements**

Wireless LANs (WLANs) implemented in accordance with this standard are subject to equipment certification

and operating requirements established by regional and national regulatory administrations. The PHY

specification establishes minimum technical requirements for interoperability, based upon established regulations

at the time this standard was issued. These regulations are subject to revision or may be superseded.

Requirements that are subject to local geographic regulations are annotated within the PHY specification.

Regulatory requirements that do not affect interoperability are not addressed in this standard. Implementers

are referred to the regulatory sources in Annex D for further information. Operation in countries within

defined regulatory domains may be subject to additional or alternative national regulations.

**TGac editor: modify TGac D3.0 P265L50 as follows:**

**22.3.18 VHT transmit specification**

**TGac editor: modify TGac D3.0 P273L18 as follows:**

**22.3.19 VHT receiver specification**

**TGac editor: modify TGac D3.0 P277L60-65 as follows:**

**22.3.19.6 RSSI**

The RSSI parameter returned in the RXVECTOR shall be calculated during the reception of the VHT-LTFs and shall be a monotonically increasing function of the received power.

**TGac editor: modify TGac D3.0 P278L1-P279L15 as follows:**

**22.3.20 PHY transmit procedure**

There are two paths for transmit PHY procedure:

— The first path, for which typical transmit procedures are shown in Figure 22-32, is selected if the

FORMAT parameter of the PHY-TXSTART.request(TXVECTOR) primitive is VHT. These transmit

procedures do not describe the operation of optional features, such as LDPC, STBC or MU.

— The second path is to follow the transmit procedure in Clause 18 if the FORMAT parameter of the

PHY-TXSTART.request(TXVECTOR) primitive is NON\_HT and the NON\_HT\_MODULATION

parameter is set to NON\_HT\_DUP\_OFDM except that the signal referred to in Clause 18 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 1—for MU the A-MPDU is per user in the MAC sublayer; and the VHT Training Symbols, VHT-SIG-B, and Data are per user in

the PHY layer in Figure 22-32.

NOTE 2—For the transmit procedure for NON\_HT format where NON\_HT\_MODULATION is OFDM, see 22.2.4.2

(Support for NON\_HT format 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).

In both paths, in order to transmit data, the MAC generates a PHY-TXSTART.request primitive, which

causes the PHY entity to enter the transmit state. Further, the PHY is set to operate at the appropriate frequency

through station management via the PLME, as specified in 22.4 (VHT PLME). Other transmit parameters,

such as MCS Coding types and transmit power, are set via the PHY-SAP using the PHY-TXSTART.request(

TXVECTOR) primitive, as described in 22.2.2 (TXVECTOR and RXVECTOR parameters). The remainder

of the clause applies to the first path.

The PHY indicates the state of the primary channel and other channels (if any) via the PHY-CCA.indication

primitive (see 22.3.19.5 (CCA sensitivity) and 7.3.5.11 (PHY-CCA.indication)). Note that under some circumstances, the MAC uses the value of the PHY-CCA.indication primitive before (and if) issuing the PHYTXSTART.request primitive. Transmission of the PPDU shall be initiated by the PHY after receiving the

PHYTXSTART.request(TXVECTOR) primitive. The TXVECTOR elements for the PHY-TXSTART.request

primitive are specified in Table 22-1 (TXVECTOR and RXVECTOR parameters).

After the PHY preamble transmission

is started, the PHY entity immediately initiates data scrambling and data encoding. The encoding method

for the Data field is based on the FEC\_CODING, CH\_BANDWIDTH, NUM\_STS, STBC, MCS, and

NUM\_USERS parameter of the TXVECTOR, as described in 22.3.2 (VHT PPDU format).

The SERVICE field and PSDU are encoded as described in 22.3.3 (Transmitter block diagram). The data

shall be exchanged between the MAC and the PHY through a series of PHY-DATA.request(DATA) primitives

issued by the MAC, and PHY-DATA.confirm primitives issued by the PHY. Zero to seven PHY padding

bits are appended to the PSDU to make the number of bits in the coded PSDU length an

integral multiple of the number of OFDM symbols.

Transmission can be prematurely terminated by the MAC through the primitive PHY-TXEND.request.

PSDU transmission is terminated by receiving a PHY-TXEND.request primitive. Each PHY-TXEND.request is acknowledged with a PHY-TXEND.confirm primitive from the PHY. In an SU transmission, normal

termination occurs after the transmission of the final bit of the last PSDU octet, according to the number of

OFDM symbols indicated supplied in the N\_SYM field.

When the PPDU transmission is completed the PHY entity enters the receive state.

In the PHY, the GI or short GI is inserted in every data OFDM symbol as a countermeasure against delay

spread.

A typical state machine implementation of the transmit PHY for an SU transmission is provided in

Figure 22-33. Request (.request) and confirmation (.confirm) primitives are issued once per state as shown.

This state machine does not describe the operation of optional features, such as multi-user, LDPC or STBC.

**Figure 22-32—PHY transmit procedure for an SU transmission**



**Figure 22-33—PHY transmit state machine for an SU transmission**



**TGac editor: modify TGac D3.0 P281L1-P282L10 as follows:**

**22.3.21 PHY receive procedure**

A typical PHY receive procedure is shown in Figure 22-34 for VHT format. A typical state machine implementation of the receive PHY is given in Figure 22-35. This receive procedure and state machine do not describe the operation of optional features, such as LDPC, STBC or partial AID. If the detected format indicates

a NON\_HT PPDU, refer to the receive procedure and state machine in Clause 18. If the detected format indicates

an HT PPDU format, refer to the receive procedure and state machine in Clause 20. Further, through

station management (via the PLME) the PHY is set to the appropriate frequency, as specified in 22.4 (VHT

PLME). The PHY has also been configured with group information (i.e., group membership and position in

group) so that it can receive data intended for the STA. Other receive parameters, such as RSSI and indicated

DATARATE, may be accessed via the PHY-SAP.

Upon receiving the transmitted PHY preamble, the PHY measures a receive signal strength. This activity is indicated by the PHY to the MAC via a PHY-CCA.indication primitive. A PHY-CCA.indication(BUSY, channel-list) primitive is also issued as an initial indication of reception of a signal as specified in 22.3.19.5 (CCA sensitivity). The channel-list parameter of the PHY-CCA.indication primitive is absent when the operating channel width is 20 MHz. The channel-list parameter is present and includes the element “primary” when the operating channel width is 40 MHz, 80 MHz, 160 MHz or

80+80 MHz.

The PHY shall not issue a PHY-RXSTART.indication primitive in response to a PPDU that does not overlap

the primary 20MHz channel.

The PHY

includes the most recently measured RSSI value in the PHY-RXSTART.indication(RXVECTOR) primitive issued to the MAC.

After the PHY-CCA.indication(BUSY, channel-list) is issued, the PHY entity shall begin receiving the training

symbols and searching for L-SIG in order to set the maximum duration of the data stream. If the check of

the L-SIG parity bit is not valid, a PHY-RXSTART.indication primitive is not issued, and instead the PHY

shall issue the error condition PHY-RXEND.indication(FormatViolation) primitive. If a valid L-SIG parity

bit is indicated, the VHT PHY shall maintain PHY-CCA.indication(BUSY, channel-list) for the predicted duration

of the transmitted PPDU, as defined by RXTIME in Equation (22-104), for all supported modes, unsupported

modes, Reserved VHT-SIG-A Indication, invalid VHT-SIG-A CRC and invalid L-SIG Length

field value. An invalid L-SIG Length field value is defined as a value not following Equation (22-20). Reserved

VHT-SIG-A Indication is defined as a VHT-SIG-A with Reserved bits equal to 0 or MU[*u*] NSTS

fields (*u* = 0, 1, 2, 3) set to 5-7 or Short GI field set to 0 and Short GI NSYM Disambiguation field set to 1,

or a combination of MCS and NSTS not included in 22.5 (Parameters for VHT MCSs) or any other VHT-SIGA

field bit combinations that do not correspond to modes of PHY operation defined in Clause 22. If the VHTSIG-

A indicates an unsupported mode, the PHY shall issue PHY-RXEND.indication(UnsupportedRate). If

the VHT-SIG-A indicates an invalid CRC or Reserved VHT-SIG-A Indication or if the L-SIG Length field

is invalid, the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation).

After receiving a valid L-SIG and VHT-SIG-A indicating a supported mode, the PHY entity shall begin receiving

the VHT training symbols and VHT-SIG-B. If the received group ID in VHT-SIG-A has a value indicating

an SU PPDU (see 9.17a (Group ID and partial AID in VHT PPDUs)), the PHY entity may choose

not to decode VHT-SIG-B. If VHT-SIG-B is not decoded, subsequent to an indication of a valid VHT-SIGA

CRC, a PHY-RXSTART.indication(RXVECTOR) primitive shall be issued. The RXVECTOR associated

with this primitive includes the parameters specified in Table 22-1 (TXVECTOR and RXVECTOR parameters).

If the Group ID field in VHT-SIG-A has a value indicating an MU PPDU (see 9.17a (Group ID and partial

AID in VHT PPDUs)), the PHY shall decode VHT-SIG-B. If the VHT-SIG-B indicates an unsupported

mode, the PHY shall issue the error condition PHY-RXEND.indication(UnsupportedRate) primitive.

If VHT-SIG-B was decoded the PHY may check the VHT-SIG-B CRC in the SERVICE field. If the VHTSIG-

B CRC in the SERVICE field is not checked a PHY-RXSTART.indication(RXVECTOR) primitive

shall be issued. The RXVECTOR associated with this primitive includes the parameters specified in

Table 22-1 (TXVECTOR and RXVECTOR parameters).

Following training and signal fields, the Data field shall be received. The number of symbols in the Data field is determined by

Equation (22-103).

**Figure 22-34—PHY receive procedure**



**Figure 22-35—PHY receive state machine**



**Clause 22.4.4 PHY characteristics (see changes to 802.11-2012 Clause 6.5)**

**Clause 22.6 VHT PMD sublayer**

**TGac editor: delete TGac D3.0 Clause 22.6 and all subsclauses (e.g. 22.6.1, 22.6.2, 22.6.3, 22.6.4, 22.6.5)**

**List of Modified Clauses in 802.11-2012**

* **4.9**
* **6.1**
* **6.5**
* **7**
* **8**
* **9**
* **Annex T**

**Clause 4.9 Reference Model**

**TGac editor: modify 802.11-2012 Clause 4.9.1 as follows:**

**4.9 Reference model**

**4.9.1 General**

This standard presents the architectural view, emphasizing the separation of the system into two major parts:

the MAC of the data link layer (DLL) and the PHY. These layers are intended to correspond closely to the

lowest layers of the ISO/IEC basic reference model of Open Systems Interconnection (OSI) (ISO/IEC 7498-

1: 1994). The layers and sublayers described in this standard are shown in Figure 4-14.



The description of the VHT PHY in Clause 22 is provided as one layer and is not separated into PLCP and PMD sublayers.

**Clause 6 Overview of management model**

**TGac editor: modify 802.11-2012 Clause 6.1 as follows:**

**6. Layer management**

**6.1 Overview of management model**

Both the MAC sublayer and PHY conceptually include management entities, called MLME and PLME,

respectively. These entities provide the layer management service interfaces through which layer

management functions are invoked.

In order to provide correct MAC operation, an SME is present within each STA. The SME is a layerindependent

entity that resides in a separate management plane or resides “off to the side.” Some of the

functions of the SME are specified in this standard. Typically this entity is responsible for such functions as

the gathering of layer-dependent status from the various layer management entities (LMEs), and similarly

setting the value of layer-specific parameters. The SME would typically perform such functions on behalf of

general system management entities and would implement standard management protocols. Figure 4-14 (in

4.9) depicts the relationship among management entities.

The various entities within this model interact in various ways. Certain of these interactions are defined

explicitly within this standard, via a SAP across which defined primitives are exchanged. This definition

includes the GET and SET operations between MLME, PLME and SME as well as other individually

defined service primitives, represented as double arrows within Figure 6-1. Other interactions are not

defined explicitly within this standard, such as the interfaces between the MAC and MLME and between the

PLME and PLCP and PMD; the specific manner in which these MAC and PHY LMEs are integrated into

the overall MAC sublayer and PHY is not specified within this standard.

The description of the VHT PHY in Clause 22 is provided as one layer and is not separated into PLCP and PMD sublayers.



**Clause 6.5 PLME SAP interface**

**TGac editor: modify 802.11-2012 Clause 6.5 as follows:**

**6.5 PLME SAP interface**

**6.5.4 PLME-CHARACTERISTICS.confirm**

**6.5.4.2 Semantics of the service primitive**

The primitive provides the following parameters:

PLME-CHARACTERISTICS.confirm(aSlotTime…, aTxPHYDelay, aRxPHYDelay, aTxPHYTxStartRFDelay, aTxPHYTxStartRMS)

The values assigned to the parameters is as specified in the PLME SAP interface specification contained

within each PHY subclass of this standard. The parameter aMPDUDurationFactor is not used by all PHYs

defined within this standard. The parameters aSignalExtension, aRIFSTime, aSymbolLength,

aSTFOneLength, aSTFTwoLength, aLTFOneLength, aLTFTwoLength, aPLCPSigTwoLength,

aPLCPServiceLength, aPLCPConvolutionalTailLength, aMPDUDurationFactor, aMPDUMaxLength,

aPSDUMaxLength, aPPDUMaxTime, aIUSTime, aDTT2UTTTime, and aMaxCSIMatricesReportDelay are

not used by all PHYs defined within this standard. The parameters aTxPLCPDelay**,** aRxPLCPDelay, aTxRFDelay, aRxRFDelay, aTxPHYDelay, aRxPHYDelay, aTxPmdTxStartRFDelay, aTxPmdTxStartRMS, aTxPHYTxStartRFDelay, and aTxPHYTxStartRMS are not used by all PHYs defined within this standard.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| … |  |  |
| aRxTxTurnaroundTime | integer | The maximum time (in microseconds) that the PHY requires to change from receiving to transmitting the start of the first symbol. When transmitting a non-VHT PPDU, the following equation is used to derive the RxTxTurnaroundTime:aTxPLCPDelay + aRxTxSwitchTime + aTxRampOnTime + aTxRFDelay.When transmitting a VHT PPDU, the following equation is used to derive the RxTxTurnaroundTime:aTxPHYDelay + aRxTxSwitchTime + aTxRampOnTime. |
| aTxPLCPDelay | integer | When transmitting a non-VHT PPDU, the nominal time (in microseconds) that the PLCP uses to deliver a symbol from the MAC interface to the transmit data path of the physical medium dependent (PMD). |
| aRxPLCPDelay | integer | When receiving a non-VHT PPDU, the nominal time (in microseconds) that the PLCP uses to deliver the last bit of a received frame from the PMD receive path to the MAC. |
| aRxTxSwitchTime | integer | When transmitting a non-VHT PPDU, the nominal time (in microseconds) that the PMD takes to switch from Receive to Transmit.When transmitting a VHT PPDU, the nominal time (in microseconds) that the PHY takes to switch from Receive to Transmit. |
| aTxRampOnTime | integer | When transmitting a non-VHT PPDU, the maximum time (in microseconds) that the PMD takes to turn the Transmitter on.When transmitting a VHT PPDU, the maximum time (in microseconds) that the PHY takes to turn the Transmitter on. |
| aTxRampOffTime | integer | When transmitting a non-VHT PPDU, the nominal time (in microseconds) that the PMD takes to turn the Transmit Power Amplifier off.When transmitting a VHT PPDU, the nominal time (in microseconds) that the PHY takes to turn the Transmit Power Amplifier off. |
| aTxRFDelay | integer | When transmitting a non-VHT PPDU, the nominal time (in microseconds) between the issuance of a PMD\_DATA.request primitive to the PMD and the start of the corresponding symbol at the air interface. The start of a symbol is defined to be 1/2 symbol period prior to the center of the symbol for FH, or 1/2 chip period prior to the center of the first chip of the symbol for DS, or 1/2 slot time prior to the center of the corresponding slot for infrared (IR). |
| aRxRFDelay | integer | When receiving a non-VHT PPDU, the nominal time (in microseconds) between the end of a symbol at the air interface to the issuance of a PMD\_DATA.indication primitive to the PLCP. The end of a symbol is defined to be 1/2 symbol period after the center of the symbol for FH, or 1/2 chip period after the center of the last chip of the symbol for DS, or 1/2 slot time after the center of the corresponding slot for IR. |
| … |  |  |
| aTxPmdTxStartRFDelay | Integer | When transmitting a non-VHT PPDU, the delay (in units of 0.5 ns) between PMD\_TXSTART.request being issued and the first frame energy sent by the transmitting port, for the current channel. |
| aTxPmdTxStartRMS | Integer | When transmitting a non-VHT PPDU, the RMS time of departure error (in units of 0.5 ns), where the time of departure error equals the difference between TIME\_OF\_DEPARTURE and the time of departure measured by a reference entity using a clock synchronized to the start time and mean frequency of the local PHY entity’s clock. |
| aTxPHYDelay | integer | When transmitting a VHT PPDU, the nominal time (in microseconds) that the PHY uses to deliver a symbol from the MAC interface to the air interface. |
| aRxPHYDelay | integer | When receiving a VHT PPDU, the nominal time (in microseconds) that the PHY uses to deliver the last bit of a received frame from the end of the last OFDM symbol at the air interface to the MAC. |
| aTxPHYTxStartRFDelay | Integer | When transmitting a VHT PPDU, the delay (in units of 0.5 ns) between PMD\_TXSTART.request being issued and the first frame energy sent by the transmitting port, for the current channel. |
| aTxPHYTxStartRMS | Integer | When transmitting a VHT PPDU, the RMS time of departure error (in units of 0.5 ns), where the time of departure error equals the difference between TIME\_OF\_DEPARTURE and the time of departure measured by a reference entity using a clock synchronized to the start time and mean frequency of the local PHY entity’s clock. |

**TGac editor: add the following to TGac D3.0 Table 22-29**

**Table 22-29—VHT PHY characteristics**

|  |  |
| --- | --- |
| **Characteristics** | **Value** |
| **…** |  |
| aTxPHYDelay | Implementation dependent |
| aRxPHYDelay | Implementation dependent |
| **…** |  |

**Clause 7 PHY service specification**

**TGac editor: modify 802.11-2012 Clause 7 as follows:**

**7. PHY service specification**

**7.1 Scope**

The PHY services provided to the IEEE 802.11 WLAN MAC are described in this clause. Different PHYs

are defined as part of this standard. Each PHY can consist of two protocol functions as follows:

a) A PHY convergence function, which adapts the capabilities of the PMD system to the PHY service. This function is supported by the PLCP, which defines a method of mapping the IEEE 802.11 MPDUs into a framing format suitable for sending and receiving user data and management information between two or more STAs using the associated PMD system.

b) A PMD system, whose function defines the characteristics of, and method of transmitting and receiving data through, a WM between two or more STAs.

Each PMD sublayer may require the definition of a unique PLCP. If the PMD sublayer already provides the defined PHY services, the PHY convergence function might be null.

The description of the VHT PHY in Clause 22 is provided as one layer and is not separated into PLCP and PMD sublayers.

**7.2 PHY functions**

The protocol reference model for the IEEE 802.11 architecture is shown in Figure 4-14 (in 4.9). Most PHY

definitions contain three functional entities: the PMD function, the PHY convergence function, and the layer

management function.

The PHY service is provided to the MAC entity at the STA through a SAP, called the PHY-SAP, as shown

in Figure 4-14. A set of primitives might also be defined to describe the interface between the PLCP

sublayer and the PMD sublayer, called the PMD\_SAP.

The description of the VHT PHY in Clause 22 is provided as one layer and is not separated into PLCP and PMD sublayers.

**7.3 Detailed PHY service specifications**

**7.3.1 Scope and field of application**

The services provided by the PHY to the IEEE 802.11 MAC are specified in this subclause. These services are

described in an abstract way and do not imply any particular implementation or exposed interface.

**7.3.2 Overview of the service**

The PHY function as shown in Figure 4-14 is separated into two sublayers: the PLCP sublayer and the PMD

sublayer. The function of the PLCP sublayer is to provide a mechanism for transferring MPDUs between

two or more STAs over the PMD sublayer.

The description of the VHT PHY in Clause 22 is provided as one layer and is not separated into PLCP and PMD sublayers.

**7.3.5 PHY-SAP detailed service specification**

**7.3.5.3 PHY-DATA.indication**

**7.3.5.3.3 When generated**

The PHY-DATA.indication primitive is generated by a receiving PHY entity to transfer the received octet of

data to the local MAC entity. When transmitting a non-VHT PPDU, the time between receipt of the last bit of the provided octet from the WM and the receipt of this primitive by the MAC entity is the sum of aRXRFDelay + aRxPLCPDelay. When transmitting a VHT PPDU, the time between receipt of the last bit of the last provided octet from the WM and the receipt of this primitive by the MAC entity is aRxPHYDelay.

**7.3.5.6 PHY-TXSTART.confirm**

**7.3.5.6.3 When generated**

This primitive is issued by the PHY to the MAC entity once all of the following conditions are met:

— The PHY has received a PHY-TXSTART.request primitive from the MAC entity.

— When transmitting a non-VHT PPDU, the PLCP has issued PMD.TX STATUS.request primitive if dot11MgmtOptionTODActivated is true and the TXVECTOR parameter TIME\_OF\_DEPARTURE\_REQUESTED in the PHY-TXSTART.request(TXVECTOR) primitive is true.

— The PHY is ready to begin accepting outgoing data octets from the MAC.

**Clause 8 Frame formats**

**TGac editor: modify 802.11-2012 Clause 8 as follows:**

**8.4.2.73.8 Time of Departure subelement**

The TOD RMS field specifies the RMS time of departure error in units equal to 1/TOD Clock Rate, where

the TOD Clock Rate is specified in the TOD Clock Rate field, where the time of departure error equals the

difference between the TOD Timestamp field and the time of departure measured by a reference entity using

a clock synchronized to the start time and mean frequency of the local PHY entity's clock. TOD RMS field

is determined from aTxPmdTxStartRMS when transmitting a non-VHT STA or aTxPHYTxStartRMS when transmitting a VHT PPDU in units equal to 1/TOD Clock Rate, where the TOD Clock Rate is specified in the TOD Clock Rate field.

**Clause 9 MAC sublayer functional description**

**TGac editor: modify 802.11-2012 Clause 9 as follows:**

**9.3.7 DCF timing relations**

The relationships between the IFS specifications are defined as time gaps on the medium. The associated

attributes are provided by the specific PHY. (See Figure 9-14.)



NOTE-- In Figure 9-14, when transmitting a VHT PPDU, D1 = aRxPHYDelay (reference from the end of the last symbol of a PPDU on the medium)

All medium timings that are referenced from the end of the transmission are referenced from the end of the last

symbol, or signal extension if present, of the PPDU. The beginning of transmission refers to the first symbol of

the preamble of the next PPDU. All MAC timings are referenced from the PHY-TXEND.confirm, PHYTXSTART.

confirm, PHY-RXSTART.indication, and PHY-RXEND.indication primitives.

aSIFSTime and aSlotTime are determined per PHY, aSIFSTime is fixed, and aSlotTime can change

dynamically as aAirPropagationTime changes (see 9.18.6).

When transmitting a non-VHT PPDU, aSIFSTime is: aRxRFDelay + aRxPLCPDelay + aMACProcessingDelay + aRxTxTurnaroundTime.

When transmitting a VHT PPDU, aSIFSTime is: aRxPHYDelay + aMACProcessingDelay + aRxTxTurnaroundTime.

aSlotTime is: aCCATime + aRxTxTurnaroundTime + aAirPropagationTime

+ aMACProcessingDelay.

**Annex T**

**TGac editor: modify 802.11-2012 Clause 7 as follows:**

**Annex T**

(informative)

**Location and Time Difference accuracy test**

**T.2 Time Difference of departure accuracy test**

l) The Time of Departure accuracy test is passed if

1) The RMS value of *e* is less than aTxPmdTxStartRMS when transmitting a non-VHT PPDU or aTxPHYTxStartRMS when transmitting a VHT PPDU, and

2) aTxPmdTxStartRMS when transmitting a non-VHT PPDU or aTxPHYTxStartRMS when transmitting a VHT PPDU is less than TIME\_OF\_DEPARTURE\_ACCURACY\_TEST\_THRESH, where the units of *e*, aTxPmdTxStartRMS when transmitting a non-VHT PPDU or aTxPHYTxStartRMS when transmitting a VHT PPDU, and TIME\_OF\_DEPARTURE\_ACCURACY\_TEST\_THRESH are properly accounted for.

NOTE 1—One possible implementation of a time of departure measurement system is a free-running oscillator clocking

(a) the digital-to-analog converter(s) used to transmit the packet, (b) a 32-bit continuously counting counter and (c) a hardware finite state machine such that PMD\_TXSTART.request causes a transition within the finite state machine that

in turn causes frame transmission at the DACs a fixed number of cycles later; where the time of departure is recorded as

the value of the counter at that transition minus aTxPmdTxStartRFDelay when transmitting a non-VHT PPDU or aTxPHYTxStartRFDelay when transmitting a VHT PPDU (using TIME\_OF\_DEPARTURE\_ClockRate), where aTxPmdTxStartRFDelay or aTxPHYTxStartRFDelay can vary by channel. In this implementation, the principal source of time of departure error is short term oscillator imperfection (e.g., phase noise) and RF group delay variation across channels uncompensated by aTxPmdTxStartRFDelay when transmitting a non-VHT PPDU or aTxPHYTxStartRFDelay when transmitting a VHT PPDU.