IEEE P802.11
Wireless LANs

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| aRxPHYStartDelay |
| Date: 2023-02-27 |
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Abstract

This submission proposes resolutions for the following comments from comment collection on P802.11me D2.0:

3038

The baseline used in this document is D2.0.

NOTE – Set the Track Changes Viewing Option in the MS Word to “All Markup” to clearly see the proposed text edits.

**Revision History:**

R0: Initial version.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CID | Commenter | Section | Page | Line | Comment |
| 3038 | Brian Hart | 10.3.2.11 | 1789 | 45 | MAC uses aRxPHYStartDelay to determine when the PPDU containing a response frame should already have been detected by the PHY. aRxPHYStartDelay is defined in 6.7.4.2 as a constant for a PHY wrt PHY-RXSTART.indication but 8.3.5.13.3 "This primitive is generated by the local PHY entity to the MAC sublayer when the PHY has successfully validated the PHY header at the start of a new PPDU." so in reality this delay varies by a) PPDU format (11a/b/g/HT/VHT/HE...), b) PPDU subformat (HESU/HEMU/HEER/...), c) number of STSs (e.g., VHTSIGB in VHT MU PPDU), or d) a great many other parameters (HE PPDUs especially HE MU PPDUs). This variability is explicit via 10.3.2.11 "... the AckTimeout interval is calculated with aRxPHYStartDelay value for >= 2 MHz short/long preamble except when the receiving STA has indicated use of 1 MHz control responses as described in 10.6.6.6 (Channel Width selection for Control frames) in which case the AckTimeout interval is calculated with aRxPHYStartDelay value for S1G\_1M preamble." Similar issues elsewhere. |

# 3038 Discussion

The commenters raise an important topic.

aRxPHYStartDelay is has an abstract definition as a parameter of the PLME-CHARACTERISTICS.confirm via:



Then aRxPHYStartDelay is defined in each PHY clause, such as Table 27-54 (HE PHY characteristics)



From clauses 16-27 (e.g., see above), aRxPHYStartDelay is not a single constant and depends on many TXVECTOR parameters, a MIB variable and a subfield in the the HE Capabilities element, includiing:

* PREMABLE\_TYPE
* FORMAT
* Channel Spacing ~ BANDWIDTH
* NON\_HT\_MODULATION
* MCS
* Max NVHTLTF supported ~ dot11NumberOfSpatialStreamsImplemented
* *NHE-SIG-B* which in turn depends on *many* TXVECTOR parameters and also Longer Than 16 HE-SIG-B OFDM Symbols Support in the HE PHY Capabilities Information field in the HE Capabilities element

We actually have a **second** problem since aRxPHYStartDelay is used widely but imprecisely in the MAC. The exhaustive list of instances is:

1. MAC
* 10.3.2.4 Setting and resetting the NAV
	+ P2093: A STA that used information from an RTS frame or MU-RTS Trigger frame as the most recent basis to update its NAV setting is permitted to reset its NAV if no PHY-RXSTART.indication primitive is received from the PHY during a NAVTimeout period starting when the MAC receives a PHY-RXEND.indication primitive corresponding to the detection of the RTS frame or MU-RTS Trigger frame.(11ax)

In non-DMG BSS, NAVTimeout period is equal to (2 × aSIFSTime) + (CTS\_Time) + aRxPHYStartDelay + (2 × aSlotTime). In a non-S1G STA, (11ax)if an RTS frame is used for the most recent NAV update, CTS\_Time shall be calculated using the length of the CTS frame and the data rate at which the RTS frame used for the most recent NAV update was received. (11ax)If an MU-RTS Trigger frame was used for the most recent NAV update, CTS\_Time shall be calculated using the length of the CTS frame and the 6 Mb/s data rate (see 26.2.6 (MU-RTS Trigger/CTS frame exchange sequence procedure(#109))). In an S1G STA, (11ax)CTS\_Time shall be calculated using the time required to transmit an NDP CTS frame that is equal to NDPTxTime, which is specified in 10.3.2.5.2 (RID update).

* + - // This is really an indication of “actively receiving a PPDU within the expected time” or not
	+ P2094: In DMG BSS, NAVTimeout period is equal to (2 × aSIFSTime) + TDMG-CTS + StartDelayCompensation + (2 × aSlotTime), where TDMG-CTS is the duration of a DMG CTS frame calculated using the TXVECTOR TRN\_LEN parameter equal to the RXVECTOR TRN\_LEN parameter of the received RTS frame and StartDelayCompensation is equal to aSlotTime

NOTE 4—This value of StartDelayCompensation is a compromise over the possible values of aRxPHYStartDelay, which are dependent on both the implementation and the DMG PHY mode

* + - // This is just a reference in a note, and can be ignored.
* 10.3.2.9 CTS and DMG CTS procedure P2100: After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful.
	+ // This is really an indication of “actively receiving a PPDU within the expected time” or not, again
* 10.3.2.11 Acknowledgment procedure
	+ P2106: After transmitting an MPDU that requires an Ack or BlockAck frame as a response (see Annex G), the STA shall wait for an AckTimeout interval, with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay, starting at the PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the AckTimeout interval, the STA concludes that the transmission of the MPDU has failed, and this STA shall invoke its backoff procedure upon expiration of the AckTimeout interval.
		- // This is really an indication of “actively receiving a PPDU within the expected time” or not, again
	+ P2108 (x3): In an S1G BSS, the AckTimeout interval depends on the TXVECTOR parameter PREAMBLE\_TYPE. When the TXVECTOR parameter PREAMBLE\_TYPE is equal to S1G\_SHORT\_PREAMBLE or S1G\_LONG PREAMBLE, the AckTimeout interval is calculated with aRxPHYStartDelay value for ≥ 2 MHz short/long preamble except when the receiving STA has indicated use of 1 MHz control responses as described in 10.6.6.6 (Channel Width selection for Control frames) in which case the AckTimeout interval is calculated with aRxPHYStartDelay value for S1G\_1M preamble. When the TXVECTOR parameter PREAMBLE\_TYPE is equal to S1G\_1M preamble, the AckTimeout interval is calculated with aRxPHYStartDelay value for S1G\_1M preamble.
		- // This is really an indication of “actively receiving a PPDU within the expected time” or not, but now the time varies according to the context (what was transmitted)
* 10.23.2.2 EDCA backoff procedure P2207: The STA shall wait for a timeout interval of duration aSIFSTime + aSlotTime + aRxPHYStartDelay, starting when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the timeout interval, the transmission of the MPDU has failed.
	+ // This is really an indication of “actively receiving a PPDU within the expected time” or not, again
* 26.2.4 Updating two NAVs P4131: An HE STA that used information from an RTS or MU-RTS Trigger frame as the most recent basis to update its NAV may reset the NAV that is updated by the RTS or MU-RTS Trigger frame if no PHY-RXSTART.indication primitive is received from the PHY during a period with a duration of 2 × aSIFSTime + CTS\_Time + aRxPHYStartDelay + 2 × aSlotTime starting when the MAC receives a PHY-RXEND.indication primitive corresponding to the detection of the RTS or MU-RTS Trigger frame (see 10.3.2.4 (Setting and resetting the NAV) for the definition of CTS\_Time).
	+ // This is really an indication of “actively receiving a PPDU within the expected time” or not, again
* 26.2.6.2 MU-RTS Trigger frame transmission P4133: After transmitting an MU-RTS Trigger frame, the AP shall wait for a CTSTimeout interval of aSIFSTime + aSlotTime + aRxPHYStartDelay that begins when the MAC receives the PHY-TXEND.confirm primitive for the transmitted MU-RTS Trigger frame. If the MAC does not receive a PHY-RXSTART.indication primitive during the CTSTimeout interval, the AP shall conclude that the transmission of the MU-RTS Trigger frame has failed, and, if the MU-RTS Trigger frame initiated a TXOP, the AP shall invoke its backoff procedure. If the MAC receives a PHY-RXSTART.indication primitive during the CTSTimeout interval, then the MAC shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the MU-RTS Trigger frame transmission was successful. The receipt of a CTS frame from any non-AP STA addressed by the MU-RTS Trigger frame before the PHY-RXEND.indication primitive shall be interpreted as the successful transmission of the MU-RTS Trigger frame, permitting the frame exchange sequence to continue. The receipt of any other type of frame shall be interpreted as a failure of the MU-RTS Trigger frame transmission. In this instance, the AP may process the received frame and, if the MU-RTS Trigger frame initiated a TXOP, shall invoke its backoff procedure at the PHY-RXEND.indication primitive.
	+ // This is really an indication of “actively receiving a PPDU within the expected time” or not, again
* 26.10.3.2 PSR-based spatial reuse initiation P4143: An HE STA that identifies an PSR opportunity may choose to not perform NAV update operations normally executed based on the receipt of the RXVECTOR parameter TXOP\_DURATION and the Trigger frame Duration field. See Figure 26-13 (PSRR PPDU spatial reuse(11ax)). A STA that identifies an PSR opportunity may issue a PHY-CCARESET.request to ignore the associated HE TB PPDU(s) that are triggered by the Trigger frame of the PSRR PPDU and that occur within aSIFSTime + aRxPHYStartDelay + 2 × aSlotTime of the end of the last symbol on the air of the PPDU that contained the Trigger frame, provided that the value of the RXVECTOR parameter BSS\_COLOR of the HE TB PPDU matches the BSS color of the PSRR PPDU. A STA that identifies an PSR opportunity shall not transmit an PSRT PPDU that terminates beyond the PPDU duration of the HE TB PPDU that is triggered by the Trigger frame of the PSRR PPDU.
	+ // This is really an indication of “actively receiving a PPDU within the expected time” or not, again

(B) The following apply to DMG and the like, and these PPDUs have a single SIG field

* 10.42.6.2 SLS phase execution P2476: (11ay)An EDMG STA that transmitted an unsolicited RSS shall wait for MBIFSTimeout interval, which has a value of MBIFS + aSlotTime + aRxPHYStartDelay, starting at the PHY-TXEND.confirm primitive of the last SSW frame transmitted as part of the unsolicited RSS. If a PHY-RXSTART.indication primitive does not occur during the MBIFSTimeout interval, the STA concludes that the unsolicited RSS failed and may initiate an ISS to the STA to which the unsolicited RSS was transmitted.
* 10.53.4 TXOP-based sectorization operation
	+ P2610: 2) Not observing the subsequent sectorized beam transmission by the AP for aSIFSTime + aSlotTime + aRxPHYStartDelay duration.
	+ P2611 (Sectorized beam operation): Note that in the first diagram in Figure 10-151 (SO frame exchange sequence 3), an OBSS non-AP STA or OBSS AP infers its spatial orthogonality with the AP by observing the omnidirectional beam RTS frame and the omnidirectional portion of the long format for the duration of one symbol (D-STF as shown in Figure 23-2 (S1G\_LONG format)) following the omnidirectional portion of the S1G\_LONG format but not the subsequent sectorized beam transmission and with the STA by observing a gap of no transmission between the omnidirectional RTS frame and the omnidirectional preamble of the long preamble. Note that in the second diagram in Figure 10-151 (SO frame exchange sequence 3), an OBSS non-AP STA or OBSS AP infers its spatial orthogonality with the AP by observing the transmission of the omnidirectional beam RTS frame and the omnidirectional beam PPDU of the short format but not observing the subsequent sectorized beam transmission for aSIFSTime + aSlotTime + aRxPHYStartDelay duration and with the STA by observing a gap of no transmission between the omnidirectional RTS frame and the omnidirectional beam PPDU of the short format by the AP.

(C) There are also values defined for aRxPHYStartDelay in each PHY clause.

Now consider an HE STA for example, that might receive a clause 15/16/17/HT/VHT/HE PPDU, with very different values for aRxPHYStartDelay for each PPDU format, and even multiple values for each PPDU format. Which value should the MAC use in the equations above? It seems to be case-by-case, since for

“After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive.”

… we’d expect the CTS to be sent in a clause 15/16/17 format in 2.4 GHz according to the format of the RTS, and a clause 17 format in 5/6 GHz. Meanwhile for

“In non-DMG BSS, NAVTimeout period is equal to (2 × aSIFSTime) + (CTS\_Time) + aRxPHYStartDelay + (2 × aSlotTime).”

… we’d expect it to be the maximum aRxPHYStartDelay across all possible supported PPDUs.

In several cases the MAC needs to do some filtering of all these aRxPHYStartDelay’s, but nothing is mentioned except one time in regard to S1G.

Rough notes from previous discussion: “aRxPHYStartDelay only matters for RTS/CTS/Ack transmissions … which then simplifies it since they are *almost* always carried in 11a/b/g PPDU formats only. If set delay to LSIG + 1 symbol then either LSIG or HT SIG, so know a packet is coming in. Then might not need a second primitive. BUT Ack in VHT is allowed because of FTM. And RTS/CTS is allowed in VHT PPDUs. Then need to create an new early-warning primitive.”

Given that discussion, when we review the (exhaustive) list of usages of aRxPHYStartDelay, we see that, almost always, the MAC is using aRxPHYStartDelay to make a decision based on whether the PHY has positively started to receive a PPDU or not, and the MAC really wants this information with lowest latency – i.e., after the successful reception of the first SIG field (or, in the case of HT-MF, then after the successful reception of the HT SIG field).

This suggests that, due to the potentially long or delayed VHTSIGB or HESIGB fields, that PHY-RXSTART.ind is coming very late, and some new primitive is required earlier, to signal to the MAC that the PHY is positively receiving a PPDU.

This leads to the following set of changes, which we attempt to limit to clause 6 as much as possible:

**Proposed Resolution: CID 3038**

**Revised**.

**Note to Commenter:**

The commenter’s concerns are valid and are substantially addressed in 23/0138R<motionedRevision> under CID 3038.

**Instruction to Editor:**

Implement the proposed text updates listed under CID 3038 in 23/0138R<motionedRevision>

***TGme Editor, make the following changes to D1.0 shown by Word track changes under CID 3038***

6.5.4.2 Semantics of the service primitive

|  |  |  |
| --- | --- | --- |
| Name | Type | Description |
| aRxPHYStartDelay | Integer(s) | One or more integer delay values for each supported PHY clause, where each delay, in microseconds, is from the start of the PPDU at the receiver’s antenna to the issuance of the earlier of the PHY-RXEARLYSIG.indication if sent or the PHY-RXSTART.indication primitive. |

6.5.4.4 Effect of receipt

The receipt of this primitive provides the operational characteristics of the PHY entity. The MAC determines aRxPHYStartDelay by excluding values of aRxPHYStartDelay for each supported PHY clause that are not allowed in the current context, then setting aRxPHYStartDelay to the maximum of the remaining values.

Table 8-2—PHY SAP inter-(sub)layer service primitives

|  |  |  |  |
| --- | --- | --- | --- |
| Primitive | Request | Indication | Confirm |
| … |  |  |  |
| PHY-CCA |  | X |  |
| PHY-RXEARLYSIG |  | X |  |
| PHY-RXSTART |  | X |  |
| … |  |  |  |

8.3.5.12a PHY-RXEARLYSIG.indication

8.3.5.12a.1 Function

This primitive is an early indication by the PHY to the local MAC entity that the PHY has received a valid start of a PPDU.

NOTE—This primitive might be generated before the PHY has narrowed down the PPDU format to a single possibility, such as either of non-HT or VHT.

8.3.5.12a.2 Semantics of the service primitive

The primitive does not include any parameters:

PHY-RXEARLYSIG.indication(

)

8.3.5.12a.3 When generated

This primitive is generated by the local PHY entity to the MAC sublayer when the PHY has successfully validated an early SIG field in the PHY and the validation of the SIG field does not cause the issuance of the PHY-RXSTART.indication. The early SIG field is the first SIG field in the PPDU except:

* If the HT-SIG field is present in an HT\_GF format PPDU, then the HT-SIG field is validated instead of the L-SIG field (and so the PHY-RXEARLYSIG.indication is not issued)
* If the RL-SIG field is present, then the pair of L-SIG and RL-SIG fields is validated instead of the L-SIG field

After generating a PHY-RXEARLYSIG.indication primitive, the PHY is expected to maintain physical medium busy status (not generating a PHY-CCA.indication(IDLE) primitive) until the issuance of the next PHY-RXSTART.indication or PHY-RXEND.indication.

8.3.5.12a.4 Effect of receipt

The receipt of this primitive by the MAC entity causes the MAC to determine that there is no NAV, CTS, Ack or similar timeout (see 10.3.2.4 (Setting and resetting the NAV), 10.3.2.9 (CTS and DMG CTS procedure), 10.3.2.11 (Acknowledgment procedure), 26.2.4 (Updating two NAVs), and 26.2.6.2 (MU-RTS Trigger frame transmission)).

10.3.2.4 Setting and resetting the NAV P2093:

A STA that used information from an RTS frame or MU-RTS Trigger frame as the most recent basis to update its NAV setting is permitted to reset its NAV if no PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive is received from the PHY during a NAVTimeout period starting when the MAC receives a PHY-RXEND.indication primitive corresponding to the detection of the RTS frame or MU-RTS Trigger frame.(11ax)

In non-DMG BSS, NAVTimeout period is equal to (2 × aSIFSTime) + (CTS\_Time) + aRxPHYStartDelay + (2 × aSlotTime). In a non-S1G STA, (11ax)if an RTS frame is used for the most recent NAV update, CTS\_Time shall be calculated using the length of the CTS frame and the data rate at which the RTS frame used for the most recent NAV update was received. (11ax)If an MU-RTS Trigger frame was used for the most recent NAV update, CTS\_Time shall be calculated using the length of the CTS frame and the 6 Mb/s data rate (see 26.2.6 (MU-RTS Trigger/CTS frame exchange sequence procedure(#109))). In an S1G STA, (11ax)CTS\_Time shall be calculated using the time required to transmit an NDP CTS frame that is equal to NDPTxTime, which is specified in 10.3.2.5.2 (RID update).

10.3.2.9 CTS and DMG CTS procedure P2100:

After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful.

10.3.2.10.1 Dual CTS protection procedure P2104

NOTE 2—When an HT STA sends an RTS frame to the AP that is a non-STBC frame, the AP returns a CTS frame that is a non-STBC frame to the STA and then immediately transmits a CTS frame that is an STBC frame. The original non-AP STA is now free to transmit. But a non-HT STA that has set its NAV based on the original RTS frame might reset its NAV and then decrement its backoff counter, given that a SIFS + the duration of CTS2 is longer than a DIFS (i.e., the STA does not detect a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive within the period specified in 10.3.2.4 (Setting and resetting the NAV)). Thus, without sending a CTS-to-AP, the NAV reservation might not always work.

10.3.2.11 Acknowledgment procedure P2106:

After transmitting an MPDU that requires an Ack or BlockAck frame as a response (see Annex G), the STA shall wait for an AckTimeout interval, with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay, starting at the PHY-TXEND.confirm primitive. If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does not occur during the AckTimeout interval, the STA concludes that the transmission of the MPDU has failed, and this STA shall invoke its backoff procedure upon expiration of the AckTimeout interval.

If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does occur during the AckTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the MPDU transmission was successful. If the STA recognizes a valid Ack frame addressed to the STA and corresponding to this PHY-RXEND.indication primitive, this recognition shall be interpreted as successful acknowledgment.

10.3.2.11 Acknowledgment procedure, P2107

a) …

- A PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive that corresponds to the received PPDU is detected within the AckTimeout interval that started as a result of the previously transmitted MPDU.

b) …

- A PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive that corresponds to the received PPDU is detected within the AckTimeout interval that started as a result of the previously transmitted MPDU.

10.3.2.11 Acknowledgment procedure¸ P2108 (x3):

In an S1G BSS, the AckTimeout interval depends on the TXVECTOR parameter PREAMBLE\_TYPE. When the TXVECTOR parameter PREAMBLE\_TYPE is equal to S1G\_SHORT\_PREAMBLE or S1G\_LONG PREAMBLE, the AckTimeout interval is calculated with aRxPHYStartDelay value for ≥ 2 MHz short/long preamble except when the receiving STA has indicated use of 1 MHz control responses as described in 10.6.6.6 (Channel Width selection for Control frames) in which case the AckTimeout interval is calculated with aRxPHYStartDelay value for S1G\_1M preamble. When the TXVECTOR parameter PREAMBLE\_TYPE is equal to S1G\_1M preamble, the AckTimeout interval is calculated with aRxPHYStartDelay value for S1G\_1M preamble.

10.23.2.2 EDCA backoff procedure P2207:

- The STA shall wait for a timeout interval of duration aSIFSTime + aSlotTime + aRxPHYStartDelay, starting when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does not occur during the timeout interval, the transmission of the MPDU has failed.

- If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does occur during the timeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to recognize a valid response MPDU(#109) that either does not have a TA field or is sent by the recipient of the MPDU requiring a response. If anything else, including any other valid frame, is recognized, the transmission of the MPDU has failed.

10.39.10 Updating multiple NAVs P2408

A STA that has updated a NAV as a result of the reception of an RTS may reset its NAV(s) as follows. After the NAV update for a duration of NAVTimeout period (10.3.2.4 (Setting and resetting the NAV)), the STA shall monitor the channel to determine if a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive is received from the PHY. If such an event has not occurred during this time period, then the STA may reset to 0 any NAV whose NAV\_RTSCANCELABLE value is true.

10.42.6.2 SLS phase execution P2476

(11ay)An EDMG STA that transmitted an unsolicited RSS shall wait for MBIFSTimeout interval, which has a value of MBIFS + aSlotTime + aRxPHYStartDelay, starting at the PHY-TXEND.confirm primitive of the last SSW frame transmitted as part of the unsolicited RSS. If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does not occur during the MBIFSTimeout interval, the STA concludes that the unsolicited RSS failed and may initiate an ISS to the STA to which the unsolicited RSS was transmitted.

10.49 Sync frame operation, P2596

(#468)After transmitting the sync frame, the AP shall wait for an AckTimeout interval (as defined in 10.3.2.11 (Acknowledgment procedure)), starting at the PHY-TXEND.confirm primitive. If a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive does not occur during the AckTimeout interval, the AP may transmit a CF-End frame or an NDP CF-End frame to reset the NAV provided that the remaining duration is long enough to transmit this frame.

10.53.4 TXOP-based sectorization operation, P2610:

2) Not observing the subsequent sectorized beam transmission by the AP for aSIFSTime + aSlotTime + aRxPHYStartDelay duration.

10.53.4 TXOP-based sectorization operation, P2611:

Note that in the first diagram in Figure 10-151 (SO frame exchange sequence 3), an OBSS non-AP STA or OBSS AP infers its spatial orthogonality with the AP by observing the omnidirectional beam RTS frame and the omnidirectional portion of the long format for the duration of one symbol (D-STF as shown in Figure 23-2 (S1G\_LONG format)) following the omnidirectional portion of the S1G\_LONG format but not the subsequent sectorized beam transmission and with the STA by observing a gap of no transmission between the omnidirectional RTS frame and the omnidirectional preamble of the long preamble. Note that in the second diagram in Figure 10-151 (SO frame exchange sequence 3), an OBSS non-AP STA or OBSS AP infers its spatial orthogonality with the AP by observing the transmission of the omnidirectional beam RTS frame and the omnidirectional beam PPDU of the short format but not observing the subsequent sectorized beam transmission for aSIFSTime + aSlotTime + aRxPHYStartDelay duration and with the STA by observing a gap of no transmission between the omnidirectional RTS frame and the omnidirectional beam PPDU of the short format by the AP.

26.2.4 Updating two NAVs P4131:

An HE STA that used information from an RTS or MU-RTS Trigger frame as the most recent basis to update its NAV may reset the NAV that is updated by the RTS or MU-RTS Trigger frame if no PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive is received from the PHY during a period with a duration of 2 × aSIFSTime + CTS\_Time + aRxPHYStartDelay + 2 × aSlotTime starting when the MAC receives a PHY-RXEND.indication primitive corresponding to the detection of the RTS or MU-RTS Trigger frame (see 10.3.2.4 (Setting and resetting the NAV) for the definition of CTS\_Time).

26.2.6.2 MU-RTS Trigger frame transmission P4133:

After transmitting an MU-RTS Trigger frame, the AP shall wait for a CTSTimeout interval of aSIFSTime + aSlotTime + aRxPHYStartDelay that begins when the MAC receives the PHY-TXEND.confirm primitive for the transmitted MU-RTS Trigger frame. If the MAC does not receive a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive during the CTSTimeout interval, the AP shall conclude that the transmission of the MU-RTS Trigger frame has failed, and, if the MU-RTS Trigger frame initiated a TXOP, the AP shall invoke its backoff procedure. If the MAC receives a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive during the CTSTimeout interval, then the MAC shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the MU-RTS Trigger frame transmission was successful. The receipt of a CTS frame from any non-AP STA addressed by the MU-RTS Trigger frame before the PHY-RXEND.indication primitive shall be interpreted as the successful transmission of the MU-RTS Trigger frame, permitting the frame exchange sequence to continue. The receipt of any other type of frame shall be interpreted as a failure of the MU-RTS Trigger frame transmission. In this instance, the AP may process the received frame and, if the MU-RTS Trigger frame initiated a TXOP, shall invoke its backoff procedure at the PHY-RXEND.indication primitive.

26.10.2.2 General operation with non-SRG OBSS PD level, P4234

If the PHY of a STA issues a PHY-CCA.indication(BUSY) followed by a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication due to a PPDU reception, then the STA’s MAC sublayer(#1119):

a) May issue a PHY-CCARESET.request primitive before the end of the PPDU and not update its basic NAV timer based on the PPDU, or …

26.10.2.3 General operation with SRG OBSS PD level, P4235

If the PHY of a STA issues a PHY-CCA.indication(BUSY) followed by a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication due to a PPDU reception, then the STA’s MAC sublayer

a) May issue a PHY-CCARESET.request primitive before the end of the PPDU and not update its basic NAV timer based on the PPDU, or …

26.10.3.2 PSR-based spatial reuse initiation P4243:

An HE STA that identifies an PSR opportunity may choose to not perform NAV update operations normally executed based on the receipt of the RXVECTOR parameter TXOP\_DURATION and the Trigger frame Duration field. See Figure 26-13 (PSRR PPDU spatial reuse(11ax)). A STA that identifies an PSR opportunity may issue a PHY-CCARESET.request to ignore the associated HE TB PPDU(s) that are triggered by the Trigger frame of the PSRR PPDU and that occur within aSIFSTime + aRxPHYStartDelay + 2 × aSlotTime of the end of the last symbol on the air of the PPDU that contained the Trigger frame, provided that the value of the RXVECTOR parameter BSS\_COLOR of the HE TB PPDU matches the BSS color of the PSRR PPDU. A STA that identifies an PSR opportunity shall not transmit an PSRT PPDU that terminates beyond the PPDU duration of the HE TB PPDU that is triggered by the Trigger frame of the PSRR PPDU.

26.10.3.2 PSR-based spatial reuse initiation

An HE STA identifies an PSR opportunity if the following two conditions are met:

a) The STA receives a PHY-RXEARLYSIG.indication or PHY-RXSTART.indication corresponding to the reception of a PSRR PPDU that is identified as an inter-BSS PPDU (see 26.2.2 (Intra-BSS and inter-BSS PPDU classification)).

Table 15-5—DSSS PHY characteristics

|  |  |
| --- | --- |
| Characteristic | Value |
| aRxPHYStartDelay | 192 us |

Table 16-4—HR/DSSS PHY characteristics

|  |  |
| --- | --- |
| Characteristic | Value |
| aRxPHYStartDelay | 192 us for long preamble and 96us for short preamble |

Table 17-21—OFDM PHY characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics | Value (20 MHz channel spacing) | Value (10 MHz channel spacing) | Value (5 MHz channel spacing) |
| aRxPHYStartDelay | 20 us | 40 us |  80 us |

Table 18-5—ERP characteristics

|  |  |
| --- | --- |
| Characteristic | Value |
| aRxPHYStartDelay | 20 µs for ERP-OFDM,192 µs for ERP-DSSS/CCK with long preamble, and96 µs for ERP-DSSS/CCK with short preamble |

Table 19-25—HT PHY characteristics

|  |  |
| --- | --- |
| Characteristics | Value |
| aRxPHYStartDelay | 24 µs |

Table 20-30—DMG PHY characteristics

|  |  |
| --- | --- |
| PHY parameter | Value |
| aRxPHYStartDelay | DMG control mode: 10 µs; DMG SC and SC low-power modes: 3.6 µs |

***TGme editor:***

* Figure 21-36—PHY receive procedure for SU transmission: add a new arrow labeled as PHY-RXEARLYSIG.indimmediatelyafter L-SIG
* Figure 21-37—PHY receive state machine: add “Issue PHY-RXEARLYSIG.ind” at the end of “Not HT-SIG”

21.3.20 PHY receive procedure

After the PHY-CCA.indication(BUSY, channel-list) primitive 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 or the RATE field is an undefined value(#18), neither a PHY-RXEARLYSIG.indication nor a PHY-RXSTART.indication primitive is 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 RATE field indicates 6 Mbps, the L-SIG field indicates at least six OFDM symbols after the L-SIG field, and the first OFDM symbol after the L-LTF field is using BPSK modulation, then the PHY entity shall issue a PHY-RXEARLYSIG.indication primitive.

If a valid L-SIG parity bit is indicated,(#18) the RATE field indicates 6 Mbps, the L-SIG field indicates at least seven OFDM symbols after the L-LTF field, the first two OFDM symbols after the L-LTF field are using BPSK modulation, and the third OFDM symbol after the L-LTF field is using QBPSK modulation, then the VHT PHY shall maintain PHY-CCA.indication(BUSY, channel-list) primitive for the predicted duration of the transmitted PPDU, as defined by RXTIME in Equation (21-105), for all supported modes, unsupported modes, Reserved VHT-SIG-A Indication, invalid VHT-SIG-A CRC and invalid L-SIG Length field value. The L-SIG Length field value of a VHT PPDU is invalid if it is not divisible by 3. 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 VHT-MCS and NSTS not included in 21.5 (Parameters for VHT-MCSs) or any other VHT-SIG-A field bit combinations that do not correspond to modes of PHY operation defined in Clause 21 (Very high throughput (VHT) PHY specification). If the VHT-SIG-A indicates an unsupported mode, the PHY shall issue a PHY-RXEND.indication(UnsupportedRate) primitive. 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) primitive.

After receiving a valid L-SIG and VHT-SIG-A indicating a supported mode, the PHY entity shall begin receiving the VHT-STF, VHT-LTFs and VHT-SIG-B. If the received group ID in VHT-SIG-A has a value indicating a VHT SU PPDU (see 10.19 (Group ID and partial AID in VHT and CMMG 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-SIG-A CRC, a PHY-RXSTART.indication(RXVECTOR) primitive shall be issued

Table 21-28—VHT PHY characteristics

|  |  |
| --- | --- |
| Characteristics | Value |
| aRxPHYStartDelay | 24 µs (see NOTE 2) |

NOTE 2—This value arises from the time to the end of when the HT\_MF PPDU format is excluded, which is at the end of first OFDM symbol after the L-SIG field (see Figure 21-4 (VHT PPDU format)).

Table 22-25—TVHT PHY characteristics

|  |  |
| --- | --- |
| Characteristics | Value |
| aRxPHYStartDelay | 20 µs ×7.5 (6 and 7 MHz channels) or 5.625 (8 MHz channels)) (see NOTE 2) |

NOTE 2—This value arises from the time to the end of the L-SIG field (see Figure 22-1 (VHT PPDU format in TVWS bands)).

***Note to reader, not for inclusion in the draft: In Figure 23-52—PHY receive procedure for an SU transmission, S1G\_LONG procedure: no need to add a new arrow labeled as PHY-RXEARLYSIG.ind immediately after SIG-A Sym 2 since this is a SU transmission and it is reasonable to assume that SIG-B will not be decoded (and the figure, by having no space for SIG-B in the middle layer, seems to reinforce that)***

***TGme editor:***

* Figure 23-53—PHY receive state machine: add: “. If SIG-B to be decoded, issue PHY-RXEARLYSIG.ind” at the end of “CRC OK”

23.3.20 PHY receive procedure

After the PHY-CCA.indication(BUSY, channel-list) is issued, the PHY entity shall begin receiving the training symbols and searching for SIG or SIG-A in order to set the maximum duration of the data stream and get other PHY parameters such as the demodulation type, code type, and the decoding rate. If the check of the SIG or SIG-A CRC is not valid, no PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive is issued, and instead the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation) primitive, and set PHY\_CCA.indication(IDLE) when receive level drops below threshold (minimum modulation and coding rate sensitivity + 20 dB). If a valid SIG or SIG-A CRC is indicated, and the Uplink Indication bit is 1 and the ID field value matches the PBSSID of the BSS of which the STA is a member or the Uplink Indication bit is 0 and the COLOR field value matches the COLOR indicated by the AP to which the STA is associated, then the S1G PHY shall maintain PHY-CCA.indication(BUSY, channel-list) for the predicted duration of the transmitted PPDU, as defined by RXTIME in Equation (23-69) or Equation (23-70), for all supported modes, unsupported modes, and Reserved SIG or SIG-A Indication. If a valid SIG or SIG-A CRC is indicated, and the Uplink Indication bit is 1 and the ID field value does not match the PBSSID of the BSS of which the STA is a member or the Uplink Indication bit is 0 and the COLOR field value does not match the COLOR indicated by the AP to which the STA is associated, then the S1G PHY shall maintain PHY-CCA.indication(BUSY, channel-list) for the predicted duration of the transmitted PPDU, as defined by RXTIME in Equation (23-69) or Equation (23-70), for all supported modes, unsupported modes, and Reserved SIG-A Indication if the reception meets the minimum CCA sensitivity level specified in 23.3.18.5.4 (CCA sensitivity for signals occupying the primary 2 MHz and/or primary 1 MHz channel). Reserved SIG or SIG-A Indication is defined as an SIG or SIG-A with Reserved bits equal to 0 or a combination not valid as defined in 23.3.8.2.2.5 (SIG definition), 23.3.8.2.3.2.5 (SIG-A definition), or 23.3.8.3.5 (SIG definition), or a combination of S1G-MCS and NSTS not included in 23.5 (Parameters for S1G-MCSs) or any other SIG or SIG-A field bit combinations that do not correspond to modes of PHY operation defined in Clause 23 (Sub 1 GHz (S1G) PHY specification).

(#455)NOTE 1—From Figure 23-53 (PHY receive state machine(#342)), Reserved SIG or SIG-A Indication does not apply to the Reserved fields in NDP CMAC PPDUs since NDP CMAC PPDUs do not use S1G\_LONG format. Subsequently, if dot11TimingMsmtActivated is true, a PHY-RXSTART.indication (RXVECTOR) shall be issued and RX\_START\_OF\_FRAME\_OFFSET parameter within the RXVECTOR shall be forwarded (see 23.2.2 (TXVECTOR and RXVECTOR parameters)).

NOTE 2—The RX\_START\_OF\_FRAME\_OFFSET value is used as described in 6.3.55 in order to estimate when the start of the preamble for the incoming (#14)PPDU was detected on the medium at the receive antenna connector.

If the SIG or SIG-A indicates an unsupported mode, the PHY shall issue PHY-RXEND.indication(UnsupportedRate). If the SIG or SIG-A indicates an invalid CRC or Reserved SIG

or SIG-A Indication, the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation).

If the PHY preamble reception is successful and a valid SIG or SIG-A CRC is indicated:

—

Upon reception of an S1G\_LONG format preamble, after receiving a valid SIG-A indicating a

supported mode, the PHY entity shall begin receiving the rest of S1G training symbols and SIG-B. If the received MU/SU subfield in SIG-A has a value indicating SU PPDU (see 23.3.8.2.3.2.5 (SIG-A definition)), the PHY entity does not need to decode SIG-B since in this case SIG-B does not carry any information bit (see 23.3.8.2.3.3.5 (SIG-B definition)). If SIG-A is valid and indicates that SIG-B is not to be decoded, then a PHY-RXSTART.indication (RXVECTOR) primitive shall be issued, and otherwise a PHY-RXEARLYSIG.indication primitive shall be issued.

Table 23-40—S1G PHY characteristics

|  |  |
| --- | --- |
| Characteristics | Value |
| aRxPHYStartDelay | 600 µs for S1G\_1M preamble;280 µs for S1G\_SHORT preamble and S1G\_LONG preamble |

Table 25-37—CMMG PHY characteristics

|  |  |
| --- | --- |
| PHY parameter | Value |
| aRxPHYStartDelay | 11 µs |

***Tgme editor:***

* Figure 27-59—PHY receive procedure for an HE SU PPDU(11ax), Figure 27-60—PHY receive procedure for an HE ER SU PPDU(11ax), Figure 27-61—PHY receive procedure for an HE MU PPDU(11ax), Figure 27-62—PHY receive procedure for an HE TB PPDU(11ax): add a new arrow labeled as PHY-RXEARLYSIG.indimmediatelyafter RL-SIG
* Figure 27-63—PHY receive state machine if midambles are not present(11ax): add “Issue PHY-RXEARLYSIG.ind” at the end of “LENGTH mod 3 = 1” and at the end of at the end of “LENGTH mod 3 = 2”

27.3.22 HE receive procedure

The PHY shall not issue a PHY-RXEARLYSIG.indication nor a PHY-RXSTART.indication primitive in response to a PPDU that does not overlap the primary channel, unless the PHY at an AP receives the HE TB PPDU solicited by the AP. For the HE TB PPDU solicited by the AP, the PHY shall issue both a PHY-RXEARLYSIG.indication primitive and a PHY-RXSTART.indication primitive for a PPDU received in the primary or at the secondary 20 MHz channel, the secondary 40 MHz channel, or the secondary 80 MHz channel.

The PHY includes the measured RSSI and RSSI\_LEGACY value in the PHY-RXSTART.indication(RXVECTOR) primitive issued to the MAC.

After the PHY-CCA.indication(BUSY, channel-list) primitive is issued, the PHY entity shall begin receiving the training symbols and searching for the preambles for non-HT, HT, VHT, and HE PPDUs, respectively. If the constellation used in the first symbol after the first long training field is QBPSK, the PHY entity shall continue to detect the received signal using the receive procedure for HT-GF depicted in Clause 19 (High-throughput (HT) PHY specification). Otherwise, for detecting the HE preamble, the PHY entity shall search for L-SIG and RL-SIG fields in order to set the maximum duration of the data stream. If an RL-SIG field is detected, the PHY entity should check the parity bit and RATE fields in the L-SIG and RL-SIG fields. If either the check of the parity bit is invalid or the RATE field is not set to 6 Mb/s in non- HT, no PHY-RXEARLYSIG.indication or PHY-RXSTART.indication primitive is issued. If the check of the parity bit is valid and the RATE field indicates 6 Mb/s in non-HT but the LENGTH field value in the L-SIG field is a multiple of 3, no PHY-RXEARLYSIG.indication or PHY- RXSTART.indication primitive is issued. In both cases, the PHY should continue to detect the received signal using non-HT, HT, and VHT receive procedure in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification), Clause 19 (High-throughput (HT) PHY specification), and Clause 21 (Very high throughput (VHT) PHY specification), respectively.

If a valid parity bit and the RATE with 6 Mb/s in non-HT are indicated in the L-SIG and RL-SIG fields and the LENGTH field value in the L-SIG and RL-SIG fields meets the condition that the remainder is 1 after LENGTH divided by 3, the PHY entity shall issue a PHY-RXEARLYSIG.indication primitive and should begin receiving the sequence of HE-SIG-A, HE-STF, and HE-LTF fields for the HE SU PPDU and HE TB PPDU as shown in Figure 27-59 (PHY receive procedure for an HE SU PPDU(11ax)) and Figure 27-62 (PHY receive procedure for an HE TB PPDU(11ax)), respectively. After the RL-SIG field, the PHY entity shall receive two symbols of the HE-SIG-A field immediately followed by HE-STF.

Table 27-54—HE PHY characteristics(11ax)

|  |  |
| --- | --- |
| Characteristic | Value |
| aRxPHYStartDelay | 24 µs |

Table 30-13—WUR PPDU Time and Length Characteristics(11ba)

|  |  |
| --- | --- |
| Characteristics | Value |
| aRxPHYStartDelay | 92 µs (see NOTE 2) |