IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)
Title	UWB Packet Format Configuration
Date Submitted	02 December 2024
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Re:	IEEE P802.15.4ab Comment Resolutions
Abstract	Comment Resolutions for selected comments on the LB207 / P802.15.4ab D01.
Purpose	This document provides text changes intended to be part of the final IEEE Std 802.15.4ab (amendment to IEEE Std 802.15.4), as part of resolving selected comments from the consolidated spreadsheet (doc 15-24-0371) that have been assigned to the author to resolve.
Notice	This document does not represent the agreed views of the IEEE 802.15 Working Group or IEEE 802.15.8 Task Group. It represents only the views of the participants listed in the "Source(s)" field above. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
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Comments addressed here:

1 Comment Index #'s: 108, 182, 1346, 1063, 28, 29, 1064, 1325, 183

Index	page	clause	line	Comment	Proposed Change
108 (Rojan)	40	10.29.9.5.1	20	FormatSpecificParameters Type should not be Enuration, also the details of the parameters seem to be missing.	Correct the FormatSpecificParameters Type and add details of the packet parameters.
182 (Wenzheng)	40	10.29.9.5.1	20	For the Table 7, FormatSpecificParameters shall be defined	FormatSpecificParameters shall include: active segment lengths preamble code(91 or 127) support active segments number(1,2,3,4)
1346 (Pooria)	40	10.29.9.5.1	20	Does "PacketFormat" parameter only specify SENS packets, or ranging packets too? If so, why is it called UWB-PACKET?	Use a more descriptive name, or generalize to STS packets as well as other 4ab packets.
1063 (Billy)	40	10.29.9.5.1	10	MLME-UWB-PACKET.request seems like a good way to configure not just sensing packets but all the UWB packet formats: Normal, STS, SENS, MMS, etc.	Unify HRP UWB PHY packet mode configuration into one place… I will prepare a submission to cover this.
28 (Mickael)	40	10.29.9.5.1	20	PacketFormat is missing for default STS_PACKET	add STS_PACKET in valid range and add phyHrpUwbPacketFormat: SENS_PACKET_0, SENS_PACKET_1, SENS_PACKET_2, STS_PACKET (default) in Table 12-8
29 (Mickael)	40	10.29.9.5.1	20	FormatSpecificParameters for SENS_PACKET	TxSensPacketStructure: 0-2 TxSensSegmentLength: 16/32/64/128/256/512 TxSensNumberSegments: 0-4 RxSensPacketStructure: 0-2 RxSensSegmentLength: 16/32/64/128/256/512 RxSensNumberSegments: 0-4
1064 (Billy)	40	10.29.9.5.1	21	If the FormatSpecificParameters parameter is not use, it should be removed. I am thinking that simple PIB values should be used for configuring such items.	Delete the FormatSpecificParameters parameter. And the INVALID_PARAMETER return value in MLME-UWB-PACKET.confirm if there are no other parameters to be invalid.
1325 (Ben)	40	10.29.9.5.1	21	"This may provide specific parameters associated with the selected packet format." can be more clear and avoid misuse of "may".	Provides lparameters specific to the selected packet format.
183 (Wenzheng)	41	10.29.9.5.2	10	For the Table 8, specific indication for not supported parameter may be introduced with respective to FormatSpecificParameters in Table 7	NOT_SUPPORTED_SENS_LENGTH NOT_SUPPORTED_PREAMBLE_CODE NOT_SUPPORTED_SEGMENTS_NUMBER

Discussion:

These comments all relate to the MLME-UWB-PACKET primitive. However, during the TG4ab call of 15th October 2024, it was proposed to remove the MLME-UWB-PACKET primitive and the related MLME-STS primitive and rework the (read only) attributes set by the STS primitive into writable attributes and rename phyHrpUwbStsTxPacketConfig and phyHrpUwbStsRxPacketConfig as more general HRP UWB PHY packet configuration attributes, and the group agreed with this approach. The following then captures the changes to the D01 draft to do this.

Proposed resolution for all the above listed CID is then: **Revised**, with the changes as below:

The Key to the edits presented below is as follows:

Notes in boxes like this introduce and explain the changes following the box. These boxes are not to be part of the draft.

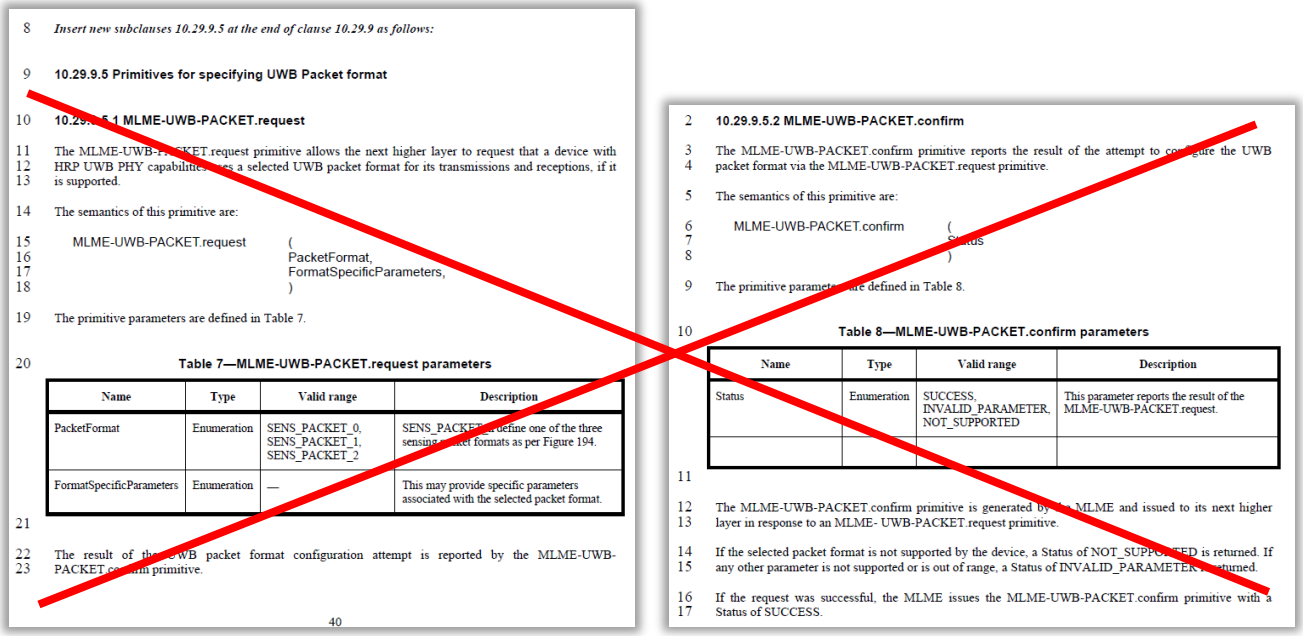
Red bold editorial instructions are instructions for the 4ab editor, to implement the changes to the D01 draft, for the comment resolution as discussed above, and these red texts also are not to be part of the draft.

Black bold editorial instructions are part of the text that should be included in the 4ab D02.

The changes are laid out in the pages that follow.

First, deletion of the MLME-UWB-PACKET and MLME-STS primitives.

Delete D01 clause 10.29.9.5 "Primitives for specifying UWB Packet format", and the immediately preceding editorial instruction saying to insert it.



Insert new subclauses 10.29.9.5 at the end of clause 10.29.9 as follows:

10.29.9.5 Primitives for specifying UWB Packet format

10.29.9.5.1 MLME-UWB-PACKET.request

The MLME-UWB-PACKET.request primitive allows the next higher layer to request that a device with HRP UWB PHY capabilities uses a selected UWB packet format for its transmissions and receptions, if it is supported.

The semantics of this primitive are:

```
MLME-UWB-PACKET.request (
                        PacketFormat,
                        FormatSpecificParameters,
                        )
```

The primitive parameters are defined in Table 7.

Table 7—MLME-UWB-PACKET.request parameters

Name	Type	Valid range	Description
PacketFormat	Enumeration	SENS_PACKET_0, SENS_PACKET_1, SENS_PACKET_2	SENS_PACKET_x define one of the three sensing packet formats as per Figure 194.
FormatSpecificParameters	Enumeration	—	This may provide specific parameters associated with the selected packet format.

The result of the UWB packet format configuration attempt is reported by the MLME-UWB-PACKET.confirm primitive.

40

10.29.9.5.2 MLME-UWB-PACKET.confirm

The MLME-UWB-PACKET.confirm primitive reports the result of the attempt to configure the UWB packet format via the MLME-UWB-PACKET.request primitive.

The semantics of this primitive are:

```
MLME-UWB-PACKET.confirm (
                        Status
                        )
```

The primitive parameters are defined in Table 8.

Table 8—MLME-UWB-PACKET.confirm parameters

Name	Type	Valid range	Description
Status	Enumeration	SUCCESS, INVALID_PARAMETER, NOT_SUPPORTED	This parameter reports the result of the MLME-UWB-PACKET.request.

The MLME-UWB-PACKET.confirm primitive is generated by the MLME and issued to its next higher layer in response to an MLME- UWB-PACKET.request primitive.

If the selected packet format is not supported by the device, a Status of NOT_SUPPORTED is returned. If any other parameter is not supported or is out of range, a Status of INVALID_PARAMETER is returned.

If the request was successful, the MLME issues the MLME-UWB-PACKET.confirm primitive with a Status of SUCCESS.

Insert the following to specify the deletion of clause 10.29.9.4 "Primitives for specifying STS parameters" from the base standard.

10.29.9.4 Primitives for specifying STS parameters

Delete clause 10.29.9.4 in its entirety.

Next, changing the read-only STS attributes previously set by MLME-STS primitive to be directly writable, (removing the dagger symbol, and updating the description accordingly), and repurposing (renaming) the STS packet configuration attributes to align with their new role as more general HRP UWB PHY packet format configurations.

*On p.180 of draft D01 we already have some changes to HRP UWB PHY PIB attributes, and already have the editorial instructions to "**Change the following attributes in Table 12-8**", so we can just add the rows necessary for the modifications to the STS attributes.*

Insert the following new rows into Table 12-8 on p.180 lines 5-6, (to show the required changes to the base standard), resolving the cross reference to the new Table X which appears later in this submission:

Attribute	Type	Range	Description

Attribute	Type	Range	Description
phyHrpUwbRxPacketConfig ~~*phyHrpUwbStsRxPacketConfig*~~	Enumeration ~~Integer†~~	BASIC_PACKET, STS_PACKET_1, STS_PACKET_2, STS_PACKET_3, SENS_PACKET_0, SENS_PACKET_1, SENS_PACKET_2, MMS_PACKET_1, MMS_PACKET_2 ~~0–3~~	This attribute specifies the format of ~~indicates the presence and position of the STS field in~~ the PPDU expected by the receiver, as per ~~Table 16-1~~ Table X.
phyHrpUwbStsRxSegLen	Integer ~~Integer†~~	0–3	This attribute ~~indicates~~ specifies the length of active STS segment(s) in the PPDU expected by the receiver, as ~~specified~~ defined in Table 16-18.
phyHrpUwbStsRxSegNum	Integer ~~Integer†~~	0–3	This attribute ~~indicates~~ specifies the number of STS segments in the PPDU expected by the receiver, as ~~specified~~ defined in Table 16-18.
phyHrpUwbTxPacketConfig ~~*phyHrpUwbStsTxPacketConfig*~~	Enumeration ~~Integer†~~	BASIC_PACKET, STS_PACKET_1, STS_PACKET_2, STS_PACKET_3, SENS_PACKET_0, SENS_PACKET_1, SENS_PACKET_2, MMS_PACKET_1, MMS_PACKET_2 ~~0–3~~	This attribute specifies the format of ~~indicates the presence and position of the STS field in~~ the transmitted PPDU as per ~~Table 16-1~~ Table X.
phyHrpUwbStsTxSegLen	Integer ~~Integer†~~	0–3	This attribute ~~indicates~~ specifies the length of active STS segment(s) in the transmitted PPDU, as ~~specified~~ defined in Table 16-18.
phyHrpUwbStsTxSegNum	Integer ~~Integer†~~	0–3	This attribute ~~indicates~~ specifies the number of STS segments in the transmitted PPDU, as ~~specified~~ defined in Table 16-18.

Next, let's insert the Table X referred to above that lists/describes the UWB packet formats. A suitable place for this is at the end of the HRP PHY general clause, 16.2.1

Insert the following paragraph and table at the end of clause 16.2.1.

Table X provides a list of the HRP UWB PHY packet formats configurations. Support of the individual format configurations is dependent on the device type and the options implemented.

Table X—HRP UWB PHY packet formats

Packet configuration specifier value	Description
BASIC_PACKET	This selects the basic PPDU format shown in Figure 16-2 (which is identical to the STS packet configuration zero shown in Figure 16-3).
STS_PACKET_1	This selects the STS packet configuration one shown in Figure 16-3.
STS_PACKET_2	This selects the STS packet configuration two shown in Figure 16-3.
STS_PACKET_3	This selects the STS packet configuration three shown in Figure 16-3.
SENS_PACKET_0	This selects the sensing packet configuration zero shown in Figure 194.
SENS_PACKET_1	This selects the sensing packet configuration one shown in Figure 194.
SENS_PACKET_2	This selects the sensing packet configuration two shown in Figure 194.
MMS_PACKET_1	This selects the UWB MMS packet format one shown in Figure 198.
MMS_PACKET_2	This selects the UWB MMS packet format two shown in Figure 198.

NOTE—the packet configuration specifier value in Table X applies to the *phyHrpUwbTxPacketConfig* and *phyHrpUwbRxPacketConfig* attributes.

Now Figure 198 referenced in the Table X above needs update to show the two MMS packet formats separately. (This was also in 0552r1)

Replace current figure 198

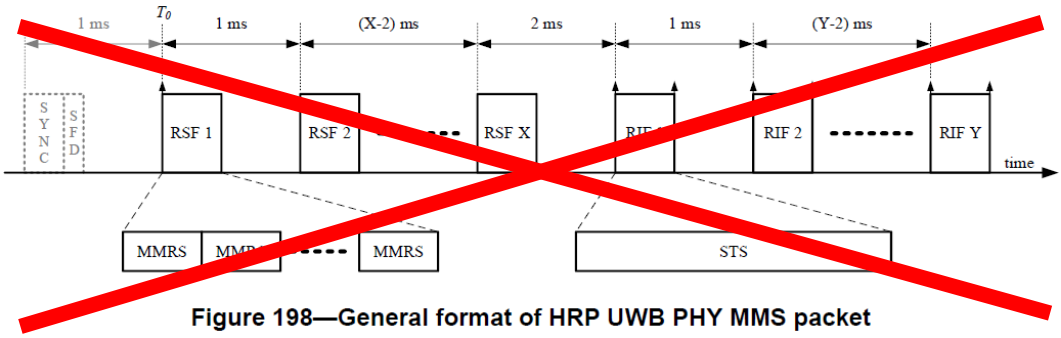


Figure 198—General format of HRP UWB PHY MMS packet

with the following:

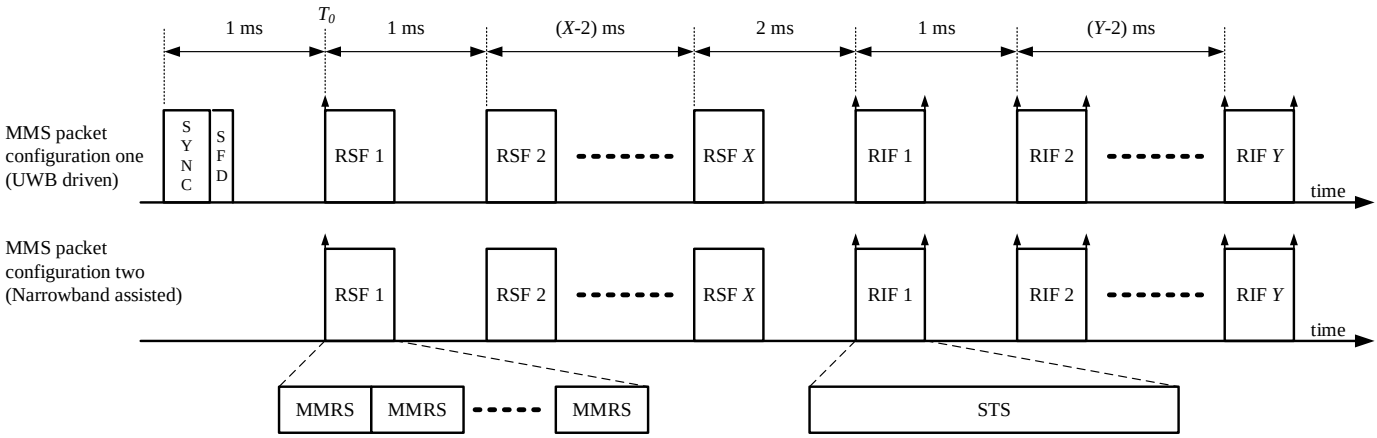


Figure 198—HRP-ARDEV MMS packet formats

Now we need to tidy where the above deleted/modified items are used.

Starting with an easy one, remove references to the MLME-UWB-PACKET primitive is used. The only place it appears in the Table 8-1 list of MLME primitives. This table also needs modification to remove the MLME-STS primitive row. The D01 text is only adding lines, now we want to add and remove lines which is achieved as follows:

In 8.2.1 existing "insert" of new rows becomes a "change" to both delete and insert rows in Table 8-1, i.e., remove this:

8.2.1 Primitives supported by the MLME-SAP interface

~~*Insert the following rows new rows into Table 8-1:*~~

Table 8-1—Summary of the primitives accessed through the MLME-SAP

Name	Request	Indication	Response	Confirm
~~MLME-UWB-PACKET~~	~~10.29.9.5.1~~	~~-~~	~~-~~	~~10.29.9.5.2~~
MLME-WU-RX	10.42.2.1	10.42.2.3	-	10.42.2.2
MLME-WU-TX	10.42.2.4	-	-	10.42.2.5

… and, replace with the below showing the inserted underlined roes and deleted ~~strikeout~~ rows.

8.2.1 Primitives supported by the MLME-SAP interface

Change the following rows in Table 8-1, (only changed rows are shown):

Table 8-1—Summary of the primitives accessed through the MLME-SAP

Name	Request	Indication	Response	Confirm
~~MLME-STS~~	~~10.29.9.4.1*~~	-	-	~~10.29.9.4.2*~~
MLME-WU-RX	10.42.2.1	10.42.2.3	-	10.42.2.2
MLME-WU-TX	10.42.2.4	-	-	10.42.2.5

Now we need to tidy up wherever the MLME-STS primitive and related configuration is mentioned.

Firstly, in clause 16.2.1 of the base standard we have Table 16-1 listing STS packet structures with note below referencing the PIB attributes. This table can be deleted since it is replaced by the new Table X (above) listing all the UWB packet formats, and the STS packet structures are graphically specified in Figure 16-3. The only other info in Table 16-1 is specifying the mandatory and optional formats, and this can be captured in text, aligning with how we did it for the sensing packets. These changes are given below:

Insert the following to show the required changes to the base standard:

Change final paragraph of subclause 16.2.1 as shown, deleting Table 16-1 and the note below it:

The HRP-ERDEV shall support transmission and reception of ~~packets as specified in Table 16-1. Figure 16-3 provides an informative depiction of the STS position in the PPDU as well as the position of the RMARKER as defined in 10.29.1.~~ STS packet configurations zero, one and three shown in Figure 16-3, with support for STS packet configuration two being optional. The RMARKER position is specified in 10.29.1, the RMARKER depiction in Figure 16-3 is informative.

~~Table 16-1—PPDU STS packet structure configurations~~

~~STS packet configuration specifier value (see note)~~	~~Selected the position of the STS in the PPDU~~	~~Support~~
~~0~~	~~There is no STS field included in the PPDU.~~	~~Mandatory~~
~~1~~	~~The STS field is placed immediately after the SFD field and before the PHR field.~~	~~Mandatory~~
~~2~~	~~The STS field is placed after the PHY Payload field.~~	~~Optional~~
~~3~~	~~The STS field is placed immediately after the SFD field and no PHR or Data fields are included.~~	~~Mandatory~~

~~NOTE—the STS packet configuration specifier value in Table 16-1 applies to the TxStsPacketStructure and RxStsPacketStructure parameters of the MLME-STS.request primitive specified in 10.29.9.4.1 and to the *phyHrpUwbStsTxPacketConfig* and *phyHrpUwbStsRxPacketConfig* attributes.~~

The next place where the MLME-STS primitive is used is in the base standard clause 10.29.6.5 and the changes necessary to capture in 4ab.:

10.29 Ranging

In clause 10.29 insert the following to show the changes to the base standard:

10.29.6 Ranging procedures

10.29.6.5 Ranging procedure for SS-TWR with fixed reply time

Replace Figure 10-206 with the following:

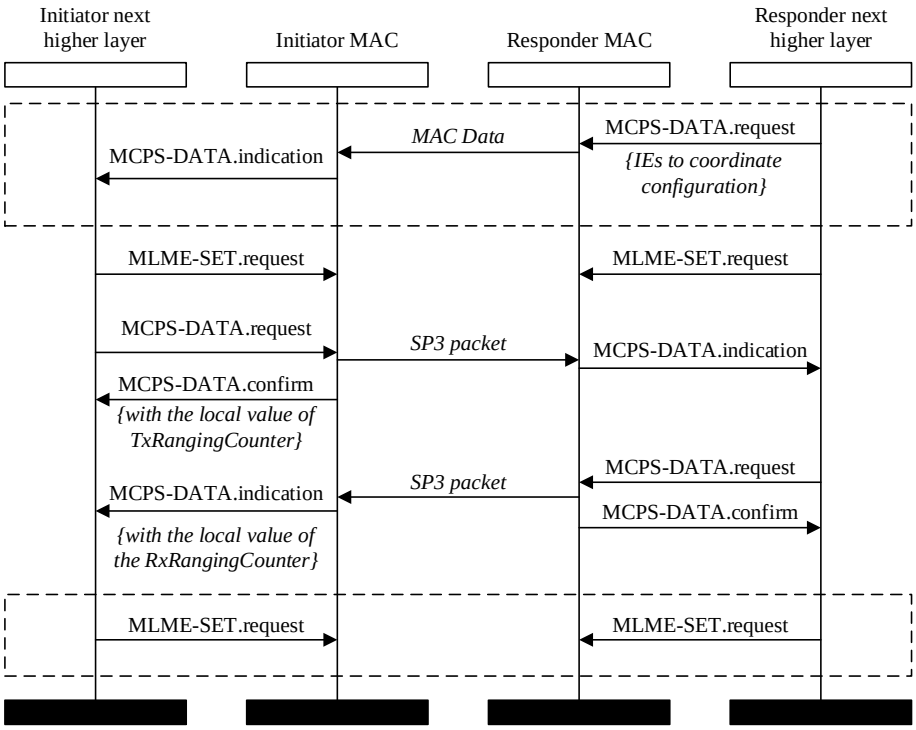


Figure 10-206—Message sequence chart for SS-TWR using SP3 packets

Change the fourth paragraph of 10.29.6.5 as shown:

The next higher layer is responsible for properly configuring the operation at each end using the ~~MLME-STS.request~~ MLME-SET.request primitive to configure the SP3 packet format at both ends, and for setting the PIB attributes *phyHrpUwbStsSeed*, *phyHrpUwbStsVCounter*, and *phyHrpUwbStsVUpper96* to the correct values. Once the higher layer has selected the SP3 packet configuration, subsequent MCPS-DATA primitives relate to SP3 packets, until the higher layer uses the ~~MLME-STS.request~~ MLME-SET.request primitive to change the packet configuration.

Change the seventh paragraph of 10.29.6.5 as shown:

The ranging exchanges are repeated as many times as the higher layers have mutually agreed. To resume PHY and MAC data interactions, the next higher layer uses the ~~MLME-STS.request~~ MLME-SET.request primitive to restore the ~~STS~~ packet configuration to a value that allows such data interactions. This is shown in the final dashed box in Figure 10-206.

The next place where the MLME-STS primitive is used is in the base standard clause 10.32.8.2 and the changes necessary to capture in 4ab.:

10.32 Ranging: Multi-node ranging

In clause 10.32 insert the following to show the changes to the base standard:

10.32.8 Ranging procedures with SP3 format packets

10.32.8.2 Ranging procedure for multi-node SS-TWR with SP3 packets

Change the second, third and fourth paragraphs of 10.32.8.2 as shown:

Multi-node SP3 ranging is based on scheduling determined by the next higher layer of the controller, where each time slot is allocated to a particular ERDEV to use. The RDM IE (described in 10.32.9.8) in the RCM is used to convey the assignment of time slots and device roles in a ranging round. The ARC IE (described in 10.32.9.1) specifies the ranging procedure and the SP3 packet format, thus the ERDEV next higher layer is -aware of the SP3 ranging phase start and end, and can invoke the ~~MLME-STS~~ MLME-SET primitive to enable (and disable) the SP3 packet configuration before (and after) the ranging phase. The RCM may convey the RSSD IE (described in 10.29.8.2) to exchange the parts of the STS seed to initialize the generation of STS among participating ERDEVs. According to the scheduling information of ranging transmissions, the value of the STS counter at the participating ERDEVs needs to be appropriately advanced and set for transmission and reception of the SP3 packets.

After the RCM, the SP3 ranging starts. The next higher layer is responsible for properly configuring the operation at both ends, which involves use of the ~~MLME-STS.request~~ MLME-SET.request primitive to select the SP3 packet format, and setting the phyHrpUwbStsSeed, phyHrpUwbStsVUpper96, and phyHrpUwbStsVCounter attributes to the correct values. Since ranging scheduling is specified by the RCM in advance of the SP3 ranging, the devices already know the identities of the participants. Figure 10-243 and Figure 10-244 are based on the time structure shown in Figure 10-225, where the ranging controller adds the SRRR IE (described in 10.32.9.9) to the RCM as required. In some specific applications, the need for reports can be known a priori by means of an out-of-band mechanism. The MAC sublayer of each device reports the arrival time of the received RFRAME to its next higher layer via the MCPS-DATA.indication, so that this information can be used to calculate reply time or round-trip time measurement.

Since multi-node SP3 ranging is based on the scheduling determined by the next higher layer of the controller, each time slot is allocated to a particular RDEV to use. With a fixed ranging procedure indicated by the Ranging Round Usage field of the ARC IE (described in 10.32.9.1), the RDEV knows when the SP3 ranging phase will be completed, and can configure the packet format ~~properly~~ for the measurement report phase via the ~~MLME-STS.request~~ MLME-SET.request primitive.

The next place that needs to change is clause 10.32.9.1 Advanced Ranging Control IE (ARC IE), where Table 10-165—"Values of STS Packet Config field in the ARC IE" is referencing the deleted Table-16.1. The following are the changes necessary to capture this in 4ab.:

In clause 10.32 insert the following to show the changes needed:

10.32.9 Nested IEs for multi-node ranging

10.32.9.1 Advanced Ranging Control IE (ARC IE)

Change Table 10-165 as shown:

Table 10-165—Values of STS Packet Config field in the ARC IE

STS Packet Config field value	Resultant ~~STS~~ packet configuration
0	Basic packet, with no STS field in the PPDU. ~~No STS field included in the PPDU.~~
1	STS packet configuration one, as per Table X. ~~structure #1 as per specified in Table 16-1.~~
2	STS packet configuration two, as per Table X. ~~structure #2 as per specified in Table 16-1.~~
3	STS packet configuration three, as per Table X. ~~structure #3 as per specified in Table 16-1.~~

The phyHrpUwbStsTxPacketConfig attribute (that we have renamed) is referenced in 16.2.2 PPDU encoding process step (f). The following changes the text to use the new more general phyHrpUwbTxPacketConfig attribute instead.

Insert the following at clause 16.2.2 to show the changes to make with respect to the base standard:

16.2.2 PPDU encoding process

Change step (f) as shown:

(f) For HRP-ERDEV, produce the STS as described in 16.2.9 according to the setting of the ~~*phyHrpUwbStsTxPacketConfig*~~, *phyHrpUwbTxPacketConfig*, *phyHrpUwbStsTxSegLen*, and *phyHrpUwbStsTxSegNum* attributes.

Some more tidying is needed, in clause 16.2.7.3 where the removed Table 16-17 referenced. We already have the 16.2.7.3 heading, so we just need to insert the paragraph with the change to remove the reference.

16.2.7.3 PHR field for HRP ERDEV in HPRF mode

Insert the following at clause 16.2.2 to show the changes to make with respect to the base standard:

Change the fourth paragraph of 16.2.7.3 as shown:

In the optional PPDU format where the STS follows the payload, i.e., STS packet configuration two, ~~as selected by STS packet configuration value of 2 (in Table 16-1),~~ the additional functionality PHR bits A1 and A0 may be optionally used to signal an additional gap between the payload and the STS. Where this feature is being employed, the receiver shall interpret A1 and A0 to select the gap as specified by the PIB attributes listed in Table 16-15. It is the responsibility of the higher layers to correctly set the *phyHrpUwbPhrA0* and *phyHrpUwbPhrA1* attributes so that A1 and A0 are correctly set in the PHR, and that the appropriate *phyHrpUwbStsPC2TxGap* is set to correctly align with the remote receiver's configuration of the attributes in Table 16-15.

There is another reference to the deleted Table 16-1 in 16.2.91, and the following change removes this.

16.2.9 Scrambled timestamp sequence (STS) field

Insert the following at 16.2.9.1 to show the changes to make:

16.2.9.1 General

Change the final paragraph of 16.2.9.1 as shown:

In the optional PPDU format where the STS follows the payload, (i.e., STS packet configuration two ~~value of 2 in Table 16-1~~), an optional additional gap as specified by the *phyHrpUwbStsPC2TxGap* attribute shall be inserted between the PSDU and the STS.

Tidying, to remove references to the MLME-STS primitive in clause 16.2.9.3, the following changes are needed:

Insert the following at 16.2.9.3 to show the changes to make with respect to the base standard:

16.2.9.3 Forming the STS

Change the Note 1, below Table 16-18, and the Note 2, below Table 16-19, as shown:

Table 16-18—STS segment length configuration

NOTE 1—The segment length specifier value in Table 16-18 applies to ~~the TxStsSegmentLength and RxStsSegmentLength parameters of the MLME-STS.request primitive specified in 10.29.9.4.1 and to~~ the *phyHrpUwbStsTxSegLen* and *phyHrpUwbStsRxSegLen* attributes.

Table 16-19—STS number of segments configuration

NOTE 2—The number of segments specifier value in Table 16-19 applies to ~~the TxStsNumberSegments and RxStsNumberSegments parameters of the MLME-STS.request primitive specified in 10.29.9.4.1 and to~~ the *phyHrpUwbStsTxSegNum* and *phyHrpUwbStsRxSegNum* attributes.

And that is it…. ALL DONE.

<END >