**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **Primitives for sensing** - **addressing CIDs 220 and 221** |
| Date Submitted | 30th May 2024 |
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| Re: | Comment Resolutions |
| Abstract | Comment Resolutions for selected comments on the Pre-Ballot Draft C of the P802.15.4ab amendment. |
| 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 consolidated comments spreadsheet (doc 15-24-0010) that have been assigned to the author to resolve. |
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# Introduction:

This document provides changes to incorporate primitives for sensing, addressing CID 220 and 221.

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| --- | --- | --- | --- | --- | --- |
| **Index#** | **Pg** | **Sub-Clause** | **Ln** | **Comment** | **Proposed Change** |
| 220 | 111 | 10.39.7 | 25 | The standard is missing API primitives to configure sensing frame format, and to send and report sensing frames. I recommend we use the MCPS-DATA primitives for TX and RX of SENS frames. And something like the MLME-STS primitive for configuration. | Add/Modify appropriate primitive for configuration of SENS packet format, and MCPS primitives to include any additional parameters to support sensing packet to transmission and reception. |
| 221 | 111 | 10.39.7 | 26 | The text is missing procedures with respect to upper layer interactions. If we take 15-23-0208 as a good model for this, then lets generate text to cover the necessary interactions and provide (or update existing) primitives to give the necessary controls and/or status reports. For example, I reckon that after reception of a sensing packet that higher layer (sensing application) should extract the CIR and generate the sensing report (formatting the IE) which it tells the MAC to send it in the appropriate slot when the intended recipient device is scheduled to listen for it.  | Add/Modify appropriate primitives to support sensing, e.g., extract CIR, etc., and define the procedures also. |

**Four things to tackle to addresss this:**

* **Primitive to send the sensing packets**
* **Primitive to receive the sensing packets**
* **Primitive to extract the CIR**
* **Primitive to select sensing packet formats**

**1 Use the MCPS-DATA primitives to send the sensing packets**

Reuse the MCPS-DATA.request primitive for sending the sensing packets since Sensing packets may have data. MCPS-DATA is already used for similar STS packets. (Assuming a separate primitive to configure the sensing packet mode)… Then all that is needed is a TxOptions parameter (SensReceive) to say whether it is TX with/without RX on at the same time depending on whether the device is doing/supporting the monostatic sensing case.

No change of MCPS-DATA.confirm is needed. The MCPS-DATA.confirm informs the application that the packet transmission has complerted and if the application set the SensReceive parameter in TxOptions, (to enable reception for the monostatic sensing case), it knows that a sensing CIR should be available.

**Changes to the draft:**

**8.3.3 TxOptions**

***Insert new parameters into the TxOptions, Table 8-29, (802.15.4 ME D3 sub-clause 8.3.3) as shown below:***

**Table 8-29—Elements of the TxOptions**

| **Name** | **Type** | **Valid range** | **Description** |
| --- | --- | --- | --- |
| SensReceive  | Boolean  | TRUE, FALSE | For sensing, this parameter is set TRUE if the receiver is to be turned on during packet transmission so that the echoes of the packet can be received in parallel to the transmission. This enables the monostatic sensing use case if supported. When this parameter is FALSE the receiver is not turned on for sensing on during the packet transmission. |
|  |  |  |  |

**2 Use the MCPS-DATA primitives to receive the sensing packets?**

For the receive side, (with monostatic already handled by the TxOptions change above), no changes are needed….

For the multistatic receive only situation, the MLME-RX-ENABLE primitive would be used to turn on the RX for the device to receive the sensing packet. (Assuming, again, a separate primitive to configure the sensing packet mode)…

The PHY receiver will be expecting the right packet format, so then, when a packet is received the MCPS-DATA.indication tells the application that a reception has occurred, and the application knows a sensing CIR should be available assuming it has configured a sensing packet mode.

NO change needed to the MLME-RX-ENABLE primitives or the MCPS-DATA.indication.

**3 Extracting the CIR**

In 4a the MLME-SOUNDING primitives were provided to extract the CIR in case of further processing being needed, (in that case it was to identify the first path). For Sensing we should reuse this, but modify it to give the format needed. The original sounding report had a Amplitudes list, for sensing we want an I/Q list, so we need a parameter to select between these.

**Changes to the draft:**

***Change the MLME-SOUNDING.request as shown below:***

**10.29.9.2.2 MLME-SOUNDING.request**

The MLME-SOUNDING.request primitive is used by the next higher layer to request ~~that the PHY respond with~~ channel sounding information, (i.e., the CIR data). ~~The MLME-SOUNDING.request primitive shall be supported by all RDEVs; however, the underlying sounding capability is optional in all cases.~~

The semantics of this primitive are as follows:

MLME-SOUNDING.request ( FormatSpecifier )

~~If the feature is supported, the MLME will begin the sounding procedure.~~

The MLME will respond with the MLME-SOUNDING.confirm delivering the sounding information and a Status of SUCCESS, or with the Status paramerter indicating an error condition.

***Insert new Table X as shown:***

**Table X—MLME-SOUNDING.request parameters**

| Name | Type | Valid range | Description |
| --- | --- | --- | --- |
| FormatSpecifier | Enumeration | AMPLITUDE\_FORMAT,IQ\_FORMAT | These are the formats supported/described for the MLME-SOUNDING.confirm primitive, as specified in 10.29.9.2.3. |
| … |  |  |  |

***Change the MLME-SOUNDING.confirm as shown below:***

**10.29.9.2.3 MLME-SOUNDING.confirm**

The MLME-SOUNDING.confirm primitive reports the result of a request ~~to the PHY~~ to provide channel sounding information, (i.e., the CIR data). ~~The MLME-SOUNDING.confirm primitive shall be supported by all RDEVs; however, the underlying sounding capability is optional in all cases.~~

The semantics of this primitive are as follows:

MLME-SOUNDING.confirm (

SoundingList,

Status

)

The primitive parameters are defined in Table 10-155.

**Table 10-155—MLME-SOUNDING.confirm parameters**

| Name | Type | Valid range | Description |
| --- | --- | --- | --- |
| ~~SoundingList~~SoundingListSet | Set of lists ~~List~~ of sounding points | — | Results of the sounding measurement. This is a set of lists, each giving a series of sounding points for a CIR generated from a received sequence. The set of lists represents a set of CIRs, one for each separately generated CIR, with respect to separate sequences, receive strips, antennas, etc.The format of the list elements depends on the requested by in MLME-SOUNDING.request by the FormatSpecifier parameter.  |
| Status | Enumeration | SUCCESS, NO\_DATA,UNSUPPORTED\_ATTRUIBUTE | The status of the attempt to return sounding data. |

The elements of a SoundingList for the format selected by FormatSpecifier of AMPLITUDE\_FORMAT are defined in Table 10-156.

**Table 10-156—Elements of a SoundingList for** **FormatSpecifier of AMPLITUDE\_FORMAT**

| Name | Type | Valid range | Description |
| --- | --- | --- | --- |
| SoundingTime | Signed integer | — | The LSB represents a nominal 16 ps. (see NOTE). |
| SoundingAmplitude | Signed integer | — | A relative measurement or the received signal strength. |
| NOTE—Each element of the SoundingList contains a SoundingTime and a SoundingAmplitude. The SoundingTime is a signed integer, and the LSB for the HRP UWB PHY represents a nominal 16 ps (2-7 of a chip time), and for the LRP UWB PHY 1ps (2-20 of a chip time). The SoundingAmplitude is a signed integer representing a relative measurement. The SoundingAmplitudes have no absolute meaning, only a relative meaning. |

The elements of a SoundingList for the format selected by FormatSpecifier of IQ\_FORMAT are defined in Table Y. Support for this format is mandatory for an SDEV.

**Table Y—Elements of a SoundingList for** **FormatSpecifier of IQ\_FORMAT**

| Name | Type | Valid range | Description |
| --- | --- | --- | --- |
| SoundingTime | Signed integer | — | As per Table 10-156. |
| SoundingInphaseValue | Signed integer | — | A relative measurement or the received signal strength for an in-phase CIR tap |
| SoundingQuadratureValue | Signed integer | — | A relative measurement or the received signal strength for a quadrature CIR tap. |
| NOTE—The in-phase and quadrature values have no absolute meaning, only a relative meaning. |

If the channel sounding information is available, the Status parameter will be set to SUCCESS, and the SoundingListSet will contain valid data. If the MLME-SOUNDING.request primitive is received when there is no information present, e.g., when the PHY is in the process of performing a measurement, the Status parameter will be set to NO\_DATA.

If the channel sounding ~~capability~~ function or the requested format is not supported ~~by the PHY~~, the Status parameters will be set to UNSUPPORTED\_ATTRIBUTE.

**3 Configuring the packet format for sensing**

Editor to insert the primitive in appropriate place..

**Changes to the draft:**

***Insert the MLME-UWB-PACKET.request as shown below:***

**x.x.x Primitives for specifying UWB Packet format**

**x.x.x.1 MLME-UWB-PACKET.request**

The MLME-STS.request primitive allows the next higher layer to request that the HRP-ERDEV utilizes a given set of STS parameters.

The semantics of this primitive are:

 MLME-UWB-PACKET.request (

PacketStructure,

PackerSpecificParameters,

)

The primitive parameters are defined in Table 30.

**Table z—MLME-UWB-PACKET.request parameters**

| **Name** | **Type** | **Valid range** | **Description** |
| --- | --- | --- | --- |
| PacketStructure | Enumeration | SENS\_PACKET\_0, SENS\_PACKET\_1, SENS\_PACKET\_2 | SENS\_PACKET\_n define one of the three sensing packet formats as per Figure 188. |
| PacketSpecificParameters | structure | – | This specifies parameters associated with the selected PacketStructue.  |
|  |  |  |  |

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

* + - 1. **MLME-** UWB-PACKET**.confirm**

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

The semantics of this primitive are:

 MLME- UWB-PACKET.confirm (

Status,

)

The primitive parameter is defined in Table Z.

**Table Z—MLME-** **UWB-PACKET.confirm parameters**

| **Name** | **Type** | **Valid range** | **Description** |
| --- | --- | --- | --- |
| Status | Enumeration | SUCCESS, INVALID\_PARAMETER | 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 any parameter in the MLME- UWB-PACKET.request primitive is not supported or is out of range, the 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.

***<END >***