**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **Text for UWB only MMS ranging** | |
| Date Submitted | July 2023 | |
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| Re: | Contribution to IEEE 802.15.4ab | |
| Abstract |  | |
| Purpose | This submission proposes text to for the IEEE Std 802.15.4ab specification framework document. | |
| Notice | This document does not represent the agreed views of the IEEE 802.15 Working Group or IEEE 802.15.4ab Task Group. It represents only the views of the participants listed in the “Sources” field above.It is offered as a basis for discussion and is not binding on the contributing individuals. The material in this document is subject to change in form and content after further study. The contributors reserve the right to add, amend or withdraw material contained herein. | |

**Rational for this proposal.**

To propose simple changes to “P802.15.4ab™/D (pre-ballot) B Draft Standard for Low-Rate Wireless Networks” to make the text inclusive of UWB-only MMS.

**All the text after this page is from the draft with proposed changes and comments.**

**10.35 Multi-millisecond (MMS) UWB operation**

**10.35.1 Introduction**

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The NBA-MMS and the UWB driven MMS approaches share common methods and messages, albeit using different PHY layers for the control and initiation of the MMS ranging and the associated reporting phases. To allow common text cover both approaches, the term MMS Control (PHY) is used to mean either.

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**10.35.3 MMS initialization and setup**

**10.35.3.1 Overview**

An MMS ranging session is configured by a set of parameters for PHY and MAC. The set of PHY parameters include as appropriate MSS Control and UWB PHY configuration of channels, modulation, and data rate to be used for control, ranging, and report phases. The MAC parameters include the slot, round, and block configuration for control, ranging, and report phases.

To start an MMS ranging session, a pair of initiator and responder devices may engage in an initialization and setup phase to negotiate a ranging configuration different from the default set of parameters. Configuration attributes as given in Table 7may be changed by the higher layer prior to the initialization and setup phase.

**10.35.3.2 Session initialization**

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To establish initialization, devices should opportunistically transmit and receive on the initialization channel using the PHY modulation, as specified in the default ranging session configuration or as configured prior to initialization via higher layer protocols. The initiator may send advertising poll (ADV-POLL) messages opportunistically at times and intervals to its discretion as deemed suitable for the higher layer functionality to be supported. Similarly, the responder may opportunistically listen for incoming ADV-POLL messages.

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If the coordination is active, the initiator determines the configuration for the ranging session based on knowledge of UWB channel usage learned from acquisition packets (APs) received from other initiators as described in 10.35.3.6. For coordination of channel use, the initiator may scan for AP packets before transmitting the SOR packet. To perform scanning for coordination and defer the transmission of the SOR packet, the initiator sends an ADV-CONF with the time offset between the end of the ADV-CONF packet and beginning of the SOR packet after the reception of ADV-RESP. This is illustrated in Figure 20.

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**10.35.3.2.1 Initialization configuration**

Channel access during initialization phase shall be conducted using back-to-back transmission slots with no IFS between slots. Packet transmissions shall start at the beginning of an initialization slot only. The macMmsInitSlotDuration attribute specifies the initialization slot duration. The default value may be changed by the next higher prior to use or via the first messages accessing the initialization channel (ADV-POLL, PUBLIC-ADV-POLL).

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**10.35.3.4 Initialization setup handshake**

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The ADV-RESP and SOR packets defined in 10.35.9 may contain the common fields e.g. NB\_Channel\_Select, UWB\_PHY\_Config, UWB\_MAC\_Config, NB\_PHY\_Config, and NB\_MAC\_Config. For these fields, the initiator may either use the same values received via ADV-RESP from the responder, or change the values of each field before transmitting the updated field values in the SOR packet.

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In addition to the common ranging configuration fields, the initiator shall provide synchronization information in the SOR message. To synchronize the start of the first ranging block (RangingBlockIndex=0) with the responder, the initiator shall set the value of the field Time\_Offset to the time difference between the start of the SOR packet and the beginning of the first ranging block. In NBA MMS to enable synchronized switching of NB channels the initiator shall set the value of NB\_Channel\_Seed. The responder shall apply the provided value to calculate the NB channel index used during the first and all following ranging blocks as defined in 10.35.7.4.

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**10.35.9.3 Common message fields**

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**10.35.9.3.6 The NB Channel Select field.**

This is a two-octet field to specify allowed NB channels, formatted as shown in Figure 36.

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**10.35.9.3.7 The Ranging PHY Config field**

This is a three-octet field formatted as shown in Figure 37.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Bits: 0–5** | **6–12** | **13–15** | **16–17** | **18–21** | **21–23** |
| Preamble Code Index | MMRS complementary set zeros | N\_MSR | STS Segment Length | UWB channel | Reserved |

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**10.35.9.3.8 The RangingMAC Config field**

This is a one-octet field formatted as shown in Figure 38.

|  |  |  |  |
| --- | --- | --- | --- |
| **Bits: 0–2** | **3–5** | **6** | **7** |
| X RSF | Y RIF | Z RSF-to-RIF gap | reserved |

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**10.35.9.3.9 The NB Control MAC Config field**

This field is formatted as shown in Figure 39.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Bits: 0–2** | **3–10** | **11–18** | **19** | **20** | **21–23** | **24–27** | **28–31** | **32–43** | **44–47** | **48–51** | **52–55** |
| Ranging Slot Duration | Ranging Round Duration | Ranging Block Duration | Channel Switching | Measurement Report Request | Reserved | RcpPollSlots | RcpResponseSlots | RpDuration | RpOffset | MrpFirstSlots | MrpSecondSlots |

**Figure 39—The NB Control MAC Config field**

Ranging Slot Duration {300, 600, …, 2400} RSTUs

Ranging Round Duration 0-255 ranging slots

Ranging Block Duration 0-255 ranging rounds

Channel Switching: 0=Disabled, 1=Blockwise

Measurement Report Request: 0=No, 1=Yes

RcpPollSlots=0-15

RcpResponseSlots=0-15

RpDuration=0-4095

RpOffset=0-15

MrpFirstSlots=0-15

MrpSecondSlots=0-15

**10.35.9.3.xx The UWB Control MAC Config field**

This field is formatted as shown in Figure xxx.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Bits: 0–2** | **3–10** | **11–18** | **19** | **20** | **21–23** | **24–27** | **28–31** | **32–43** | **44–47** | **48–51** | **52–55** |
| Ranging Slot Duration | Ranging Round Duration | Ranging Block Duration | Reserved | Measurement Report Request | Reserved | RcpPollSlots | RcpResponseSlots | RpDuration | RpOffset | MrpFirstSlots | MrpSecondSlots |

**Figure xxx—The UWBNB MAC Config field**

Ranging Slot Duration {300, 600, …, 2400} RSTUs

Ranging Round Duration 0-255 ranging slots

Ranging Block Duration 0-255 ranging rounds

Measurement Report Request: 0=No, 1=Yes

RcpPollSlots=0-15

RcpResponseSlots=0-15

RpDuration=0-4095

RpOffset=0-15

MrpFirstSlots=0-15

MrpSecondSlots=0-15

**10.35.9.3.10 The Request Bitmap field**

This is a one-octet field formatted as shown in Figure 40.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Bits: 0** | **1** | **2** | **3** | **4** | **5–7** |
| NbaChannelMap requested if NB Control PHY otherwise reserved | Control PHY Config requested | Control MAC Config requested | Ranging PHY Config requested | Ranging MAC Config requested | reserved |

**Figure 40—The Request Bitmap field**

The Control PHY Config and the Control MAC Config is either both the NB Control PHY Config and the NB Control MAC Config or both the UWB Control PHY Config and the UWB Control MAC Config.

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**10.35.9.3.14 The NB Control PHY Config field**

This is a three-octet field formatted as shown in Figure 41.

|  |  |
| --- | --- |
| **Bits: 0–3** | **4–7** |
| Control Phase Config | Report Phase Config |

**Figure 41—The NB Control PHY Config field**

**10.35.9.3.xx The UWB Control PHY Config field**

This is a three-octet field formatted as shown in Figure xxx.

|  |  |
| --- | --- |
| **Bits: 0–3** | **4–7** |
| Control Phase Config | Report Phase Config |

**Figure xxx—The UWB Control PHY Config field**

< add text to describe/define the above fields >

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**10.35.9.5 ADV-RESP**

This is the advertising response message used by the responder during the initialization phase. The ADV-RESP message shall be formatted as shown in Figure 44.

|  |  |  |
| --- | --- | --- |
| **Octets: 3** | **1** | **variable** |
| RPA hash | Message Control | Message Content |

**Figure 44—ADV-RESP Compact Message**

The RPA Hash field shall be set as specified in 10.35.9.2.1.

The Message Control field and Message Content field shall be one of the following:

For the Message Control field value of zero, the Message Content field shall be formatted as shown in Figure 45.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Octets: 2** | **3** | **2** | **1** | **7** |
| NB Channel Select | Ranging PHY Configuration | Ranging MAC Configuration | NB Control PHY Configuration | NB Control MAC Configuration |

**Figure 45—Message Content field in ADV-RESP**

< add text to describe/define the above fields >

For the Message Control field value of 0x01, the Message Content field shall be formatted as shown in Figure xx.

|  |  |  |  |
| --- | --- | --- | --- |
| **Octets:3** | **2** | **1** | **7** |
| Ranging PHY Configuration | Ranging MAC Configuration | UWB Control PHY Configuration | UWB Control MAC Configuration |

**Figure xx—Message Content field in ADV-RESP**

For MessageControl=0x10: MessageContent={ Presence Bitmap[1],

If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},

If Bit 1 of Presence Bitmap == 1 then {NB Control PHY Config[1]},

If Bit 2 of Presence Bitmap == 1 then {NB Control MAC Config[7]},

If Bit 3 of Presence Bitmap == 1 then {Ranging PHY Config[3]},

If Bit 4 of Presence Bitmap == 1 then {Ranging MAC Config[2]}}

For MessageControl=0x11: MessageContent={ Presence Bitmap[1],

If Bit 0 of Presence Bitmap == 1 then {UWB Control PHY Config[1]},

If Bit 1 of Presence Bitmap == 1 then {UWB Control MAC Config[7]},

If Bit 2 of Presence Bitmap == 1 then {Ranging PHY Config[3]},

If Bit 3 of Presence Bitmap == 1 then {Ranging MAC Config[2]}}

For MessageControl=0x20: MessageContent={ SMC TLVs[]}

For MessageControl=0x30: MessageContent={ SMC TLVs[], Presence Bitmap[1],

If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},

If Bit 1 of Presence Bitmap == 1 then {NB Control PHY Config[1]},

If Bit 2 of Presence Bitmap == 1 then {NB Control MAC Config[7]},

If Bit 3 of Presence Bitmap == 1 then {Ranging PHY Config[3]},

If Bit 4 of Presence Bitmap == 1 then {Ranging MAC Config[2]}}

For MessageControl=0x31: MessageContent={ SMC TLVs[], Presence Bitmap[1],

If Bit 0 of Presence Bitmap == 1 then {UWB Control PHY Config[1]},

If Bit 1 of Presence Bitmap == 1 then {UWB Control MAC Config[7]},

If Bit 2 of Presence Bitmap == 1 then {Ranging PHY Config[3]},

If Bit 3 of Presence Bitmap == 1 then {Ranging MAC Config[2]}}

**10.35.9.6 SOR**

This is the start of ranging message used by the initiator during the initialization phase. The SOR message shall be formatted as shown in Figure 46.

|  |  |  |
| --- | --- | --- |
| **Octets: 3** | **1** | **variable** |
| RPA hash | Message Control | Message Content |

**Figure 46—SOR Compact Message**

The RPA Hash field shall be set as specified in 10.35.9.2.1.

For MessageControl=0x00:

The Message Content field shall be formatted as shown in Figure 47.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Octets: 4** | **1** | **2** | **3** | **2** | **1** | **7** |
| Time Offset | NB Channel Seed | NB Channel Select | Ranging PHY Configuration | Ranging MAC Configuration | NB Control PHY Configuration | NB Control MAC Configuration |

**Figure 47—Message Content field in SOR**

< add text to describe/define the above fields >

For MessageControl=0x01:

The Message Content field shall be formatted as shown in Figure xx.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Octets: 4** | **3** | **2** | **1** | **7** |
| Time Offset | Ranging PHY Configuration | Ranging MAC Configuration | UWB Control PHY Configuration | UWB Control MAC Configuration |

**Figure xx—Message Content field in SOR**

< add text to describe/define the above fields >

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**10.35.9.18 PUBLIC-SOR**

This is the public start of ranging message used by the responder during the initialization phase. The PUBLIC-SOR message shall be formatted as shown in figxxxx.

|  |  |  |  |
| --- | --- | --- | --- |
| **Octets: 3** | **3** | **1** | **variable** |
| ADV Address | Resp Address | Message Control | Message Content |

**Figure 61—PUBLIC-SOR Compact Message**

The ADV Address field and Resp Address field shall be set as specified in x.x.x.

MessageControl=0x00: MessageContent={ Time Offset[4], NB Channel Seed[1], NB Channel Select[2], NB Control PHY Config[1], NB Control MAC Config[7], Ranging PHY Config[3], Ranging MAC Config[2]}

MessageControl=0x00: MessageContent={ Time Offset[4], UWB Control PHY Config[1], UWB Control MAC Config[7], Ranging PHY Config[3], Ranging MAC Config[2]}

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**10.35.10 MAC constants and PIB attributes for MMS operation**

**10.35.10.1 MMS specific MAC PIB attributes**

**Table 7—MMS related MAC PIB attributes**

| Attribute | Type | Range | Description | Default |
| --- | --- | --- | --- | --- |
| *macMmsNbChannelMap* | Bitmap | 6 octets | See 10.35.7.4.2 and Figure 29 | - |
| *macMmsNbChannelAllowList* | Array of integers | - | List of channels enabled for channel switching | All channels 0 to 249 allowed and present in the array list. |
| *macMmsNbAllowListLength* | Integer | 0–250 | Length of the channel allow list array | 250 |
| *macMmsPrngSeed* | Integer | 0–255 | Seed value for the channel switching function | 0 |
| *macMmsReportMode* | Integer | 0–3 | 0 – None,  1 – Initiator,  2 – Responder, 3 – Responder and Initiator. | 3 |
| *macMmsRcpPollNSlots* | Integer | 0–16 | Number of slots allocated to the Control Phase Poll message | 2 |
| *macMmsRcpRespNSlots* | Integer | 0–16 | Number of slots allocated to the Control Phase Response message | 2 |
| *macMms1stReportNSlots* | Integer | 0–16 | 2 slots = 1 ms for 1st report period | 2 |
| *macMms2ndReportNSlots* | Integer | 0–16 | 2 slots = 1 ms for 2nd report period | 2 |
| *macMmsNbInitChannel* | Integer | 0–249 | Initialization channel | 2 |
| *macMmsNbInitMode* | Integer | 1–9 | Modulation mode for initialization phase, values relate to Table 28. | 1 |
| *macMmsUwbInitChannel* | Integer | TBD | TBD | TBD |
| *macMmsUwbInitMode* | Integer | TBD | TBD | TBD |
| *macMmsInitSlotDuration* | Integer | 600+300×N, 0 ≤ N ≤ 15 | Initialization slot duration in RSTU | 1800 |
|  |  |  |  |  |