**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | Proposed Comments Resolution on Draft C7, [52, 318, 683, 894], [212, 901], [80, 81, 90, 91, 729], 29, 296, 879 |
| Date Submitted | May 2024 |
| Sources | Carl Murray (Qorvo) |  |
| Re: |   |
| Abstract |  |
| Purpose | To propose comments resolution for “P802.15.4ab™/D (pre-ballot) C Draft Standard for Low-Rate Wireless Networks”  |
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Revision 1 : Functional changes

* Added text on initialization and setup for UWB driven on page 3.
* Added the following text to page 6: The values 1.5ms and 2ms shall be supported for A in Figure 1.

Revision 1 : Editorial changes

* Corrected typo on page 6: changed ‘Figure 1’ to ‘Figure 2’ in text
* Reordered paragraphs in section 6.5

Revision 2 : Functional changes

* Added option #4 to Section 6 and now add this as the resolution

Revision 3 :

* Removed CIDs [859-862]. They will be covered in document 15-24-0326.
* Removed all options from CID #29 and just propose a solution that is technically complete but which can be revisited in LB.

Revision 4 :

* Updated CID #296

## Source Documents

1. 15-24-0156-03-04ab-toward-consensus-before-resolving-mms-ranging-cids.pptx
2. 15-22-0608-01-04ab-header-ie-extension.pptx
3. 15-24-0204-01-04ab-draft-c-comment-resolution-cid-222.docx

## Introduction

This set of comment resolutions is based heavily on the consensus agreed during the TG4ab calls in March/April. This consensus is documented in [1].

Familiarity with this document [1] is assumed.

# Comment ID 7

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 7 | Li-Hsiang Sun | 10.38.3.1 | 43 | 28 | The title of 10.38.3 is "Narrowband MMS initialization and setup". It is not very clear whether it is part of Narrowband assisted (NBA) UWB MMS. Does this clause not apply to UWB driven UWB MMS? | clarify this clause can be used for UWB-driven UWB MMS | Revised |

## Discussion

This resolution draw on the consensus on the agreed configurations in slides #5 and #6 in [1].

## Proposed Resolution – Revised

**In section 10.38.1 on page 42 update lines 10 to 23 as follows -**

This clause describes the UWB MMS operation and the details of the MAC and PHY interactions involved in UWB MMS based two-way ranging. There are ~~three~~ two general methods to initiate the UWB MMS exchange and accumulation, each of which is optional but at least one of which is required to support UWB MMS mode:

⎯ Narrowband assisted (NBA) UWB MMS. Here the O-QPSK PHY described in clause 13 is employed for initialization, setup, control and result reporting and to initiate the UWB MMS packet exchange, and, where O-QPSK PHY shares a common clock source with the UWB PHY, to determine the clock offset to assist the MMS accumulation.

 ⎯ UWB driven UWB MMS. Here UWB itself, (i.e., HRP UWB PHY described in clause 16), is employed for control and result reporting, and to initiate switching to the UWB MMS packet mode at the appropriate times.

 ⎯[*Note to Editor removed as bulleted sentence*]Another PHY may be employed for control and reporting, and to initiate the UWB MMS packet exchange appropriately. This alternative is considered an OOB mechanism and is not detailed below.

**In section 10.38.2 on page 43 update lines 14 to 20 as follows -**

In NBA UWB MMS, the O-QPSK PHY is employed for the initialization, setup, control ~~phase~~ and ~~the~~ report phase, while the HRP UWB PHY is employed for the ranging phase.

In UWB driven UWB MMS, the HRP UWB PHY is employed for the control phase, the ranging phase and ~~optionally~~ the report phase. UWB driven may use the O-QPSK PHY described in clause 13 for initialization and setup. It may also use an OOB mechanism. ~~In this case, the control phase may employ complete UWB packets with data, but its most basic mode consists of just SYNC and SFD fields to provide the initial timing/frequency synchronization for the UWB MMS ranging sequence as described in 16.2.11.1, while the report phase may use UWB data frame(s) or an OOB mechanism.~~

**In section 10.38.3 on page 43 update line 28 as follows -**

**10.38.3 ~~Narrowband~~ MMS initialization and setup**

**In section 10.38.8.1 on page 57 update lines 4 to 5 as follows -**

For the NBA UWB MMS, the O-QPSK PHY is employed in the initialization, setup, control and report phases of the UWB MMS ranging exchange ~~and may also be employed for earlier initialization phases~~.

# Comment IDs 52, 318, 683 and 894

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 318 | Bin Qian | 10.38.1 | 42 | 24 | According to the latest consensus, the interval between the last RSF and the first RIF is fixed to be 2ms, Figure 21 needs to be redrew to clear show Z = 2 | As in the comment | AcceptedDuplicate of #74 |
| 683 | Carl Murray | 10.38.1 | 42 | 24 | In figure 21 where does "1 or 2 ms" come from? |  | Revised |
| 894 | Mickael Maman | 10.38.1 | 42 | 24 | In Figure 21, clarification is needed concerning 1 or 2 ms slot for NB Packet and not for UWB SHR | both 1 or 2 ms | Revised |
| 52 | Alex Krebs | 10.38.1 | 42 | 24, 29-30 | The figure restricts the first slot length to 1 or 2ms, but macMmsRcpPollNSlots is up to 15 variable length slots (see Table-9, p.103) | Figure 21: Remove gray "1 or 2 ms" and "1 ms" text and arrows. Line 29-30: remove "in the preceding millisecond". | Revised |



## Proposed Resolution – Revised

**In section 10.38.1 on page 42 replace Figure 21 by Figure 1 and Figure 2.**



Figure 1 Narrowband assisted UWB MMS ranging transmission



Figure 2 UWB driven UWB MMS ranging transmission

**In section 10.38.1 on page 42** **update lines 26 to 30 as follows -**

~~Figure 21~~ Figure 1 and Figure 2 illustrate the core UWB MMS ranging transmission concept. The UWB ranging sensitivity is improved by combining multiple ranging sequence fragments (RSF) and/or multiple ranging integrity fragments (RIF).~~, with the initial synchronisation for this being provided by either a narrowband (NB) packet sent by the O-QPSK PHY or by an initial UWB SHR sent by the HRP UWB PHY in the preceding millisecond.~~ In both figures the time interval between the start of the packet in the control phase and the start of the MMS packet in the ranging phase as described in 10.38.4 and 10.38.5 respectively is indicated by (A). The values 1.5ms and 2ms shall be supported for A in Figure 1. In the UWB driven MMS ranging transmission case (Figure 2) the HRP UWB PHY MMS packet includes the initial SYNC and SFD fragment specified in 16.2.11.

**In section 10.38.4.1 on page 50 to 51 delete lines 43 to 2 as follows -**

~~Where the control phase is not being provided by the tightly coupled NBA PHY, which could either be because UWB modulation is being used for the One-to-one Poll Compact frame and the RESP Compact frames or because this content is being conveyed by some OOB mechanism, then the transmitted UWB MMS packet~~ ~~shall include the initial SYNC+SFD fragment option specified in 16.2.11. 2~~

**In section 16.2.11.1 on page 160 update lines 18 to 24 as follows -**

The MMS UWB packet consists of multiple fragments which are classified into ~~two~~ three types; a fragment consisting of SYNC and SFD defined in 16.2.6, a ranging sequence fragments (RSF) defined in 16.2.11.2 and ranging integrity fragments (RIF) defined in 16.2.11.3. ~~These are optionally preceded by~~ ~~a fragment consisting of SYNC and SFD, used to obtain initial timing/frequency synchronization. The alternative scheme, where this optional fragment is not present, uses another PHY, assisting the MMS, to provide this initial synchronization.~~ ~~Both~~ ~~these~~ Two cases, Narrowband assisted MMS and UWB driven MMS, are described in 10.38 which defines the procedures and packet exchanges involved in UWB MMS operation which uses these HRP UWB PHY MMS packets.

# Comment IDs 212 & 901

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 212 | Billy Verso | 10.38.9.4.3 | 62 | 22 | This line says "In the ranging phase, one (SYNC + SFD) only packet is transmitted to trigger multiple RSF transmissions." which disagrees with the description in 16.2.11.1 where the SYNC+SDF and the subsequent RSF & RIF fragments are all considered to comprise the packet. | Change this line to read: "In the ranging phase, the UWB MMS packet includes the initial SYNC+SFD fragment, as per Figure 176." | Revised |
| 901 | Mickael Maman | 10.38.9.4.3 | 63 | 1 | Where is Sync SFD only packet? |  | RevisedThere is no SYNC+SFD packet now |

## Proposed Resolution - Revised

**In section 10.38.9.4.2 on page 62 update lines 12 to 18 as follows -**

The procedure for multiple RSF transmissions in a slot is divided into three phases, the control phase, the ranging phase, and the measurement report phase. In the control phase, RSF transmissions are scheduled to have the RSF transmission timing of each responder. In the ranging phase, the initiator sends ~~(SYNC + SFD) packet of UWB or~~ a poll Compact frame ~~of NB~~ to trigger RSF transmission. After that, multiple RSF transmissions occur from the responders to the initiator in the slot. The measurement report phase delivers ranging results from the responders to the initiator. Responders may send Ranging report Compact frames to the initiator to conduct this phase.

**In section 10.38.9.4.3 on page 62 update lines 20 to 24 as follows –**

The operation of multiple RSF transmissions in a slot without NB assist is presented in Figure 41. Control phase is conducted in the UWB channel by transmitting a Data frame that carries the Scheduling IE, (10.31.9.10). In the ranging phase, ~~one (SYNC + SFD) only packet~~ a poll Compact frame is transmitted to trigger multiple RSF transmissions. In the measurement report phase the ranging reports are sent in the UWB channel from the responders to the initiator.

# Comment IDs 80, 81, 90, 91 & 729

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 80 | Pooria Pakrooh | 10.38.10.3.15 | 70 | 8 | Value 13 should refer to SHR only, Value 14 should be set 1 and value 15 set #2 from table 61. Both of these modes have mandatory support for 1.95Mbps. | Change "value 14" to "value 13". | Revised |
| 729 | Carl Murray | 10.38.10.3.15 | 70 | 9 | The protocol does not support this configuration "… selects a control phase consisting of just the UWB SHR...". The UWB SHR only fragment is part of the MMS ranging packet not the control packet | Resolve | Revised |
| 81 | Pooria Pakrooh | 10.38.10.3.15 | 70 | 14 | Value 13 should refer to SHR only, Value 14 should be set 1 and value 15 set #2 from table 61. Both of these modes have mandatory support for 1.95Mbps. | Change "value 15" to "value 14". | Revised |
| 90 | Pooria Pakrooh | 10.38.11.1 | 103 | 1 | Row 4 of the table, change to include mandatory modes for 1.95Mbps UWB. | Change row 4 to: "Modulation for the MMS control phase, values 1-9 relate to Table 45, value 13 means control phase is just UWB SHR, value 14 selects UWB according to set #1, and value 15 selects UWB according to set #2 from Table 61." | Revised |
| 91 | Pooria Pakrooh | 10.38.11.1 | 103 | 1 | Row 5 of the table, change to include mandatory modes for 1.95Mbps UWB. | Change row 5 to: "Modulation for the MMS report phase, values 1-9 relate to Table 45, value 14 selects UWB according to set #1 and value 15 selects UWB according to set #2 from Table 61." | Revised |

## Proposed Resolution - Revised

**In section 10.38.10.3.15 on page 70 update lines 7 to 21 as follows -**

The Control Phase Config field specifies the PHY layer modulation for the MMS control phase. Control Phase Config field values 1 to 9 select a modulation mode from Table 45 (also numbered 1 to 9), ~~value 14 selects a control phase consisting of just the UWB SHR, i.e., SYNC and SFD, while the value 15 selects UWB modulation according to set #1 from Table 61, is used in the slot preceding the UWB SHR.~~ value 14 selects UWB modulation according to set #1 from Table 61, while the value 15 selects UWB modulation according to set #2 from Table 61. All other Control Phase Config field values are reserved.

The Report Phase Config field specifies the PHY layer modulation for the MMS report phase. Report Phase Config field values 1 to 9 select a modulation mode from Table 45 (also numbered 1 to 9), ~~while the value of 15 selects UWB modulation according to set #1 from Table 61~~ value 14 selects UWB modulation according to set #1 from Table 61, while the value 15 selects UWB modulation according to set #2 from Table 61. All other Report Phase Config field values are reserved.

When UWB modulation is selected for the control and/or the report phase, the preamble code index used for these UWB packets is based on the Sequence Code Index field as carried in the Ranging PHY Config field defined in 10.38.10.3.8. Sequence Code Index field values ~~9~~ 25 to 32, directly indicate the UWB packet preamble code index, while for Sequence Code Index field values 9 to 24 and 33 to ~~3~~48, the UWB packet code index is selected by the expression: 25 + (Sequence Code Index field value - 1) MOD 8, i.e., selecting one of the length-91 ternary codes from Table 16-9, where MOD is the modulo division operator.

**In section 10.38.11.1 on page 103 update rows 4 and 5 of Table 9 as follows –**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Attribute** | **Type** | **Range** | **Description** | **Default** |
| *macMmsControlPhaseMode*  | Integer  | 1–9, 14, 15  | ~~Modulation for the MMS control phase, values 1-9 relate to Table 45, value 14 means control phase is just UWB SHR, value 15 selects UWB according to set #1 from Table 61.~~ Values 1-9 relate to Table 45 and select the modulation for the O-QPSK PHY in the control phase.Value 14 selects operating parameter set #1 and value 15 selects operating parameter set #2 from Table 61 for the UWB PHY in the control phase. | 1 |
| *macMmsReportPhaseMode*  | Integer  | 1–9, 14, 15  | ~~Modulation for the MMS report phase, values 1-9 relate to Table 45, value 15 selects UWB according to set #1 from Table 61.~~ Values 1-9 relate to Table 45 and select the modulation for the O-QPSK PHY in the report phase.Value 14 selects operating parameter set #1 and value 15 selects operating parameter set #2 from Table 61 for the UWB PHY in the report phase.  | 1 |

# Comment ID 29

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 29 | Li-Hsiang Sun | 10.38.10.3.8 | 67 | 2 | should SYNC/SFD config used in Fig 21 for UWB driven MMS be included in Management/Ranging PHY/MAC config field? Or they are determined elsewhere? | include the SYNC preamble code/PSR/SFD # in the ranging PHY/MAC config | Revised |

## Proposed Resolution – Revised

There is currently no mechanism that specifies the preamble code, SYNC length or SFD of the SYNC+SFD fragment in the HRP UWB PHY MMS packet.

There have been proposals to use the Sequence Code Index field to determine the preamble code. This is the approach that has been adopted below.

Resolving for the SYNC length and SFD are more complex.

* The SYNC+SFD options should contain the mandatory set of UWB only MMS (Table 13)
* Ideally the SYNC length and SFD should draw from currently defined options as defined in 16.2.6.2 and 16.2.6.3.



## Proposed Resolution – Revised

**In section 10.38.10.3.8 on page 67 add the following text after line 15 –**

In UWB driven MMS the SYNC PSR and the SFD# are based on the N\_MSR field value of the Ranging PHY Config field (eg as can be included in the one-to-one POLL) as shown in Table X.

Table X SYNC and SFD fragment parameters

|  |  |  |  |
| --- | --- | --- | --- |
| N\_MSR field value | SYNC PSR | Selected SFD length | SFD # per Table 16-11 |
| < 64 | 32 | 8 | 2 |
| >= 64 | 64 | 8 | 2 |

**In section 10.38.10.3.8 on page 67 add the following text after line 7 -**

In UWB driven MMS, the preamble code index used in the for the SYNC and SFD in the HRP UWB PHY MMS packets is based on the Sequence Code Index field as carried in the Ranging PHY Config field defined in 10.38.10.3.8. Sequence Code Index field values 25 to 32, directly indicate the UWB fragment preamble code index, while for Sequence Code Index field values 9 to 24 and 33 to 48, the UWB fragment preamble code index is selected by the expression: 25 + (Sequence Code Index field value - 1) MOD 8, i.e., selecting one of the length-91 ternary codes from Table 16-9, where MOD is the modulo division operator.

# Comment ID 296

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 296 | Riku Pirhonen | 16.2.11.1 | 160 | 20 | The fragements can be preceded by SYNC and SFD or a SP0 packet as defined in 10.38.10.3.15 | These are optionally preceded by a fragment consisting of containing at least SYNC and SFD, used to … | Revisedas related text has been deleted  |

## Proposed Resolution – Revised

### Discussion

The MMS text has many ambiguities. We agreed consensus on some of these in [1]. This comment is resolved with this context.

Note that this section is describing the multi-millisecond ranging packet and not the overall protocol so we do not need to consider the packets other than the ranging packet here. We now have consensus (slide #7 of [1]) that the only optional part of the ranging packet is the SYNC+SFD. There is no SP0 option within the ranging packet.

**In section 16.2.11.1 on page 160 update lines 20 to 22 as follows –**

~~These are optionally preceded by a fragment consisting of SYNC and SFD, used to obtain initial timing/frequency synchronization. The alternative scheme, where this optional fragment is not present, uses another PHY, assisting the MMS, to provide this initial synchronization.~~

# Comment ID 684

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| 684 | Carl Murray | 10.38.2 | 43 | 18 | The treatment of the SYNC+SFD is not coherent in this draft. Here it is a basic control packet (even though an SHR only packet doesn't exist) and in section 16.2.11.1 it is treated as part of the ranging packet. |  | RevisedResolved by CIDs 29, 52, 80, 81, 90, 91, 212, 296, 318, 683, 729 and 894 in this doc |

# Comment ID 879

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Disposition** |
| 879 | Carl Murray | 16.2.11.1 | 160 | 28 | The following text allows for a gap after the RSF only if there is RIFs. Is this gap not needed also when there are only RSFs and also a similar gap after the RIFs. If the intention is that this gap can be specified via the slot size then a note to this effect would add great clarity."Where the MMS packet consists of both RSF and RIF fragments, the time between the start of the last RSF and the start of first RIF shall be two milliseconds." |  | Revised |

## Proposed Resolution – Revised

**In section 10.38.5 on page 52 update lines 8 to 12 as follows –**

Figure 29 shows an example UWB MMS ranging phase. In the figure, X is *phyUwbMmsRsfNumberFrags* and Y is *phyUwbMmsRifNumberFrags* either of which may be zero. The total duration of the UWB MMS ranging phase is *macMmsRpDuration* slots. *macMmsRpDuration* shall be set at minimum to the required duration for all RSF and RIF fragments to be transmitted and received but may be larger to provide flexibility in scheduling the report phase and/or to allow extra time after the final fragment.