**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 C  7, [52, 318, 683, 894], [212, 901], [80, 81, 90, 91, 729], 29, 296, 879, [859-862] | |
| 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

## 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 | Accepted  Duplicate 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 |

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Description automatically generated with medium confidence

## Proposed Resolution – Revised

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

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Figure 1 Narrowband assisted UWB MMS ranging transmission

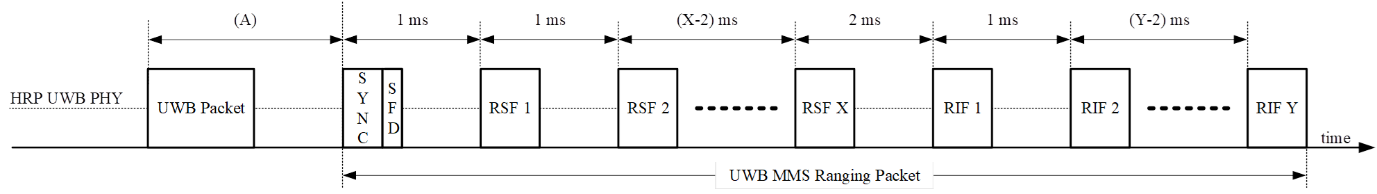


Figure 2 UWB driven UWB MMS ranging transmission

**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? |  | Revised  There 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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **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.
* Ideally the SYNC+SFD fragment should have the same energy as the RSF or RIF fragments. As the SYNC+SFD is always HPRF and the RSF can be either BPRF, HPRF or Complementary sets there is an optimum number of HPRF preamble symbols that will match the energy in the RSF.

In the table below the SYNC length has been chosen as the maximum length from the set defined in 16.2.6.2 without exceeding the optimum number of symbols to match RSF energy and also allowing for at least the minimum SFD length of 4. The SFD may then be further extended selecting from 8, 16 or 32 if increasing the SFD length does not cause the SYNC+SFD fragment energy to exceed the RSF fragment energy. This leads to the following mapping.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence Code Index field value** | **N\_MSR field value** | **SYNC PSR** | **Selected SFD length** |  | **Optimum HPRF SHR PSR** | **Actual HPRF SHR PSR** | **SHR Weaker than RSF in dB by** |
| **9 to 24** | **32** | 16 | 8 |  | 25.3 | 24 | 0.2 |
|  | **40** | 16 | 8 |  | 31.6 | 24 | 1.2 |
|  | **48** | 32 | 4 |  | 37.9 | 36 | 0.2 |
|  | **64** | 32 | 16 |  | 50.6 | 48 | 0.2 |
|  | **128** | 64 | 32 |  | 101.1 | 96 | 0.2 |
|  | **256** | 128 | 32 |  | 202.3 | 160 | 1.0 |
| **25-32** | **32** | 16 | 16 |  | 32.0 | 32 | 0.0 |
|  | **40** | 32 | 8 |  | 40.0 | 40 | 0.0 |
|  | **48** | 32 | 16 |  | 48.0 | 48 | 0.0 |
|  | **64** | 32 | 32 |  | 64.0 | 64 | 0.0 |
|  | **128** | 96 | 32 |  | 128.0 | 128 | 0.0 |
|  | **256** | 128 | 32 |  | 256.0 | 160 | 2.0 |
| **33-48** | **32** | 32 | 16 |  | 50.6 | 48 | 0.2 |
|  | **40** | 48 | 8 |  | 63.2 | 56 | 0.5 |
|  | **48** | 48 | 16 |  | 75.9 | 64 | 0.7 |
|  | **64** | 64 | 32 |  | 101.1 | 96 | 0.2 |
|  | **128** | 128 | 32 |  | 202.3 | 160 | 1.0 |
|  | **256** | 256 | 32 |  | 404.5 | 288 | 1.5 |

One issue with this mapping is that it does not generate the mandatory set in Table 13 in section 10.38.12.5. Also there are several values for N\_MSR (particularly 256) where the SYNC+SFD is consistently compromised in strength relative to the RIF fragment.

Note that for the mandatory set as currently defined the energy of the SYNC+SFD is 1 dB and 1.5 dB lower than the RIF (STS) fragment for configurations #1 and #2 respectively

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There are several potential solutions to this –

* Change the mandatory set in Table 13
* Revisit CID #878 to decouple the SYNC+SFD pulse amplitude from the RSF pulse amplitude
  + CID #878 Issue Statement
    - If the SYNC+SFD is a part of the MMS packet then the following text will lead to sub optimum performance.  
        
      "The same pulse shape shall be used for the entire MMS packet and all the pulses within the packet shall be modulated with a constant amplitude."
  + CID #878 Proposed Resolution
  + Change to:  
    "The same pulse shape shall be used for the entire MMS packet and all RIF and RSF pulses within the packet shall be modulated with a constant amplitude."

## Option #1

**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 Sequence Code Index field value and the N\_MSR field value as shown in Table X. The values are selected to match the energy between an RIF/RSF fragment and the SYNC and SFD fragment.

Table X SYNC and SFD fragment parameters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence Code Index field value** | **N\_MSR field value** | **SYNC PSR** | **Selected SFD length** | **SFD # per Table 16-11** | **Optimum HPRF SHR PSR** | **Actual SHR PSR** | **SHR Weaker by** |
| **9 to 24** | **32** | 16 | 8 | 2 | 25.3 | 24 | 0.2 |
|  | **40** | 16 | 8 | 2 | 31.6 | 24 | 1.2 |
|  | **48** | 32 | 4 | 1 | 37.9 | 36 | 0.2 |
|  | **64** | 32 | 16 | 3 | 50.6 | 48 | 0.2 |
|  | **128** | 64 | 32 | 4 | 101.1 | 96 | 0.2 |
|  | **256** | 128 | 32 | 4 | 202.3 | 160 | 1.0 |
| **25-32** | **32** | 16 | 16 | 3 | 32.0 | 32 | 0.0 |
|  | **40** | 32 | 8 | 2 | 40.0 | 40 | 0.0 |
|  | **48** | 32 | 16 | 3 | 48.0 | 48 | 0.0 |
|  | **64** | 32 | 32 | 4 | 64.0 | 64 | 0.0 |
|  | **128** | 96 | 32 | 4 | 128.0 | 128 | 0.0 |
|  | **256** | 128 | 32 | 4 | 256.0 | 160 | 2.0 |
| **33-48** | **32** | 32 | 16 | 3 | 50.6 | 48 | 0.2 |
|  | **40** | 48 | 8 | 2 | 63.2 | 56 | 0.5 |
|  | **48** | 48 | 16 | 3 | 75.9 | 64 | 0.7 |
|  | **64** | 64 | 32 | 3 | 101.1 | 96 | 0.2 |
|  | **128** | 128 | 32 | 4 | 202.3 | 160 | 1.0 |
|  | **256** | 256 | 32 | 4 | 404.5 | 288 | 1.5 |

**In section 10.38.12.5 on page 106 update Table 13 as indicated**

**Table 13—Mandatory UWB only MMS Configuration Sets**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **UWB Only Set #** | **UWB SYNC PSR** | **UWB SFD #** | **SFD Length** | **Number of RSFs: X** | **Number of RIFs: Y** | **RIF: STS length** |
| 1 | 32 | ~~2~~ 3 | ~~8~~ 16 | 0 | 1 | 32 |
| 2 | 64 | ~~2~~ 3 | ~~8~~ 16 | 0 | 1 | 64 |

## Option #2

**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 Sequence Code Index field value and the N\_MSR field value as shown in Table X.

Table X SYNC and SFD fragment parameters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence Code Index field value** | **N\_MSR field value** | SYNC PSR | Selected SFD length | SFD # per Table 16-11 | Optimum HPRF SHR PSR | Actual SHR PSR | SHR Weaker by |
| **9 to 24** | **32** | 16 | 8 | 2 | 25.3 | 24 | 0.2 |
|  | **40** | 16 | 8 | 2 | 31.6 | 24 | 1.2 |
|  | **48** | 32 | 4 | 1 | 37.9 | 36 | 0.2 |
|  | **64** | 32 | 16 | 3 | 50.6 | 48 | 0.2 |
|  | **128** | 64 | 32 | 4 | 101.1 | 96 | 0.2 |
|  | **256** | 128 | 32 | 4 | 202.3 | 160 | 1.0 |
| **25-32** | **32** | 16 | 16 | 3 | 32.0 | 32 | 0.0 |
|  | **40** | 32 | 8 | 2 | 40.0 | 40 | 0.0 |
|  | **48** | 32 | 16 | 3 | 48.0 | 48 | 0.0 |
|  | **64** | 32 | 32 | 4 | 64.0 | 64 | 0.0 |
|  | **128** | 96 | 32 | 4 | 128.0 | 128 | 0.0 |
|  | **256** | 128 | 32 | 4 | 256.0 | 160 | 2.0 |
| **33-48** | **32** | 32 | 8 | 2 | 50.6 | 40 | 1.0 |
|  | **40** | 48 | 8 | 2 | 63.2 | 56 | 0.5 |
|  | **48** | 48 | 16 | 3 | 75.9 | 64 | 0.7 |
|  | **64** | 64 | 8 | 2 | 101.1 | 72 | 1.5 |
|  | **128** | 128 | 32 | 4 | 202.3 | 160 | 1.0 |
|  | **256** | 256 | 32 | 4 | 404.5 | 288 | 1.5 |

## Option #3

**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 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 16.2.11.1 on page 160 update lines 25 and 26 as follows -**

~~The same pulse shape shall be used for the entire MMS packet and all the pulses within the packet shall be modulated with a constant amplitude.~~

All pulses for the entire MMS packet shall comply with the same mask e.g., Figure 16-14 or Figure 186 but a different amplitude can be used for the initial SYNC+SFD fragment versus the amplitude for the RSF and RIF fragments. This facilitates balancing the energy in the SYNC+SFD independently to match the other fragments. All the pulses within the SYNC+SFD fragments shall be modulated with the same amplitude. All the pulses within the RSF and RIF fragments shall be modulated with the same amplitude.

## Proposed Resolution – Revised

Implement Option #3 from section 6.4

**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 packet preamble code index, while for Sequence Code Index field values 9 to 24 and 33 to 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.

# 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 … | Revised |

## 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 aid ~~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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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. |  | Revised  Resolved by CIDs 29, 52, 80, 81, 90, 91, 212, 296, 318, 683, 729 and 894 in this doc |

# Comment ID 879

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **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.

# Comment IDs 859-862, (457, 907)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** |
| 859 | Carl Murray | 10.39.7.1 | 115 | 2 | Allow for a configuration of 32 - better than leaving reserved. | Revised |
| 860 | Carl Murray | 10.39.7.1 | 115 | 6 | Allow for a configuration of 32 - better than leaving reserved. | Revised |
| 861 | Carl Murray | 10.39.7.1 | 116 | 2 | Allow for a configurations of 8 and 16 - better than leaving reserved configurations and allows for the new ETSI +10dB | Revised |
| 862 | Carl Murray | 10.39.7.1 | 116 | 6 | Allow for a configurations of 8 and 16 - better than leaving reserved configurations and allows for the new ETSI +10dB | Revised |
| 114/457 | Bin Qian | 12.3.7 | 149 | 5 | The number of RSFs is 0-16 instead of 0-32 in the fourth row of Table 12-8 | As in the comment |
| 114/907 | Mickael Maman | 12.3.7 | 149 | 5 | phyUwbMmsRsfNumberFrags is 0-32 | 0, 1, 2, 4, 8, 16 as in table 14 |

We should take a forward looking position when designing the next release of the standard. We need to look beyond any current limitations and at the same time not go completely crazy 😊.

Note that this approach has already been taken many times, e.g. extending the UWB Channel field in the Application Control IE so that all the extended channels can be used (see CID #222 in [3])

### Discussion on 859 and 860

The common pushback on having more than 16 fragments is that the accumulated phase error will be too large for 32 fragments and beyond. This has the implicit assumption that the carrier frequency offset is not being tracked. There are usecases where this is not the case e.g. where there is a strong NLOS path but a very weak first path (the classic Fira FP dynamic range usecase).

Also in [2] by Alex et al, one of the stated aims of the 250kbps uncoded O-QPSK is to “… balance link budget of *32-fragment* MMS-UWB”. So 32 fragments were envisioned right from the start.

Currently there are reserved values in the ‘Number of RSF field value’. It is likely that these can only be used for specifying further RSF numbers. Similarly for the ‘Number of RIF field value’.

So why not assign them now. What else will they be used for?

## Proposed Resolution for 859 and 860 – Revised

**In section 10.39.7.1 on page 115 update Table 14 on line 1 as follows –**

|  |  |
| --- | --- |
| **Number of RSF field value** | **Meaning, Number of RSF** |
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 8 |
| 5 | 16 |
| 6~~-7~~ | ~~Reserved~~ 32 |
| 7 | 64 |

**In section 10.39.7.1 on page 115 update Table 15 on line 5 as follows –**

|  |  |
| --- | --- |
| **Number of RIF field value** | **Meaning, Number of RIF** |
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 8 |
| 5~~–7~~ | ~~Reserved~~ 16 |
| 6 | 32 |
| 7 | 64 |

**If the above are accepted the need to revisit CID # 114**

Change the Table 12-8, Range values for "phyUwbMmsRifNumberFrags" to "0, 1, 2, 4, 8, 16, 32, 64" and Range values for "phyUwbMmsRsfNumberFrags" to "0, 1, 2, 4, 8, 16, 32, 64".

### Discussion on 861 and 862

In the original comment it states that one reason for using shorter fragments is that “… allows for the new ETSI +10dB”. This point was not properly explained and therefore has been misunderstood.

The essential point is that in the future there may be UWB devices that have an increased energy budget by +10dB (but with regulatory restrictions). To achieve this extra 10dB more than likely the transmitter will need to be more powerful. The reasoning here is that rather than increasing the sequence lengths by a factor of 10, it is likely that part of the solution will be to have a more powerful transmitter. Therefore, this more powerful transmitter could be used for MMS ***but*** still observe the existing energy budget of 37 nJ per ms. The idea is not to use the extra energy afforded by the extra +10dB for MMS but to use the more powerful transmitter.

One advantage of shorter fragments is less airtime and less receiver on-time.

The ‘MSR for MMRS field value’ has reserved values. There does not seem to be any disadvantage to allocating the reserved values for this purpose up front.

The ‘STS Segment Length’ does not have the same number of possible configurations as ‘MSR for MMRS’. This is probably an oversight independent of these CIDs as the RSF and RIF fragments should have similar energy.

## Proposed Resolution for 861 and 862– Revised

**In section 10.39.7.1 on page 114 update Table 132 on line 24 as follows –**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Bits: 0–2** | **3–5** | **6–11** | **12–18** | **19–21** | **22–2~~3~~4** | **2~~4~~5–2~~7~~8** | **2~~8~~9–31** |
| Number of RSF | Number of RIF | Preamble Code Index | MMRS Gap Size | MSR For MMRS | STS Segment Length | UWB Channel | Reserved |

**Figure 132—MMS Ranging Configuration field of the AC IE**

**In section 10.39.7.1 on page 116 update Table 16 on line 1 as follows –**

**Table 16—Values of the MSR for MMRS subfield in the MMS Ranging Configuration**

|  |  |
| --- | --- |
| **MSR for MMRS field value** | **Meaning, MSR** |
| 0 | ~~32~~ 8 |
| 1 | ~~40~~ 16 |
| 2 | ~~48~~ 32 |
| 3 | ~~64~~ 40 |
| 4 | ~~128~~ 48 |
| 5 | ~~256~~ 64 |
| 6~~–7~~ | ~~Reserved~~ 128 |
| 7 | 256 |

**In section 10.39.7.1 on page 116 update Table 17 on line 5 as follows –**

**Table 17—Values of the STS Segment Length subfield of the MMS Ranging Configuration**

|  |  |
| --- | --- |
| **STS Segment Length field value** | **Meaning, STS segment length** |
| 0 | ~~32~~ 8 |
| 1 | ~~64~~ 16 |
| 2 | ~~128~~ 32 |
| 3 | ~~256~~ 64 |
| 4 | 128 |
| 5 | 256 |
| 6-7 | Reserved |