**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **Comment resolution – 31, 40, 137, 957, 1400, 958, 671, 963** |
| Date Submitted | Nov 4th, 2024 |
| Sources | Riku Pirhonen (NXP) |
| Abstract | Comment resolution for 31, 40, 137, 957, 1400, 958, 671, 963 |
| Purpose | Propose resolutions to comments received on IEEE P802.15.4ab/D01, June 2024. |
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# Summary of comments

The following comments are offered a resolution in this document:

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| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Mickael Maman | 31 | 55 | 10.38.1 | 21 | In UWB driven UWB MMS, a value of 1 ms shall be supported for time interval A. Does it means that UWB packet for Initiator and responder are interleaved in 1ms? | two options: clarify interleaved UWB SP0 packet or define two values for A as done in NBA UWB MMS. In the first case, new values for macMmsRcpPollNSlots, macMmsRcpRespNSlots and optionnaly macMms1stReportNSlots in Table 20 should be defined. |
| Mickael Maman | 40 | 67 | 10.38.4 | 21 | Clarify if the UWB MMS control phase is defined for both PHYs (UWB and OQPSK) and if they are using the same packet format (POLL and RESP compact frame) | as in comment |
| Wenzheng Li | 187 | 68 | 10.38.5 | 23 | In this sub-clause, the ranging phase only for NBA UWB MMS is stated. For the UWB driven UWB MMS, the initial exchanged MMS fragment shall be SYNC+SFD.  | The UWB driven UWB MMS with initial SYNC+SFD fragments exchange shall be added to be described in this sub-clause  |
| Riku Pirhonen | 957 | 87 | 10.38.9.3.14 | 25 | To keep NB and UWB clock synchronization simple, and avoid issues with the 100 ppm tolerance requirement, the Time Offset value should take chip rate clock into account. For NB it is 2 MHz (0.5 µs) and for UWB 1/499.2 MHz (~2ns). The smallest common step size is 2.5 µs. Add the same comment to the corresponding PIB attribute if such is defined. | … and the value shall be mulitple of 2.5 µs.  |
| Alex Krebs | 1400 | 87 | 10.38.9.3.14  | 25 | We discussed/agreed limiting time offset to 1s before to improve responder energy consumption. I wonder if it is too strict to mandate this, since 1. SOR time offset is a one-time process hence impact on overall energy consumption is scanning once per ranging session 2. energy consumption wrt to SOR time offset is determined by the responder's crystal accuracy which is an implementation choice. My suggestion is to not prohibit use, but rather make a more practical recommendation in the standard, allowing higher accurcy devices to take advantage of the full value range. | "Replace ""The maximum...second."" by |
| Riku Pirhonen | 958 | 87 | 10.38.9.3.15 | 29 | Offset value betwee two NB packets should be multiple of chip rate of 2 MHz (0.5 µs). The smallest common step size is thus 0.5 µs. | … and the value shall be mulitple of 0.5 µs.  |
| Tero Kivinen | 671 | 128 | 10.38.12 | 3 | This whole clause looks more like a clause that should be inside the clause 16, not in 10.38.  | Move to clause 16. |
| Riku Pirhonen | 963 | 193 | 16.2.11.2 | 8 | When Ipatov codes are used as RSF, MMRS is identical to the preamble and similar length RSF identical to SYNC. By adding the same SFD as in SHR at end of each Ipatov-RSF, each RSF could act as a SHR in case the first SHR is lost e.g. due to interference. This improves the robustness of ranging as the sequence is not necessarily lost in case the first SHR is lost.  | Continue on line 8: "When these codes are used, a copy of the SFD sequence is added at the end of each RSF. RSF consists of MMRS repetitions and SFD, and can be identical to the initial SHR (SYNC+SFD) fragment" |

Resolution proposals

## Comment 31

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| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Mickael Maman | 31 | 55 | 10.38.1 | 21 | In UWB driven UWB MMS, a value of 1 ms shall be supported for time interval A. Does it means that UWB packet for Initiator and responder are interleaved in 1ms? | two options: clarify interleaved UWB SP0 packet or define two values for A as done in NBA UWB MMS. In the first case, new values for macMmsRcpPollNSlots, macMmsRcpRespNSlots and optionnaly macMms1stReportNSlots in Table 20 should be defined. |

The supported value for (A) is 1 ms and with that value control packets are interleaved within 1 ms with a 500 μs offset, which is aligned with the MMS packet interleaving. To have (A) value equal to 1 ms, *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots* are both set to have value 1. See figure 35 for definition for *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots*.

If longer separation between start of control and ranging packet is desired, value 2 for *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots* results to (A) to be 2 ms for initiator and 1.5 ms for responder like in the NBA case, because MMS packet interleaving remains as one slot (500 μs). If *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots* have value 0, the SP0 packets are not sent at all.

**Resolution:** Add the text shown in red starting on page 55, line 21

In the figures, the time interval, A, is 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. For the NBA UWB MMS case, of Figure 23, values of 1.5 ms and 2 ms shall be supported for this time interval and *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots* are set to value 2 (see Figure 35). In the UWB driven case of Figure 24, the HRP UWB PHY MMS packet includes the initial SYNC and SFD fragment as specified in 16.2.11.~~, and a~~ A value of 1 ms shall be supported for time interval A between the start of a UWB data packet and start of the MMS packet by setting *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots* values to 1, which will result in the same 600 RSTU (500 μs) offset between data packets as the MMS fragments. Parameters *macMmsRcpPollNSlots* and *macMmsRcpRespNSlots* are set to 0 if the UWB data packet is not used in the UWB driven MMS case.

## Comment 40

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| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Mickael Maman | 40 | 67 | 10.38.4 | 21 | Clarify if the UWB MMS control phase is defined for both PHYs (UWB and OQPSK) and if they are using the same packet format (POLL and RESP compact frame) | as in comment |

Poll compact frame and response compact frame can use either NB or UWB data packets. The payload is the same compact frame. In case there is no need to send payload, the control frame can be skipped in UWB driven mode, as the UWB PHY MMS packet has the SYNC and SFD for signal frequency and timing acquisition, and this is indicated by setting the report period length to 0. Control and report phase modulation can be clarified by adding a reference to the Management PHY Configuration field.

**Resolution:** Add the text shown in red on page 67, line 24

The UWB MMS control phase begins the UWB MMS ranging exchange and includes (macMmsRcpPollNSlots + macMmsRcpRespNSlots) ranging slots for peer-to-peer ranging. Control phase modulation is defined by the Management PHY Configuration field, see 10.38.9.3.17.

**Resolution:** Add the text shown in red on page 69, line 21

UWB MMS ranging reports may be transferred during the optional report phase. The report phase is configured as part of UWB MMS ranging session configuration as described in 10.38.3.7. If it is enabled, the report phase starts when the ranging phase ends. The macMmsReportSender attribute enables reporting and selects whether the initiator, the responder or both send report packets. Report phase modulation is defined by the Management PHY Configuration field, see 10.38.9.3.17.

## Comment 187

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| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Wenzheng Li | 187 | 68 | 10.38.5 | 23 | In this sub-clause, the ranging phase only for NBA UWB MMS is stated. For the UWB driven UWB MMS, the initial exchanged MMS fragment shall be SYNC+SFD.  | The UWB driven UWB MMS with initial SYNC+SFD fragments exchange shall be added to be described in this sub-clause  |

Poll compact frame and response compact frame can use either NB or UWB data pack

**Resolution:** Add the text shown in red on page 68, line 22

The UWB MMS ranging phase follows the control phase. Ranging phase uses the UWB PHY MMS packet formats defined in 16.2.11.

**Resolution:** Add the text shown in red on page 69, between current lines 6 and 7.

… The responder may continue to send phyUwbMmsRifNumberFrags RIF fragments at regular intervals of 1200 RSTU.

In UWB driven mode both the initiator and the responder start the UWB PHY MMS packet with a SYNC + SFD fragment as shown in 16.2.11.1, Figure 198.

Figure 36 shows an example UWB MMS ranging phase …

## Comment 957

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| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Riku Pirhonen | 957 | 87 | 10.38.9.3.14 | 25 | To keep NB and UWB clock synchronization simple, and avoid issues with the 100 ppm tolerance requirement, the Time Offset value should take chip rate clock into account. For NB it is 2 MHz (0.5 µs) and for UWB 1/499.2 MHz (~2ns). The smallest common step size is 2.5 µs. Add the same comment to the corresponding PIB attribute if such is defined. | … and the value shall be mulitple of 2.5 µs.  |

In NBA-MMS the timing of O-QPSK and UWB packet transmissions are linked with the Time Offset field, which defines the offset between the Start of Ranging Compact frame and start of the Poll frame, which in turn fixes the exact timing of the first UWB fragment. The timing between Poll frame and the first UWB fragment is adjustable only at resolution of slot length, the start of each slot is aligned at exact 600 RSTU (500 µs).

When doing transitions between NB and UWB and possibly back to NB, it would be convenient if timing is done at chip rate of both radios, so there is no need to adjust timing counters in fractions of chip rate or resync the clocks used to generate the rates. This can be done by selecting the offset between start of SOR and POLL as multiple of both chip rates. O-QPSK chip rate is 2 MHz (0.5 µs) and UWB 1/499.2 MHz rate (2.0032… ns). The smallest common counter rate for these two signal is 0.4 MHz (2.5 µs), i.e., at every 2.5 µs the O-QPSK clock would be non-fractional multiple of the UWB clock.

The Start of Ranging Time Offset field has 1/499.2 MHz resolution, so the offset field value should be a multiple of 1248.

**Resolution:** Add the text shown in red on page 87, line 25.

This is a four-octet, 32-bit field that specifies the time offset in 1/499.2 MHz resolution between the first symbol of the Start of Ranging Compact frame and the first symbol of the subsequent poll frame starting the ranging session. The maximum value of this field shall be limited to 1 second and in NBA-MMS operation the value shall be a multiple of 1248 (2.5 µs).

## Comment 1400

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| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Alex Krebs | 1400 | 87 | 10.38.9.3.14  | 25 | We discussed/agreed limiting time offset to 1s before to improve responder energy consumption. I wonder if it is too strict to mandate this, since 1. SOR time offset is a one-time process hence impact on overall energy consumption is scanning once per ranging session 2. energy consumption wrt to SOR time offset is determined by the responder's crystal accuracy which is an implementation choice. My suggestion is to not prohibit use, but rather make a more practical recommendation in the standard, allowing higher accurcy devices to take advantage of the full value range. | Replace "The maximum...second." byA value of 0-300ms is recommended for this field to limit packet arrival time uncertainty for the responder device. |

**Resolution as proposed:** Replace the text on page 87, line 25 as shown below and take also into account resolution to comment 957 to complete the sentence.

## ~~The maximum value of this field shall be limited to 1 second~~

A value of 0-300ms is recommended for this field to limit packet arrival time uncertainty for the responder device

## Comment 958

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| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Riku Pirhonen | 958 | 87 | 10.38.9.3.15 | 29 | Offset value betwee two NB packets should be multiple of chip rate of 2 MHz (0.5 µs). The smallest common step size is thus 0.5 µs. | … and the value shall be mulitple of 0.5 µs.  |

The SOR Time Offset defines the offset between advertising frame and start of ranging frame. In NBA-MMS these frames are transmitted using O-QPSK, that has 2 MHz chip rate. To adjust the start of the frame it is better to have the offset a multiple of chip rate, as adjusting the start of frame at fractions of O-QPSK chip rate (at UWB chip rate as defined by this parameter) may be difficult for the NB radio.

In case the UWB chip counter and O-QPSK chip counter are started at the same time, it would be easier to do the later transition to UWB if the offsets between O-QPSK packets are defined as multiples of both O-QPSK and UWB chip rates, i.e., at 2.5 µs instead of 0.5 µs or 2 ns, as explained in comment resolution 957.

**Resolution:** Add the text shown in red on page 87, line 29.

This is a four-octet, 32-bit field that specifies the time offset in 1/499.2 MHz resolution between the start of the Advertising Poll Compact frame, or the Public Advertising Poll Compact frame, and the start of the Start of Ranging Compact frame. NBA-MMS operation the value shall be a multiple of 1248 (2.5 µs).

## Comment 671

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| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Tero Kivinen | 671 | 128 | 10.38.12 | 3 | This whole clause looks more like a clause that should be inside the clause 16, not in 10.38.  | Move to clause 16. |

**Resolution**: Subclauses 10.38.11 and 10.38.12 could be moved to subclause 16.7, which could have 16.7.1 for data parameter sets and 16.7.2 for MMS parameter sets. The comment can be recategorized as editorial and to be decided by the editor.

## Comment 963

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| **Name** | **Index #** | **Page** | **Sub-clause** | **Line #** | **Comment** | **Proposed Change** |
| Riku Pirhonen | 963 | 193 | 16.2.11.2 | 8 | When Ipatov codes are used as RSF, MMRS is identical to the preamble and similar length RSF identical to SYNC. By adding the same SFD as in SHR at end of each Ipatov-RSF, each RSF could act as a SHR in case the first SHR is lost e.g. due to interference. This improves the robustness of ranging as the sequence is not necessarily lost in case the first SHR is lost.  | Continue on line 8: "When these codes are used, a copy of the SFD sequence is added at the end of each RSF. RSF consists of MMRS repetitions and SFD, and can be identical to the initial SHR (SYNC+SFD) fragment" |

The UWB driven MMS mode is vulnerable to loss of the SYNC + SFD fragment. If this fragment is not received, there is no successful signal acquisition, and the whole ranging round fails.

The preamble code index used for SYNC and SFD is based on the Sequence Code Index of the Ranging PHY configuration as defined in 10.38.9.3.10. Therefore when the UWB PHY MMS packet uses Ipatov codes in the UWB driven mode, the UWB SYNC and MMRS are identical. In order to improve robustness, the UWB PHY MMS packet can be simplified and all the fragments, the SYNC + SFD as well as the RSFs, all made identical by adding SFD to end of each RSF. In that case each fragment can be used for acquisition.

The more SYNC + SFD fragments there are, the more likely it is that at least one of those is received successfully and can be used for acquisition and ranging. The responder and initiator know the MMS packet structure and also know how many repeated fragments are missed and how many there are left. All the fragments received after one successfully used for acquisition can be used as regular MMS fragments.

When the Preambe Code Index refers to an Ipatov code (Sequence code index value 9-32) the Golay code gap size value doesn’t have relevance and can be repurposed to indicate the robust mode. See Figure 52 – The Ranging PHY Configuration field and Figure 149 – MMS Ranging Configuration field of the AC IE.

Text above may look complex, but the figure below illustrates the simplification of the packet.



**Resolution:** Add following text to page 193, after line 11.

When the length-91 ternary codes or the length-127 ternary codes are used for RSF MMRS, the UWB driven mode SYNC is identical to the RSF. A SFD may be added after the MMRS repetitions to each RSF to make the RSFs identical to the SYNC + SFD fragment used by UWB PHY MMS packet. This improves robustness of the MMS packet as any of the fragments can be used for signal acquisition.

**Resolution:** Change the text on page 84, line 15 as below.

… The MMRS complementary set zeros field specifies the number of zeros to insert into the complementary set, value range {0, …, 64}. ~~This field is only valid for Sequence Code Index field values in the range 33 to 48.~~ In case of Sequence Code Index from 9 to 32, bit 6 can be set to value 1 to indicate insertion of SFD at end of each RSF, so that each RSF fragment becomes identical to the UWB SYNC + SFD fragment, and bits 7 – 12 are reserved.

**Resolution:** Change following text on page 140, line 14.

The MMRS Gap Size field value indicates the size of the gaps of zeros inserted into the complementary set when forming the MMRS symbol that will be used by the AC IE sender for transmission in the forthcoming ranging exchange. If the Preamble Code Index field value is less than 33 the MMRS Gap Size field ~~shall be ignored~~ bit 12 can be set to value 1 to indicate insertion of SFD at end of each RSF, so that each RSF fragment becomes identical to the UWB SYNC + SFD fragment. Bits 13 – 18 are reserved..

**Resolution:** Editorial change, if editor sees necessary, “MMRS complementary set zeros” or “MMRS Gaps Size” parameter names can be changed e.g. into “MMRS zeros / SFD insert” or “MMRS gap size / SFD insert”.