**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 time efficient one-to-many ranging** |
| Date Submitted | Feb. 2024 |
| Sources | Bin Qian, Lei Huang, Rojan Chitrakar, David Xun Yang (Huawei)  |  |
| 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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***Comment Index #23 in 15-24-0010-05-04ab-cc-consolidated-comments***

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** |
| 23 | Li-Hsiang Sun | 10.38.9.3 | 61 | 24 | One-to-many Initiator Report Compact frame withthe Message Control field set to 0x10 is not defined | define message with the message control in 10.38.10 |

**Discussion:**

In the time efficient one-to-many MMS ranging, if the report phase has only a single transmission, the initiator shall transmit either the One-to-many Initiator Report Compact frame or the One-to-many Initiator Secure Report Compact frame both with the Message Control field set to 0x10 to the two responders involved in the same sub-round. This messages indicate the round-trip time of the two responders in the Round-trip Time 1 and Round-trip Time 2 fields, respectively.

**Resolution: Revised**

**Proposed text changes on P802.15.4ab™/D (pre-ballot) C:**

**10.38.10.15 One-to-many Initiator Report Compact frame**

*Change Line 6 on page 90 as follows*

The Message Control field value shall be either 0x00 or 0x10. This value determines the formatting of the Message Control field.

*Insert the following text at the end of 10.38.10.13 as follows*

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Octets: 5** | **5** | **0/1** | **0/variable** |
| Round-trip Time 1 | Round-trip Time 2 | PT Data Length | PT Data |

**Figure xx – Format of the Message Content field in the One-to-many Initiator Report Compact frame when the Message Control field value is 0x10**

The Round-trip Time 1 field is an unsigned integer that conveys the time difference between the transmit time of the poll MMS fragments initiating a round-trip time measurement and the receive time of the response MMS fragments from the responder with Time Shift Indication field (defined in 10.38.10.12) set to zero that completes the round-trip time measurement. The units of time are specified in 6.9.1.4.

The Round-trip Time 2 field is an unsigned integer that conveys the time difference between the transmit time of the poll MMS fragments initiating a round-trip time measurement and the receive time of the response MMS fragments from the responder with Time Shift Indication field (defined in 10.38.10.12) set to one that completes the round-trip time measurement. The units of time are specified in 6.9.1.4.

The PT Data Length field value and meaning is defined in 10.38.10.3.5. The presence of this field is determined by the Frame Length field specified in 13.1.3.2.

The PT Data field is defined in 10.38.10.3.6.

**10.38.10.23 One-to-many Initiator Secure Report Compact frame**

*Change Line 17 on page 100 as follows*

The Message Control field value shall be either 0x00 or 0x10. This value determines the formatting of the Message Control field.

*Insert the following text at the end of 10.38.10.23 as follows*

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Octets: 1** | **0/1** | **0/variable** | **5** | **5** |
| Key ID  | PT Data Length | PT Data | Round-trip Time 1 | Round-trip Time 2 |

**Figure xx – Format of the Message Content field in the One-to-many Initiator Secure Report Compact frame when the Message Control field value is 0x10**

The Key ID field is defined in 10.38.10.3.19.

The PT Data Length field value and meaning is defined in 10.38.10.3.5. The presence of this field is determined by the Frame Length field specified in 13.1.3.2.

The PT Data field is defined in 10.38.10.3.6.

The Round-trip Time 1 field is an unsigned integer that conveys the time difference between the transmit time of the poll MMS fragments initiating a round-trip time measurement and the receive time of the response MMS fragments from the responder with Time Shift Indication field (defined in 10.38.10.12) set to zero that completes the round-trip time measurement. The units of time are specified in 6.9.1.4.

The Round-trip Time 2 field is an unsigned integer that conveys the time difference between the transmit time of the poll MMS fragments initiating a round-trip time measurement and the receive time of the response MMS fragments from the responder with Time Shift Indication field (defined in 10.38.10.12) set to one that completes the round-trip time measurement. The units of time are specified in 6.9.1.4.

NOTE – The Round-trip Time 1 field and the Round-trip Time 2 field are encrypted if a security level with encryption is negotiated.

**9.2.12 Outgoing frame security procedure for Compact frames**

*Change Table 2 on page 25 as follows*

**Table 2—Compact frame exceptions to Private Payload field and Open Payload field** **definitions**

|  |  |  |
| --- | --- | --- |
| **Compact frame type** | **Private Payload field** | **Open Payload field** |
| One-to-one Initiator Secure Report | Round-trip Time field | All other fields in the Message Content field |
| One-to-one Responder Secure Report | Reply Time field  | All other fields in the Message Content field |
| One-to-many Initiator Secure Report (Message Control field = 0x00) | Round-trip Time field  | All other fields in the Message Content field |
| One-to-many Initiator Secure Report (Message Control field = 0x10) | Round-trip Time 1 field, Round-trip Time 2 field | All other fields in the Message Content field |
| One-to-many Responder Secure Report | Reply Time field | All other fields in the Message Content field |

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***Comment Index #22，#328, #329, #24 in 15-24-0010-05-04ab-cc-consolidated-comments***

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| **Index #** | **Commenter** | **Sub-Clause** | **Page** | **Line** | **Comment** | **Proposed Change** |
| 22 | Li-Hsiang Sun | 10.38.9.3 | 61 | 16 | The time shift indication should be implicit if the each responder already knows its respective order for transmitting RESP and REPORT messages and the number of responders.  | remove Time Shit Indication |
| 328 | Bin Qian | 10.38.9.3 | 61 | 14-21 | The case when there exists RIF is missing | As in the comment |
| 329 | Bin Qian | 10.38.9.3 | 61 | 28 | It should be two One-to-one Initiator Report Compact frames instead of one | As in the comment |
| 24 | Li-Hsiang Sun | 10.38.9.3 | 61 | 24 | The use of msg ctrl 0x10 in initiator report compact frame should be indicated in earlier frames such as SOR or one-to-many POLL so responder would base on that to determine the timing for transmitting REPORT frame | as in comment |

**Discussion:**

In each sub-round of the time efficient one-to-many ranging, two responders shall transmit the RESP messages in sequence during the ranging control phase, and may transmit the REPORT messages in sequence during the measurement report phase.

Technically, there are two possible methods for each responder to acquire its respective order for transmitting RESP and REPORT messages:

1. Applying the Time Shift Indication field to indicate the respective transmission order. The responder with Time Shift Indication field set to zero should transmit first, and the responder with Time Shift Indication field set to one should transmit second.
2. Applying the order in which responder addresses appear in the Responder Detail List field to imply the respective transmission order. For two responders with the same Start Slot Index field value, the responder address appears first in the Responder Detail List field should transmit first, and the responder address appears second in the Responder Detail List field should transmit second.

Method 1 requires fewer changes to Draft C, it is suggested to apply method 1.

Further, in the time efficient one-to-many MMS ranging, the maximum number of UWB MMS fragments per ranging sub-round is limited to two. The fragments used could be RSF and/or RIF.

In the report phase of the time efficient one-to-many ranging, I think there are three possible ways to send the reports to ease the implementation as follows.

1. The initiator sends the One-to-many Initiator Report Compact frame or the One-to-many Initiator Secure Report Compact frame with the Message Control field set to 0x10 to both responders.
2. Each responder sends the One-to-many Responder Report Compact frame or the One-to-many Responder Secure Report Compact frame to the initiator sequentially.
3. Both the initiator and the responder send report.

**Resolution: Revised**

**Proposed text changes on P802.15.4ab™/D (pre-ballot) C:**

*Change 10.38.9.3 as follows*

**10.38.9.3 Time efficient one-to-many ranging**

For some time-sensitive applications, e.g., VR/AR, it is useful to improve the time efficiency of the one-to-many ranging by allowing at most two responders to reply at different times within one ranging slot. The responders shall be capable of a fixed reply time of sufficient precision. The supported number of UWB MMS fragments (i.e., RSF and/or RIF) per ranging sub-round is limited to two fragments.

As a ranging initialization message, the One-to-many Poll Compact frame with the Message Control field set to 0x90 or 0xA0 serves to enable the time efficient one-to-many SS-TWR from an initiator to multiple responders in the first ranging sub-round.Each ranging sub-round, except the last ranging sub-round, has two responders. The last ranging sub-round has either one or two responders. In case of there are two responders scheduled in a ranging sub-round, the corresponding Start Slot Index fields shall set to the same value; and the corresponding Time Shift Indication fields shall set to zero and one, respectively. In case of there is one responder scheduled in a ranging sub-round, the corresponding Time Shift Indication field shall set to zero. The Start Slot Index field is used to indicate the slot index of the corresponding On-to-many Poll Compact frame. In the subsequent ranging sub-round, the One-to-many Poll Compact frame with the Message Control field set to 0x00 shall be used.

In each ranging sub-round shown in Figure 39, during the ranging control phase, the responder with Time Shift Indication field set to zero may transmit a RESP Compact frame back to the initiator at the beginning of the ranging slot following the poll period. The responder with Time Shift Indication field set to one may transmit a RESP Compact frame back to the initiator at the beginning of the ranging slot following the first RESP Compact frame. When there is one responder scheduled in the last ranging sub-round, the ranging control phase is same as the basic operation of one-to-many MMS ranging.

During the ranging phase, the initiator may start transmitting the first RSF fragment at *RpRsfOffset* slots into the ranging phase, and continue to send the second RSF fragment at a regular interval of 1200 RSTU if the RSF only MMS packet is used. The initiator may start transmitting the first RIF fragment at *RpRifOffset* slots into the ranging phase and continue to send the second RIF fragment at a regular interval of 1200 RSTU if the RIF only MMS packet is used. The initiator may start transmitting the first RSF fragment at *RpRsfOffset* slots into the ranging phase and continue to send the RIF fragment 2 ms after the start of its first RSF fragment transmission if the mixed RSF/RIF packet is used.

The responder with Time Shift Indication field set to zero may start transmitting the first RSF fragment at *RpRsfOffset* + 400 RSTU into the ranging phase, and continue to send the second RSF fragment at a regular interval of 1200 RSTU if the RSF only MMS packet is used. This responder may start transmitting the first RIF fragment at *RpRifOffset* + 400 RSTU into the ranging phase and continue to send the second RIF fragment at a regular interval of 1200 RSTU if the RIF only MMS packet is used. This responder may starting transmitting the first RSF fragment at *RpRsfOffset* slots into the ranging phase and continue to send the RIF fragment 2 ms after the start of its first RSF fragment transmission if the mixed RSF/RIF packet is used.

The responder with Time Shift Indication field set to one may start transmitting the first RSF fragment at *RpRsfOffset* + 800 RSTU into the ranging phase, and continue to send the second RSF fragment at a regular interval of 1200 RSTU if the RSF only MMS packet is used. This responder may start transmitting the first RIF fragment at *RpRifOffset* + 800 RSTU into the ranging phase and continue to send the second RIF fragment at a regular interval of 1200 RSTU if the RIF only MMS packet is used. This responder may starting transmitting the first RSF fragment at *RpRsfOffset* slots into the ranging phase and continue to send the RIF fragment 2 ms after the start of its first RSF fragment transmission if the mixed RSF/RIF packet is used.

When there are two responders involved in ranging in the same ranging sub-round, the report phase consists of one, two, or three periods for transmission of a report packet. The durations of the three reporting periods are specified by the *macMms1stReportNSlots*, *macMms2ndReportNSlots*, and *macMms3rdReportNSlots* attributes. If the report phase has only a single transmission, the initiator shall transmit the One-to-many Initiator Report Compact frame or the One-to-many Initiator Secure Report Compact frame with the Message Control field set to 0x10 to the two responders in the first reporting period. This message indicates the round-trip time of the two responders in the Round-trip Time 1 and Round-trip Time 2 fields, respectively. If the report phase has two transmissions, the responder with Time Shift Indication field set to zero shall transmit the One-to-many Responder Report Compact frame or the One-to-many Responder Secure Report Compact frame in the first reporting period, and the responder with Time Shift Indication field set to one shall transmit the One-to-many Responder Report Compact frame or the One-to-many Responder Secure Report Compact frame in the second reporting period. If the report phase has three transmissions, the responder with Time Shift Indication field set to zero shall transmit the One-to-many Responder Report Compact frame or the One-to-many Responder Secure Report Compact frame in the first reporting period, the responder with Time Shift Indication field set to one shall transmit the One-to-many Responder Report Compact frame or the One-to-many Responder Secure Report Compact frame in the second reporting period, and the initiator shall transmit the One-to-many Initiator Report Compact frame or the One-to-many Initiator Secure Report Compact frame with the Message Control field set to 0x10 in the third reporting period. Figure a shows the possible report packet positions in the report phase.



Figure a – Time efficient one-to-many ranging report phase

When there is one responder involved in ranging in a ranging sub-round, the report phase is same as the basic operation of one-to-many MMS ranging.

*Insert the following row to Table 9 on page 102*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Attribute** | **Type** | **Range** | **Description** | **Default** |
| **…** | **…** | **…** | **…** | **…** |
| *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 |
| *macMms3rdReportNSlots* | Integer | 0-16 | 2 slots = 1 ms for 3rd report period | 2 |