**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **NBA-UWB MMS ranging text for 15.4ab TFD change proposal** | |
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| Sources | Alexander Krebs, Yong Liu, Santhosh Kumar Mani, Robert Golshan, Lochan Verma, Jinjing Jiang, SK Yong (Apple) |  |
| Re: | Contribution to IEEE 802.15.4ab | |
| Abstract |  | |
| Purpose | This submission proposes text to for the IEEE Std 802.15.4ab specification framework document. | |
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1. NBA-UWB MMS Ranging
   1. NBA-UWB MMS ranging cycle
      1. Overview
      2. NBA-UWB MMS control phase
      3. NBA-UWB MMS ranging phase

…

An initiator may start transmitting a first UWB RSF fragment at *RpRsfOffset* slots into the ranging phase. The initiator may continue to send up to X UWB RSF fragments at regular intervals of *1200* RSTUs (where X refers to [5]).

An initiator may start transmitting a first UWB RIF fragment at *RpRifOffset* slots into the ranging phase if no RSF fragments were transmitted by the initiator during this ranging round before, or *RpRifOffset* after the beginning of the initiator’s last RSF fragment otherwise. The initiator may continue to send up to Y UWB RIF fragments at regular intervals of *1200* RSTUs (where Y refers to [5]).

A responder may start transmitting a first UWB RSF fragment at *RpRsfOffset* + 600 RSTUsslots into the ranging phase. The responder may continue to send up to X UWB RSF fragments at regular intervals of *1200* RSTUs (where X refers to [5]).

A responder may start transmitting a first UWB RIF fragment at *RpRifOffset* slots into the ranging phase if no RSF fragments were transmitted by the responder during this ranging round before, or *RpRifOffset* after the beginning of the responder’s last RSF fragment otherwise. The responder may continue to send up to Y UWB RIF fragments at regular intervals of *1200* RSTUs (where Y refers to [5]).

…

~~An HRP-ARDEV which is required to send the report to a peer may either pass the report to the next higher layer and request the next higher layer to transmit the report to the peer, or engage using 802.15.4 NB O-QPSK in the report phase.~~

…

* + 1. NBA-UWB MMS report phase
  1. NBA-UWB MMS initialization and setup
     1. Overview
     2. Ranging session initialization
        1. Overview
        2. Initialization setup handshake

…

In addition to the common ranging configuration fields, the initiator shall provide synchronization information in the SOR packet. 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. 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 via the function defined in subsection 1.5.3.

…

* + - 1. Initialization configuration

The channel used for packet transmissions during initialization phase is referred to as the “initialization channel”. The default value of the initialization channel is defined in Table 1.2.2.3.1. The initialization channel may be changed prior to initialization channel access using higher layer methods.

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 duration of the transmissions slots is uniform and referred to by “Initialization Slot Duration” and assigned a default value in Table 1.2.2.3.1. The initialization slot duration may be changed by any of the following methods:

* prior to initialization channel access using higher layer methods
* via the first message accessing the initialization channel (ADV-POLL, PUBLIC-ADV-POLL)

The initialization slot used during first initialization channel access is referred to as initialization slot 0. Every following initialization slot is referred to by incrementing the slot number, independent of whether or not an initialization slot is used for a packet transmission or not.

| Parameters | Value range/options | Default value | Description |
| --- | --- | --- | --- |
| Initialization channel | NB: 0-249 | 2 | NB channel used for transmissions during initialization phase (see Table 1.6.3.1) |
| Initialization Slot Duration | 600+300\*N (where 0<=N<=15) | 1800 | RSTU |

**Table 1.2.2.3.1 – NBA-UWB MMS initialization channel parameters**

* + 1. Ranging session configuration

…

*Delete the row “Initialization channel” (as it was moved to its dedicated subsection and Table 1.2.2.3.1)*

| Parameters | Value range/options | Default value | Description |
| --- | --- | --- | --- |
| ~~Initialization channel~~ | ~~NB: 0-249~~ | ~~2~~ | ~~NB channel used for transmissions during initialization phase (see Table 1.6.3.1)~~ |

**Table 1.2.3.1 – NBA-UWB MMS ranging session general parameters**

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| Phases | Parameters | Value range/options | Default value | Description |
| --- | --- | --- | --- | --- |
| Control phase | *RcpPollSlot* | 1-16 ranging slots | 2 (1ms) | ranging slots |
| *RcpResponseSlot* | 1-16 ranging slots | 2 | ranging slots |
| Ranging phase | Number of RSF fragments (X in [1]) | 0, 1, 2, 4, 8, 16 | 8 |  |
| Number of RIF fragments (Y in [1]) | 0, 1, 2, 4, 8 | 0 |  |
| *RpDuration* | 0-4096 ranging slots | 20 (10ms) | ranging slots |
| *RpRsfOffset* | 0-16 ranging slots | 0 (0ms) | ranging slots |
| *RpRifOffset* | 0-16 ranging slots | 4 (2ms) | ranging slots |
| MMRS code index | 9-32 (Ipatov), 33-48 (Complementary Set) | 33 |  |
| MMRS complementary set zeros | 0-64 | 64 |  |
| STS segment length in RIF in 512-chip units | 32, 64, 128, 256 | 64 |  |
| MMRS symbol repetition in RSF (N\_MSR) | 32, 40, 48, 64, 128, 256 | 40 |  |
| Report phase | Report mode | Uni-directional initiator only, uni-directional responder only, bi-directional | Bi-directional |  |
| *MrpFirstSlot* | 0-16 ranging slots | 2 ranging slots | 0: Report is carried out by higher layer function |
| *MrpSecondSlot* | 0-16 ranging slots | 2 ranging slots | 0: Report is carried out by higher layer function |
|  |  |  |  |

**Table 1.2.3.3 – NBA-UWB MMS ranging cycle parameters**

* 1. Coordination
  2. NBA-UWB MMS bands and channels
     1. Overview
     2. NBA listen before talk (LBT)
  3. NBA-UWB MMS channel switching
     1. Overview
     2. NBA channel lists
     3. NBA channel switch protocol
  4. NBA-UWB MMS control channel messages
     1. Overview
     2. Address formats
        1. Private addresses

In order to impede tracking of NBA-UWB MMS ranging devices resolvable private addresses (RPA)s are used by initiator and responder devices. To generate its private address, every device shall be equipped with a 128-bit identity resolving key (IRK) and every initiator shall be equipped with a cryptographically secure pseudo random number generator (CSPRNG). The initiator shall generate and communicate a 3-octet output RPA\_prand of the CSPRNG in the first packet of every ranging block (in the POLL message).

A device’s 3-octet RPA\_hash is then computed using its own IRK and the initiator’s RPA\_prand as follows:

RPA\_hash = AES-128-ECB(key=IdentityResolvingKey, data=RPA\_prand]) % 2^24

where AES-128-ECB is defined in [2] (using MSB-wise zero-padded inputs) and % is the integer modulo operator. RPA\_hash shall then be used by the device as it’s source RPA for its own packet transmissions.

In order to resolve a RPA of an incoming packet the receiving device shall compute RPA\_hash using the IRK of an assumed sender device and the RPA\_prand communicated by the initiator at the beginning of the ranging block. If the result of the computation matches the received RPA, the incoming packet shall be marked as resolved. Otherwise, the incoming packet shall be marked as unresolved. If marked unresolved, the receiving device should recompute the RPA\_hash using additional IRKs from further possible sender device’s until the incoming packet is marked as resolved, or the receiving device’s list of assumed sender IRKs is exhausted.

The generation and mutual exchange of IRKs among initiator(s) and responder(s) is out of scope of this standard and may be conducted using higher layer methods.

* + 1. PSDU formats
    2. Compressed PSDU format
       1. Compressed PSDU messages

…

***Update the table as follows (unchanged rows not shown):***

…

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Phase** | **Message Name** | **Octet 0 (Msg ID)** | **Octets 1-N [Len]** | **Description** |
| Initialization | ADV-POLL | 0x01 | [RPA\_hash[3],  RPA\_prand[3], MessageControl[1], MessageContent[], CRC16] | Adverising poll message used by initiator during initialization phase.  MessageControl=0x00: MessageContent={}  selects MessageControl=0x00 for MsgIDs (0x02-0x07).  MessageControl=0x40: MessageContent={InitializationSlotDuration[1]}  selects MessageControl=0x00 for MsgIDs (0x02-0x07) and sets initialization slot duration (see subsection 1.2.2.3) |
|  | Reserved | 0x60-0x7f | Reserved | Reserved for vendor specific use |
|  | Reserved | 0x80-0xff | Reserved | Reserved |

* + - 1. Compressed PSDU message fields

…

***Modify the description of the following rows in the table (unchanged rows not shown):***

…

|  |  |  |
| --- | --- | --- |
| **Field name** | **Length in bits** | **Description** |
| RPA\_hash | 24 | The hashed part of the RPA (see subsection 1.6.2.1) |
| RPA\_prand | 24 | The CSPRNG generated part of the RPA (see subsection 1.6.2.1) |
| NB MAC Config | 56 | Bits 0-2: Ranging Slot Duration {300, 600, …, 2400} RSTUs  Bits 3-10: Ranging Round Duration 0-255 ranging slots  Bits 11-18: Ranging Block Duration 0-255 ranging rounds  Bits 19: Channel Switching: 0=Disabled, 1=Blockwise  Bits 20: Responder Measurement Report: 0=No, 1=Yes  Bits 21: Initiator Measurement Report: 0=No, 1=Yes  Bits 22-23: Reserved  Bits 24-27: RcpPollSlots=0-15  Bits 28-31: RcpResponseSlots=0-15  Bits 32-43: RpDuration=0-4095  Bits 44-47: RpOffset=0-15  Bits 48-51: MrpFirstSlots=0-15  Bits 52-55: MrpSecondSlots=0-15 |
| Time Offset | 32 | Time offset in 1/499.2MHz resolution between start of SOR packet and beginning of first POLL packet of starting ranging session.  Range: 0 to ~8.6 seconds |
| SOR Time Offset | 32 | Time offset in 1/499.2MHz resolution between start of ADV\_CONF packet and beginning of SOR packet.  Range: 0 to ~8.6 seconds |
| InitializationSlotDuration | 8 | Duration of packet transmission slot duration during initialization and setup phase:  0: 600 RSTU 1: 900 RSTU 2: 1200 RSTU … 14: 4800 RSTU 15: 5100 RSTU 16-255: reserved |

* 1. AP message for Coordination
     1. NB AP MAC Payload
     2. UWB AP MAC Payload
     3. UWB Per-Session Info
  2. References