**IEEE P802.15**

**Wireless Personal Area Networks**

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| 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
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…

A poll message serves to enable carrier coherent transmissions from the initiator to the responder device. Additionally, a poll message may with the MessageControl field set to 0x10 may indicate short-term operating parameters (i.e. NbaChannelMap, NB PHY configuration, NB MAC configuration, UWB PHY configuration and UWB MAC configuration) for the current ranging cycle and include a request for the responder to suggest short-term operating parameters for the next ranging cycle. The Presence Bitmap field of the poll message with the MessageControl field set to 0x10 indicates which of short-term operating parameters are indicated. The Request Bitmap field of the poll message with the MessageControl field set to 0x10 indicates which of short-term operating parameters are requested to suggest from the responder. The poll message is transmitted at long-term NB PHY configuration. After receiving the poll message with the MessageControl field set to 0x10 which indicates short-term operating parameters, the responder shall update the short-term operating parameters accordingly.

A response message serves to enable carrier coherent transmissions from the responder to the initiator device. Additionally, a response message may serve to transmit control information from the responder to the initiator. For example, if the responder receives the request from the initiator to suggest short-term operating parameters in the poll message with the MessageControl field set to 0x10, and does not transmit any measurement report in the current ranging cycle, then the response message with the MessageControl field set to 0x10 transmitted by the responder shall include the suggested short-term operating parameters. The Presence Bitmap field of the response message with the MessageControl field set to 0x10 indicates which of short-term operating parameters are suggested. The initiator may make use of the suggested short-term operating parameters to determine updated short-term operating parameters to be used in the next ranging round. If the NB PHY configuration is indicated in the poll message, the response message is transmitted at the NB PHY configuration indicated in the poll message. Otherwise, the response message is transmitted at long-term NB PHY configuration.

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* + 1. NBA-UWB MMS ranging phase

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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

…

A report message primarily serves to provide ranging results obtained during the ranging phase. Additionally, report messages may be used to serve other purposes. For example, if the responder receives the request from the initiator to suggest short-term operating parameters in the poll message with the MessageControl field set to 0x10, then the report message with the MessageControl field set to 0x10 transmitted by the responder shall include the suggested short-term operating parameters. The Presence Bitmap field of the report message with the MessageControl field set to 0x10 indicates which of short-term operating parameters are suggested. The initiator may make use of the suggested short-term operating parameters to determine updated short-term operating parameters to be used in the next ranging round. If the NB PHY configuration is indicated in the poll message, the report message is transmitted at the NB PHY configuration indicated in the poll message. Otherwise, the report message is transmitted at long-term NB PHY configuration.

…

* 1. NBA-UWB MMS initialization and setup
		1. Overview
		2. Ranging session initialization
			1. Overview

…

After transmitting ADV-POLL on the initialization channel, the initiator shall listen for an incoming advertising response message (ADV-RESP) in the subsequent initialization slot. Once a responder has received ADV-POLL, it may transmit ADV-RESP in the subsequent initialization slot. When the responder has transmitted ADV-RESP, it shall listen for a start-of-ranging (SOR) message in the initialization slot following the ADV-RESP message. Once the initiator has received an ADV-RESP message, it may transmit an SOR message in the initialization slot following the ADV-RESP message.

…

~~Alternatively, public addresses may be used (PUBLIC-ADV-POLL, PUBLIC-ADV-RESP, and PUBLIC-SOR).~~

…

* + - 1. Initialization setup handshake

…

If the initiator changes the value of NB\_Channel\_Select received from ADV-RESP, it shall change the value to a subset of the channels requested by the responder. For all other fields, the initiator may choose all field values independently from the values requested by the responder via ADV-RESP if the selected configuration is mandatorily supported. If the initiator chooses field values that correspond to optional support features, the initiator may take a-priori information about the supported optional features of the responder into account. The acquisition of a-priori information on optional features supported by the responder device may be provided by higher layer functionality, e.g., a pairing process, that is out of scope here.

In addition to the common ranging configuration fields, the initiator shall provide synchronization information in the SOR message. 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 message 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.

…

~~Alternatively, the same procedure can be applied using public addresses (PUBLIC-ADV-POLL, PUBLIC-ADV-RESP, PUBLIC-ADV-SOR).~~

* + - * 1. Supported message control list indication

The initiator (controller) may indicate the supported message control commands for each of ADV-RSP, RESP and REPORT messages in ADV-POLL with the MessageControl field set to 0x10 or 0x30.

The responder (controlee) may request ranging session configuration in ADV-RESP. The responder (controlee) may indicate the supported message control commands for each of SOR, POLL and REPORT messages in ADV-RESP with the MessageControl field set to 0x10 or 0x20.

The ADV-RESP and SOR messages are defined in subsection 1.6.4. The ADV-RESP message with the MessageControl field set to 0x10 or 0x30 may contain the fields NB\_Channel\_Select, UWB\_PHY\_Config, UWB\_MAC\_Config, NB\_PHY\_Config, and NB\_MAC\_Config. The Presence Bitmap field of the ADV-RESP message indicates which of these fields are suggested. The SOR message may contain all of these fields. For these fields, the initiator may either use the same values received via ADV-RESP from the responder, or change the values of each field before transmitting the updated field values in the SOR message.

* + - 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 1.6.4.1) |
| 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. Contention based initialization setup handshake

Contention based initialization and setup may be used for one-to-one ranging or one-to-many ranging. In the contention based initialization and setup stage, the initiator sends an ADV-POLL message with the MessageControl field set to 0x20 or 0x30 on the initialization channel to one or more intended responders opportunistically at times and intervals as deemed suitable for the higher layer functionality to be supported. The ADV-POLL message with the MessageControl field set to 0x20 or 0x30 sets the number of contention access based period (CAP) slots starting from the end of the ADV-POLL message. The CAP consists of multiple initialization slots and the initialization slot duration is specified in the ADV-POLL message with the MessageControl field set to 0x20 or 0x30. After transmitting the ADV-POLL message, the initiator shall listen for one or more incoming ADV-RESP messages in the subsequent CAP.

Upon the reception of the ADV-POLL message with the MessageControl field set to 0x20 or 0x30 from the initiator, any intended responder with the intention to start a ranging session with the initiator shall randomly select one of the initialization slots in the CAP and transmit an ADV-RESP message at the beginning of the selected initialization slot. Once the CAP has ended, each responder which has transmitted the ADV-RESP message shall listen for an ADV-CONF or SOR message.

Upon receipt of one or more ADV-RESP messages in the CAP, if the initiator intends for one-to-one ranging, the initiator should select one of the responders from which the initiator has received the ADV-RESP message in the CAP. If the initiator intends for one-to-many ranging, the initiator should select two or more of the responders from which the initiator has received the ADV-RESP messages in the CAP.

If only a single responder is selected and the coordination is inactive, the initiator shall send an SOR message to the selected responder in the initialization slot following the CAP. The SOR message indicates the corresponding ranging configurations and the time offset between the start of the SOR message and the beginning of the first ranging block.

If only a single responder is selected and the coordination is active, the initiator should send an ADV-CONF message with the MessageControl field set to 0x00 to the selected responder in the initialization slot following the CAP. The ADV-CONF message with the MessageControl field set to 0x00 indicates the time offset between the start of the ADV-CONF message and the start of a following SOR message, during which the initiator may attempt to capture the acquisition packets transmitted by other initiators on the initialization channel in NB and/or the default channel in UWB. Then the initiator should send the SOR message to the selected responder at the time indicated in the preceding ADV-CONF message. The SOR message specifies the corresponding ranging configurations and the time offset between the start of the SOR message and the beginning of the first ranging block.

If two or more responders are selected, the initiator shall send an ADV-CONF message with the MessageControl field set to 0x20 in the initialization slot following the CAP. The ADV-CONF message indicates the selected responders and the time offset between the start of the ADV-CONF message and the beginning of an SOR message for each of the selected responders. During the minimum of all the time offsets, the initiator may attempt to capture the acquisition packets transmitted by other initiators on the initialization channel in NB and/or the default channel in UWB. Then the initiator should send SOR messages to the selected responders individually at the respective times indicated in the preceding ADV-CONF message. Each SOR message specifies the corresponding ranging configurations and the time offset between the start of the SOR message and the beginning of the POLL message addressed to the corresponding responder in the first ranging block.

Upon receipt of the ADV-CONF message in the CAP, each of the selected responders shall listen for incoming SOR message at the corresponding time specified in the ADV-CONF message.

After transmitting the SOR message, the initiator shall enter the control phase. After receiving the SOR message, the responder shall enter the control phase. After the initiator has confirmed receipt of the RESP message from the responder during the control phase, and unless initialization of further HRP-ARDEVs is required, the initiator shall discontinue ranging initialization and cease the transmission of ADV-POLL messages.

The contention based initialization and setup process for one-to-one ranging is exemplified in the following figure:



1. The coordination is inactive



1. The coordination is active

**Figure 1.2.2.3.1 - An example of contention based initialization and setup process for one-to-one ranging**

The contention based initialization and setup process for one-to-many ranging is exemplified in the following figure:



**Figure 1.2.2.3.2 - An example of contention based initialization and setup process for one-to-many ranging**

* + 1. Ranging session configuration

***Replace the 2nd paragraph with:***

An initiator and a responder shall use the parameters which are set or updated by the next higher layers or the parameters which are not set or updated by the next higher layers but are negotiated during the initialization setup handshake as the long-term operating parameters. If the parameters are not set or updated by the next higher layers and not negotiated during initialization setup handshake, an initiator and a responder shall use default parameters as the long-term operating parameters.

***Replace 4th paragraph with:***

A responder may request short-term operating parameters for the next ranging cycle during the control phase. The initiator may serve the responder’s request in the next ranging cycle or ignore the request.

…

*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 1.6.4.1)~~ |

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

…

| 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. Ranging Session using public addresses
			1. Overview

Public addresses may be used to establish an NBA-UWB MMS ranging session. The NBA-UWB MMS initialization process using public addresses is same as in the process described in 1.2.2 except messages such as PUBLIC-ADV-POLL, PUBLIC-ADV-RESP, PUBLIC-ADV-CONF and PUBLIC-SOR include public addresses specified in 1.6.2.2 which are used for initialization process.

To establish a ranging session, HRP-ARDEVs may engage in an initialization and setup stage and perform an initialization setup handshake as described in 1.2.2. After that the HRP-ARDEVs enter the control phase and the ranging session is started. The ranging session procedure is the same as described in 1.1 except for generating IdentityResolvingKeys (IRKs) for the RPA\_hash specified in 1.6.2.1.

In the initialization and setup stage, the initiator may send public advertising poll (PUBLIC-ADV-POLL) messages with a public address which is AdvAddr specified in 1.6.2.2.

After transmitting PUBLIC-ADV-POLL on the initialization channel, the initiator shall listen for an incoming public advertising response message (PUBLIC-ADV-RESP) in the subsequent initialization slot. Once a responder has received PUBLIC-ADV-POLL, it should transmit PUBLIC-ADV-RESP with the public address which is RespAddr specified in 1.6.2.2 in the subsequent initialization slot. The responder shall set RespAddr as source address and AdvAddr obtained from PUBLIC-ADV-POLL as destination address when PUBLIC-ADV-RESP is transmitted by the responder. When the responder has transmitted PUBLIC-ADV-RESP, it shall listen for a public start-of-ranging (PUBLIC-SOR) message in the initialization slot following the PUBLIC-ADV-RESP message. Once the initiator has received a PUBLIC-ADV-RESP message, the initiator shall set AdvAddr as source address and RespAddr obtained from PUBLIC-ADV-RESP as destination address for PUBLIC-SOR and it should transmit a PUBLIC-SOR message in the initialization slot following the PUBLIC-ADV-RESP message. This procedure is shown in the Figure 1.2.4.1.



**Figure 1.2.4.1.1 – Initialization setup handshake sequence using public addresses**

The initialization process using public addresses is exemplified in the following figure:



**Figure 1.2.4.1.2 - An example of the initialization process with public addresses (PUB-ADV-POLL refers to PUBLIC-ADV-POLL, PUB-ADV-RESP refers to PUBLIC-ADV-RESP, and PUB-SOR refers to PUBLIC-SOR as defined in Table 1.6.4.1)**

If the coordination is active and the initiator intends to engage in scanning for coordination packets, the initiator should send PUBLIC-ADV-CONF with a public address to defer the transmission of PUBLIC-SOR as shown in Figure 1.2.2.1.2. In this case, the public address (AdvAddr) of PUBLIC-ADV-CONF shall be the same as the address of PUBLIC-ADV-POLL.

After ranging session is initialized using public addresses, private addresses described in 1.6.2.1 shall be used during that ranging session. To handle private addresses, the IdentityResolvingKey(IRK) is generated by the initiator and the responder(s) to generate the RPA\_hash value specified in 1.6.2.1. The initiator’s address and a responder’s address which are exchanged during initialization shall be used to generate the IRK for obtaining the RPA\_hash value.

* + - 1. RPA\_hash generation and resolution after initialization using public addresses

For the ranging session after the initialization setup handshake using PUBLIC-ADV-POLL, PUBLIC-ADV-RESP, PUBLIC-ADV-CONF and PUBLIC-SOR, the IdentityResolvingKey (IRK) shall be generated using the public addresses which are known to both the initiator and the responder(s) for the RPA\_hash specified in 1.6.2.1 to use POLL, RESP and REPORT messages. The IRK shall be generated by concatenating the initiator’s address (AdvAddr) and the responder’s address (RespAddr for one-to-one, or GroupID for one-to-many) (MSBs zero-padded to make 16 bytes).

The format of the IdentityResolvingKey is shown in Figure 1.2.4.2.



**Figure 1.2.4.2.1 –Format of IdentityResolvingKey**

A GroupID represents a group of devices in a one-to-many ranging session as described in 1.2.1 [DCN 363]. By transmitting a PUBLIC-ADV-POLL message with the MessageControl field set to 0x21 on the initialization channel, a GroupID is shared to responders. The GroupID shall be used to generate the IRK for the RPA\_hash used in POLL (one-to-many) (message id 0x12) in the one-to-many ranging session as described in 1.2.1 [DCN 363] in case GroupID is shared to responders.

The GroupID is not shared if a PUBLIC-ADV-POLL message with the MessageControl field not set to 0x21 on the initialization channel. In this case, the value, 0xFFFFFF shall be used to generate the IRK for the RPA\_hash used in. POLL (one-to-many) (message id 0x12)

The initiator and responder devices maintain a resolving list by adding multiple IRKs. The resolving list shall be used to resolve RPA\_hash in a message from an incoming packet. If multiple IRKs are existing in the resolving list, whole IRKs shall be iterated to resolve RPA\_hash as described in 1.6.2.1.

The example in the below specifies a resolving list in case GroupID is shared to the responders.

AdvAddr = 0x6E538F, RespAddr = 0x401F4C, GroupId = 0x2A3E88

IRK1 (for POLL (message id 0x04)) = AdvAddr || RespAddr (MSBs zero padded) = 0x000000000000000000006E538F401F4C
IRK2 (for POLL (one-to-many) (message id 0x12)) = AdvAddr || GroupID (MSBs zero padded) = 0x000000000000000000006E538F2A3E88

The example in the below specifies a resolving list in case GroupID is not shared to the responders.

AdvAddr = 0x6E538F, RespAddr = 0x401F4C

IRK1 (for POLL (message id 0x04))) = AdvAddr || RespAddr (MSBs zero padded) = 0x000000000000000000006E538F401F4C
IRK2 (for POLL (one-to-many) (message id 0x12)) = AdvAddr || 0xFFFFFF (MSBs zero padded) = 0x000000000000000000006E538FFFFFFF

* + - 1. Advertisement information in PUBLIC-ADV-POLL

In PUBLIC-ADV-POLL, an AdvData field specified in 1.6.4.2 may be included to announce public advertisement information. The AdvData contains a sequence of AD structures. Each AD structure shall have Length, Type and Value. The sequence is terminated when Length field is zero in an AD structure.

AdvData = {AD Structure1,…, AD StructureN} Where AD Structure={LEN[1], Type[1], Value[]}

The AD Structure may contain information which an initiator announces such as service representation, friendly name, advertising interval, vendor specific information and so on. It is omitted if there is no advertisement information.

* 1. Coordination
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		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 message 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. Public addresses

In order to establish ranging session to an NBA-UWB MMS ranging devices for a public infrastructure, public addresses may be used by initiator and responder devices. The initiator and responder devices shall use 3-octet random address during NBA-UWB MMS initialization process.

AdvAddr shall be 3-octet initiator’s address randomly generated by an initiator and RespAddr shall be 3-octet responder’s address randomly generated by a responder.

AdvAddr shall be used for public advertising poll (PUBLIC-ADV-POLL) as the advertising address by an initiator. For public advertising response (PUBLIC-ADV-RESP) from a responder to an initiator, AdvAddr shall be used as destination address and RespAddr shall be used as source address by the responder. For public start of ranging (PUBLIC-SOR) from an initiator to a responder, RespAddr shall be used as destination address and AdvAddr shall be used as source address by the initiator.

Public addresses shall not change while initiator(s) and responder(s) are in ranging session.

The random function to generate public addresses for 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=0x10:MessageContent={SMC TLVs[]}Where SMC\_TLVs is the list of supported message control commands.Message Control=0x20:MessageContent={CapDuration[1],InitializationSlotDuration[1]}Message Control=0x30:MessageContent={SMC TLVs[],CapDuration[1],InitializationSlotDuration[1]}MessageControl=0x40:MessageContent={InitializationSlotDuration[1]}selects MessageControl=0x00 for MsgIDs (0x02-0x07) and sets initialization slot duration (see subsection 1.2.2.3) |
| ADV-RESP | 0x02 | [RPA\_hash[3], MessageControl[1],MessageContent[], CRC16] | Advertising response message used by responder during initialization phase.MessageControl=0x00:MessageContent={NB Channel Select[2],UWB PHY Config[3],UWB MAC Config[2],NB PHY Config[1],NB MAC Config[7]}MessageControl=0x10:MessageContent={Presence Bitmap[1],If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence Bitmap == 1 then {UWB MAC Config[2]}}MessageControl=0x20:MessageContent={SMC TLVs[]}MessageControl=0x30:MessageContent={SMC TLVs[],Presence Bitmap[1],If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence Bitmap == 1 then {UWB MAC Config[2]}} |
| ADV-CONF | 0x08 | [RPA\_hash[3], MessageControl[1],MessageContent[],CRC16] | Advertising confirmation message used by initiator during initialization phase.MessageControl=0x00:MessageContent={SOR Time Offset [4]}MessageControl=0x20:MessageContent={Number of Responders [1],List of {Responder Address [3], SOR Time Offset [4]}} |
| PUBLIC-ADV-POLL | 0x21 | [AdvAddr[3],MessageControl[1],MessageContent[],CRC16] | Public Advertising poll message used by initiator during initialization phase for public advertisement purpose.MessageControl=0x00:MessageContent={}MessageControl=0x10:MessageContent={SMC\_TLVs[]}MessageControl=0x20:MessageContent={CapDuration[1],InitializationSlotDuration[1],AdvData[]}MessageControl=0x21:MessageContent={SMC\_TLVs[],CapDuration[1],InitializationSlotDuration[1],GroupID[3],AdvData[]}MessageControl=0x30:MessageContent={SMC\_TLVs[],CapDuration[1],InitializationSlotDuration[1],AdvData[]}MessageControl=others: Reserved Where SMC\_TLVs is a sequence of structure which shall have Type, Length and Value (TLV). It is the list of supported message control commands. Where AdvData is the sequence of AD structure which shall have Length, Type and Value. |
| PUBLIC-ADV-RESP | 0x22 | [AdvAddr[3],RespAddr[3],MessageControl[1],MessageContent[],CRC16] | Public Advertising response message used by responder during initialization phase.MessageControl=0x00:MessageContent={Presence Bitmap[1],If Bit 0 of Presence\_Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence\_Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence\_Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence\_Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence\_Bitmap == 1 then {UWB MAC Config[2]}}MessageControl=0x10:MessageContent={SMC\_TLVs[]}MessageControl=0x20:MessageContent={SMC\_TLVs[],Presence Bitmap[1],If Bit 0 of Presence\_Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence\_Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence\_Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence\_Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence\_Bitmap == 1 then {UWB MAC Config[2]}}MessageControl=others: ReservedWhere SMC\_TLVs is a sequence of structure which shall have Type, Length and Value (TLV). It is the list of supported message control commands. |
| PUBLIC-SOR | 0x23 | [AdvAddr[3],RespAddr[3],MessageControl[1],MessageContent[],CRC16] | Public Start of ranging message used by initiator during initialization phase.MessageControl=0x00:MessageContent={Time Offset[4],NB Channel Seed[1],NB Channel Select[2],NB PHY Config[1],NB MAC Config[7],UWB PHY Config[3],UWB MAC Config[2]}MessageControl=others: Reserved |
| PUBLIC-ADV-CONF | 0x26 | [AdvAddr[3],MessageControl[1],MessageContent[],CRC16] | Public Advertising confirmation message used by initiator during initialization phase.MessageControl=0x00:MessageContent={SOR Time Offset [4]}MessageControl=0x20:MessageContent={Number of Responders [1],List of {Responder Address [3], SOR Time Offset [4]}}MessageControl=others: Reserved |
| Control | POLL | 0x04 | [RPA\_hash[3], RPA\_prand[3], MessageControl[1],MessageContent[],CRC16] | A qualifying poll message. MessageControl=0x00:MessageContent={0x00, 0x00}MessageControl=0x10:MessageContent={Request Bitmap[1],Presence Bitmap[1],If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence Bitmap == 1 then {UWB MAC Config[2]}} |
| RESP | 0x05 | [RPA\_hash[3], MessageControl[1],MessageContent[],CRC16] | A qualifying response message.MessageControl=0x00:MessageContent={0x00, 0x00, 0x00, 0x00, 0x00}MessageControl=0x10:MessageContent={Presence Bitmap[1],If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence Bitmap == 1 then {UWB MAC Config[2]}, zero, one, two or three times 0x00}where the number of padding bytes are determined so that the MessageContent field has a minimum size of 5 bytes; and at least one of NbaChannelMap, NB PHY Config, NB MAC Config, UWB PHY Config and UWB MAC Config fields shall be present. |
| Report | REPORT(from responder) | 0x07 | [RPA\_hash[3],MessageControl[1],MessageContent[],CRC16] | A qualifying report message.MessageControl=0x00:MessageContent={ReplyTime[5],PTDataLength[1],PTData[PTDataLength]}, where PTDataLength and PTData fields are optionally present and represent pass through data to higher layers.MessageControl=0x10:MessageContent={Presence Bitmap[1],ReplyTime[5],PTDataLength[1],PTData[PTDataLength],If Bit 0 of Presence Bitmap == 1 then {NB Channel Select[2]},If Bit 1 of Presence Bitmap == 1 then {NB PHY Config[1]},If Bit 2 of Presence Bitmap == 1 then {NB MAC Config[7]},If Bit 3 of Presence Bitmap == 1 then {UWB PHY Config[3]},If Bit 4 of Presence Bitmap == 1 then {UWB MAC Config[2]}}, where PTDataLength and PTData fields are optionally present and represent pass through data to higher layers; and at least one of NbaChannelMap, NB PHY Config, NB MAC Config, UWB PHY Config and UWB MAC Config fields shall be present.  |
|  |  |  |  |  |
|  | 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} RSTUsBits 3-10: Ranging Round Duration 0-255 ranging slotsBits 11-18: Ranging Block Duration 0-255 ranging roundsBits 19: Channel Switching: 0=Disabled, 1=BlockwiseBits 20: Responder Measurement Report: 0=No, 1=YesBits 21: Initiator Measurement Report: 0=No, 1=YesBits 22-23: ReservedBits 24-27: RcpPollSlots=0-15Bits 28-31: RcpResponseSlots=0-15Bits 32-43: RpDuration=0-4095Bits 44-47: RpOffset=0-15Bits 48-51: MrpFirstSlots=0-15Bits 52-55: MrpSecondSlots=0-15 |
| NB PHY Config | 8 | Sets O-QPSK PHY #1-#9 referring to [1]{#1: 250k uncoded, …, #9}Bits 0-3: NB Control PhaseBits 4-7: NB Report PhaseNote: If Bit 4-7 value 0b1111 means NB is disabled for report phase, and UWB mode #1 from Table in slide 14 of [15-23-0307-00-04ab] with Code index #32 in Table 15-7a [IEEE 802.15.4z] is used instead. |
| Time Offset | 32 | Time offset in 1/499.2MHz resolution between start of SOR message and beginning of first POLL message 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 message and beginning of SOR message.Range: 0 to ~8.6 seconds |
| InitializationSlotDuration | 8 | Duration of packet transmission slot duration during initialization and setup phase:0: 600 RSTU1: 900 RSTU2: 1200 RSTU…14: 4800 RSTU15: 5100 RSTU16-255: reserved |
| AdvAddr | 24 | Initiator's public address randomly generated by an initiator (see subsection 1.6.2.12) |
| RespAddr | 24 | Responder’s public address randomly generated by a responder (see subsection 1.6.2.12) |
| GroupID | 56 | Group ID of an initiator and responder(s) participating one-to-many ranging (see subsection 1.6.2.12) |
| AdvData | var | Advertisement information in PUBLIC-ADV-POLL (see subsection 1.2.4.3) |
| Request Bitmap | 8 | Bit 0: NbaChannelMap requested: 0: not requested, 1: requestedBit 1: NB PHY Config requested: 0: not requested, 1: requestedBit 2: NB MAC Config requested: 0: not requested, 1: requestedBit 3: UWB PHY Config requested: 0: not requested, 1: requestedBit 4: UWB MAC Config requested: 0: not requested, 1: requestedBits 5-7: reserved |
| Presence Bitmap | 8 | Bit 0: NB Channel Select or NbaChannelMap’s presence: 0 not present, 1: presentBit 1: NB PHY Config’s presence: 0 not present, 1: presentBit 2: NB MAC Config’s presence: 0 not present, 1: presentBit 3: UWB PHY Config’s presence: 0 not present, 1: presentBit 4: UWB MAC Config’s presence: 0 not present, 1: presentBit 5: Scheduling Information's presence (i.e., StartSlotIndex[2] and EndSlotIndex[2]): 0 not present, 1: present Bits 6-7: reserved |
| CapDuration | 8 | The number of initialization slots contained in the CAP minus one. |
| SMC\_TLVs | var | The list of supported message control commands, where SMC\_TLVs[] contains one or more SMC\_TLV items. |
| SMC\_TLV | var  | SMC = {PSDU\_ID[1], LEN(SMC\_MessageControls)[1], SMC\_MessageControls[]}, where each octet in SMC\_MessageControls signals support for message PSDU\_ID. |
| SMC\_MessageControls[] | var | Array of supported MessageControl codes. |

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