**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **Text proposal for public addresses of NBA-UWB MMS** |
| Date Submitted | June 2023 |
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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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***The baseline for this contribution is 15-22-0381-05-04ab-nba-uwb-ranging-text-proposal-for-15-4ab-tfd\_clean***

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

***Modify sub-clause as follows:***

Before entering the control phase, HRP-ARDEVs may engage in an initialization and setup stage. The initialization and setup stage provides time synchronization of the first poll packet transmitted by the initiator during an upcoming control phase. Furthermore, ranging session configuration may be altered by a two-way handshake packet exchange between the HRP-ARDEVs. Unless renegotiated during initialization and setup, the default ranging configuration parameters shall be used for the ranging session. Alternatively, the ranging session configuration may be set up by radio technology controlled by a higher layer.

To establish NB O-QPSK initialization, HRP-ARDEVs should opportunistically transmit and receive on the dedicated initialization channel using the PHY modulation, as specified in the default ranging session configuration or as configured prior to initialization via higher layer protocols. The initiator may send advertising poll (ADV-POLL) packets opportunistically at times and intervals to its discretion as deemed suitable for the higher layer functionality to be supported. Similarly, the responder may opportunistically listen for incoming ADV-POLL packets.

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

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

The initialization process is exemplified in the following figure:

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**Figure 1.2.2.1.1 - An example of NBA-UWB MMS initialization and ranging phase**

If the coordination is active, initiator determines the configuration of ranging session based on the knowledge of UWB channel usages via receptions of acquisition packets (APs) from other initiators described in 1.3. For coordination, Initiator may need to scan the initialization channel in NB and the default channel in UWB before the transmissions of SOR. To perform scanning for coordination and to defer the transmission of SOR, initiator sends ADV-CONF with the time offset between end of ADV-CONF packet and beginning of SOR after the reception of ADV-RESP.

If the coordination is activated and the scanning of APs nearby is required after ADV-CONF and before the SOR, the initialization process with ADV-CONF is exemplified in the following figure:



**Figure 1.2.2.1.2 - An example of the initialization process with ADV-CONF**

* + - 1. Initialization setup handshake

The responder (controlee) requests ranging session configuration in ADV-RESP.

The initiator (controller) receives the request from the responder via ADV-RESP, sets the session configuration, and communicates the session configuration in SOR to the responder.

The ADV-RESP and SOR packets are defined in subsection 1.6.3 and contain the common fields NB\_Channel\_Select, UWB\_PHY\_Config, UWB\_MAC\_Config, NB\_PHY\_Config, and NB\_MAC\_Config. 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 packet.

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 independent 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 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 end 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. Ranging session configuration

***Add new clause as follows:***

* + 1. Ranging Session using public addresses
			1. Overview

Public addresses may be used to establish 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 message IDs such as PUBLIC-ADV-POLL, PUBLIC-ADV-RESP, PUBLIC-ADV-CONF and PUBLIC-SOR including public addresses specified in 1.6.2.2 which are used for initialization process.

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

In the initialization and setup stage, the initiator may send public advertising poll (PUBLIC-ADV-POLL) packets with 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 packet (PUBLIC-ADV-RESP) in the subsequent ranging slot. Once a responder has received PUBLIC-ADV-POLL, it may transmit PUBLIC-ADV-RESP with public address which is RespAddr specified in 1.6.2.2 in the subsequent ranging slot. The responder set RespAddr as source address and AdvAddr obtaining 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) packet in the ranging slot following the PUBLIC-ADV-RESP packet. Once the initiator has received a PUBLIC-ADV-RESP packet, the initiator set AdvAddr as source address and RespAddr obtaining from PUBLIC-ADV-RESP as destination address for PUBLIC-SOR and it may transmit a PUBLIC-SOR packet in the ranging slot following the PUBLIC-ADV-RESP packet.

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



**Figure 1.2.2.1.3 - An example of the initialization process with public addresses**

If the coordination is active, initiator sends PUBLIC-ADV-CONF with public address to defer the transmission of PUBLIC-SOR described in Figure 1.2.2.1.2. In this case, the public address of PUBLIC-ADV-CONF is the AdvAddr same as the address of PUBLIC-ADV-POLL.

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

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

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

A GroupID represents a group of devices in one-to-many ranging session described in 1.x.x. By transmitting PUBLIC-ADV-POLL packet with the MessageControl field set to 0x21 on the initialization channel, a GroupID is shared to responders. The GroupID may be assigned by an initiator and it may be used to generate IRK for RPA\_hash used by broadcasting POLL in one-to-many ranging session described in 1.x.x. GroupID may be assigned as 0xFFFFFF unless it is included in PUBLIC-ADV-POLL.

* + - 1. There may be resolving list to maintain multiple IRKs. The resolving list is used to resolve RPA\_hash in a message from a peer device. If multiple IRKs are existing in resolving list, one may be AdvAddr || RespAddr (MSBs zero padded) and the other may be AdvAddr || GroupID (MSBs zero padded) where ‘||’ is concatenation. More IRKs may be included in resolving list if necessary. If there are multiple IRKs in resolving list, whole IRKs may be iterated to resolve RPA\_hash.Advertisement information in PUBLIC-ADV-POLL

In PUBLIC-ADV-POLL, AdvData field specified in 1.6.4.2 may be included to announce public advertisement information. 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.

The size of AdvData may be determined to consider transmission time. For example, if transmission time requirement is under 1ms, the size of AdvData in PUBLIC-ADV-POLL may not exceed 25 bytes – [Len (ID) + Len (AdvAddr) + Len (MsgCtl) + Len (MsgContent except AdvData) + Len (CRC16)] bytes where MsgCrl is 0x20.

* 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
			2. Public addresses

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

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

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

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

The generation of 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

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

|  |  |  |  |
| --- | --- | --- | --- |
| …**Message Name** | **Octet 0 (Msg ID)** | **Octets 1-N [Len]** | **Description** |
| 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 packet 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 packet 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 packet 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 |

* + - 1. Compressed PSDU message fields

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

…

|  |  |  |
| --- | --- | --- |
| **Field name** | **Length in bits** | **Description** |
| AdvAddr | 24 | Initiator's public address randomly generated by an initiator (see subsection 1.6.2.2) |
| RespAddr | 24 | Responder’s public address randomly generated by an initiator (see subsection 1.6.2.2) |
| GroupID | 56 | Group ID of an initiator and responder(s) participating one-to-many ranging (see subsection 1.2.4.2) |
| AdvData | var | Advertisement information in PUBLIC-ADV-POLL (see subsection 1.2.4.3) |

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