**IEEE P802.15**

**Wireless Specialty Networks**

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| Project | IEEE P802.15 Working Group for Wireless Specialty Networks (WSNs) – 802.15.4ab |
| Title | **Proposed Text for 4ab MAC – Block Assignment in Hyper Blocks** |
| Date Submitted | 12 May 2023 |
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| Re: | Developing technical content for actual specification text. |
| Abstract | This document provides details of MAC features for 4ab especially for Hyper block-based mode |
| Purpose | Support development of technical content for the draft |
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The baseline for this TFD is 15-23-0155-01-04ab-status-update-on-hyper-block-based-mode-v2. The modifications compared to the baseline are shown as markups.

**6.9.7.3.5 Hyper block-based mode**

 ***Modify the subclause as follows (Track changes ON):***

A hyper block is a group of ranging blocks. Hyper block-based mode uses the time structure that is periodic. Figure 6-XXX shows an example timing diagram of hyper block-based mode.



**Figure 6-XXX – Example of timing diagram of hyper block-based mode**

Each hyper block consists of a whole number of ranging blocks. In the hyper block-based mode, the individual ranging blocks within a hyper block may have different configuration for their ranging block duration, ranging round duration, and ranging slot duration, while successive hyper blocks employ the same configuration.

The configuration for the hyper block structure can be repeatedly transmitted in every RCM by the controller. The Hyper Block Structure IE (HBS IE), as defined in 7.4.4.56, can be used to signal the durations of each of the ranging blocks in the hyper block. The HBS IE specifies the index of the corresponding ranging block and includes a list of the durations of all the ranging blocks within the hyper block. Optionally, round duration, slot duration and block assignment(s) can also be specified in the HBS IE. On reception of an HBS IE with the RCM, a controlee can assume that hyper block structure is followed. Each block structure can be setup by specifying the Ranging Block Duration field, the Ranging Round Duration field, and the Ranging Slot Duration field in the HBS IE and/or the ARC IE within the RCM. The hyper block structure is determined by the next higher layer.

The hyper block-based mode is optional. Each hyper block is identified by hyper block index. This is the total number of hyper blocks that has elapsed since the start of the network and increments by one with each hyper block execution. It is announced by controller with HBS IE. It is used by devices as hyper block counter to identify where it is now, as ranging block index restarts from 0 again in every hyper block.

The packets sent in the ranging block/round/slots may be used for ranging and/or sensing and/or data communications as well.

The Controller may also allocate a hyper block advertisement (HBA) round, at least once in each hyper block, to advertise the assigned block for each participating device or network (e.g. RAN (Ranging Area Network)). The hyper block advertisement round may be fixed as the first round of each ranging block in each hyper block or it may be a negotiated round in a certain block of each hyper block. (e.g., negotiated during session setup). In each hyper block advertisement round, the Controller transmits an HBS IE carrying the block assignment(s), as defined in 7.4.4.56, for that hyper block. An example where the controller allocates a hyper block advertisement (HBA) round in the first round of every ranging block is illustrated in Figure 6-OOO.



Figure 6-OOO

In an allocated ranging round of a ranging block within a hyper block, the controller may transmit an Enhanced Ranging Round IE (ERR IE) (as described in 7.4.4.57) to inform the next ranging block that is assigned to a controlee, the number of rounds in the next assigned ranging block and the ranging round information in the next assigned ranging block. The ERR IE may be included in the RCM or in the last message sent by the controller to the controlees in the current ranging round. The ERR IE will also signal to the controlees whether to hop to a different round and/or use a different transmission offset in the ranging round of the next assigned ranging block. After receiving the ERR IE in the final message of a ranging message sequence or in an RCM, the controlee next higher layer is responsible for using the indicated ranging round and transmission offset in the next assigned ranging block. If the controlee does not receive the ERR IE (either in the final message of the exchange or in the RCM), for example due to an interference event, the controlee can listen to the channel at the next known hyper block advertisement round to receive the HBS IE carrying the block assignment(s) for the hyper block. After receiving the block assignment(s), if the controlee finds its address or the address of the network it belongs to in the HBS IE, it will know the block that is assigned to it and if round hopping is enabled, it can also calculate the number of rounds in the block based on the Block Duration field and the Round Duration field in the HBS IE and will be able to calculate its allocated round in the block.

 ***Modify the subclause 7.4.4.56 as follows (Track changes ON):***

**7.4.4.56 Hyper Block Structure IE (HBS IE)**

The HBS IE is used by the controller to send the hyper block structure configuration to controlees in the RCM message. The Content field of the HBS IE shall be formatted as illustrated in Figure 6-ZZZ.

|  |  |  |  |
| --- | --- | --- | --- |
| **Octets:2** | **1** | **1** | **Variable** |
| Hyper Block Index | Content Control | Ranging Block Description List Length | Ranging Block Description List |

Figure 6-ZZZ – HBS IE Content field format

The Hyper Block Index field specifies the index of the Hyper block,

The Content Control field is formatted as per Figure 6-LLL, and indicates the presence of duration fields in the Block List, which is structured as per Figure 6-KKK.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bits: 0 - 1** | **2** | **3** | **4** | **5 - 7** |
| Ranging Block Duration Units | Ranging Round Duration Presence | Ranging Slot Duration Presence | Ranging Block Assignment List Presence | Reserved |

Figure 6-LLL – Content Control field format

The Block Duration Units field indicates the size of the Block Duration field as per Table XXX.

Table XXX. Block Duration Units field

|  |  |
| --- | --- |
| Block Duration Units field value | Description |
| 00 | Size of Block Duration field is 1 octets and the unit of Block Duration field is the number of rounds |
| 01 | Size of Block Duration field is 2 octets and the unit of Block Duration field is the number of slots |
| 10 | Size of Block Duration field is 3 octets and the unit of Block Duration field is the number of RSTU |
| 11 | Reserved |

The Ranging Round Duration Presence indicates the presence of the Round Duration field when it is”1”, and it is not present when it is “0” as per Figure 6-KKK.

The Ranging Slot Duration Presence indicates the presence of the Slot Duration field when it is “1”, and it is not present when it is “0” as per Figure 6-KKK.

The Ranging Block Assignment List Presence field indicates the presence of the Ranging Block Assignment List Length field and the Ranging Block Assignment List field. The fields are present when the Ranging Block Assignment List Presence field is “1”, and are not present when the Ranging Block Assignment List Presence field is “0” as per Figure 6-KKK.

Ranging Block Description List Length specifies the number of Ranging Block Description List elements in the Ranging Block Description List field. The number of Ranging Block Description List Elements shall be set equal to the number of blocks in the hyper block.

Ranging Block Description List field contains Ranging Block Description List elements each of which is structured as per Figure 6-KKK.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Octets: 1 | 1/2/3 | 0/1 | 0/2 | 0/1 | 0/variable |
| Ranging Block Index | Block Duration | Round Duration | SlotDuration | Ranging Block Assignment List Length | Ranging Block Assignment List |

Figure 6-KKK – Block Description List field format

The Ranging Block Index field specifies the index of the ranging block within the hyper block.

The Ranging Block Duration field is an unsigned integer that specifies the duration of a ranging block. The size and the unit of the Block Duration field is determined by the Unit of Block Duration field as per Table XXX

The Ranging Round Duration field is an unsigned integer that specifies the duration of the round in units of slots, which is the number of slots in the round.

The Ranging Slot Duration field is an unsigned integer that specifies the duration of a slot in RSTU.

The Ranging Block Assignment List Length field specifies the number of Ranging Block Assignment fields in the Ranging Block Assignment List field. The value of zero is reserved.

The Ranging Block Assignment List carries one or more Ranging Block Assignment fields as per Figure 6-MMM.

|  |  |  |
| --- | --- | --- |
| Bits: 0 | 1 - 7 | Octets: Variable |
| Address Size | Address List Length | Address List |

Figure 6-MMM – Ranging Block Assignment

The Address Size field specifies the size used for addresses in the Address List field. If the Address Size

field is zero, all addresses in the Address List field are short addresses. If the Address Size field is one, all

addresses are extended addresses.

The Address List Length field specifies the number of addresses in the Address List field.

The Address List field carries a list of address of the network or devices that are allocated one or more round in the block. For networks, short address is used.

 ***Insert the subclause*** ***7.4.4.57 as follows (Track changes ON):***

**7.4.4.57 Enhanced Ranging Round IE (ERR IE)**

The ERR IE is used by the controller to inform the next assigned ranging block, the number of rounds in the next assigned ranging block and the ranging round information in the next assigned ranging block to devices. The Content field of the ERR IE shall be formatted as illustrated in Figure 6-NNN.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Octets: 2 | 1 | Bits: 0 | 1 - 15 | Octets: 2 | 0 or 1 |
| Hyper Block Index | Ranging Block Index | Hopping Mode | Round Index | Transmission Offset | Number of Rounds |

Figure 6-NNN – ERR IE Content field format

The Hyper Block Index field specifies the index of the hyper block in which the next assigned ranging block is located.

The Ranging Block Index field specifies the index of the next assigned ranging block within the hyper block (zero indicates the first ranging block).

The Hopping Mode field specifies the hop mode for the next assigned ranging block, where zero means no hopping and one means hopping.

The Round Index field specifies the round index for the next assigned ranging block when round hopping is not enabled.

The Transmission Offset field specifies the value of transmission offset of the round in the next assigned ranging block, in RSTU. This offset shall be at most the ranging slot duration minus the packet duration.

The Number of Rounds field specifies the number of rounds in the next assigned ranging block and is present when the Hopping mode field is set to one.