**IEEE P802.15**

**Wireless Personal Area Networks**

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| Source | Taeyoung Ha, Mingyu Lee, Youngwan So, Aniruddh Rao Kabbinale, Clint Chaplin (Samsung Electronics) |
| 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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Multiple RSF Transmission in a slot

## Introduction

As one of the PAR objectives provided by TG4ab, next generation UWB should improve link budget and/or reduced air-time. In this document we address the way to reduce air-time by allowing multiple transmitters to transmit ranging sequence fragments (RSFs) simultaneously.

There are two main sections: One focuses on MAC aspects of various features that rely on multiple RSF transmission in a slot, and the other one develops the message formats required to support the features introduced in the MAC section.

## Basic Operation

In order to support delay sensitive applications among the co-located devices at the same time, efficient use and scheduling of resources (i.e., slots) are required. The purpose of multiple RSF transmission in a slot is to increase slot efficiency by allowing multiple RSF transmission in a slot between devices. Support of multiple RSF transmission in a slot is optional.

As presented in Figure 1, Multiple RSF transmission can be applied to devices in a ranging area network (RAN). For example, as shown in Figure 1, responders in a RAN can transmit RSFs simultaneously as scheduled by an initiator. In order to provide performance, it is recommended to have a channel condition between an initiator and responders good enough to keep the received signal strength levels within the cross-correlation performance.



Figure 1 Multiple RSF Transmission in a RAN

Procedure of multiple RSF transmission in a slot is divided into 4 phases, which are scheduling, trigger, transmission, and ranging report phase. In scheduling phase, RSF transmission is scheduled to have the RSF transmission timing of each responder. This phase can be proceeded by sending a control message of UWB or NB by an initiator. This scheduling phase can be achieved through out-of-band (OOB) procedures. The trigger phase indicates the anchor point of RSF transmission. Initiator sends (SYNC + SFD) packet of UWB or poll message of NB to trigger RSF transmission. After trigger phase, multiple RSF transmissions occur among the responders in the slot. The ranging report phase delivers ranging results to the responders. Initiator may send Ranging report message to responders to conduct this phase. Scheduling and ranging report phase of multiple RSF transmission can be omitted if unnecessary.

### Multiple RSF transmission without NB assist

The operation of multiple RSF transmission in a slot without NB assist is presented in Figure 2. Scheduling phase is conducted by transmitting a control message in UWB channel. This control message shall include the scheduling IE. After scheduling phase, (SYNC + SFD) only packet is transmitted to trigger multiple RSF transmission. After RSF transmission occurs, ranging report phase is proceeded by sending ranging report messages in UWB channel from initiator to responders, if necessary. If there is no change in scheduling, the scheduling phase of RSF transmission (i.e., control message in UWB channel) can be omitted.



Figure 2 Multiple RSF transmission in a slot without NB assist

### Multiple RSF transmission in a slot with NB assist

The operation of multiple RSF transmission in a slot with NB assist is shown in Figure 3. Scheduling phase is conducted by sending a control message in NB channel. After scheduling the phase, poll message is transmitted to trigger RSF transmissions. After the RSF transmission occurs, ranging report step is proceeded by sending ranging report messages in NB channel from initiator to responders, if necessary. If there is no change in scheduling, the scheduling phase of RSF transmission (i.e., control message in NB channel) can be omitted.



Figure 3 Multiple RSF transmission in a slot with NB assist

# Message Format

## UWB messages

### Scheduling IE

These information are included in [1] (Already approved).

## NB Message

### Control/Poll Message

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Phase** | **Message Name** | **Octet 0 (Msg ID)** | **Octets 1-N [Len]** | **Description** |
| Initialization | POLL (one-to-many) | 0x10 | [RPA\_hash[3], RPA\_prand[3], MessageControl[1], MessageContent[], CRC16] | MessageControl=0x80: MessageContent={ Number of Responders[1], Request Bitmap[1], Presence Bitmap[1], List of {Responder Address[3], If Bit 0 of Presence Bitmap == 1 then {NbaChannelMap[6]}, 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]}, If Bit 5 of Presence Bitmap == 1 then {StartSlotIndex[2], EndSlotIndex[2]} }} |

### Ranging Report

These information are included in 1.6.3.1 of [2] (Already approved).

# References

[1] 15-23-0062-03-04ab-text-for-scheduling-ie, March 2023.

[2] 15-22-0381-05-04ab-nba-uwb-ranging-text-proposal-for-15-4ab-tfd, May 2023.