**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **UWB Sensing by Proxy Technical Framework Proposal** |
| Date Submitted |  July, 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 TFD is 15-22-0538-04-04ab-proposal-of-sensing-framework.*

*Insert a new subclause 2.5 after 2.4 as follows*

1.
2.

## Sensing by Proxy

1.
2. 1.
	2.
	3.
	4.
	5. 1. General

SBP is a procedure that allows a 4ab advanced device which supports SBP to request another SDEV to perform sensing on its behalf. Implementation of SBP is optional.

A 4ab advanced device which supports SBP shall set the SBP subfield of the UWB HRP Capability Information field in the HRP UWB Association Request command to 1.

SBP has two modes:

* Basic SBP mode: The sensing requesting device exchanges information with the sensing initiator directly.
* Hierarchical SBP mode: The sensing requesting device exchanges information with the sensing initiator via one or more sensing requesting relay devices.
	+ 1. SBP setup

The SBP setup procedure consists of the following steps:

1. The sensing requesting device may transmit an SBP Request IE to the sensing initiator. The SBP Request IE includes valid SBP parameters and sensing control parameters. The sensing initiator shall send an acknowledgement to the sensing requesting device in response to a successful reception of the SBP Request IE. The SBP Request IE, as specified in 2.6.3, can be included in out-of-band signalling or custom messages.
2. The sensing initiator may issue an SBP Response IE to the sensing requesting device. The SBP Response IE includes the status code parameters. The sensing requesting device shall send an acknowledgement to the sensing initiator in response to a successful reception of the SBP Response IE. The SBP Response IE, as specified in 2.6.4, can be included in out-of-band signalling or custom messages.
	* 1. SBP reporting

In the SBP reporting procedure, the sensing initiator may sequentially transmit one or more sensing measurement reports of the corresponding sensing measurement exchange to the sensing requesting device. Alternatively, the sensing initiator may transmit an aggregated sensing measurement report to the sensing requesting device, which includes one or more sensing measurement reports of the corresponding sensing measurement exchange.

* + 1. SBP session termination phase

An SBP procedure can be terminated either by the associated sensing requesting device or the sensing initiator by transmitting an SBP Termination IE at any time.

If the sensing initiator transmits an SBP Termination IE or receives an SBP Termination IE from the sensing requesting device to indicate the termination of the SBP procedure, the sensing initiator should terminate corresponding sensing session with all the sensing responders involved in the sensing session. The SBP Termination IE, as specified in 2.6.5, can be included in out-of-band signalling or custom messages.

*Change the original subclause 2.5 and 2.6 to subclause 2.6 and 2.7.*

## Information Elements for Sensing Scheduling and Control

*Insert new subclauses 2.6.3, 2.6.4, and 2.6.5 after 2.6.2 as follows*

* + 1. SBP Request IE

The SBP Request IE is used by the sensing requesting device to send the SBP parameters and sensing control parameters to the sensing initiator. The SBP request IE may also convey the preferred sensing responder address parameters. The content field of the SBP Request IE shall be formatted as shown in Figure x1.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Bits:****0** | **1-2** | **3** | **4-7** | **8** | **9** | **10** | **11-14** |
| Address Size | SBP Procedure Expiry Exponent | Sensing Responder | Number of Sensing Responders | Mandatory Number of Sensing Responders | Sensing Initiator Address Presence | Preferred Sensing Responder List | Number of Preferred Sensing Responders |

|  |  |  |  |
| --- | --- | --- | --- |
| **Bits:****15** | **Octets:****0/2/8** | **Variable** | **Variable** |
| Mandatory Preferred Sensing Responders | Sensing Initiator Address | Sensing Control | Sensing Responder Address List |

**Figure x1-SBP Request IE Content field format**

The Address Size field specifies the size of the addresses used in the SBP Request IE. If the Address Size field is zero, all addresses in the SBP Request IE are short addresses. If the Address Size field is one, all addresses in the SBP Request IE are extended addresses.

The value of the SBP Procedure Expiry Exponent field contains an unsigned integer. The SBP Procedure Expiry Exponent value is equal to $2^{\left(SBP Procedure Expiry Exponent+8\right)}$ ms. This parameter indicates the termination time for the SBP procedure in the event of no frame exchange sequence.

When the Sensing Responder field is set to 1, it signifies that the sensing requesting device wants to join the sensing procedure as a sensing responder initiated by the sensing initiator. Conversely, when the Sensing Responder field is set to 0, it indicates that the sensing requesting device does not wish to participate in the sensing procedure used by the sensing initiator.

The Number of Sensing Responders field denotes the number of sensing responders needed for the sensing initiator to fulfill the SBP request. If the Sensing Responder field is set to 1, the value specified in the Number of Sensing Responders field includes the sensing requesting device itself.

The Mandatory Number of Sensing Responders field determines the interpretation of the requested number of sensing responders specified in the Number of Sensing Responders field by the sensing initiator. If the Mandatory Number of Sensing Responders field has a value of 0, it means that the requested number of sensing responders serves as an upper limit, and the sensing requesting device accepts measurements even with a smaller number of responders. On the other hand, if the Mandatory Number of Sensing Responders field has a value of 1, it signifies that the requested number of sensing responders is a mandatory requirement.

The Sensing Initiator Address Presence field when one indicates the presence of the Sensing Initiator Address field, or not present when zero.

When the Preferred Sensing Responder List field is set to 1, it signifies that the sensing requesting device specifies a preferred set of sensing responders to be included by the sensing initiator in the sensing procedure for fulfilling the SBP request. Conversely, if the Preferred Sensing Responder List field is set to 0, the Sensing Responder Address List field is not included.

The Number of Preferred Sensing Responders field represents the number of preferred sensing responders with corresponding addresses included in the Sensing Responder Address List field when the Preferred Sensing Responder List field is set to 1. If the Sensing Responder field is also set to 1 in this scenario, the value specified in the Number of Preferred Sensing Responders field includes the address of the sensing requesting device. The Number of Preferred Sensing Responders field is reserved when the Preferred Sensing Responder List field is set to 0. If both the Sensing Responder field and the Preferred Sensing Responder List field are set to 1, the address of the sensing requesting device is included in the Sensing Responder Address List field.

The Mandatory Preferred Sensing Responder field determines whether the preferred sensing responders should be treated as mandatory by the sensing initiator if the Preferred Sensing Responder List field is set to 1. A value of 1 means that the sensing initiator is obligated to include only the SDEVs listed in the Sensing Responder Address List field within the SBP Request IE during the sensing procedure for fulfilling the SBP request. On the other hand, a value of 0 indicates that the sensing initiator has the option to include SDEVs not listed in the Sensing Responder Address List field within the SBP Request IE when satisfying the SBP request. The Mandatory Preferred Sensing Responder field is reserved when the Preferred Sensing Responder List field is 0. When the Mandatory Preferred Sensing Responder field is set to 1, the Number of Sensing Responders and Mandatory Number of Sensing Responders fields are reserved.

The Sensing Initiator Address field specifies the address of the sensing initiator. If the address of the SBP Request IE recipient is same as the address specified by the Sensing Initiator Address field, the recipient is the sensing initiator. Otherwise, the recipient is the sensing requesting relay device, which shall forward the SBP Request IE to the sensing initiator.

The Sensing Control field is described in 2.6.2 Application Control IE.

The Sensing Responder Address List field is present only if the Preferred Sensing Responder List field is set to 1. The Sensing Responder Address List field contains one or more addresses that indicate the set of preferred sensing responders to include in the sensing procedure used by the sensing initiator to satisfy the SBP request.

* + 1. SBP Response IE

The SBP Response IE is used by the sensing initiator to send the SBP parameters and sensing control parameters as well as the status code parameters to the sensing requesting device. The content field of the SBP Response IE shall be formatted as shown in Figure x2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Bits:****0** | **1-2** | **3-6** | **7** | **8** | **9-15** |
| Address Size | SBP Status Code | Number of Sensing Responders | Sensing Requesting Device Address Presence  | Sensing Responder List | Reserved |

|  |  |  |  |
| --- | --- | --- | --- |
| **Octets:****2** | **0/2/8** | **Variable** | **Variable** |
| Sensing Session ID | Sensing Requesting Device Address | Sensing Control | Sensing Responder Address List |

**Figure x2-SBP Response IE Content field format**

The Address Size field specifies the size of the addresses used in the SBP Response IE. If the Address Size field is zero, all addresses in the SBP Response IE are short addresses. If the Address Size field is one, all addresses in the SBP Response IE are extended addresses.

The SBP Status Code field shall have one of the values specified in Table x.1.

Table x.1-Values of the SBP Status Code field in the SBP Response IE

|  |  |
| --- | --- |
| **Sensing Mode field value** | **Meaning** |
| 0 | SUCCESS |
| 1 | REJECT |
| 2 | REJECTED\_WITH\_SUGGESTED\_CHANGES |
| 3 | Reserved |

The Number of Sensing Responders field represents the number of sensing responders utilized by the sensing initiator in the sensing procedure to fulfill the SBP request, if the SBP Status Code field in the SBP Response IE is SUCCESS. Conversely, if the SBP Status Code field in the SBP Response IE is REJECTED\_WITH\_SUGGESTED\_CHANGES, the Number of Sensing Responders field suggests the number of sensing responders to consider.

The Sensing Requesting Device Address Presence field when one indicates the presence of the Sensing Requesting Device Address field, or not present when zero.

The Sensing Responder List field is set to 1 to indicate that the Sensing Responder Address List field is present. If the Sensing Responder List field is set to 0, the Sensing Responder Address List field is not present.

The Sensing Session ID field specifies the session ID of the sensing session corresponding to the SBP procedure.

The Sensing Requesting Device Address field specifies the address of the sensing requesting device. If the address of the SBP Response IE recipient is same as the address specified by the SBP Requesting Address field, the recipient is the sensing requesting device. Otherwise, the recipient is the sensing requesting relay device, which will forward the SBP Response IE to the sensing requesting device.

The Sensing Control field is described in 2.6.2 Application Control IE.

The Sensing Responder Address List field is present only if the Sensing Responder List field is set to 1. The field contains one or more addresses that indicate the set of sensing responders involved in the sensing session corresponding to the SBP procedure if the SBP Status Code field is SUCCESS. Conversely, if the SBP Status Code field is REJECTED\_WITH\_SUGGESTED\_CHANGES, the Sensing Responder Address List field suggests the preferred sensing responders to consider.

* + 1. SBP Termination IE

The SBP Termination IE is used either by the associated sensing requesting device or the sensing initiator to terminate the corresponding SBP procedure. The content field of the SBP Response IE shall be formatted as shown in Figure x3.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bits:****0** | **1** | **2-7** | **Octets:****0/2/8** | **2** |
| Address Size | Destination Address Presence | Reserved | Destination Address | Sensing Session ID |

**Figure x3-SBP Termination IE Content field format**

The Address Size field specifies the size of the addresses used in the SBP Termination IE. If the Address Size field is zero, all addresses in the SBP Termination IE are short addresses. If the Address Size field is one, all addresses in the SBP Termination IE are extended addresses.

The Destination Address Presence field when one indicates the presence of the Destination Address field, or not present when zero.

The Destination Address field specifies the address of the intended SDEV to which the SBP Termination IE is transmitted. If the address of the SBP Termination IE recipient is same as the address specified by the Destination Address field, the recipient is the intended SDEV. Otherwise, the recipient is the sensing requesting relay device, which will forward the SBP Termination IE to the intended SDEV.

The Sensing Session ID field specifies the session ID of the sensing session corresponding to the SBP procedure to be terminated.

*Change Figure 7-XX in 15-23-0174-01-04ab-text-for-uwb-discovery-and-association as follows*

The UWB HRP Capability Information field shall be formatted as illustrated in Figure 7-XX.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Bits: 0 | 1 | 2–3 | 1 | TBD | TBD | … | 15 |
| LDPC | High Throughput | Supported AIFS | SBP | TBD | TBD | … | TBD |

**Figure 7-XX – HRP UWB Capability Information field format**