**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
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| Re: | Letter Ballot Comments with Figures and Tables – P802.15.4z-D2 |
| Abstract | This contribution proposes updated text for the baseline draft P802.15.4z-D2 |
| Purpose | Provision of the text to facilitate its incorporation into the draft text of the IEEE 802.15.4z standard currently under development in TG4z. |
| Notice | This document does not represent the agreed views of the IEEE 802.15 Working Group. It represents only the views of the participants listed in the “Source(s)” field above. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. |
| Release |  |
| Patent Policy | The contributor is familiar with the IEEE-SA Patent Policy and Procedures:  <http://standards.ieee.org/guides/bylaws/sect6-7.html#6> and  <http://standards.ieee.org/guides/opman/sect6.html#6.3>.  Further information is located at <http://standards.ieee.org/board/pat/pat-material.html> and  <http://standards.ieee.org/board/pat>. |

**Changes**



**Figure 38—Message sequence chart for ACRP based SS-TWR with one-way authentication**

If the Challenge is not received at the Prover device with the Ranging Verifier command both devices will timeout with the confirm primitive and status=TIMEOUT as shown in Figure 38a.



**Figure 38a—Message sequence chart for ACRP based SS-TWR with Challenge timeout**

If the Ranging Prover command is not received at the Verifier device the Prover device will still indicate a successful data transfer to the Prover next higher layer, but the Verifier devices will timeout with the confirm primitive and status=TIMEOUT as shown in Figure 38b.



**Figure 38b—Message sequence chart for ACRP based SS-TWR with Response timeout**



**Figure 44—Message sequence chart for multi-node SS-TWR with fixed reply time)**

**7.5.1 Command ID field**

(Table 7-49)

[ANA] Ranging ~~Challenge~~ Verifier command

[ANA] Ranging ~~Response Reply~~ Prover command

**7.5.27 Ranging Verifier command**

This command shall only be sent by the Verifier ranging device in combination with the MCPS-RANGING-VERIFIER.request primitive.

The Frame Pending field and the AR field shall be set to zero and the Frame Version field shall set to 0b10.

For shortest packet size the Destination Addressing Mode field and Source Addressing Mode field can be set to indicate no addressing or short addressing and the Sequence Number Suppression field shall be set to one.

The Content field uses the following format.

|  |  |
| --- | --- |
| **Octets: 1** | **4/8/16/32** |
| Reserved | RangingVerifier |

**Figure 69—Content field for Ranging Verifier command**

Reserved is used for future use and shall be set to zero.

RangingVerifier field includes Challenge and Response data created by the MAC and the length is defined by the SecurityLevel for MCPS-RANGING-VERIFIER.request primitive.

**7.5.28 Ranging Prover command**

This command shall only be sent by the Prover ranging device in combination with the MCPS-RANGING-PROVER.request primitive.

The Frame Pending field and the AR field shall be set to zero and the Frame Version field shall set to 0b10.

For shortest packet size the Destination Addressing Mode field and Source Addressing Mode field can be set to indicate no addressing or short addressing and the Sequence Number Suppression field shall be set to one.

The Content field uses the following format.

|  |  |
| --- | --- |
| **Octets: 1** | **4/8/16/32** |
| Reserved | RangingProver |

**Figure 70—Content field for Ranging Prover command**

Reserved is used for future use and shall be set to zero.

RangingProver field includes Challenge and Response data created by the MAC and the length is defined by the SecurityLevel for MCPS-RANGING-PROVER.request primitive.

**8.3.6 MCPS-RANGING-VERIFIER.request**

The MCPS-RANGING-VERIFIER.request primitive configures a Verifier device and starts a ranging with fixed reply time as shown in clause 6.9.8. The Verifier device configures the MAC with *phyLrpUwbFixedReplyTime*, enabling or disabling the FCS checking and enabling Ranging with setting of the TimeOut. If the TimeOut timer expires ranging will be aborted and automatically disabled and the MCPS-RANGING-VERIFIER.confirm is called with status=TIMEOUT. After configuration a RangingVerifier payload is generated using *phyLrpUwbChallenge* and the ranging is started using the Ranging Verifier command. In multi-node ranging with broadcast address an AddressMask is configured to filter addresses from the Prover responses.

The semantics of this primitive are:

MCPS-RANGING-VERIFIER.request (

TimeOut,

AuthenticatedChallengeResponseRangingMode,

RawMode,

AddressMask,

SrcAddrMode,

DstAddrMode,

DstPanId,

DstAddr,

SecurityLevel,

KeyIdMode,

KeySource,

KeyIndex,

DistanceCommitmentLevel,

UwbPreambleSymbolRepetitions,

DataRate,

LocationEnhancingInformationPostamble,

LocationEnhancingInformationPostambleLength,

PanIdSuppressed,

SeqNumSupressed

)

The primitive parameters are defined in Table 30.

**Table 30—MCPS-RANGING-VERIFIER.request**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| TimeOut | Integer | 0x000000 – 0xFFFFFF | Max. time period for the activation of the ranging. When the timeout period expires or the MCPS-RANGING-VERIFIER.confirm is received the current ranging transfer will be aborted and ranging disabled. The time out period is defined by TimeOut \* *phyLrpUwbFixedReplyTime* |
| AuthenticatedChallengeResponseRangingMode | Enumeration | ACRRM\_SS\_TWR\_OWA, ACRRM\_SS\_TWR\_MA,  ACRRM\_DS\_TWR\_OWA, ACRRM\_DS\_TWR\_MA | Specifies the types of supported authenticated challenge response ranging methods |
| RawMode | Boolean | TRUE, FALSE | If set to TRUE the FCS check is ignored and the received frame is returned to the higher layer. If set to FALSE FCS check is active. |
| AddressMask | -- | As specified by the  SrcAddrMode parameter. | The address mask bits enable the corresponding address bit check when set to 1. When set to 0 the corresponding address bit is don’t care. |
| SrcAddrMode | Enumeration | NONE, SHORT, EXTENDED | The source addressing mode. |
| DstAddrMode | Enumeration | NONE, SHORT, EXTENDED | The destination addressing mode. |
| DstPanId | Integer | 0x0000–0xffff | The PAN ID of the entity to which the command is being transferred. |
| DstAddr | -- | As specified by the  DstAddrMode parameter. | The address of the entity to which the command is being transferred. |
| SecurityLevel | Integer | As defined in Table 9-6 | The security level to be used. |
| KeyIdMode |  | As defined in Table 9-7 | The mode used to identify the key to be used. This parameter is ignored if the SecurityLevel parameter is set to 0x00. |
| KeySource | Set of octets | As specified by the  KeyIdMode parameter | The originator of the key to be used, as described in 9.4.3.1. This parameter is ignored if the KeyIdMode parameter is ignored or set to 0x00 or 0x01. |
| KeyIndex | Integer | 0x01–0xff | The index of the key to be used, as described in 9.4.3.2. This parameter is ignored if the KeyIdMode parameter is  ignored or set to 0x00. |
| DistanceCommitmentLevel | Enumeration | DCL\_1\_4096, DCL\_2\_2048, DCL\_1\_1024, DCL\_1\_512, DCL\_1\_256, DCL\_1\_128, DCL\_1\_64,  DCL\_DISABLED | Specifies the aperture time Tint,RF in the fraction of one microsecond used to collect earliest path(s) by the receiver for symbol decoding in the PSDU in the LRP UWB PHY (see clause 19.10) |
| UwbPreambleSymbolRepetitions | Integer | 0, 16, 32, 64, 128, 256, 512, 1024, 4096, 8192 | The preamble symbol repetitions of the LRP UWB frame. A zero value is used for all other PHYs. |
| DataRate | Integer | -- | Indicates the data rate. For LRP UWB PHYs, valid values are defined in Table 19-1. For all other PHYs, the parameter is set to zero. |
| LocationEnhancingInformationPostamble | Enumeration | LEIP\_NONE, LEIP\_IMMEDIATE, LEIP\_DELAYED | For the LRP UWB PHY this parameter specifies whether the Location enhancing information postamble sequence is to be sent or not and, if present, whether it directly follows the CRC or is delayed by the *aLeipDelayTime*. A value of LEIP\_NONE is used for non-LRP UWB PHYs. |
| LocationEnhancingInformationPostambleLength | Enumeration | LEIP\_LEN\_16, LEIP\_LEN\_64,  LEIP\_LEN\_128, LEIP\_LEN\_192,  LEIP\_LEN\_256,  LEIP\_LEN\_512,  LEIP\_LEN\_1024 | LEIP\_LEN\_16, LEIP\_LEN\_64,  LEIP\_LEN\_128, LEIP\_LEN\_192,  LEIP\_LEN\_256, LEIP\_LEN\_512, LEIP\_LEN\_1024  For the LRP UWB PHY when the  LocationEnhancingInformationPostamble parameter has a value of either LEIP\_IMMEDIATE or  LEIP\_DELAYED, then this parameter specifies the length in pulses of the location enhancing information postamble to send. This parameter is ignored when the LocationEnhancingInformationPostamble parameter has a value of LEIP\_NONE. |
| PanIdSuppressed | Boolean | TRUE, FALSE | Set to TRUE if the PAN ID is suppressed in the frame, FALSE otherwise. |
| SeqNumSuppressed | Boolean | TRUE, FALSE | Set to TRUE if the sequence number is suppressed in the frame, FALSE otherwise. |

**8.3.7 MCPS-RANGING-VERIFIER.indication**

The MCPS-RANGING-VERIFIER.indication primitive indicates the reception of the Ranging Prover command from a Prover device.

The semantics of this primitive are:

MCPS-RANGING-VERIFIER.indication (

SrcAddrMode,

SrcPanId,

SrcAddr,

DstAddrMode,

DstPanId,

DstAddr,

SecurityLevel,

KeyIdMode,

KeySource,

KeyIndex,

DistanceCommitmentLevel,

RangingStatus,

RxRangingCounter,

Rssi,

RangingChallenge,

RangingResponse

)

The primitive parameters are defined in Table 31.

**Table 31—MCPS-RANGING-VERIFIER.indication**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| SrcAddrMode | Enumeration | NONE, SHORT, EXTENDED | The source addressing mode of the received command. |
| SrcPanId | Integer | 0x0000–0xffff | The PAN ID of the entity from which the command was received. Valid only when a source PAN ID is included in the received frame. |
| DstAddrMode | Enumeration | NONE, SHORT, EXTENDED | The destination addressing mode of the received command. |
| DstPanId | Integer | 0x0000–0xffff | The PAN ID of the entity to which the command is being transferred. Set to the receiver’s PAN ID if the PAN ID is not carried in the received frame. |
| DstAddr | -- | As specified by the  DstAddrMode parameter. | The address of the entity to which the command is being transferred. |
| SecurityLevel | Integer | 0x00-0x07 | The security level purportedly used by the received command, as defined in Table 9-6. |
| KeyIdMode | Integer | 0x00-0x03 | The mode used to identify the key purportedly used by the originator of the received frame, as defined in Table 9-7. This parameter is invalid if the SecurityLevel parameter is set to 0x00. |
| KeySource | Set of octets | As specified by the  KeyIdMode parameter | The originator of the key purportedly used by the originator of the received frame, as described in 9.4.3.1. This parameter is invalid if the KeyIdMode parameter is invalid or set to 0x00 or 0x01. |
| KeyIndex | Integer | 0x01–0xff | The index of the key purportedly used by the originator of the received frame, as described in 9.4.3.2. This parameter is invalid if the KeyIdMode parameter is invalid or set to 0x00. |
| DistanceCommitmentLevel | Enumeration | DCL\_1\_4096, DCL\_2\_2048, DCL\_1\_1024, DCL\_1\_512, DCL\_1\_256, DCL\_1\_128, DCL\_1\_64,  DCL\_DISABLED | The aperture time Tint,RF in the fraction of one microsecond used to collect earliest path(s) by the receiver for symbol decoding in the PSDU in the LRP UWB PHY (see clause 19.10) |
| RangingStatus | Enumeration | RANGING\_ACTIVE, RANGING\_ABORTED,  NO\_RANGING\_RECEIVED | A value of NO\_RANGING\_  RECEIVED indicates that the received frame was not a ranging frame. A value of RANGING\_ACTIVE denotes ranging operations is active and enabled. A value of RANGING\_ ABORTED denotes that ranging is disabled or timed out. |
| RxRangingCounter | Unsigned  Integer | 0x00000000–  0xffffffff | A count of the time units corresponding to an RMARKER at the antenna with respect to the reception of the frame delivered by this MCPS-RANGING-VERIFIER.indication. The value here is meaningless if ranging is not supported or enables. The 36bit ranging counter operates with the time unit defined in clause 6.9.1.4. for the LRP UWB PHY. The RxRangingCounter are the 32bit MSB of this counter. |
| Rssi | Integer | 0x00-0xff | The Received Signal Strength Indicator is a measure of the RF power level at the input of the transceiver measured during the SFD. |
| RangingChallenge | Set of octets | As defined in clause 7.5.27 | Payload send by the Verifier with Ranging Verifier command. |
| RangingResponse | Set of octets | As defined in clause 7.5.28 | Payload send by the Prover with Ranging Prover command. |

**8.3.8 MCPS-RANGING-VERIFIER.confirm**

The MCPS-RANGING-VERIFIER.confirm primitive reports the result of a ranging request to transfer a Ranging Prover command from a Prover device.

The semantics of this primitive are:

MCPS-RANGING-VERIFIER.confirm (

Status

)

The primitive parameter is defined in Table 32.

**Table 32—MCPS-RANGING-VERIFIER.confirm**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| Status | Enumeration | SUCCESS, TIMEOUT,  INVALID\_PARAMETER,  RANGING\_NOT\_SUPPORTED | The result of the request for the ranging operation. |

**8.3.9 MCPS-RANGING-PROVER.request**

The MCPS-RANGING-PROVER.request primitive configures a Prover device and starts the receiver for ranging with fixed reply time as shown in clause 6.9.8. The Prover device configures the MAC with *phyLrpUwbFixedReplyTime*, enabling or disabling the FCS checking and enabling Ranging with setting of the TimeOut. If the TimeOut timer expires ranging will be aborted and automatically disabled and the MCPS-RANGING-PROVER.confirm is called with status=TIMEOUT. After configuration a RangingProver is created when a Ranging Verifier command is received using *phyLrpUwbResponse* and the transfer of a Ranging Prover command using the Response as payload is started when the *phyLrpUwbFixedReplyTime* is expired. In multi-node ranging the Prover replies to the broadcast address using the *FixedReplyDelayTime* as described in clause 6.9.8.4.7.

The semantics of this primitive are:

MCPS-RANGING-PROVER.request (

TimeOut,

AuthenticatedChallengeResponseRangingMode

RawMode,

SrcAddrMode,

DstAddrMode,

DstPanId,

DstAddr,

SecurityLevel,

KeyIdMode,

KeySource,

KeyIndex,

DistanceCommitmentLevel,

UwbPreambleSymbolRepetitions,

DataRate,

LocationEnhancingInformationPostamble,

LocationEnhancingInformationPostambleLength,

PanIdSuppressed,

SeqNumSupressed

)

The primitive parameters are defined in Table 33.

**Table 33—MCPS-RANGING-PROVER.request**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| TimeOut | Integer | 0x000000 – 0xFFFFFF | Max. time period for the activation of the ranging. When the timeout period expires or the MCPS-RANGING-PROVER.confirm is received the current ranging transfer will be aborted and ranging disabled. The time out period is defined by TimeOut \* *phyLrpUwbFixedReplyTime* |
| AuthenticatedChallengeResponseRangingMode | Enumeration | ACRRM\_SS\_TWR\_OWA, ACRRM\_SS\_TWR\_MA,  ACRRM\_DS\_TWR\_OWA, ACRRM\_DS\_TWR\_MA | Specifies the types of supported authenticated challenge response ranging methods |
| RawMode | Boolean | TRUE, FALSE | If set to TRUE the FCS check is ignored and the received frame is returned to the higher layer. If set to FALSE FCS check is active. |
| SrcAddrMode | Enumeration | NONE, SHORT, EXTENDED | The source addressing mode. |
| DstAddrMode | Enumeration | NONE, SHORT, EXTENDED | The destination addressing mode. |
| DstPanId | Integer | 0x0000–0xffff | The PAN ID of the entity to which the command is being transferred. |
| DstAddr | -- | As specified by the  DstAddrMode parameter. | The address of the entity to which the command is being transferred. |
| SecurityLevel | Integer | As defined in Table 9-6 | The security level to be used. |
| KeyIdMode |  | As defined in Table 9-7 | The mode used to identify the key to be used. This parameter is ignored if the SecurityLevel parameter is set to 0x00. |
| KeySource | Set of octets | As specified by the  KeyIdMode parameter | The originator of the key to be used, as described in 9.4.3.1. This parameter is ignored if the KeyIdMode parameter is ignored or set to 0x00 or 0x01. |
| KeyIndex | Integer | 0x01–0xff | The index of the key to be used, as described in 9.4.3.2. This parameter is ignored if the KeyIdMode parameter is  ignored or set to 0x00. |
| DistanceCommitmentLevel | Enumeration | DCL\_1\_4096, DCL\_2\_2048, DCL\_1\_1024, DCL\_1\_512, DCL\_1\_256, DCL\_1\_128, DCL\_1\_64,  DCL\_DISABLED | Specifies the aperture time Tint,RF in the fraction of one microsecond used to collect earliest path(s) by the receiver for symbol decoding in the PSDU in the LRP UWB PHY (see clause 19.10) |
| UwbPreambleSymbolRepetitions | Integer | 0, 16, 32, 64, 128, 256, 512, 1024, 4096, 8192 | The preamble symbol repetitions of the LRP UWB frame. A zero value is used for all other PHYs. |
| DataRate | Integer | -- | Indicates the data rate. For LRP UWB PHYs, valid values are defined in Table 19-1. For all other PHYs, the parameter is set to zero. |
| LocationEnhancingInformationPostamble | Enumeration | LEIP\_NONE, LEIP\_IMMEDIATE, LEIP\_DELAYED | For the LRP UWB PHY this parameter specifies whether the Location enhancing information postamble sequence is to be sent or not and, if present, whether it directly follows the CRC or is delayed by the *aLeipDelayTime*. A value of LEIP\_NONE is used for non-LRP UWB PHYs. |
| LocationEnhancingInformationPostambleLength | Enumeration | LEIP\_LEN\_16, LEIP\_LEN\_64,  LEIP\_LEN\_128, LEIP\_LEN\_192,  LEIP\_LEN\_256,  LEIP\_LEN\_512,  LEIP\_LEN\_1024 | LEIP\_LEN\_16, LEIP\_LEN\_64,  LEIP\_LEN\_128, LEIP\_LEN\_192,  LEIP\_LEN\_256, LEIP\_LEN\_512, LEIP\_LEN\_1024  For the LRP UWB PHY when the LocationEnhancingInformationPostamble parameter has a value of either LEIP\_IMMEDIATE or  LEIP\_DELAYED, then this parameter specifies the length in pulses of the location enhancing information postamble to send. This parameter is ignored when the LocationEnhancingInformationPostamble parameter has a value of LEIP\_NONE. |
| PanIdSuppressed | Boolean | TRUE, FALSE | Set to TRUE if the PAN ID is suppressed in the frame, FALSE otherwise. |
| SeqNumSuppressed | Boolean | TRUE, FALSE | Set to TRUE if the sequence number is suppressed in the frame, FALSE otherwise. |

**8.3.10 MCPS-RANGING-PROVER.indication**

The MCPS-RANGING-PROVER.indication primitive indicates the reception of the Ranging Verifier command from a Verifier device.

The semantics of this primitive are:

MCPS-RANGING-PROVER.indication (

SrcAddrMode,

SrcPanId,

SrcAddr,

DstAddrMode,

DstPanId,

DstAddr,

SecurityLevel,

KeyIdMode,

KeySource,

KeyIndex,

DistanceCommitmentLevel,

Rssi,

RangingChallenge,

RangingResponse

)

The primitive parameter is defined in Table 34.

**Table 34—MCPS-RANGING-RESPONSE.indication**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| SrcAddrMode | Enumeration | NONE, SHORT, EXTENDED | The source addressing mode of the received command. |
| SrcPanId | Integer | 0x0000–0xffff | The PAN ID of the entity from which the command was received. Valid only when a source PAN ID is included in the received frame. |
| DstAddrMode | Enumeration | NONE, SHORT, EXTENDED | The destination addressing mode of the received command. |
| DstPanId | Integer | 0x0000–0xffff | The PAN ID of the entity to which the command is being transferred. Set to the receiver’s PAN ID if the PAN ID is not carried in the received frame. |
| DstAddr | -- | As specified by the  DstAddrMode parameter. | The address of the entity to which the command is being transferred. |
| SecurityLevel | Integer | 0x00-0x07 | The security level purportedly used by the received command, as defined in Table 9-6. |
| KeyIdMode | Integer | 0x00-0x03 | The mode used to identify the key purportedly used by the originator of the received frame, as defined in Table 9-7. This parameter is invalid if the SecurityLevel parameter is set to 0x00. |
| KeySource | Set of octets | As specified by the  KeyIdMode parameter | The originator of the key purportedly used by the originator of the received frame, as described in 9.4.3.1. This parameter is invalid if the KeyIdMode parameter is invalid or set to 0x00 or 0x01. |
| KeyIndex | Integer | 0x01–0xff | The index of the key purportedly used by the originator of the received frame, as described in 9.4.3.2. This parameter is invalid if the KeyIdMode parameter is invalid or set to 0x00. |
| DistanceCommitmentLevel | Enumeration | DCL\_1\_4096, DCL\_2\_2048, DCL\_1\_1024, DCL\_1\_512, DCL\_1\_256, DCL\_1\_128, DCL\_1\_64,  DCL\_DISABLED | The aperture time Tint,RF in the fraction of one microsecond used to collect earliest path(s) by the receiver for symbol decoding in the PSDU in the LRP UWB PHY (see clause 19.10) |
| Rssi | Integer | 0x00-0xff | The Received Signal Strength Indicator is a measure of the RF power level at the input of the transceiver measured during the SFD. |
| RangingChallenge | Set of octets | As defined in clause 7.5.27 | Payload send by the Verifier with Ranging Verifier command. |
| RangingResponse | Set of octets | As defined in clause 7.5.28 | Payload send by the Prover with Ranging Prover command. |

**8.3.11 MCPS-RANGING-PROVER.confirm**

The MCPS-RANGING-PROVER.confirm primitive reports the result of a ranging request to transfer a Ranging Prover command to a Verifier device.

The semantics of this primitive are:

MCPS-RANGING-PROVER.confirm (

Status

)

The primitive parameter is defined in Table 35.

**Table 35—MCPS-RANGING-PROVER.confirm**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| Status | Enumeration | SUCCESS, TIMEOUT,  INVALID\_PARAMETER,  RANGING\_NOT\_SUPPORTED | The result of the request for the ranging operation. |

**11.3 PHY PIB attributes**

**Table 11-2–PHY PIB attributes**

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid Range | Description |
| *phyLrpUwbFixedDelayFactor* | Integer | 0 to 32767 | Define the reply delay factor for the reply time in multi-node ranging with a time unit of *phyLrpUwbFixedReplyTime=FRT4/4*. |
| *phyLrpUwbChallenge* | Set of octets | As defined in clause 7.5.27 | This is the current challenge payload. |
| *phyLrpUwbResponse* | Set of octets | As defined in clause 7.5.28 | This is the current response payload. |