IEEE P802.11  
Wireless LANs

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| LB253 Phase shift TOA feedback CR | | | | |
| Date: 2021-07-19 | | | | |
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Abstract

We are here proposing a resolution to LB253 CIDs 5231 and 5271.

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| **CID** | **P.L** | **Clause** | **Comment** | **Proposed change** | **Proposed resolution** |
| 5231 | 130.13 | 11.21.6.3.3 | It is not specified how phase shift feedback reporting works if the ISTA is reporting phase shift TOAs in non-TB and TB ranging. How will the ISTA get the required information from the RSTA in order to compute the RTT? | Add specification and description for the case when the ISTA is reporting phase shift TOAs in non-TB and TB ranging and how the ISTA will get the required information from the RSTA in order to compute the RTT. | Revised.  TGaz editor, make the changes as shown in document https://mentor.ieee.org/802.11/dcn/20/11-21-1108-04-00az-lb253-phase-shift-toa-feedback-cr.docx. |
| 5271 | 74 | 9.4.2.298 | "LMR to phase shift" and "LMR to be phase shift type of ToA" are they the same or different? If they are the same why are they described using different words? If not, how are they different?  The R2I TOA Type subfield is set to 1 in the IFTMR frame to set the TOA feedback type in the R2I LMR to phase shift which corresponds to the average linear phase across the subcarriers. Otherwise, the R2I TOA Type subfield is set to 0 and the R2I LMR TOA feedback type will be first path reporting. The R2I TOA Type subfield is set to 1 in the initial Fine Timing Measurement frame to indicate that the RSTA estimates TOA using phase shift; and set to 0 to indicate that the RSTA estimates TOA using first path reporting. (#1648)  The I2R TOA Type subfield in the IFTMR frame is set to 1 to indicate that the ISTA supports phase shift type TOA feedback and is set to 0 to indicate support of only first path reporting in the I2R LMR. The I2R TOA type subfield in the initial Fine Timing Measurement frame is set to 1 to indicate that the TOA feedback type in the I2R LMR to be phase shift type of TOA, corresponding to the average linear phase across the subcarriers and is set to 0 to indicate that the feedback type in the I2R will be of the first path reporting." | Use consistent terminology to avoid confusion. If Phase Shift type estimation is common to R2I ToA and I2R ToA, defining it once would help avoid scenarios where one definition is modified while other is not rendering it inconsistent can be avoided. | Revised.  TGaz editor, make the changes as shown in document https://mentor.ieee.org/802.11/dcn/20/11-21-1108-04-00az-lb253-phase-shift-toa-feedback-cr.docx. |

***TGaz Editor: Thoughout the draft text, including in text below, replace all instances of ‘phase shift feedback’ with ‘phase shift TOA feedback’ with the appropriate capitalizations. (#5271)***

***TGaz Editor: Change the text in Subclause 9.4.2.298 (Ranging Parameters element) as follows:***

**9.4.2.298 Ranging Parameters element**

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|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 B6 | B7 | B8 B9 | B10 B11 | B12 | B13 | B14 | B15 |
|  | Status  Indication | Value | I2R LMR Feedback | Reserved | Ranging  Priority | PSTOA Included | Reserved | R2I AOA Request | I2R AOA Request |
| Bits: | 2 | 5 | 1 | 2 | 2 | 1 | 1 | 1 | 1 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B16 B21 | B22 | B23 | B24 B26 | B27 B29 | B30 | B31 | B32 B34 | B35 B37 |
|  | Format  and Bandwidth | Immediate R2I  Feedback | Immediate I2R  Feedback | Max I2R Repetition | Max R2I Repetition | Reserved | Reserved | Max R2I STS ≤ 80 MHz | Max R2I  STS > 80 MHz |
| Bits: | 6 | 1 | 1 | 3 | 3 | 1 | 1 | 3 | 3 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B38 B39 | B40 B41 | B42 B45 | B45 B47 | B48 B55 |
|  | Max R2I LTF Total | Max I2R LTF Total | Max I2R STS ≤ 80 MHz | Max I2R STS > 80 MHz | BSS Color Information |
| Bits: | 2 | 2 | 3 | 3 | 8 |

**Figure 9-788edh—Ranging Parameters field format (#1947, #TC707r3, #5271)**

<Scroll to P75L21>

(#**5088**, #**5454**, #**5193**, #**5175**)The PSTOA Included subfield is set to 1 in the IFTMR frame to request that phase shift TOA feedback is included in the LMR reporting. The phase shift TOA corresponds to the average linear phase across the subcarriers. Otherwise, the PSTOA Included subfield is set to 0. The PSTOA Included subfield is set to 1 in the initial Fine Timing Measurement frame to require that phase shift TOA feedback is included in the LMR reporting. Otherwise, the PSTOA Included subfield is set to 0. (#**1648, #5231, #5271)**

***TGaz Editor: Change the text in Subclause 9.4.2.304 (ISTA Passive TB Ranging Measurement Report element) as follows:***

**9.4.2.304 ISTA Passive TB Ranging Measurement Report element**

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The PSTOA timestamp represents the time, with respect to the ISTA’s time base, at which the start of preamble of the NDP in question arrived at the receive antenna connector, calculated based on the average linear phase shift between two adjacent tones normalized by the tone spacing. An example of calculation of the phase shift TOA feedback is shown in Annex AD. (#**5271**)

***TGaz Editor: Insert the subclause below after Subclause 9.4.2.307 (LOS Likelihood element) as follows:***

**9.4.2.308 Phase Shift TOA Timestamp element**

The Phase Shift TOA Timestamp element is used to signal phase shift TOA timestamps and their errors in the Location Measurement Report frame. The format of the Phase Shift TOA Timestamp element is shown in Figure 9-788ed6 (Phase Shift TOA Timestamp element).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element Id | Element Length | Element ID Extension | PSTOA | PSTOA  Error |
| Octets: | 1 | 1 | 1 | 6 | 1 |

**Figure 9-788ed6—** **Phase Shift TOA Timestamp element Action field format (#5231)**

The Element ID, Length and Element ID Extension fields are defined in 9.4.2.1 (General).

The PSTOA field contains a phase shift TOA timestamp. See appendix AD.1 Phase Shift TOA Feedback Calculation for how to calculate a phase shift TOA timestamp. (#**5271**)

The PSTOA Error field contains an error field for the phase shift TOA timestamp reported in the PSTOA field, formatted and defined the same way as a TOA Error field described in Figure 9-909ac (Format of the TOA Error field).

***TGaz Editor: Change the text in Subclause 9.6.7.49 (Location Measurement Report frame format) as follows:***

**9.6.7.49 Location Measurement Report frame format**

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|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Category | Public Action | Dialog Token | TOD | TOA | TOD Error | TOA Error |
| Octets: | 1 | 1 | 1 | 6 | 6 | 1 | 1 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | CFO Parameter | R2I NDP Tx Power | I2R NDP Target RSSI | Secure LTF Parameters (optional) | AOA Feedback (optional) | Phase Shift TOA Timestamp(optional) |
| Octets: | 2 | 1 | 1 | 13 | 9 | 10 |

**Figure 9-909aa—Location Measurement Report frame (#1856) Action field format (#TC1208r1, #3883)** (#**5231**)

<Scroll to P101L15>

The TOA field contains a timestamp calculated based on the first arrival path of the channel impulse response (#**5231**) that represents the time, with respect to a time base, at which the start of the preamble of the corresponding NDP (#**2274**) arrived at the receive antenna connector. The corresponding NDP in an R2I LMR frame is an I2R NDP, while in an I2R LMR frame it is a R2I NDP. In both cases the corresponding NDP refers to a measurement exchange that included an Ranging NDP Announcement frame which carried the matching dialog token that is also included in this LMR. (#**1967**)

<Scroll to P102L4>

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0 B4 | B5 | B6 | B7 |
|  | Max TOA Error Exponent | Reserved | Invalid Measurement | Reserved |
| Bits: | 5 | 1 | 1 | 1 |

**Figure 9-909ac—Format of the TOA Error field** (#**5231**)

<Scroll to P102L22>

<Scroll to P103L22>

The AOA Feedback field is optionally present. If present, it contains a Direction Measurement Results element; see 9.4.2.300 (Direction Measurement Results element).

If phase shift TOA feedback is negotiated, the Phase Shift TOA Timestamp field contains a Phase Shift TOA Timestamp element that containts the phase shift TOA timestamp and error for the corresponding NDP. The phase shift TOA timestamp is always associated with the NDP transmitted in the current measurement exchange. (#**5231**)

***TGaz Editor: Change the text in Subclause 11.21.6.1.3 (Passive TB Ranging overview) as follows:***

**11.21.6.1.3 Passive TB Ranging overview**

… <Scroll to P120L25>

NOTE—Below are a list of example exceptions for Passive TB Ranging where it does not follow the rules 14 for TB Ranging: (#**3547**, #**3548**, #**3791**)

* The rules and procedures specific for the secure version of TB Ranging does not apply to Passive TB Ranging.
* The RSTA uses the Ranging Trigger frame of subtype Passive TB Ranging for its sounding trigger frames.
* The ISTAs use HE Ranging NDPs for its I2R NDPs.
* The ISTAs does not use the Location Measurement Report frame for reporting of I2R LMR but instead uses the ISTA Passive TB Ranging Measurement Report frame for this purpose, with its associated different measurements.
* The RSTA send the Primary and Secondary RSTA Broadcast Passive TB Ranging Measurement Report frames at the end of the measurement exchange. (#**3544**)
* The number of spatial streams (NSTS) for Passive TB Ranging is limited to 4.

***TGaz Editor: Change the text in Subclause 11.21.6.3.3 (Negotiation for TB and Non-TB Ranging measurement exchange) as follows:***

**11.21.6.3.3 Negotiation for TB and Non-TB Ranging measurement exchange**

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An ISTA and an RSTA may negotiate phase shift TOA feedback to be included in the R2I and I2R LMR for the Non-TB Ranging or TB Ranging measurement exchanges (11.21.6.4.3). (#**5231**)

If phase shift TOA feedback is negotiated, then the RSTA shall, in addition to reporting its TOA, also report its phase shift TOA timestamp in the Phase Shift TOA Timestamp element in the R2I LMR frame. (#**5231**)

If phase shift TOA feedback is negotiated, and I2R LMR feedback is negotiated, then the ISTA shall, in addition to reporting its TOA timestamp and error, also report its phase shift TOA timestamp and error in the Phase Shift TOA Timestamp element in theI2R LMR frame. (#**5231**)

The phase shift TOA timestamps shall always referr to the timestamps corresponding to the NDPs transmitted in the current measurement exchange, i.e. shall not use delayed reporting. (#**5231**)

The TOA timestamp may, as negotiated, use immediate or delayed reporting. (#**5231**)

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An RSTA in which dot11PhaseShiftFeedbackImplemented is true shall set the Phase Shift TOA Feedback Support field in the Extended Capabilities element to 1 to indicate RSTA’s capability to support phase shift TOA feedback. If an RSTA has set the Phase Shift TOA Feedback Support field to 1 in the Extended Capabilities element, then to request phase shift TOA feedback to be included in the LMR reporting, an ISTA shall set the PSTOA Included subfield in the Ranging Parameter field in an IFTMR frame to 1. To assign phase shift TOA feedback to be included in the LMR reporting, the RSTA shall set the TOA subfield in the Ranging Parameter field in an initial Fine Timing Measurement frame to 1 (#**3607**), otherwise it shall set it to 0. If the RSTA sets the PSTOA Included subfield in the Ranging Parameter field in an initial Fine Timing Measurement frame to 1, the phase shift TOA feedback shall be included in the LMR reporting. (#**1581**, #**3606, #5231, #5271**)

***TGaz Editor: Change the text in Subclause 11.21.6.4.3.4 (Reporting phase of TB Ranging measurement) as follows:***

**11.21.6.4.3.4 Reporting phase of TB Ranging measurement**

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In the TB ranging measurement reporting, any phase shift TOA timestamps that are reported shall be reported immediately, i.e. not delayed. Any TOA timestamps that are reported shall be reported immediate or delayed as negotiated. (#**5231, #5271**) (#**5231**)

***TGaz Editor: Change the text in Subclause 11.21.6.4.4.3 (Non-TB Ranging Measurement Reporting phase) as follows:***

**11.21.6.4.4.3 Non-TB Ranging Measurement Reporting phase**

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Based on Figure 11-37u (Timing diagram of a Measurement Sounding phase in TB Ranging based on phase shift TOA of I2R NDP or R2I PPDUs), and Equation (11-6e) (#**2334**), to enable the ISTA to derive the RTT, the RSTA needs to compute TOA t2 and feed t2 and t3 back to ISTA using R2I LMR. Instead of utilizing TOA t2 for RTT computation, a phase shift TOA feedback can be prepared by RSTA and fed back to ISTA for deriving RTT. (#**5271**)

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In the Non-TB Ranging measurement reporting phase, any phase shift TOA timestamps that are reported shall be reported immediately, i.e. not delayed. Any TOA timestamps that are reported shall be reported immediate or delayed as negotiated. (#**5231, #5271**)

***TGaz Editor: Change the text in Subclause 11.21.6.4.7 (Time of arrival estimation using Phase Shift Feedback) as follows:***

**11.21.6.4.7 Time of arrival estimation using Phase Shift TOA Feedback**

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**Figure 11-37u—Timing diagram of a Measurement Sounding phase in TB Ranging based on phase shift TOA feedback for I2R NDP and R2I NDP PPDUs (#5171)**

As shown in Figure 11-37u (Timing diagram of a Measurement Sounding phase in TB Ranging based on phase shift TOA for the I2R NDP and R2I NDP PPDUs), in the phase shift TOA feedback method, the ISTA transmits an I2R NDP at TOD t1, and the RSTA determines the phase shift TOA tp2 of the I2R NDP. The RSTA transmits a R2I NDP at TOD t3, and the ISTA determines the phase shift TOA tp4 and TOA t4 of the R2I NDP. tp2 and tp4 are determined from the phase slope of the frequency domain channel estimation of the corresponding NDP. An example of calculation of the phase shift TOA is shown in Annex AD.1. (#**5271**)

The RSTA sends the R2I NDP at TOD t3, and after receiving the R2I NDP, the ISTA calculates the phase shift TOA tp4 and TOA t4 of R2I NDP. The value of tp2 and tp4 are calculated utilizing the frequency domain channel estimation of I2R NDP and R2I NDP. (#**5271**)

The phase shift TOA is defined as the average linear phase shift between two adjacent tones normalized by the tone spacing. To enable the ISTA calculates the RTT, the RSTA should feed phase shift TOA tp2 and TOD t3 back to the ISTA using R2I LMR, and the ISTA can calculate the RTT as: (#**5271**)

RTTISTA = (t4 – t1) – (t3 – t2’’), with t2’’ = tp2 – (tp4 – t4) (11-6e)

When the I2R LMR with phase shift TOA feedback is negotiated between ISTA and RSTA, I2R LMR carries phase shift TOA tp4 and TOD t1, and then the RSTA can calculate the RTT as: (#5271)

RTTRSTA = (t4’’ – t1) – (t3 – t2), with t4’’ = tp4 – (tp2 – t2) (11-6f)

(#1958)

***TGaz Editor: Change the text in Subclause 11.21.6.4.8.3 (Passive TB Ranging measurement sounding phase) as follows:***

**11.21.6.4.8.3 Passive TB Ranging measurement sounding phase**

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As in TB Ranging, an ISTA participating in a Passive TB Ranging exchange shall measure the TOD of its own HE Ranging NDP and either the TOAs, or both the TOAs and the phase shift TOAs (PSTOAs), when it receives the RSTA’s HE Ranging NDP. In addition, optionally the ISTA also measures and reports either the TOAs, or both the TOAs and the PSTOAs, when it receives the HE Ranging NDPs transmitted by the other ISTAs participating in the Passive TB Ranging exchange. By reporting the timestamps for when it received the other ISTAs NDP transmissions, the quality of the location estimate for a PSTA listening in to the Passive TB Ranging exchanges can be improved. (#**5271**)

The max number of NSTS used in the Passive TB Ranging exchanges is limited to 4.

When phase shift TOA feedback is negotiated between an ISTA and an RSTA in Passive TB Ranging, the protocol for the measurement sounding phase differs from Passive TB Ranging with TOA feedback on the following points: (#**1515, #5271**)

* The RSTA shall measure phase shift TOA (PSTOA), in addition to measuring the TOA, on the I2R NPD it receives from the ISTA. (#**5271**)
* The ISTA shall measure:
  + the phase shift TOA (PSTOA), in addition to measuring the TOA, for the R2I NDP it receives from the RSTA,
  + and may also measure phase shift TOA(s) (PSTOAs), in addition to measuring the TOA(s), for the I2R NDP(s) it receives from other ISTA(s).

(#1515)

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**References:**

**[1] Draft P802.11az\_D3.2**