IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| LB240 CID Resolutions - Phase Shift TOA in Passive Location – Amendment text | | | | |
| Date: 2019-11-07 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | Email |
| Erik Lindskog | Samsung | 3655 N 1st St, San Jose, CA 95134 |  | e.lindskog@samsung.com |
| Roy Want | Google |  |  | roywant@google.com |
| Christian Berger | Marell | 5488 Marvell Ln, Santa Clara |  | crberger@marvell.com |
| Feng Jiang | Intel | 3600 Juliette Ln, Santa Clara, CA 95054 |  | feng1.jiang@intel.com |
| Qinghua Li | Intel | 3600 Juliette Ln, Santa Clara, CA 95054 |  | qinghua.li@intel.com |

Abstract

This document proposes resolutions to comments related Phase Shift TOA in Passive TB Ranging.

The changes here are in relation to [1].

TGaz LB240 CIDs addressed: 1515, 1563, and 1557.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **P.L** | **Clause** | **Comment** | **Proposed change** | **Resolution** |
| 1515 | 125.16 | 11.22.6.4.10.3 | In the current draft phase shift TOA reporting is specifed for TB Ranging. As Passive Location Ranging is a sub-variant of TB Ranging it is natural that we also should be allowed do use phase shift TOA reporting also there. Thus we should explicitly allow this and make the necessary additions the the LMR reporting formats for Passive Location Ranging. | Explicitly allow phase shift TOA reporting in Passive Location Ranging, make the necessary additions the the LMR reporting formats for Passive Location Ranging, and add description for how phase shift TOA reporting works in Passive Location Ranging. | Revised. TGaz editor, make the changes as shown below in document 11/19-1043. |
| 1563 | 118.01 | 11.22.6.4.6a | We also need to have a figure depicting the Timing diagram of a Measurement Sounding part in Passive Location Ranging based on phase shift of UL NDP and DL NDP. Such a figure is missing. | Add the missing figure for the Passive Location Ranging case as per the comment. | Revised. TGaz editor, make the changes as shown below in document 11/19-1043. |
| 1557 | 240 | 11.22.6.3.3 | The option to feed back phase shift based TOAs should apply also to the Passive Location Ranging case. The description for this is missing. | Add specification that an ISTA and an RSTA may negotiate a phase shift feedback mode of the Passive Location Ranging protocol. | Revised. TGaz editor, make the changes as shown below in document 11/19-1043. |

***TGaz Editor: Change the text in subclause 3.4 (“Abbreviations and acronyms”) as follows:***

…

***Change the text in Subclause 3.4 (“Abbreviations and acronyms”) as follows:***

**Insert the following abbreviations into 3.4 in alphabetic order:**

**FPBT first path beamforming training**

**…**

**SAC sequence authentication code**

**PSTA passive STA.**

**PS-TOA phase shift TOA**

***TGaz Editor: Change the text in Section 9.4.2.285 (*ISTA Passive Location Measurement Report element*) as follows:***

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

…

The Timestamp Measurement Reports field contains one or more Timestamp Measurement Report subfields defined as in Figure 9-1024.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 | B3 B50 | B51 B66 | B67 B78 | B79 |
|  | Type | Valid | Time-Stamp | Time-Stamp Error | AID12/RID12 | Reserved |
| bits: | 2 | 1 | 48 | 16 | 12 | 1 |

**Figure 9-1024 – Time Stamp Measurement Report subfield (#1515)**

The Type subfield is set according to the Table in Figure 9-1024b. (#1515)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Field value | Time-Stamp Type | Description |
|  | 00 | TOD | Time of departure time stamp. |
|  | 01 | TOA | Time of arrival time stamp. |
|  | 10 | PS-TOA | Phase Shift TOA |
|  | 11 | Reserved | Reserved |

**Figure 9-1024b – Type subfield (#1515)**

***TGaz Editor: Change the text in Section 11.22.6.2 as follows:***

**11.22.6.2 FTM capabilities**

**…**

If the STA in which dot11TriggerBasedRangingRespImplemented, dot11NonTriggerBasedRangingRespImplemented, dot11PassiveLocationRangingInitiatorActivated, or dot11PassiveLocationRangingResponderActivated is true supports **(#1515)**

(a) Phase Shift Feedback, it shall set the Phase Shift Feedback Support field in the Extended Capabilities element to 1. Otherwise it shall set the Phase Shift Feedback Support field in 2 the Extended Capabilities element to 0.

***TGaz Editor: Change the text in 11.22.6.1.3 (Passive Location Ranging) as follows:***

***11.22.6.1.3 Passive Location Ranging***

**(#1520, #1542, #1543, #1544, #1548, #1551, #1552, #1553, #1554, #1555, #1556, #1561, #1562, #1564, #1565, and #1574)**

Passive Location Ranging is a variant of the TB ranging mode referred to in Subclause 11.22.6 (Fine timing measurement (FTM) procedure). In all aspects, except where explicitly stated differently, the Passive Location Ranging mode, its protocols, procedures, components, and definitions follow the rules for TB ranging.

In particular, along to the general statement in the paragraph above, the text in the following subclauses, and their subclauses, apply also to Passive Location Ranging:

* Subclause 11.22.6.1.1 - EDCA based Ranging and TB Ranging overview
* Subclause 11.22.6.3.3 - Negotiation for TB and non-TB Ranging measurement exchange
* Subclause 11.22.6.4.3 - TB ranging measurement exchange
* Subclause 11.22.6.5 - Fine Timing Measurement parameter modification
* Subclause 11.22.6.5.1 - Availability Window parameter modification
* Subclause 11.22.6.6 - Fine timing measurement termination

Below are a list of example exceptions for Passive Location Ranging where the rules for it differs from the t the rules for TB Ranging:

* The rules and procedures specific for the secure version of TB Ranging does not apply to Passive Location Ranging.
  + For example, the following subclauses dealing with secure features of TB ranging do not apply to Passive Location Ranging:
    - 11.22.6.3.4 - Negotiation for Secure LTF in the TB and non-TB Ranging measurement exchange
* The RSTA uses the ‘Passive TB Ranging’ Ranging Trigger Subtype for its sounding trigger frames.
* The ISTAs use HE Ranging NDP PPDUs for its I2R NDPs.
* The ISTAs does not use the Location Measurement Report for reporting of its measurements but instead uses the ISTA Passive Location Measurement Report frame for this purpose, with its associated different measurements.
* The RSTA send the Primus and Secundus broadcast frames as specified.
* The number of spatial streams (NSTS) for passive location ranging is limited to max 4.
* The use of phase shift feedback in Passive TB Ranging differs from its use in TB ranging as described in, but not necessarily limited, in subclauses 11.22.6.3.8 (Passive TB Ranging Measurement Negotiation), 11.22.6.4.8.1 (General in subclause 11.22.6.4.8 (Measurement Exchange in Passive TB Ranging mode)), 11.22.6.4.8.3 (Passive TB Ranging measurement sounding phase), 11.22.6.4.8.4 (Passive TB Ranging measurement reporting phase) and 11.22.6.4.8.5 Passive TB Ranging differential time-of-flight calculations using phase shift TOA time stamps. (#1515)

The Passive Location Ranging mode consists of ranging exchanges between an RSTA and a set of ISTAs. These ranging exchanges and associated measurement reporting are set up such that an arbitrary STA can listen in to them and use the ranging exchanges and reported ranging measurements to estimate its differential distance to pairs or sets consisting of the RSTA and/or one or more ISTAs. The listening STA, a ‘passive’ STA or PSTA, is not itself an active transmitting participant in the ranging exchange. That is, the PSTA can passively estimate its differential distances to the RTA and the ISTAs pairs. It can then use these differential distances together with knowledge of the RSTA and ISTA locations to estimates its own location.

The RSTA centric Scheduling for Passive Location Ranging operation operates as the RSTA centric Scheduling for TB Ranging operation referred to in subclause 11.22.6.1.1 (RSTA scheduled operation overview). The availability window is here referred to as a Passive Location Ranging Availability window. The Passive Location Ranging is scheduled by the RSTA in an availability window used for passive location. In order to announce the scheduling and parameters of the availability window for passive location ranging the RSTA includes an RSTA Availability Element (see subclause 9.4.2.278 (RSTA Availability Window element)) in its beacon frame (see subclause 9.3.3.3 (Beacon frame format)). Here the RSTA Availability Window element contains a single Availability Window Information field with the Passive Location Ranging Availability Window bit is set to 1. (#1646)

The purpose of the announcement of the availability window for the passive location ranging is to enable PSTAs to listen to the Passive Location Ranging exchanges that are occurring there.

***TGaz Editor: Change subclause 11.22.6.3.8 (“Passive Location Ranging Measurement Negotiation”) as follows:***

**11.22.6.3.8 Passive Location Ranging Measurement Negotiation**

The Passive Location Ranging measurement negotiation follows the rules and procedures of the TB Ranging measurement negotiation detailed in Subclause 11.22.6.3.3 (Negotiation for TB and non-TB Ranging measurement exchange), unless explicitly stated otherwise. (#1520, #1542, #1543, #1544, #1548, #1551, #1552, #1553, #1554, #1555, #1556, #1561, #1562, #1564, #1565, and #1574)

An RSTA in which dot11PassiveLocationRangingRespoinderActivated is true shall set the Passive Location Ranging Responder Measurement Support field in the Extended Capabilities element to 1.

When an RSTA has set the Passive Location Ranging Responder Measurement Support field to 1 in the Extended Capabilities element it transmits, an ISTA with dot11PassiveLocationRangingActivated equal to true may set the Passive Location Ranging field in the TB Specific Parameters field in an initial Fine Timing Measurement Request frame to 1 to request a Passive Location Ranging measurement session between the ISTA and the RSTA. **(#1287)**

In Passive TB Ranging, ISTA2RSTA LMR feedback is mandatory. Therefore: **(#1515)**

* when an ISTA sets the Passive Location Ranging field in the TB Specific Parameters field in an initial Fine Timing Measurement Request frame to 1 it shall also set the ISTA2RSTA LMR Feedback subfield in the Ranging Parameters field of the Ranging Parameters element in the initial Fine Timing Measurement Request frame to 1, and
* the RSTA shall set the ISTA2RSTA LMR Feedback subfield in the Ranging Parameters field of the Ranging Parameters element in the initial Fine Timing Measurement Request frame to 1 to request ISTA2RSTA LMR feedback.

To grant an ISTA Passive Location Ranging, the RSTA shall respond with the Passive Location Ranging subfield in the Ranging Parameters field to set 1 in the corresponding IFTMR.

When an ISTA sets the Passive Location Ranging field in the TB Specific Parameters field in an initial Fine Timing Measurement Request frame to 1, the ISTA shall set the Secure LTF Required subfield in the Ranging Parameters field in an initial Fine Timing Measurement Request frame to 0.

The negotiation of phase shift feedback in Passive TB Ranging follows the same procedures as for TB Ranging. However, once negiated the protocol is the same no matter which side initiated the phase shift feedback request. See subclause 11.22.6.4.8 (Measurement exchange in passive TB ranging mode), with subclauses, for a description of the operation of Passive TB Ranging with phase shift feedback. **(#1515, #1557)**

***TGaz Editor: Change the text in subclause 11.22.6.4.8.1 (General) as follows:***

**11.22.6.4.8.1 General**

As stated in subclause 11.22.6.1.3 (“Passive TB Ranging overview”), the Passive Location Ranging mode is a variant of the TB ranging mode. In all aspects, except where explicitly stated differently, the Passive Location Ranging mode, its protocols, procedures, components,, and definitions follow the rules for TB ranging mode. (#1520, #1542, #1543, #1544, #1548, #1551, #1552, #1553, #1554, #1555, #1556, #1561, #1562, #1564, #1565, and #1574)

In particular the measurement exchanges for Passive Location Ranging follows the rules and procedures described in subclause 11.22.6.4.3 (TB ranging measurement exchange), with subclauses, unless explicitly stated otherwise.

Some of the exceptions for the Passive Location Ranging measurement session are:

- The RSTA sends the Passive Location Ranging Sounding Sub-variant Ranging Trigger Frame instead of the Sounding Sub-variant Ranging Trigger frame. Upon receiving of the Passive Location Ranging Sounding Sub-variant Ranging Trigger Frame, the ISTA responds with an HE Ranging NDP instead of an HE TB Ranging NDP. See 11.22.6.4.8.3 (Passive TB Ranging measurement sounding phase) for further details.

- In Passive Location Ranging, the ISTA sends its LMR feeback to the RSTA in an ISTA Passive Location Measurement Report frame. See subclause 9.6.7.49 (ISTA Passive Location Measurement Report frame format) for its format. **(#1515)**

- The RSTA broadcasts two RSTA Broadcast Passive Location Measurement Report frames containing measurement data and related information. See 11.22.6.4.8.4 (Passive TB ranging measurement reporting phase) for further details.

* The Passive Location Ranging exchanges occur in an availability window used for passive location.
* For Passive Location Ranging, either the ISTA or the RSTA may request phase shift feedback. Once negiated, the protocol is the same no matter which side initiated the phase shift feedback request, as described in subclause 11.22.6.4.8 (Measurement exchange in Passive TB Ranging mode) with subclauses. **(#1515)**

***TGaz Editor: Change the text in subclause 11.22.6.4.8.3 (“Passive TB Ranging measurement sounding phase”) as follows:***

**11.22.6.4.8.3 Passive TB Ranging measurement sounding phase**

The Passive Location Ranging measurement sounding follows the same rules and procedures for the measurement sounding for TB Ranging described in subclause 11.22.6.4.3.3 (“Measurement Sounding Phase of TB Ranging”), unless explicitly stated otherwise. (#1520, #1542, #1543, #1544, #1548, #1551, #1552, #1553, #1554, #1555, #1556, #1561, #1562, #1564, #1565, and #1574)

The second phase of the Passive Location Ranging measurement sequence, after the Passive Location Ranging polling phase, is called the Passive Location Ranging measurement sounding phase. The Passive Location Ranging measurement sounding phase is composed by one or more Passive Location Sounding subvariant Ranging Trigger frame and HE Ranging NDP exchanges, a Ranging NDPA frame, and an HE Ranging NDP transmissions.

In Passive Location Ranging, the Trigger frame that the RSTA send is of variant Ranging and subvariant Passive Location Sounding. The Trigger frame here only allocates uplink resources to a single STA.

An RSTA shall transmit one or more Passive Location Subvariant Ranging Trigger feach of which is addressed to a single ISTA, the first one coming a SIFS time after the TB polling phase.

An ISTA addressed by the RSID in the Passive Location Sounding Subvariant Ranging Trigger frame shall transmit an HE Ranging NDP a SIFS time after the reception of the Passive Location Sounding subvariant Ranging Trigger frame.

An RSTA transmitting a Passive Location Sounding Subvariant Ranging Trigger frame shall not use a bandwidth wider than that indicated in the initial Fine Timing Measurement frame sent to the ISTA and the RSTA shall set the TXVECTOR parameter CH\_BANDWIDTH to be the same value as the BW subfield of the Common Info field in the Passive Location Subvariant Ranging Trigger frame.

An RSTA transmitting a Ranging NDP Announcement frame and an HE Ranging NDP after receiving an HE Ranging NDP as a response to a Passive Location Sounding Subvariant Ranging Trigger frame shall set the TXVECTOR parameter CH\_BANDWIDTH to be the same value as the BW subfield of the Common Info field in the Passive Location Sounding Subvariant Ranging Trigger frame.

An ISTA transmitting an HE Ranging NDP as a response of to a Passive Location Sounding Subvariant Ranging Trigger frame shall set the TXVECTOR parameter CH\_BANDWIDTH to be the same value as the BW subfield of the Common Info field in the Passive Location Sounding Subvariant Ranging Trigger frame.

Similar to in TB Ranging, an ISTA participating in a Passive Location Ranging exchange shall measure the ToD of its own HE Ranging NDP and the ToA of when it receives the RSTA’s HE Ranging NDP. In addition, optionally the ISTA also measures and reports the TOAs of when it receives the HE Ranging NDPs transmitted by the other ISTAs participating in the Passive Location Ranging exchange. By reporting the TOA timestamps for when it received the other ISTAs NDP transmissions, the quality of the location estimate for a PSTA listening in to the Passive Location exchanges can be improved.

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

When phase shift 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 regular TOA feedback on the following points: **(#1515)**

* The RSTA measures phase shift feedback TOA (PS-TOA), in addition to measuring the TOA, on the I2R NPD it receives from the ISTA.
* The ISTA measures:
  + the phase shift TOA (PS-TOA), in addition to measuring the TOA, for the R2I NDP it receives from the RSTA,
  + and may also measure phase shift TOA(s) (PS-TOAs), in addition to measuring the TOA(s), for the I2R NDP(s) it receives from other ISTA(s).

**(#1515)**

***TGaz Editor: Change the text in subclause 11.22.6.4.8.4 (“Passive Location Ranging Measurement Reporting”) as follows:***

**11.22.6.4.8.4 Passive TB Ranging measurement reporting phase**

The Passive Location Ranging measurement reporting follows the same rules and procedures for the measurement reporting for TB Ranging described in subclause 11.22.6.4.3.4 (“TB Ranging Measurement Sounding Phase”), unless explicitly stated otherwise.

The last phase of the Passive Location Ranging measurement sequence is the Passive Location Ranging measurement reporting phase and is transmitted SIFS time after the Passive location ranging measurement sounding phase.

In the Passive Location Ranging measurement reporting phase, the RSTA shall send a Location Measurement Report frame and the LMR Subvariant Ranging Trigger to one or more ISTAs that sent an HE Ranging NDP in the preceding passive location ranging measurement sounding phase. An ISTA addressed by the LMR Subvariant Ranging Trigger frame shall transmit an ISTA Passive Location Measurement Report frame SIFS time after the LMR Subvariant Ranging Trigger frame transmission.

The ISTA Passive Location Measurement Report frame is defined in subclause 9.6.7.49 (ISTA Passive Location Measurement Report frame format). The ISTA Passive Location Measurement Report frame contains an ISTA Passive Location Measurement Report element, see Subclause 9.4.2.285 (ISTA Passive Location Measurement Report element), containing the TOD time stamp for the I2R NDP that the ISTA transmitted, the TOA time stamp of the R2I NDP that the ISTA received from the RSTA, the CFO of the ISTA with respect to the RSTA, and optionally the TOAs for I2R NDPs received from other ISTAs participating in the Passive Location Ranging Polling-Sounding-Reporting triplet identified by a Dialog Token included in the report.

The ISTA Passive Location Measurement Report frame shall include an entry for the ISTA's I2R NDP TOD. **(#1169)**

The RSTA shall send two RSTA Broadcast Passive Location Measurement Report frames a SIFS time after receiving the ISTA Passive Location Measurement Report frames from the ISTAs.

The Primus RSTA Broadcast Passive Location Measurement Report frame containing the following is transmitted first:

—— Current Passive Location LCI Table Number

— Passive Location LCI Table Countdown

— RSTA Passive Location LMR

— Passive Location LCI Table (optionally present)

When the Passive Location LCI Table is present in the Primus Broadcast Passive Location Measurement Report frame, the RSTA LCI Report field of the Passive Location LCI Table Report element shall contain the Antenna Placement and Calibration subelement if the RSTA has dot11PassiveRangingAoDEnablementActivated set to 1, and shall not contain the Antenna Placement and Calibration subelement if the RSTA has dot11PassiveRangingAoDEnablementActivated set to 0. (#**2302**)

When the Passive Location LCI Table is present in the Primus Broadcast Passive Location Measurement Report frame, the corresponding entree of the ISTA LCI Reports Entries field of the Passive Location LCI Table Report element shall contain the Antenna Placement and Calibration subelement if the ISTA has dot11PassiveRangingAoDEnablementActivated set to 1, and shall not contain the Antenna Placement and Calibration subelement if the ISTA has dot11PassiveRangingAoDEnablementActivated set to 0. (#**2302**)

See subclause 9.6.7.39 Primus RSTA Broadcast Passive Location Measurement Report frame format.

The Secundus RSTA Broadcast Passive Location Measurement Report frame containing the following is subsequently transmitted ~~with~~ after a SIFS time.

— ISTA Passive Location Measurement Reports

See subclause 9.6.7.40 Secundus RSTA Broadcast Passive Location Measurement Report frame format.

When phase shift feedback is negotiated between an ISTA and an RSTA in Passive TB Ranging, the protocol for the measurement reporting phase differs from Passive TB Ranging with regular TOA feedback on the following points:

* The RSTA reports it measured PS-TOA in the RSTA2ISTA LMR frame.
* The ISTA reports its measured PS-TOA(s), in addition to its measured TOA(s), in the ISTA Passive TB Ranging Measurement Report frame.
  + The PS-TOAs are indicated as phase shift TOA time stamps by setting the Measurement Report field of the ISTA Passive TB Ranging Measurement Report element , see Subclause 9.4.2.286 (ISTA Passive TB Ranging Measurement Report element), to the value 10 (PS-TOA).
* In the Primus RSTA Broadcast Passive TB Ranging Measurement Report frame, the RSTA broadcasts, its measured PS-TOA, in addition to its measured TOA, for the I2R NDPs it has received from the ISTA.
* In the Secundus Primus RSTA Broadcast Passive TB Ranging Measurement Report frame, the RSTA re-broadcasts the time-stamps the ISTA has reported to the RSTA. As the ISTA has negotiated phase shift feedback, these would contain PS-TOAs in addition to TOAs.

**(#1515)**

When phase shift feedback is negotiated in Passive TB Ranging, the reporting by both the RSTA and the ISTA of phase shift TOAs shall be of the immediate type. The TOD time-stamps shall also be reported as immediate feedback. The reported TOAs do not need to be of the immediate report type but can be delayed. In this case the dialog token used in the report refers to the Passive TB Ranging availability window where the reported TOA time stamps were measured, and not the availability window where the reported PS-TOAs and TODs were measured, as this is the availability window containing the reports themself. **(#1515)**

Furthermore the broadcasting of TODs and PS-TOAs, related to the ISTAs that has negotiated phase shift feedback, in the Primus and Secundus RSTA Broadcast Passive TB Ranging Measurement Report frames shall also be immediate. That is the TODs and PS-TOAs measured by the RSTA shall be broadcast in the Primus RSTA Broadcast Passive TB Ranging Measurement Report frame following the measurement phase in which they were measured. Correspondingly, the TODs and PS-TOAs reported by the phase shift TOA reporting ISTA(s) shall be re-broadcast in the Secundus RSTA Broadcast Passive TB Ranging Measurement Report frame following the reporting from the ISTA(s). Again, the reported TOAs do not need to be of the immediate report type but can be delayed. The dialog token used in the reports here refers to the Passive TB Ranging availability window where the reported TOA time stamps were measured, and not the availability window where the reported PS-TOAs and TODs were measured, as this is the availability window containing the reports themself. **(#1515)**

***TGaz Editor: Insert a new subclause 11.22.6.4.8.5 (Passive TB Ranging differential distance calculations with phase shift TOA time* stamps*) in D1.5 after subclause 11.22.6.4.8.4 (Passive TB ranging measurement reporting phase) as follows:***

***Insert the following new clause:***

**11.22.6.4.8.5 Passive TB Ranging differential time-of-flight calculations using phase shift TOA time stamps**

**(#1563)**

In Figure 11-36s (Example of Passive TB Ranging measurement exchanges with PS-TOA measurements), Passive TB Ranging measurement exchanges and their reception by a passive station, a PSTA, is depicted for the case when the RSTA and the ISTA are measuring and reporting phase shift TOAs, PS-TOAs. See Annex Z for how the phase shift TOAs are calculated.

The RSTA measures and reports the PS-TOA tp2 and the ISTA measures and reports the PS-TOA tp4, in addition to measuring and reporting their TODs, t3 and t1 respectively, of their transmitted ranging NDPs. The ISTA reports its time-stamps to the RSTA and the RSTA broadcasts the ISTA’s and its own time stamps to the PSTA.

The ISTA also measures and reports the TOA time stamps for the ranging NDPs it receives and the RSTA also measures and broadcasts the TOAs of the ranging NDPs it receives, as well as the ISTAs reported TOAs, though these time stamps are not used in the calculations described here.

****

**Figure 11-36s—** **Example of Passive TB Ranging measurement exchanges with PS-TOA measurements.**

The PSTA can use the ISTA’s and RSTA’s time stamps, together with its own measured TOAs of the ranging NDPs, t5 and t6, to calculate its differential time of flight to the RSTA and the ISTA.

The differential time of flight from the PSTA to the RSTA and the ISTA (DToF\_PRI) is defined by equation (11-dtp1):

DToF\_PRI = ToF\_PR – ToF\_PI, (11-dtp1)

where ToF\_PR is the time of flight between the PSTA and the RSTA, and the ToF\_PI is the time of flight between the PSTA and the ISTA.

The differential time of flight DToF\_PRI can then be computed as as per equation (11-dtp2):

(11-DD\_PRI)

DToF\_PRI = t6 – t5 – 0.5\*t3’ + 0.5\*tp2’ – 0.5\*tp4’ + 0.5\*t1’. (11-dtp2)

The time stamp t1’ is the time at which the I2R NDP was transmitted from the ISTA and tp4’ is PS-TOA measurement for the time at which the R2I NDP was received by the ISTA, converted from the ISTA’s time basis to the PSTA’s time basis.

The time stamp tp2’ is the time at which the I2R NDP was received by the RSTA and t3’ is the time at which the R2I NDP was transmitted from the RSTA, converted from the RSTAs time basis to the PSTA’s time basis.

To derive the time stamps t1’ and tp4’, the PSTA may use the ISTA’s time stamps t1 and tp4 and the ISTA’s CFO, reported in the Secundus RSTA Broadcast Passive Location Measurement Report frame, together with its own CFO as compared to the RSTA.

To derive the time stamps tp2’ and t3’, the PSTA may use the RSTA’s time stamps tp2 and t3, reported in the Primus RSTA Broadcast Passive Location Measurement Report frame, together with its own CFO as compared to the RSTA.

**References:**

**[1] Draft P802.11az\_D1.5**

**[2] Draft P802.11ay\_D3.0**

**[3] Draft P802.11REVmd\_D3.0**