IEEE P802.11
Wireless LANs

|  |
| --- |
| Informative text for passive location ranging |
| 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 |
|  |  |  |  |  |

Abstract

This document proposes resolutions to TGaz LB240 comments related to Passive TB Ranging, in particular related to general description of its function or description. The changed described here are in relation to [1].

TGaz LB240 CIDs addressed: 1291, 1578, 1575, 1576, 2287, 1577, 1563, 2218, 2212, 2213, and 2340.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **P.L** | **Clause** | **Comment** | **Proposed change** | **Proposed resolution** |
| 1291 | 126.37 | 11.22.6.4.10.3 | "transmitted with a SIFS": remove strikethough text | as in comment | Revised. See change instructions in 11/19-35. |
| 1578 | 126.13 | 11.22.6.4.10.3 | A detailed description of and figure depicting Passive Location Ranging measurement reporting is missing. | Add detailed description of and figure depicting Passive Location Ranging measurement reporting. | Revised. A depiction of the Passive TB Ranging measurement reporting phase is added, as per change instructions in 11/19-35. |
| 1575 | 125.16 | 11.22.6.4.10.2  | Timing diagram of a Measurement Sounding part in Passive Location Ranging is missing. | Add Timing diagram of a Measurement Sounding part in Passive Location Ranging that also shows the meausrments a passive STA (PSTA) is doing. | Revised. Added Timing diagram of a Measurement Sounding part in Passive Location Ranging that also shows the meausrments a passive STA (PSTA) is doing, as per change instructions in 11/19-35. |
| 1576 | 125.16 | 11.22.6.4.10.2 | An example of what calculations a passive STA (PSTA) is doing when listeing in to Passive Location Ranging exchanges is missing. | As in comment. | Revised. Added Timing diagram of a Measurement Sounding part in Passive Location Ranging that also shows the meausrments a passive STA (PSTA) is doing, as per change instructions in 11/19-35. |
| 2287 | 124.26 |  | "An ISTA whose dot11PassiveLocationRangingInitiatorActivated is true and an RSTA whose dot11PassiveLocationRangingResponderActivated is true may activate passive location ranging exchanges in which case, the ISTA and RSTA follow the rules described in subclause 11.22.6.4.3 (Measurement Exchange in TB Mode) with the exceptions described in Section 11.22.6.4.9 (Measurement Exchange in TB Passive Range Location Ranging mode), with subsections." The RSTA and ISTA that perform passive ranging have distinct functionality from the RSTA and ISTA of active ranging. They should be given a separate name, e.g., anchor STAs. | As in comment. | Rejected. For ease of specifying the Passive TB Ranging protocol as a variant of TB Ranging we are retaining the RSTA and ISTA naming. A passive STA that listens in on the Passive TB Ranging is however denoted as a PSTA. |
| 1577 | 125.15 | 11.22.6.4.10 | A description of how a passive STA (PSTA) can listen in to multiple Passive Location Ranging sessions performed my multiple RSTAs and multiple ISTAs is missing. | Add a description of how a passive STA (PSTA) can listen in to multiple Passive Location Ranging sessions performed my multiple RSTAs and multiple ISTAs. | Revised. Added description, as per change instructions in 11/19-35. |
| 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. Added figure, as per change instructions in 11/19-35. |
| 2218 | 71.02 | 11.22.6.4.9.3 | [Re-raising this comment from the comment collection, as it is not possible to determine from 18/1544r8 whether/how it was addressed. References are to the CC draft and hence may be wrong against D1.0.]"The RSTA shall send two broadcast Passive Location Measurement Report frames a SIFS timeafter receiving the Location Measurement Report frame " -- does this mean an MU transmission has to be used? | Clarify. I think this is trying to say that following the LMR frame rx the RSTA sends one LMR frame after SIFS, then another LMR frame SIFS after the first | Revised. Changed text, as per change instructions in 11/19-35. |
| 2212 | 70.01 | 11.22.6.4.9.2 | [Re-raising this comment from the comment collection, as it is not possible to determine from 18/1544r8 whether/how it was addressed. References are to the CC draft and hence may be wrong against D1.0.]"The HEz passive range measurement sounding part commences a SIFS time after the HEz polling 2part and is the 2nd part of the HEz passive range measurement sequence. " but what's the first part? | Make sure that for all the techniques all three parts are covered (by having a subclause for each, even if to say e.g. that the passive HEz polling part is the same as the active HEz polling part). And include a figure showing all the parts/phases/whatever you end up deciding to call them | Revised. Added subclauses for each part and added a figure showing the parts, as per change instructions in 11/19-35. |
| 2213 | 69.00 | 11.22.6.4.9 | [Re-raising this comment from the comment collection, as it is not possible to determine from 18/1544r8 whether/how it was addressed. References are to the CC draft and hence may be wrong against D1.0.]There needs to be some information on how passive ranging works, i.e. how you can passively determine ranges from the information in certain frames you overhear | As it says in the comment | Revised. Added description, as per change instructions in 11/19-35. |
| 2340 | 61.04 | 9.4.2.286 | Please unify subclause titles of 9.4.2.286 and 9.4.2.287 "ISTA Passive Location Measurement Report element" vs. "RSTA Passive Location LMR element" | as in comment | Revised. Changed, as per change instructions in 11/19-35. |

***TGaz Editor: Change the text in Subclause 9.4.2.286 (ISTA Passive Location Measurement Report element) as follows:***

**11.22.6.1.3 Passive Location Ranging**

…

In particular, along 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. 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 it does not follow the 11 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 Location 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 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 (EDCA based Ranging and TB Ranging 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 and with the Passive TB Ranging paraneters subfield included. (#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.

**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 Section 11.22.6.3.3 (Trigger-based and non-Trigger-based Ranging Measurement Negotiation), unless explicitly stated otherwise**. (#1520, #1542, #1543, #1544, #1548, #1551, #1552, #1553, #1554, #1555, #1556, #1561, #1562, #1564,** 34 **#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 dot11PassiveLocationRangingInitiatorActivated 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)**

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.

**11.22.6.4.8 Measurement exchange in passive TB (#1807, #1808) ranging mode**

**11.22.6.4.8.1 General**

As stated in subclause 11.22.6.1.3 (“Passive TB Ranging”), 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 Subvariant Ranging Trigger frame instead of the TB Sounding Subvariant Ranging Trigger frame. Upon receiving of the Passive Location Subvariant 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.

- The RSTA broadcasts two frames, the Primus and Secundus RSTA Broadcast Passive Location Measurement Report frames, contain measurement data and related information. See 11.22.6.4.8.3 (Passive TB ranging measurement reporting phase) for further details.

The Passive Location Ranging exchanges occur in an availability window used for passive location.

**11.22.6.4.8.2 Polling Phase of Passive Location Ranging**

The polling phase of Passive Location Ranging follows the same rules and procedures for the polling phase of TB ranging described in subclause 11.22.6.4.3.2 (“Polling Phase of TB Ranging”). **(#1520, #1542, #1543, #1544, #1548, #1551, #1552, #1553, #1554, #1555, #1556,**  **#1561, #1562, #1564, #1565, and #1574)**

**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 (“TB Ranging Measurement Sounding Phase”), 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.



**Figure 11-<PTBR-Triplet>—Passive TB Ranging Polling, measurent sounding, and measurement reporting parts. (#2212)**

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 frame 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 Subvariant Ranging Trigger frame shall transmit an HE Ranging NDP a SIFS time after the reception of the Passive Location 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 an 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 STA 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.

See Figure 11-<PTB-timing for an example of time stamps measured by the RSTA, ISTA and a PSTA in a Passive TB Ranging measurement exchange. The timestamp values t1, t2, t3 and t4 are analogous to the correspondly labeled time stamps in Subclause 11.22.6.4.3.3 (Measurement Sounding Phase of TB) for TB Ranging. The time-stamps t5 and t6 are the times at which the I2R NDP and R2I NDPs arrive at the PSTA, respectively.



**Figure 11-<PTB-timing>—Example Timing diagram of a Measurement Sounding phase in Passive TB Ranging (#1575, #1576, #1563)**

The PSTA can, for example, 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 distance to the RSTA and the ISTA.

Define the differential distance from PSTA to the RSTA and the ISTA, DD\_PIR as:

(11-DD-PID-definition)

DD\_PRI = D\_PR – D\_PI

Where D\_PR is the distance between the PSTA and the RSTA, and the D\_PI is the distance between the PSTA and the ISTA. The differential distance DD\_PRI can then be computed as:

(11-DD\_PRI)

DD\_PRI = [t6 – t5 – 0.5\*t3’ + 0.5\*t2’ – 0.5\*t4’ + 0.5\*t1’]\*c

where t1’ and t4’ are the time at which the I2R NDP was transmitted from the ISTA and the time at which the R2I NDP was received by the ISTA, respectively, converted by the PSTA from the ISTA’s time basis to its own time basis.

Similarly t2’ and t3’ are the time at which the I2R NDP was received by the ISTA and the time at which the R2I NDP was transmitted by the RSTA, respectively, converted by the PSTA from the RSTA’s time basis to its own time basis.

To derive t1’, t2’, t3’, and t4’ from t1, t2, t3 and t4, the PSTA may use the CFOs reported in the Primus and Secundus Primus RSTA Broadcast Passive Location Measurement Report frames. **(#1575, #1576, #2213)**

**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.

See Figure 11-<PTB meas rep> (Passive TB Ranging measurement reporting phase) for a depiction of the Passive TB Ranging measurement reporting phase.



**Figure 11-<PTB meas rep>—Passive TB Ranging measurement reporting phase (#1578)**

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

In the Passive Location Ranging measurement reporting phase, an 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 a 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 the Primus and Secundus RSTA Broadcast Passive Location Measurement Report frames, the Primus a SIFS time after receiving the ISTA Passive Location Measurement Report frames from the ISTAs and the Secundus a SIFS following the Primus. See Figure 11-<PTB meas rep> (Passive TB Ranging measurement reporting phase). **(#2218)**

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 after a SIFS time. **(#1291)**

— ISTA Passive Location Measurement Reports

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

***TGaz Editor: Insert a new subclause 11.22.6.8 (Passive TB Ranging system aspects) with subclauase 11.22.6.8.x (Passive TB Ranging differential distance calculations with phase shift TOA time* stamps*) in D1.5 after subclause 11.22.6.4.7 (LCI and Location Civic retrieval using FTM procedure) as follows:***

***Insert the following new clauses:***

**11.22.6.8 Passive TB Ranging system aspects (#1577, #2213)**

**11.22.6.4.8.1 Passive TB Ranging switching between RSTAs (#1577, #2213)**

Passive TB Ranging between a set of ISTAs and a set of RSTAs can be used to enable client STAs that are listening in to the ranging exchanges to determine its location without the client STA transmitting. These non-transmiting client STA here is therefore referred to as a passive STA or a PSTA.

Consider the scenario depicted in Figure 11-<PTBR-SYS1>. Here three access points, AP1, AP2, and AP3 act as three Passive TB Ranging responders, RSTA1, RSTA2, and RSTA3. It is envisioned here that each access point has two client STAs accociated to them, though this envision accociated is inconsequential to the setup. In Figure 11-<PTBR-SYS1>, RSTA1 is performing ranging exchanges in an availability window for Passive TB Ranging. RSTA1 is here performing Passive TB Ranging exchanges with ISTAs, ISTA1, ISTA2, ISTA3, ISTA4, ISTA5, and ISTA6.

The passive client STA, the PSTA in Figure 11-<PTBR-SYS1>, is listening in to the Passive TB Ranging exchanges between RSTA1 and the ISTAs. The overhearing of one such ranging exchange is depicted in Figure 11-<PTBR-SYS1> with the dashed arrows. The PSTA however has the opportunity to listen in to all the Passive TB Ranging opportunities occurring. The PSTA can thus listen in to a quite a few ranging exchanges. The overhearing of each of these ranging exchanges can be used by the PSTA towards estimating its location.

In addition to the ranging exhanges between the ISTAs and RSTA1, the Passive TB Ranging protocol also allows the ISTAs to perform ranging exchanges between each other. One such ranging exchange is depicted in Figure 11-<PTBR-SYS1> in form of the dotted double arrow between ISTA 1 and ISTA 2, though such ranging exchanges can occur between any of the ISTA pairs.

Furthermore, if one of the other APs in Figure 11-<PTBR-SYS1> temporarily takes on the role of being an ISTA it can also participate in RSTA1’s Passive TB Ranging opportunity.

****

**Figure 11-<PTBR-SYS1>—** **Example of Passive TB Ranging used for PSTA location – AP1/RSTA1’s Passive TB Ranging opportunity.**

At a later point in time, in Figure 11-< PTBR-SYS2>, AP2 acting as RSTA2 operates a different Passive TB Ranging opportunity. Now the ISTAs have switched to participating in RSTA2’s Passive TB Ranging opportunity. Correspondingly the PSTA has also swithed to listen in to RSTA2’s Passive TB Ranging opportunity. The PSTA thus here gets a new set of ranging exchanges it can use towards estimating its location. This is especially true if AP2 did not participate in AP1’s Passive TB Ranging opportunity, which is quite likely as it can be somewhat burdening for an access point to operate as an ISTA.

****

**Figure 11-<PTBR-SYS2>—** **Example of Passive TB Ranging used for PSTA location – AP2/RSTA2’s Passive TB Ranging opportunity.**

At yet a later point in time, in Figure 11-< PTBR-SYS3>, AP3 acting as RSTA3 operates a a yet different Passive TB Ranging opportunity. Now the ISTAs have switched to participating in RSTA3’s Passive TB Ranging opportunity. Correspondingly the PSTA has also swithed to listen in to RSTA3’s Passive TB Ranging opportunity. The PSTA thus here gets yet more ranging exchanges it can use towards estimating its location.

****

**Figure 11-<PTBR-SYS3>—** **Example of Passive TB Ranging used for PSTA location – AP2/RSTA2’s Passive TB Ranging opportunity.**

Each of the access points operating as RSTA1, RSTA2, and RSTA3, announces the timing and bandwidth of its Ranging Availbility window in its beacon in a RSTA Availability Window element for Passive TB Ranging, see Subclause 9.4.2.278 (RSTA Availability Window element). The PSTA can thus by listening the the AP’s beacons be informed about when and on what bandwidth the different Passive TB Ranging availbillity windows will occur.

**11.22.6.4.8.2 Passive stations location estimation using Passive TB Ranging (#1577, #2213)**

As exemplified in Subclause 11.22.6.4.8.1 (Passive TB Ranging switching between RSTAs), Passive TB Ranging between a set of RSTAs and ISTAs can be set up such as to provide a PSTA with a great many ranging exchanges it can listen in to and use for estimating its location.

The PSTA can use many different methods to estimates its location but a simple way to exemplify the calculations is to assume that the PSTA uses the ranging exchange between each pair of RSTA/ISTAs, or ISTA/ISTAs that it listens in to to calculate its differential distance to the pair. See Subclause 11.22.6.4.8.3 (Passive TB ranging measurement sounding phase) for a detailing of how this differential distance can be calculated.

The locations of the RTA/ISTAs or ISTA/ISTAs together with their differential distance with respect to the PSTA, generates a set of hyperbolic curves to which the PSTAs location is constrained. The intersection of these hyperbolic curves, or the best approximation to their intersection, is then an estimate of the PSTA’s location.

***TGaz Editor: Insert a subclause heading on page 67 before line 22 as:***

**9.4.2.278 RSTA Availability Window element**

***TGaz Editor: Replace according to instructions listed here:***

Throughout the 802.11az draft, replace:

* ‘Passive Location Ranging’ with ‘Passive TB Ranging’
* ‘Passive Location Measurement’ to ‘Passive TB Ranging Measurement’
* ‘Passive Ranging’ to ‘Passive TB Ranging’
* ‘Passive Location LCI’ to ‘Passive TB Ranging LCI’
* ‘Passive Location Sounding’ to ‘Passive TB Sounding’
* ‘Passive Location subvariant’ to ‘Passive TB Ranging subvariant’
* ‘dot11PassiveLocationRanging’ to ‘dot11PassiveTBRanging’
* ‘RSTA Passive Location LMR’ with ‘RSTA Passive Location Measurement Report’ ***(TGaz Editor: Insert indication ‘(#2340)’ to the change here in the draft text.)***
* ‘passive TB ranging’ to ‘Passive TB Ranging’
* ‘dot11PassiveRanging’ to ‘dot11PassiveTBRanging’
* ‘passive location ranging’ to ‘Passive TB Ranging’
* ‘passive location ranging’ to ‘Passive TB Ranging’
* ‘passive Location Ranging’ to ‘Passive TB Ranging’
* ‘Passive TB ranging’ to ‘Passive TB Ranging’
* ‘passive TB ranging’ to ‘Passive TB Ranging’
* ‘Passive Location Subvariant’ to ‘Passive TB Ranging subvariant’ or maybe ‘Passive TB Ranging Subvariant’?
* ‘Passive Location exchanges’ to ‘Passive TB Ranging exchanges’
* ‘passive location ranging’ to ‘Passive Location Ranging’
* ‘passive ranging’ to ‘Passive TB Ranging’
* ‘FTM passive location’ to ‘FTM Passive TB Ranging’

**References:**

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