IEEE P802.11  
Wireless LANs

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| CC28 CR HEz Protocol Rewrite | | | | |
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**Abstract**

This submission proposes resolutions of comments received from TGaz CC28.

(The proposed change is based on TGaz Draft 0.5.4)

* CIDs: 491, 387, 43, 122, 397, 392, 396, 45, 132, 393, 394, 400, 401, 402, 403, 404, 40, 168,169,339,342,345,346,347,349, 354,355,356,357,358, 372, 381, 382, 386,388, 389, 395, 41,170,171, 359,260,261,362,363,364, 530,508,510 (49 CIDs)

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Some changes that are highlighted in green.
* Rev 2: Fixed document number in instruction to editor.

| **CID** | **Page** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| --- | --- | --- | --- | --- | --- |
| 491 | 52.00 | 11.22.6.4.3.4 | Definition of t3' and t2' is not clear. What is the difference between t3 and t3'? |  | Revised  No specific solution outlined in comment but made changes to clarify definitions. |
| 387 | 57 | 11.22.6.4.3.4 | "and if negotiate from ISTA to RSTA" -- what does this mean? | Clarify | Revised  No specific solution outlined, but reworded text to clarify |
| 43 | 57 | 11.22.6.4.3.4 | Typo on the word "negotiated" |  | Accepted |
| 122 | 57 | 11.22.6.4.3.4 | Missing 'd' in 'negotiate'. |  | Accepted |
| 397 | 57 | 11.22.6.4.3.4 | Should also illustrate the case with no ISTA-to-RSTA | Add a figure, or say it is the same as the figure except no TF and no UL | Revised  No specific solution outlined, but tried to clarify |
| 392 | 57 | 11.22.6.4.3.4 | "For the details of HEz Polling Part and HEz Range Measurement Sounding Part, please refer to 21 the descriptions in 11.22.6.4.2.2 (HEz Polling Part) and 11.22.6.4.2.3 (HEz Range Measurement 22 Sounding)." -- not needed (not used in other subclauses) | Delete | Revised  No specific solution outlined, but reworded that text |
| 396 | 57 | 11.22.6.4.3.4 | "the ISTA shall response with the ISTA-to- 26 RSTA LMR using the HE TB PPUD format" -- this is normal TF behaviour so need not be stated | Delete | Revised  Made it clear that the specified behaviour is not to repond to the TF with \*any\* frame, but with the specific LMR frame |
| 45 | 57 | 11.22.6.4.3.4 | Typo on word "PPDU" | As per comment | Accepted |
| 132 | 57 | 11.22.6.4.3.4 | Correct typo | change TB PPUD to TB PPDU | Accepted |
| 393 | 57 | 11.22.6.4.3.4 | "PPUD" | "PPDU" | Accepted |
| 394 | 57 | 11.22.6.4.3.4 | New term? " HE Location Measurement Report Part" |  | Revised-  No specific solution outlined, but tried to align all the terms used |
| 400 | 57 | 11.22.6.4.3.4 | What if not all the reports from the ISTAs are received by the RSTA? | Clarify how this is handled | Revised-  No specific solution outlined, but tried to clarify in text. |
| 401 | 57 | 11.22.6.4.3.4 | What if not all the reports to the ISTAs are received by the ISTAs? | Clarify how this is handled | Revised-  No specific solution outlinedbut tried to clarify in text. |
| 404 | 58 | 11.22.6.4.3.4 | This should not just be a NOTE | Delete "Note:" | Accepted  Removed “Note:” |
| 403 | 58 | 11.22.6.4.3.4 | ", for example, receiving the PHY-RXEND.indication(Integrity Check Error) " -- this should not just be an example | Change to "In the secured mode of HEz, if the RSTA receives a PHY-RXEND.indication(IntegrityCheckError) instead of an UL NDP from an ISTA". Ditto below | Revised-  Agree in principle, revised language. |
| 402 | 58 | 11.22.6.4.3.4 | "Integrity Check Error" should be one word and italics | As it says in the comment (5x in total) | Revised-  Agree in principle, revised terminology |
|  |  |  |  |  |  |
| 40 | 53 | 11.22.6.4.3.1 | Should the NOTE reflect secure operation only? | As per comment | Revised.  Removed the note since TB Ranging does not use VHT PPDUs. |
| 168 | 53 | 11.22.6.4.3.1 | The description is not in line with the figure. | change the description: multiple windows are shown in the figure | Revised. Clarified the description of Fig-11-35b by rewording as follows:  “TB Ranging availability windows each with one instance of polling/sounding/reporting triplet” |
| 169 | 54 | 11.22.6.4.3.1 | What is the same rules? | Clarify it. | Revised. Clarified that RIDs follow the same rules of assignment and usage as that of AIDs in HE operation by rewording as follows:  “The AID and RID assignment shall be non-conflicting and, shall have the same size and valid address space (as defined in sections 9.4.1.8 and 27.16.3). The RID usage shall follow the same rules as that of AIDs for HE operations.” |
| 339 | 53 | 11.22.6.4.3.1 | What does "dynamic" mean here? | Clarify | Revised. The intention is to emphasize the variable set of users that can participate in each availability window. This in contrast to REVmc FTM where each RSTA has to perform a fixed number of measurements. Clarified by adding the following lines in 11.22.6.4.3.1: “  The TB Ranging protocol is dynamic as the actual number of ISTAs participating for measurement activities can vary across availability windows. This occurs as even though the availability windows are scheduled for range measurements, the ISTAs can dynamically decide which subset of these availability windows to frequent.” |
| 342 | 53 | 11.22.6.4.3.1 | What does "ordered" mean here? | Clarify | Revised. Re-worded the phrase to clarify that we are referring to sequential parts:  “Each availability window of the TB Ranging protocol consists of one or more triplets of sequential parts: polling part, measurement sounding part and measurement reporting part.” |
| 345 | 53 | 11.22.6.4.3.1 | What does "nominal" mean here? | Clarify | Revised. Clarified that it is an example of an availability window: “  Figure 11-35b shows an example of two availability windows…”. |
| 346 | 54 | 11.22.6.4.3.1 | What does "nominally" mean here? | Clarify | Rejected.  Dictionary definition of “nominal” is “stated or expressed but not necessarily corresponding to the exact or real value”. Accordingly, the TB Ranging operation under normal conditions consists of one sequence of polling, measurement sounding and measurement reporting parts. However, due to instantaneous medium limitations, there could be multiple such sequences. |
| 347 | 53 | 11.22.6.4.3.1 | " a single polling, Range Measurement, Sounding and Location Measurement Report parts" is not clear | Change to "one Polling part, one Range Measurement, Sounding and one Location Measurement Report part" | Revised. Reworded as follows:  “Each availability window of the TB Ranging protocol consists of one or more triplets of sequential parts: polling part, measurement sounding part and measurement reporting part.” |
| 349 | 53 | 11.22.6.4.3.1 | "all ISTA" should be "all ISTAs" | As it says in the comment | Accepted. Reworded to: “If the available bandwidth is insufficient to allow for the polling of all ISTAs assigned to the availability window with one poll” |
| 354 | 54 | 11.22.6.4.3.1 | " Measurement resources and results are made available" -- what are measurement resources? | Clarify | Rejected. This is a high-level description of TB ranging behaviour and not normative behaviour. For normative behaviour please refer to section 11.22.6.4.3.3 and 11.22.6.4.3.4. |
| 355 | 53 | 11.22.6.4.3.1 | Figure 11-35b says the interval from the end of one PMP and the start of the next is fixed. Is this the case even if the polling part of the first is extended to poll for extra ISTAs? That would mean the other parts would have to be shortened somehow -- how? | Clarify | Accepted. The figure has been changed to reflect that only the start of each availability window remains fixed. |
| 356 | 53 | 11.22.6.4.3.1 | The relationship between "Position Measurement Phase" and "availability window" is not clear | Clarify | Accepted. Fig. 11-35b has changed and clarify that the measurement phase consists of one or more availability windows. |
| 357 | 53 | 11.22.6.4.3.1 | "An RSTA and ISTA participating in a HEz  mode ranging shall perform HEz ranging measurement and measurement results activities only within the availability window" -- but what defines the availability window? The figure only shows position measurement phases, which include polling parts | Clarify | Accepted. Added definition of availability windows: “The availability windows are scheduled periodic time windows assigned to ISTAs during the negotiation phase.” |
| 358 | 54 | 11.22.6.4.3.1 | "The AID and RID shall be non-conflicting (9-b), 10  shall have the same size and valid address space (9-b), and shall follow the same rules (9-a)" is not clear. What address space? What rules? | Clarify | Accept. Re-worded that particular sentence to: “The AID and RID assignment shall be non-conflicting and, shall have the same size and valid address space (as defined in sections 9.4.1.8 and 27.16.3). The RID usage shall follow the same rules as that of AIDs for HE operations.” |
| 386 | 57 | 11.22.6.4.3.4 | "shall be carried in a Location Measurement Results (LMR) frames" -- well, carried in one or more? | Clarify | Accepted. Clarified by re-wording the sentence as:  “The measurement results shall be carried in LMR frames (see section 9.6.7.37 Location Measurement Report frame format). |
| 388 | 57 | 11.22.6.4.3.4 | Is it a "part" or a "phase"? | Be consistent (and use lowercase) | Accepted. Revised the section to use “part” everywhere. |
| 389 | 57 | 11.22.6.4.3.4 | "shall be either from this availability window or the 12  previous availability window used by ISTA" -- missing article | Add "the" before "ISTA" | Revised.  Reworded that sentence altogether for better readability as below:  “The feedback type of the ISTA-to-RSTA and RST-to-ISTA LMRs shall be either immediate (i.e., from the current availability window) or delayed (i.e., from the last availability window in which the ISTA responded to the TF Location Poll and the RSTA allocated resources to that RSTA during the measurement sounding part).”. |
| 395 | 57 | 11.22.6.4.3.4 | "shall response" | "shall respond". Also line 31 | Accepted. |
| 372 | 55 | 11.22.6.4.3.3 | The figure shows that the NSS for the UL NDP is the same as in the corresponding DL NDP. Is this required? | If required, say in text. If not required, change figure to show can be different | Accepted. There are two figures (Figure 11-35c and Figure 11-35c2) that show that NSS can be different. |
| 381 | 56 | 11.22.6.4.3.3 | Equation (11-5a) is not labelled | Label line 9 so | Revised. Removed the reference to the equation by rewriting as:  “The Round Trip Time (RTT) is defined as  RTT = [(t4-t1) – (t3’-t2’)]” |
| 382 | 56 | 11.22.6.4.3.3 | "The TOA field's value" -- where is this field? No frame/element has been mentioned so far. Ditto TOD field below | Specify where these fields are. And move to the location reporting phase subclause | Revised.  Specified that those fields are in an LMR and included a reference to the LMR frame format in the preceding sentence as:  “The mechanism by which the ISTA derives t3’ and t2’ from the TOD and TOA fields of the relevant LMR (see section 9.6.7.37) are implementation dependent.” However, did not move the sentence to a different section since current section describes the measurement sounding phase and how those measurements are stored. |
| 41 | 54 | 11.22.6.4.3.2 | Do we need the NOTE in this section as it is included in prior section (i.e. general) | As per comment. | Accepted. Removed the note. |
| 170 | 54 | 11.22.6.4.3.2 | The normative behavior of ISTA and RSTA should refer to the UL MU behavior of 11ax STA and AP with only the new rules mentioned here. | Change the text per the comment. | Accepted. |
| 171 | 54 | 11.22.6.4.3.2 | the "shall" may not be possible given that the meidum is shared medium. | Change "shall" to "should" or change the sentence to " ...shall schedule an additional poll opportunity within the availability window and shall indicate that set More TF subfield to 1 in the TF Location Poll frame and the associated subsequent measurement and polling parts the other Trigger frames in the MU measurement to indicate that the additional TF Location Poll frame. will be scheduled in the measurement service period." | Revised. Re-worded the same as: “If the available bandwidth does not allow for the polling of all ISTAs assigned to this availability window using a single TF Location Poll, the RSTA shall attempt to schedule one or more extra polling/sounding/reporting triplets within the availability window.” |
| 359 | 54 | 11.22.6.4.3.2 | What's the difference between a "Position Measurement phase instance" and a "Position Measurement Phase" (Figure 11-35b)? | Clarify | Accept. Clarified by rewording the sentence as:  “The polling part is the first part of each polling/sounding/reporting triplet.”. |
| 360 | 54 | 11.22.6.4.3.2 | There are references to "Location Poll TF"/"TF Location Poll"/"TF Location Polling"/"TF Location Sounding"/"TF Location Sound" but what are these? Frames? | Change all instances of these to "Location Trigger frame". Also rationalise all the things of the form "TF with type Location and sub-type xyz" | Revised. We use the term Location TF everywhere. To talk about a particular variant of the Location TF we use “Location TF of subvariant xyz”. |
| 361 | 54 | 11.22.6.4.3.2 | "a Ranging Poll Response message" -- what is this? | Define this (I expect it's actually a frame) | Revised. Agreed in principle. Defined that it is a CTS-to-self frame as below:  “An ISTA shall request to participate in measurements in this availability window by responding to the TF Location Poll with a CTS-to-self in an S-MPDU its designated frequency allocation (see Figure 11-35c)..” |
| 362 | 54 | 11.22.6.4.3.2 | "in its designated time and frequency allocation as identified in the TF Location Polling SIFS time after the TF Location Polling frame" is just standard TF behaviour and should not be duplicated | Change to "in response to the Location Trigger frame" | Revised.  We need to specify because it is special behaviour for unassociate STAs. However, the text was modified to use 11ax terminology for RUs:  "in its designated RU allocation as identified in the TF Location Poll” |
| 363 | 54 | 11.22.6.4.3.2 | Why is this NOTE duplicated (except for the different xrefs)? | Delete one of the NOTEs, and make sure the xrefs are correct | Accepted. |
| 364 | 54 | 11.22.6.4.3.2 | "the RSTA shall schedule an additional poll opportunity within the availability window and shall indicate that in the TF Location Poll frame and the associated  subsequent measurement and polling parts. " -- how does the RSTA indicate this in the associated  subsequent measurement and polling parts? | Clarify. | Accepted. Clarified as below:  “If the available bandwidth does not allow for the polling of all ISTAs assigned to this availability window using a single TF Location Poll, the RSTA shall attempt to schedule one or more extra polling/sounding/reporting triplets within the availability window. The RSTA shall indicate the extra polling/sounding/reporting triplets by setting the More TF bit in the Common Info field to 1 and the RA field to the broadcast address in the TF Location Poll, and in TFs in subsequent polling, measurement sounding and measurement reporting parts in the same availability window.” |
| 530 | 54 | 11.22.6.4.3.2 | The RSTA centric scheduling shoud allow the timing measurement procedure initiated by an ISTA. |  | Revised.  The RSTA centric scheduling is always initiated by ISTA during the negotiation phase. |
| 508 | 54 | 11.22.6.4.3.2 | If the available bandwidth (#Ed) does not allow for the polling of all ISTAs served by this availability window, the RSTA shall schedule an additional poll opportunity within the availability window and shall indicate that in the TF Location Poll frame and the associated subsequent measurement and polling parts." The detailed signaling should be specified. | Specify the detailed signaling to schedule additional polling parts, etc. | Duplicate of CID 364. Accepted. Clarified as below:  “If the available bandwidth does not allow for the polling of all ISTAs assigned to this availability window using a single TF Location Poll, the RSTA shall attempt to schedule one or more extra polling/sounding/reporting triplets within the availability window. The RSTA shall indicate the extra polling/sounding/reporting triplets by setting the More TF bit in the Common Info field to 1 and the RA field to the broadcast address in the TF Location Poll, and in TFs in subsequent polling, measurement sounding and measurement reporting parts in the same availability window |
| 510 | 57 | 11.22.6.4.3.2 | "When ISTA supports delayed ISTA-to-RSTA LMR, if the ISTA-to-RSTA LMR for the previous availability window is not ready, the ISTA shall not response to the poll in the Hez polling part of the current availability window." In an ISTA negotiated a delayed iSTA-to-rSTA LMR, the rSTA should not poll the iSTA for the LMR transmission in the same Txop. | Modify the text to have a sensible | Revised.  Modify the text as below:  “If an ISTA negotiated delayed ISTA-to-RSTA LMR reporting, and if the TOA measurement for the previous availability window is not ready, then the ISTA shall not respond to the TF Location Poll in the polling part of any availability window until the ISTA-to-RSTA LMR is ready.” |

***TGaz Editor: replace Section 11.22.6.4.3 with the following revised text, changes relative to draft 0.5.4***

##### **11.22.6.4.3 Measurement Phase in TB Ranging**

11.22.6.4.3.1 General

TB Ranging is the dynamic trigger-based variant of the FTM procedure. The measurement phase of TB Ranging consists of one or more availability windows. The TB Ranging protocol is dynamic, as the actual number of ISTAs participating for measurement activities can vary across availability windows. This occurs as even though the availability windows are scheduled for range measurements, the ISTAs can dynamically decide which subset of these availability windows to frequent.

The availability windows are scheduled periodic time windows assigned to ISTAs during the negotiation phase. Within each availability window the RSTA and ISTAs shall only perform ranging activities related to polling, measurement sounding and measurement results reporting and group related scheduling indications. Each availability window consists by default of a single TXOP and can be extended to multiple TXOPs by announcement, if a single TXOP is insufficient to accommodate all ISTAs responding to the polling part (refer to sections 11.22.6.4.3.2 and 11.22.6.4.3.3).

Each availability window of the TB Ranging protocol consists of one or more triplets of sequential parts: polling part, measurement sounding part and measurement reporting part. Figure 11-35b shows an example of two availability windows, each composed of a single triplet of polling, measurement sounding and measurement reporting parts. An RSTA and ISTA participating in TB Ranging shall perform any measurement sounding and measurement results reporting activities only within the availability windows.



**Figure 11-35b – TB Ranging availability windows each with one instance of polling/sounding/reporting triplet**

Each availability window nominally contains a single poll, which should poll all ISTAs assigned to the availability window. If the available bandwidth is insufficient to allow for the polling of all ISTAs assigned to the availability window with one poll, the RSTA shall indicate that one or more extra polling/sounding/reporting triplets can be expected within the availability window (see example in Figure 11-35b1 and Figure 11-35b2). All instances of polling/sounding/reporting triplets must be completed before the end of the availability window

During the availability window, measurement resources and results are made available to each ISTA whose poll response was correctly received at the RSTA. This may also lead to extra instances of polling/sounding/reporting triplets, even if all ISTAs assigned to this availability window were polled in the first polling part instance (e.g., if the RSTA is not able to accommodate all ISTAs that responded in a single measurement sounding part instance; see Section 11.22.6.4.3.3).

Within each availability window, an RSTA shall use an AID or Ranging ID (RID) to identify an associated or unassociated ISTA respectively. The AID and RID assignment shall be non-conflicting and, shall have the same size and valid address space (as defined in sections 9.4.1.8 and 27.16.3). The RID usage shall follow the same rules as that of AIDs for HE operations. The RIDs are assigned to unassociated ISTAs during the FTM negotiation phase (refer to section 11.22.6.3).

An RSTA shall follow the usual rules defined in subclause 27.5.3 (UL MU Operation) when transmitting any Trigger frames of variant Location for TB Ranging with the following exceptions.

* An RSTA shall not transmit a Location variant Trigger frame as part of an A-MPDU.
* An RSTA shall not transmit a Location variant Trigger frame in a VHT MU PPDU or HE MU PPDU.

An ISTA shall follow the usual rules defined in subclause 27.5.3 (UL MU Operation) when transmitting any HE TB PPDUs for TB Ranging with the exception defined in subclause 11.22.6.4.2, 11.22.6.4.3 and 11.22.6.4.4.



**Figure 11-35b1 –TB Ranging availability window with two instances of polling/sounding/reporting triplets within a single TXOP.**



Figure 11-35b2 – TB Ranging availability window with two instances of polling/sounding/reporting triplets in separate TXOPs.

11.22.6.4.3.2 TB Ranging Polling Part

The polling part is the first part of each polling/sounding/reporting triplet.

At the beginning of each availability window the RSTA shall transmit a Location variant Trigger frame of subvariant TB Ranging Poll (“TF Location Poll”, see Section 9.3.1.23.9 Location Trigger variant). Any ISTA addressed by a User Info field in a TF Location Poll, can request to participate in measurements in this availability window by responding with a CTS-to-self in an S-MPDU in its designated RU allocation as identified in the TF Location Poll (see Figure 11-35c). In the CTS-to-self frame, the Duration/ID field is set to the value obtained from the Duration/ID field of the TF Location Poll that elicited the CTS-to-self frame minus the time, in microseconds, between the end of the PPDU carrying the Trigger frame and the end of the PPDU carrying the CTS-to-self frame.

If the available bandwidth does not allow for the polling of all ISTAs assigned to this availability window using a single TF Location Poll, the RSTA shall attempt to schedule one or more extra polling/sounding/reporting triplets within the availability window. The RSTA shall indicate the extra polling/sounding/reporting triplets by setting the More TF bit in the Common Info field to 1 and the RA field to the broadcast address in the TF Location Poll, and in TFs in subsequent polling, measurement sounding and measurement reporting parts in the same availability window. Any extra polling/sounding/reporting triplets can either be transmitted in the same TXOP (see example in Figure 11-35b1) or a new TXOP (see example in Figure 11-35b2) depending on the maximum allowed TXOP duration and the predicted length of the extra instances of polling/sounding/reporting triplets.



Figure 11-35c TB Ranging availability window with two ISTAs

11.22.6.4.3.3 TB Ranging Measurement Sounding Part

The measurement sounding part commences SIFS time after the polling part and is the second part of each polling/sounding/reporting triplet (see Figure 11-35c). The measurement sounding part consists of one or more Trigger frames of variant Location, subvariant TB Ranging Sounding (“TF Location Sounding”, see Section 9.3.1.23.9 Location variant) allocating uplink resources to one or more ISTAs (see Figure 11-35c and Figure 11-35c2). Each TF Location Sounding shall allocate uplink resources for one or more ISTA’s UL NDP multiplexed in the spatial stream domain.The frame format of the UL NDP is an HE TB Ranging NDP PPDU (see Section 28.3.17). SIFS time after receiving the last UL NDP, the RSTA shall transmit an NDP-A frame followed by a DL NDP sounding frame; the NDP-A is a Ranging NDP Announcement frame, see Section 9.3.1.19 and the DL NDP is an HE Ranging NDP PPDU, see Section 28.3.16. Figure 11-35c shows an availability window with an RSTA and two ISTAs (ISTA 1 and ISTA 4) responding to the poll. The TF Location Sounding allocates a separate spatial stream to each ISTA. The NDP-A is addressed to and the DL NDP is used by all ISTA taking part in the exchange.

The RSTA shall select one bandwidth value for the measurement sounding part based on the Format and Bandwidth subfield of the Ranging Parameters field(s) (see 9.4.2.278) provided by each of the ISTAs during negotiation. This bandwidth can be different from the bandwidth used in the polling part but needs to adhere to the rules of multiple frame transmission in an EDCA TXOP (see Section 10.22.2.7).

* The RSTA shall set the TXVECTOR parameter CH\_BANDWIDTH of the TF Location Sounding to that same bandwidth and use the same value for the BW subfield of the Common Info field of said TF.
* When transmitting the Ranging NDP-A and DL NDP frames, the RSTA shall set the TXVECTOR parameter CH\_BANDWIDTH to that same bandwidth.
* Any ISTA that transmits an UL NDP as a response to the TF Location Sounding, shall set the TXVECTOR parameter CH\_BANDWIDTH to the value defined in the BW subfield of the Common Info field of the soliciting TF.



Figure 11-35c2 TB Ranging availability window with multiple TF Location Sounding

The RSTA may schedule some ISTAs that replied during the polling part to the first measurement sounding part instance and other ISTAs to one of possibly multiple extra measurement sounding part instances (see Figure 11-35b1 and Figure 11-35b2). This is necessary, for example, if different ISTAs have indicated varying, incompatible Format and Bandwidth parameters in their Ranging Parameters fields or if the RSTA wants to limit the time duration of each range measurement sounding instance.

Both RSTA and ISTA perform TOF measurements by capturing the timestamps of the NDP frames. The ISTA records the time at which the UL NDP is transmitted (t1). The RSTA then captures the time at which the UL NDP arrives (t2) and records the time at which the DL NDP is transmitted (t3). The ISTA finally captures the time at which the DL NDP arrives (t4). See Figure 11-35d. The timestamp values t2 and t3 shall be measured according to the RSTA’s clock (i.e., without applying any frequency offset correction to the time basis).



Figure 11-35d Timing diagram of a Measurement Sounding part in TB Ranging

The Round Trip Time (RTT) is defined as

RTT = [(t4-t1) – (t3’-t2’)]

where t3’ and t2’ are the time at which the DL NDP was transmitted and the time at which the UL NDP was received, respectively, as converted by the ISTA from the RSTA’s time basis to its own time basis.

The mechanism by which the ISTA derives t3’ and t2’ from the TOD and TOA fields of the relevant LMR (see section 9.6.7.37) are implementation dependent.

The TOA field’s value contains a timestamp that represents the time, with respect to a time base, at which the start of the first HE-LTF of the associated NDP frame arrived at the receive antenna connector. The TOD field’s value contains a timestamp that represents the time, with respect to a time base, at which the start of the first HE-LTF of the associated NDP frame appeared at the transmit antenna connector.

If the measurement sounding part includes more than a single TF Location Sounding frame (see Figure 11-35c1), the ISTA and RSTA shall refer to the t1 and t2 of the UL NDP frame transmitted by that ISTA (see Figure 11-35e).



Figure 11-35e Measurement Sounding Part with UL TDMA Multiplexing

The UL power control, timing and frequency synchronization requirements of associated and unassociated STAs performing TB ranging shall follow the same rules as those of any associated HE STA .

11.22.6.4.3.4 TB Ranging Measurement Reporting Part

The last part of each polling/sounding/reporting triplet is the measurement reporting part, which appears SIFS time after the measurement sounding part (see Figure 11-35c). The measurement results shall be carried in LMR frames (see section 9.6.7.37 Location Measurement Report frame format). LMR frames shall carry measurement results from the RSTA to the ISTA, and if negotiated also from the ISTA to the RSTA (see Figure 11-35f). The feedback type of the ISTA-to-RSTA and RST-to-ISTA LMRs shall be either immediate (i.e., from the current availability window) or delayed (i.e., from the last availability window in which the ISTA responded to the TF Location Poll and the RSTA allocated resources to that ISTA during the measurement sounding part). The LMR feedback (immediate/delayed) is indicated by the RSTA during the negotiation phase (see Section 11.22.6.3.1 Range Measurement Negotiation).

Each LMR is a unicast frame. It is carried in Action No Ack frames (see 9.6.7.37) and are therefore neither acknowledged nor retransmitted.

All the ISTAs that were allocated resources in the preceeding measurement sounding part receive an HE MU PPDU containing the RSTA-to-ISTA LMRs. If ISTA-to-RSTA LMR was negotiated, the RSTA shall assign UL resources to the ISTAs using a Trigger frame of variant Location, subvariant TB Ranging LMR (“TF Location LMR”, see Section 9.3.1.23.9 Location Trigger variant).

A TB Ranging measurement repoting part including the optional ISTA-to-RSTA LMR is illustrated in Figure 11-35f. If the ISTA-to-RSTA LMR was negotiated by one or more ISTAs, then SIFS time after sending out the RSTA-to-ISTA LMR, the RSTA transmits a TF Location LMR to solicit the ISTA-to-RSTA LMR frame(s). This TF shall allocate uplink resources to ISTAs that negotiated ISTA-to-RSTA LMR and were allocated resources in the preceding measurement sounding part. In response to the TF, each addressed ISTA shall respond by transmitting an ISTA-to-RSTA LMR frame. If an ISTA negotiated delayed ISTA-to-RSTA LMR reporting, and if the TOA measurement for the previous availability window is not ready, then the ISTA shall not respond to the TF Location Poll in the polling part of any availability window until the ISTA-to-RSTA LMR is ready.



Figure 11-35f TB Ranging measurement reporting part with Bidirectional LMR Feedback for n ISTA

If the PHY of an RSTA issues a PHY-RXEND.indication (*IntegrityCheckError*) primitive, the RSTA shall set the Invalid Measurement field in the RSTA-to-ISTA LMR frame carrying the TOA measured from the UL NDP to 1. Similarly, if ISTA-to-RSTA LMR was negotiated between the ISTA and RSTA and the PHY of an ISTA issues a PHY-RXEND.indication (*IntegrityCheckError*) primitive, the ISTA shall set the Invalid Measurement field in the ISTA-to-RSTA LMR carrying the TOA measured from the DL NDP to 1.

If ISTA-to-RSTA LMR reporting was negotiated, then the ISTA shall include a CFO parameter in the ISTA-to-RSTA LMR (See 9.6.7.37 Location Measurement Report frame format). The ISTA shall estimate the CFO parameter based on the PPDU carrying the TF Location Sounding that solicits the UL NDP from the ISTA. The RSTA may account for clock rate differences between ISTA and RSTA based on the CFO parameter included in the received ISTA-to-RSTA LMR. The mechanism by which t4 and t1 are adjusted by the RSTA is implementation specific. The CFO parameter refers to the t1 and t4 indicated in the same ISTA-to-RSTA LMR.

If the Invalid Measurement field in an RSTA-to-ISTA LMR or ISTA-to-RSTA LMR is set to 1, the RSTA or ISTA receiving the LMR should discard the TOA carried in the LMR.