Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Correction of U-TDOA Measurement Procedure**
Date Submitted	**2007-01-04**
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Re:	Contribution on comments to IEEE 802.16g/D6
Abstract	Correction of U-TDOA Measurement Procedure
Purpose	Adoption
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Correction of U-TDOA Measurement Procedure

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ETRI

1. Motivation

The U-TDOA measurement algorithm introduced in the current draft is based on the ranging mechanism as defined in IEEE 802.16 standard. For the reliable measurement, there should be no collision during ranging between MS and BS.

For association during scanning, Serving BS can coordinate the dedicated ranging between MS and non-serving BS, and BS also can assign dedicated ranging region for MSs which perform location update in Idle mode or perform network re-entry from Idle mode. However, there is no way for the serving BS to allocate MS any dedicated region for dedicated ranging between the MS and the Serving BS

This contribution proposes an optional dedicated ranging mechanism for the U-TDOA measurement algorithm.

2. Proposed Text Changes

[***Insert new subclause 6.3.10.3.4***]

6.3.10.3.4 Dedicated ranging and automatic adjustments

A dedicated ranging is an optional initial ranging which can be used to expedite ranging process when the ranging is performed as an initial step of a certain procedure such as location determination, coordinated association during scanning, location update in idle mode, etc. For a dedicated ranging, BS will provide dedicated ranging information and allocate the dedicated ranging region at a pre-defined "rendezvous time", in terms of relative frame number. The BS will also assign:

- A unique code number (from within the initial ranging codeset)
- A transmission opportunity within the allocated region (in terms of offset from the start of the region)

The BS may assign the same code or transmission opportunity to more than one MS, but not both. In case all allocated transmission opportunities in current region are different, there is no potential for collision of transmissions from different MSs. In case the BS allocates the same transmission opportunity to several MSs, there is some probability of collision and then BS may fail to identify transmitted codes.

The BS will provide the dedicated ranging information via MAC management messages which are different according to the procedures for which the dedicated ranging is used.

When the "Dedicated ranging indicator" is set to 1, the ranging region will be allocated via UIUC=12 in the UL-MAP.

When "Dedicated ranging indicator" is set to 1, then the ranging region and ranging method defined could be used for the purpose of ranging using dedicated CDMA code and transmit opportunity assigned in the unsolicited RNG-RSP message (for location determination of MS), the MOB_PAG-ADV message (for location update in idle mode) or in the MOB_SCN-RSP message (for coordinated association).

MSs registered to this BS are prohibited from use of the named ranging region.

Upon receiving one of aforementioned messages which include the dedicated ranging information, the MS should interpret the provided rendezvous time, dedicated code, and transmission opportunity as follows:

- "Rendezvous time" specified the frame in which the BS will transmit a UL-MAP containing the definition of the dedicated ranging region where the MS can use the assigned CDMA ranging code. "Rendezvous time" is provided in units of frames, beginning at the frame where the MAC management message which includes the dedicated ranging information is transmitted.
- The MS shall read the UL-MAP transmitted at the first frame immediately following the rendezvous time and extract the description of the dedicated ranging region (ranging region with "Dedicated ranging indicator" bit set to 1). The MS shall determine the specific region it should use for transmission of the dedicated CDMA code by applying the offset defined by the "transmission opportunity offset" field in the management message, which was received from the BS, to the dedicated ranging region definition in the UL-MAP of the BS. In case the BS decides to provide a regular (non-dedicated) ranging region with "Dedicated ranging indicator" set to 0, the MS may transmit the allocated CDMA code in the regular ranging region.
- If the MS could not obtain UL-MAP at the first frame immediately following the rendezvous time, it shall abort the dedicated ranging process. The MS may perform a contention-based ranging process as described in 6.3.10.3.1.

When BS sends an unsolicited RNG-RSP message for the location determination of MS, "Power Level Adjust" field may be included in the RNG-RSP message. In this case, the MS shall send a CDMA code with the transmission power which is adjusted with the received value of "Power Level Adjust" field.

In case of dedicated ranging for location determination, BS may not send RNG-RSP message in response to the CDMA code sent by MS.

[***Change the second paragraph on the page 362 of IEEE Std 802.16e-2005 (8.4.4.5)***]

The BS shall not allocate more than three ranging allocation IEs (UIUC 12) per frame, one for initial ranging/handover ranging (Dedicated ranging indicator bit in UL-MAP IE is set to 0 and Ranging Method is set to 0b00 or 0b01), one for bandwidth request/periodic ranging (Dedicated ranging indicator bit in UL-MAP IE is set to 0 and Ranging Method is set to 0b10 or 0b11), and one for initial ranging for the paged MS, location measurement and/or coordinated association (Dedicated ranging indicator bit in UL-MAP IE is set to 1).

[***Change "Dedicated ranging indicator" row of Table 287 in IEEE Std 802.16e-2005 as follows***]

Syntax	Size	Notes
~~Reserved~~Dedicated ranging indicator	1 bit	~~Shall be set to zero~~ 0: the OFDMA region and Ranging Method defined

		are used for the purpose of normal ranging 1: the OFDMA region and Ranging Method defined are used for the purpose of ranging using dedicated CDMA code and transmission opportunities assigned in the MOB_PAG-ADV message, in the RNG-RSP message or in the MOB_SCN-RSP message

[*Add the following rows to the end of Table 367*]

Name	Type (1byte)	Length	Value (variable-length)	PHY Scope
Rendezvous time	36	1	This is offset, measured in units of frame duration, when the BS is expected to provide non-contention-based ranging opportunity for the MS. The offset is calculated from the frame where RNG-RSP message is transmitted. The BS is expected to provide non-contention-based Ranging opportunity at the frame specified by Rendezvous time parameter.	OFDMA
CDMA code	37	1	A unique code assigned to the MS, to be used for dedicated ranging. Code is from the initial ranging codeset.	OFDMA
Transmission opportunity offset	38	1	A unique transmission opportunity assigned to the MS, to be used for dedicated ranging in units of symbol duration.	OFDMA

[*Modify Annex G as follow*]

Annex G U-TDOA measurement

Annex G describes the U-TDOA measurement for networks based on FRF (Frequency Reuse Factor) > 1 (e.g. 1X3X3), and FRF = 1 (e.g. 1X3X1 or 1X1X1). Figure ~~H~~G1 shows a diagram for U-TDOA measurement.

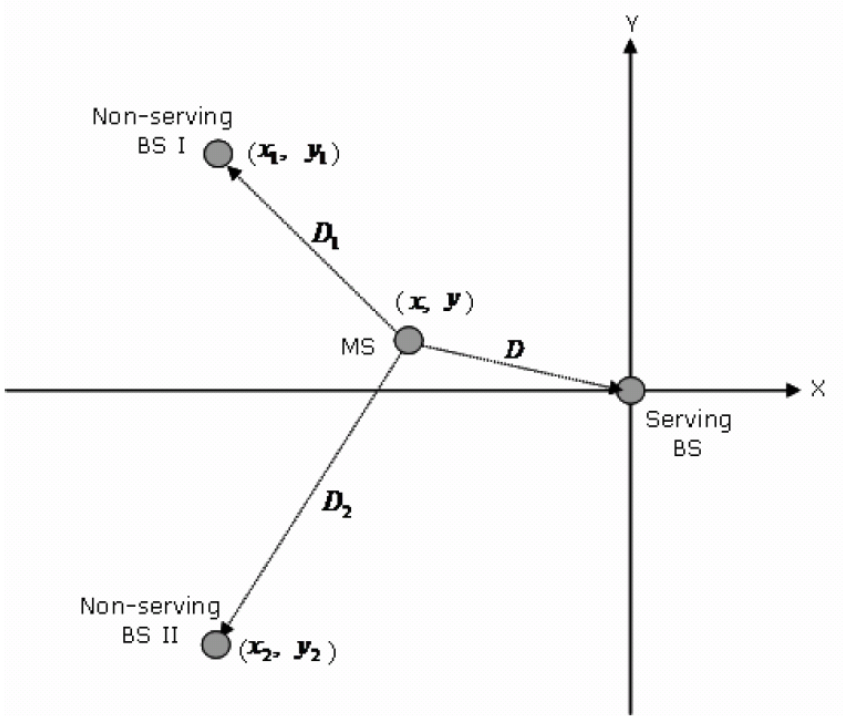


Figure G1 – Network Diagram for U-TDOA Measurement

The U-TDOA measurement algorithm is based on the ranging mechanism as defined in IEEE 802.16 standard. It should be noted that the ranging capability was designed for MS to synchronized with BS in terms of time and frequency, and may not provide sufficient accuracy for LBS applications, such as E911 Phase II. It is recommended that the Automatic Timing Correction (ATC) algorithm in the BS should use better resolution (e.g. in the increments of 50ns or 25ns) than what is required for the timing adjustment increments of the ranging procedure.

G.1 FRF > 1

Figure G2 shows the timing diagram of U-TDOA measurement. t_1 is the Timing Advance. t_2 and t_3 are the intervals between the time of burst arrival and the beginning of granted slot for Serving BS and Non-serving BS 1 respectively. t_2 and t_3 are also the Timing Adjustments that BS will ask MS to adjust the timing advance when transmitting the next UL burst. BS calculates t_2 and t_3 during the ranging process.

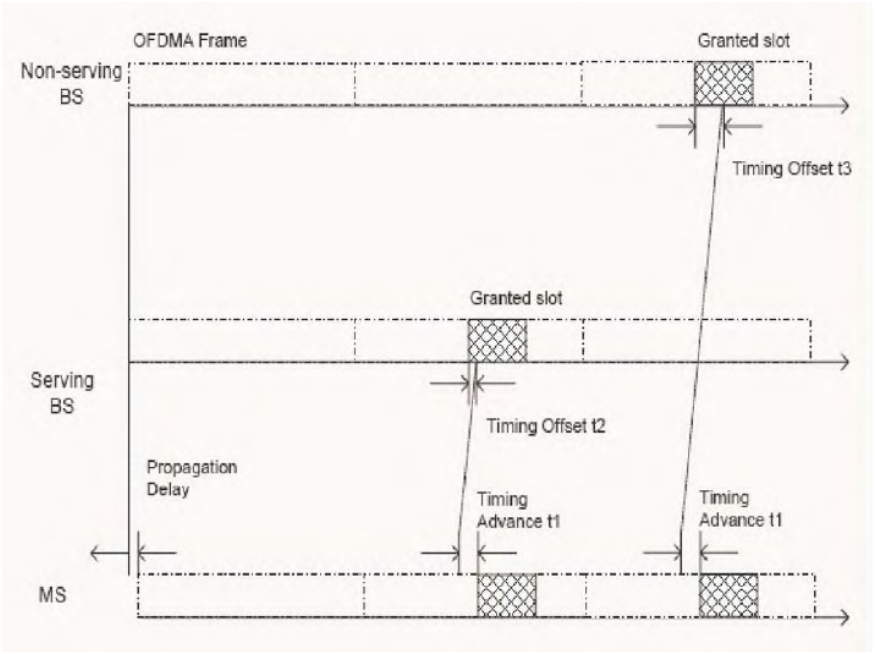


Figure G2 – U-TDOA Measurement Timing Diagram

The propagation delay for serving BS and non-serving BS 1 can be derived from the equation below, assuming the frames of serving BS and non serving BS are synchronized. The sum of timing adjustment and timing advance equals to two times of MS to BS propagation delay. The propagation delay for non-serving BS II can be obtained from the same approach.

Propagation delay MS → Serving BS $\frac{D}{C} \quad \frac{(t_1 \quad t_2)}{2}$ (1)

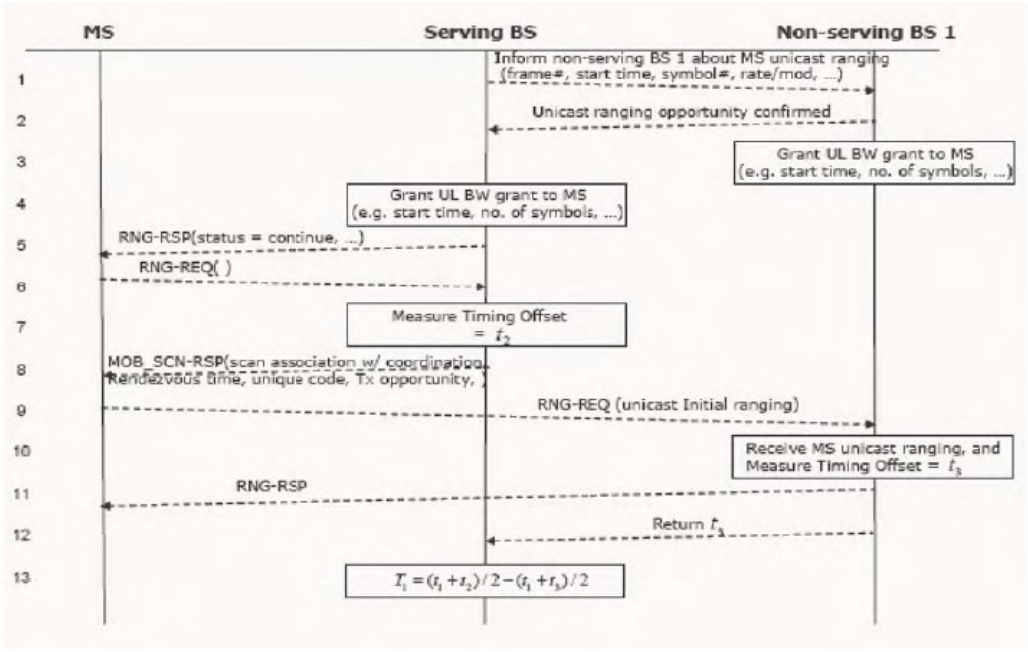
Propagation delay MS → non Serving BS $\frac{D_1}{C} \quad \frac{(t_1 \quad t_3)}{2}$ (2)

Therefore, TDOA T_1 can be shown as follows:

$$T_1 \quad \frac{(t_1 \quad t_2)}{2} \quad \frac{(t_1 \quad t_3)}{2} \qquad (3)$$

Figure G3 shows the U-TDOA measurement algorithm that includes a non-serving BS. The algorithm can be duplicated to support additional non-serving BS. Here are the assumptions for the algorithm.

•The neighboring sectors of serving BS and non-serving BS are operating on the different band.
•Serving BS and non-serving BS are operating on the same frame duration
•The frames in both serving BS and non-serving BS are synchronized
•MS can communicates with both serving BS and non-serving BS



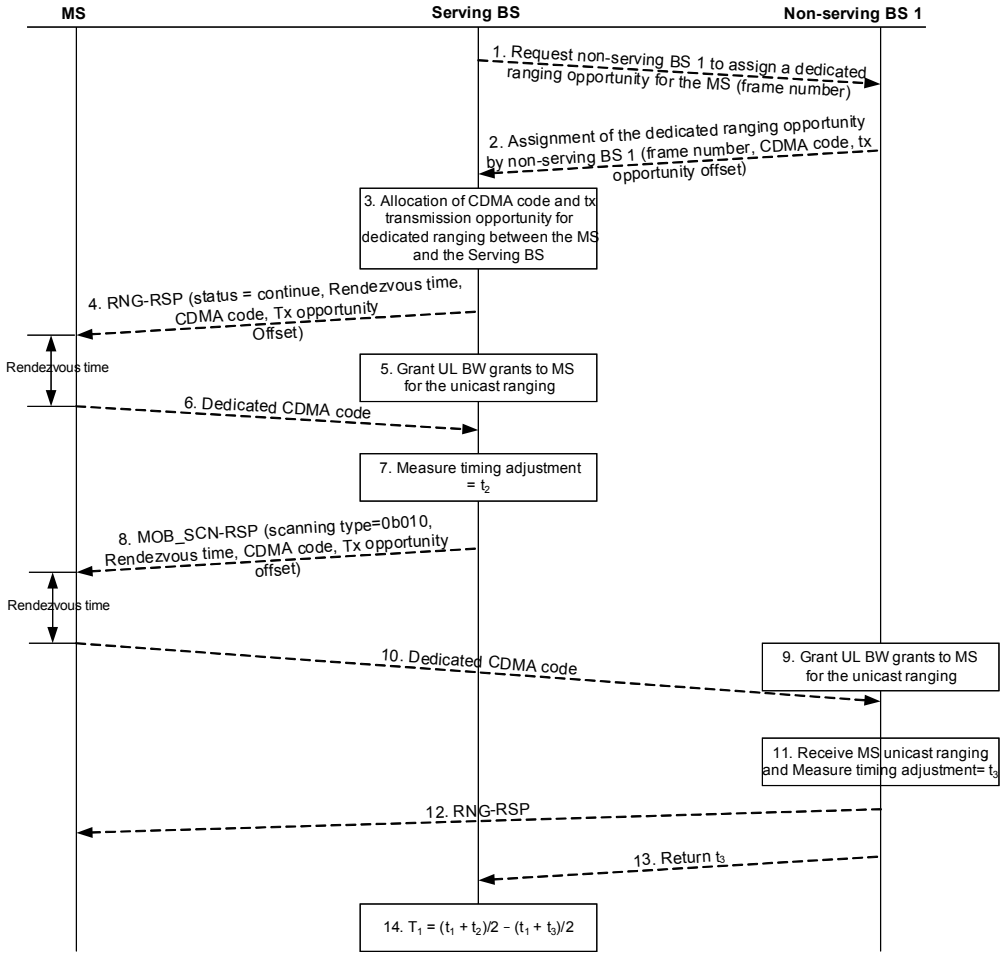


Figure G3 – UTDOA Measurement Algorithm

1. ~~Serving BS informs non-serving BS 1 about MS is going to do unicast ranging by passing frame number, start time, number of symbols,~~
2. ~~Non-serving BS 1 confirms unicast ranging opportunity for MS~~
3. ~~Non-serving BS 1 grant such UL slot to the MS~~
4. ~~Serving BS allocates a UL slot for MS to do unicast ranging.~~

5. ~~Serving BS sends an autonomous RNG-RSP message to ask MS performing unicast ranging~~
6. ~~When MS receives the RNG-RSP from serving BS, it shall send RNG-REQ at the assigned slot~~
7. ~~Serving BS 1 measures Timing Adjustment t_2~~
8. ~~Serving BS sends autonomous MON_SCN-RSP with scanning type = 0b10 (scan association with coordination) to force MS performing initial ranging after scan~~
9. ~~MS synchronized with non-serving BS 1, and sends RNG-REQ~~
10. ~~Non-serving BS 1 receives unicast ranging, and measures Timing Adjustment t_3~~
11. ~~Non-serving BS returns RNG-RSP to MS~~
12. ~~Non-serving BS returns t_3 to serving BS~~
13. ~~Serving BS reads the Timing Advance t_1 that was captured previously, and calculate U-TDOA~~
    1. Serving BS requests non-serving BS 1 to assign the dedicated ranging opportunity for the MS.
    2. Non-serving BS 1 confirms the allocation of the dedicated ranging opportunity for the MS and returns the related parameters used for dedicated ranging between the MS and the non-serving BS 1.
       - Frame Number
       - CDMA code
       - Transmission opportunity offset
    3. Serving BS allocates a CDMA code and transmission opportunity for dedicated ranging between the MS and the Serving BS.
    4. Serving BS sends an autonomous RNG-RSP message to ask MS performing dedicated ranging. The dedicated ranging information for dedicated ranging between the MS and the Serving BS is included in RNG-RSP message.
       - Rendezvous time
       - CDMA code
       - Transmission opportunity offset
    5. Serving BS allocates a UL slot for MS to do dedicated ranging which means “dedicated ranging indicator” bit of the UL-MAP IE shall be set to 1.
    6. After the rendezvous time from the reception of the RNG-RSP message, MS sends the CDMA code assigned in the RNG-RSP message at the allocated transmission opportunity offset.
    7. Serving BS measures Timing Adjustment t_2
    8. Serving BS sends autonomous MOB_SCN-RSP with scanning type = 0b10 (scan association with coordination) to force MS performing initial ranging after scan. The related parameters assigned by non-serving BS 1 are included in the MOB_SCN-RSP message.
       - Rendezvous time
       - CDMA code
       - Transmission opportunity offset
    9. Non-serving BS 1 grants UL slot to the MS and sets “dedicated ranging indicator” bit of the UL-MAP IE to 1 to use the allocated region for the purpose of dedicated ranging.
    10. After the rendezvous time from the reception of the MOB_SCN-RSP, MS synchronized with non-serving BS 1, and sends the allocated CDMA code at the allocated transmission opportunity offset.
    11. Non-serving BS 1 receives the assigned CDMA code, and measures Timing Adjustment t_3.
    12. Non-serving BS 1 returns RNG-RSP to MS
    13. Non-serving BS 1 returns t_3 to serving BS
    14. Serving BS reads the Timing Advance t_1 that was captured previously, and calculate U-TDOA

$$T_1 \quad \frac{(t_1 \quad t_2)}{2} \quad \frac{(t_1 \quad t_3)}{2}$$

G2 FRF = 1

Figure G4 shows the timing diagram of U-TDOA measurement. ~~is the~~ t_1 is the Timing Advance. t_2 and t_3 are the intervals between the time of burst arrival and the beginning of granted slot for Serving BS

and Non-serving BS 1 respectively. t_2 and t_3 are also the Timing Adjustments that BS will ask MS to adjust the timing advance when transmitting the next UL burst. BS calculates t_2 and t_3 during the ranging process.

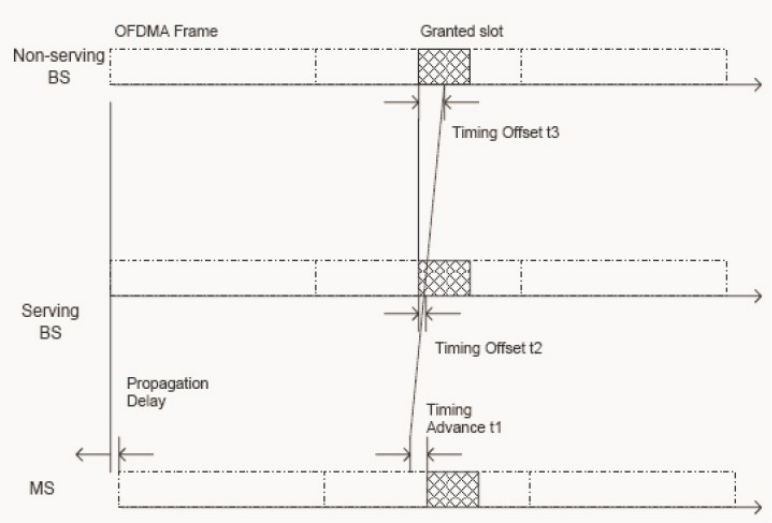


Figure G4 – U-TDOA Measurement Timing Diagram

The propagation delay for serving BS and non-serving BS 1 can be derived from the equation below, assuming the frames of serving BS and non serving BS are synchronized. The sum of timing adjustment and timing advance equals to two times of MS to BS propagation delay. The propagation delay for non-serving BS II can be obtained from the same approach.

Propagation delay MS → Serving BS $\frac{D}{C} \quad \frac{(t_1 \quad t_2)}{2}$ (6)

Propagation delay MS → non Serving BS $\frac{D_1}{C} \quad \frac{(t_1 \quad t_3)}{2}$ (7)

Therefore, TDOA T_1 can be shown as follows:

$$T_1 \quad \frac{(t_1 \quad t_2)}{2} \quad \frac{(t_1 \quad t_3)}{2} \qquad (8)$$

Figure G5 shows the U-TDOA measurement algorithm that includes a non-serving BS. The algorithm can be duplicated to support additional non-serving BS. Here are the assumptions for the algorithm.

•Serving BS and non-serving BS are operating on the same band (Frequency reuse = 1)
•Serving BS and non-serving BS are operating on the same frame duration
•The frames in both serving BS and non-serving BS are synchronized
•MS can communicates with both serving BS and non-serving BS

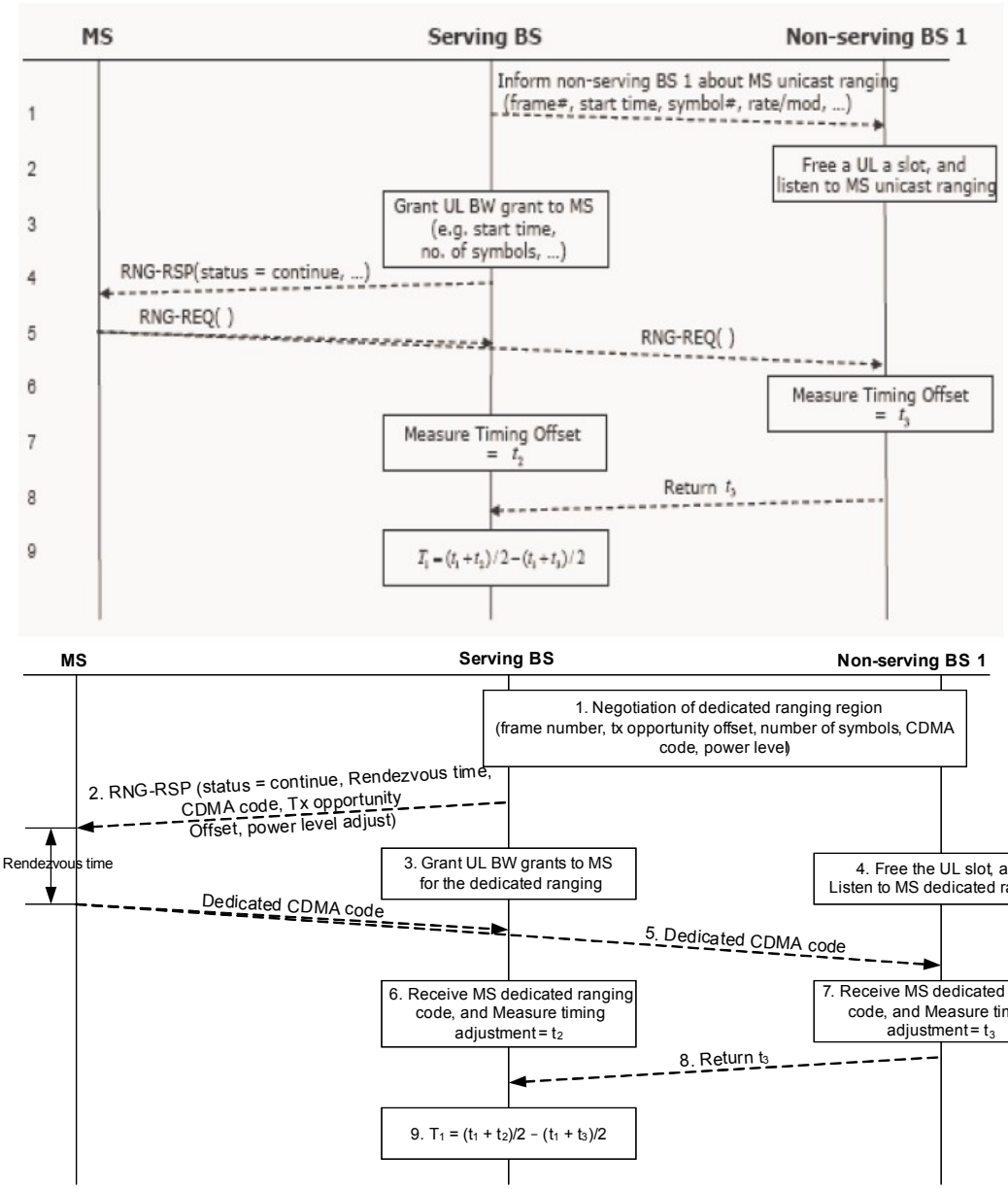


Figure G5 – U-TDOA Measurement Algorithm

1. ~~Serving BS informs non-serving BS 1 about MS is going to do unicast ranging by passing frame number, start time, number of symbols,~~
2. ~~Non-serving BS 1 does not grant such UL slot to the MS, and listens to the unicast ranging from MS~~
3. ~~Serving BS allocates a UL slot for MS to do unicast ranging.~~
4. ~~Serving BS sends an autonomous RNG-RSP message to ask MS performing unicast ranging~~
5. ~~When MS receives the RNG-RSP from serving BS, it shall send RNG-REQ at the assigned slot that can be received by non-serving BS.~~
6. ~~Non-serving BS 1 measures Timing Adjustment t_3~~
7. ~~Serving BS measures Timing Adjustment t_2~~
8. ~~Non-serving BS 1 returns t_3 to serving BS~~
9. ~~Serving BS reads the Timing Advance that was captured previously, and calculates U-TDOA~~

1. Serving BS and non-serving BS 1 negotiate the allocation of a dedicated ranging region for the MS.
   - Frame Number
   - Transmission opportunity offset

- Number of Symbols
- CDMA code
- Power Level

2. The serving BS sends an unsolicited RNG-RSP message to ask MS performing the dedicated ranging. The dedicated ranging information is included in the RNG-RSP message.
   - Rendezvous time
   - CDMA code
   - Transmission opportunity offset
3. The serving BS allocates a UL slot for MS to do dedicated ranging at the pre-assigned rendezvous time and listens to the dedicated ranging code from the MS.
4. At the same time, the non-serving BS 1 does not grant such UL slot to any MSs at the pre-assigned rendezvous time and listens to the dedicated ranging code from the MS.
5. When the MS receives the unsolicited RNG-RSP from the serving BS, it shall send the dedicated CDMA code at the assigned slot. The transmission power shall be changed based on the power level adjust parameter included in the receive RNG-RSP message to allow the non-serving BS to receive the code successfully.
6. The non-serving BS 1 measures Timing Adjustment t_3
7. The serving BS measures Timing Adjustment t_2
8. The non-serving BS 1 returns t_3 to serving BS
9. The serving BS reads the Timing Advance that was captured previously, and calculates U-TDOA

$$T_1 \quad \frac{(t_1 \quad t_2)}{2} \quad \frac{(t_1 \quad t_3)}{2}$$