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Correction of U-TDOA Measurement Procedure

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ETRI

1. Motivation

In the current draft, two U-TDOA measurement algorithms are introduced in Annex G and they are used to measure the difference of time arrival for packet transmission between a MS and multiple BSs. The main idea of U-TDOA measurement algorithm is to use the unicast ranging procedure and scan association with coordination for measuring time difference.

The dedicated ranging procedure and scan association with coordination are defined only for OFDMA system. According to the dedicated ranging procedure during scanning defined in 802.16e-2005 standard, serving BS allocates a unique CDMA code and a dedicated ranging region using MOB_SCN-RSP message, and MS transmits the allocated CDMA code at the allocated ranging region. In the current draft, however, MS sends RNG-REQ message for initial ranging instead of CDMA code.

More critical problem is that there is no way for the serving BS to allocate a unicast ranging region to a MS. The reason why the allocation of unicast ranging region is impossible is as follows:

- An unsolicited RNG-RSP is defined only for periodic ranging.
- If the dedicated ranging indicator in initial ranging IE() is not set to 1, other MSs may send a CDMA code. In that case, the serving BS can't know who sends which CDMA code.
- Even though dedicated ranging indicator in initial ranging IE() is set to 1, the MS doesn't know the region is allocated to itself, so it doesn't send a CDMA code.

Therefore, U-TDOA measurement algorithms need to be modified and refined based on OFDMA-based ranging procedure.

2. Proposed Text Changes

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

6.3.10.3.4 unicast ranging and automatic adjustments

A BS that wishes to determine MS location may send an unsolicited RNG-RSP message with continue status to ask the MS to perform unicast ranging. For unicast ranging, BS will provide a ranging region at a predefined "rendezvous time", in terms of relative frame number. The BS also assigns

- 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 will provide the pre-assigned ranging information via the RNG-RSP message. If "power level adjust" TLV is included in an unsolicited RNG-RSP, MS shall change the transmission power according to the "power level adjust" TLV when it sends a CDMA code.

The ranging region will be allocated via UIUC=12 in the UL-MAP and the "dedicated ranging indicator" will be set to 1.

If the MS finds the ranging region with dedicated ranging indicator = 1 at the pre-assigned rendezvous time, the MS shall perform unicast ranging using the dedicated CDMA code and transmit opportunity offset assigned in the RNG-RSP message. If the MS can't find the unicast ranging region at the pre-assigned rendezvous time, the MS shall disregard the received RNG-RSP message.

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

[***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 unicast 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 unicast ranging in units of symbol duration.	OFDMA

[*Modify Annex G as follow*]

Annex G U-TDOA measurement

Annex ~~H~~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.1~~G1 shows a diagram for U-TDOA measurement.

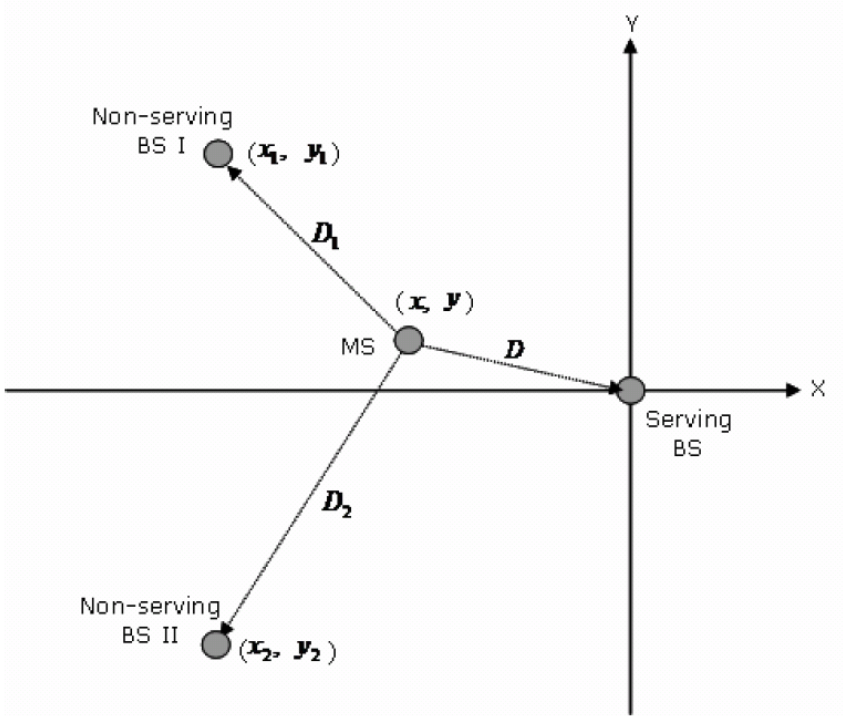

Figure G1 – Network Diagram for U-TDOA Measurement

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.

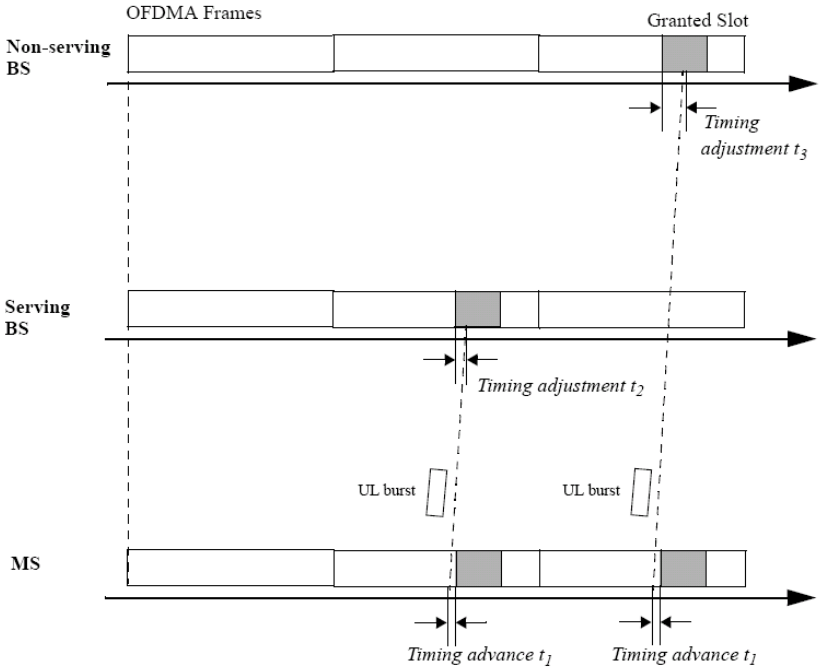

Figure G2 – U-TDOA Measurement Timing Diagram

The propagation delay for serving BS and non-serving BS I can be derived from the equation below, assuming the frames of serving BS and non serving BS are synchronized. The U-TDOA can be measured even before the MS is successfully ranged. The propagation delay for non-serving BS II can be obtained from the same approach.

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

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

Therefore, TDOA can be shown as follows:

$$T_1 \quad (t_1 \quad t_2) \quad (t_1 \quad t_3) \qquad (3)$$

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

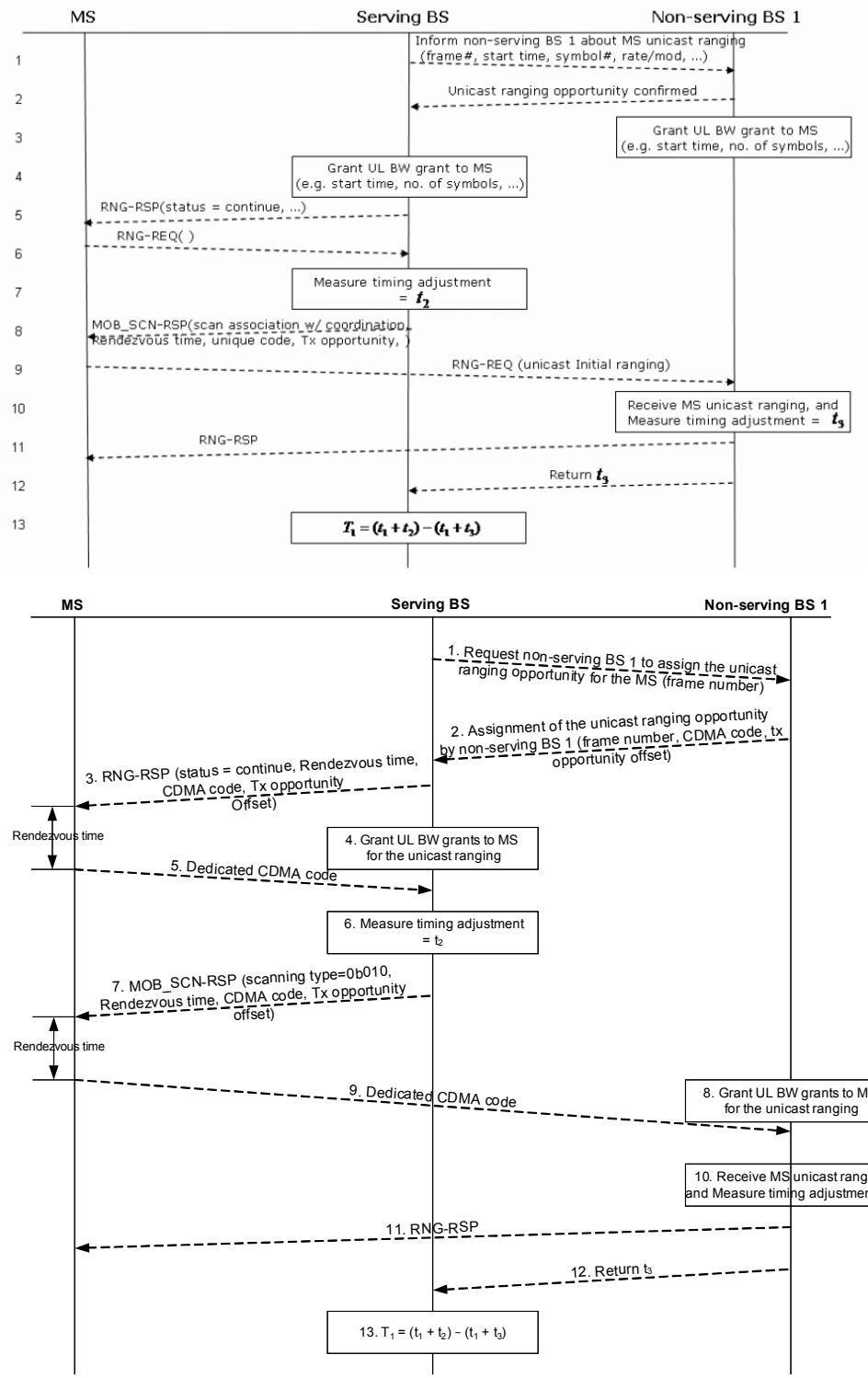

Figure G3 – UTDOA Measurement Algorithm

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 unicast ranging opportunity for the MS.
2. Non-serving BS 1 confirms the allocation of the unicast ranging opportunity for the MS and returns the related parameters
   - Frame number
   - CDMA code
   - Transmission opportunity offset
3. Serving BS sends an autonomous RNG-RSP message to ask MS performing unicast ranging. The unicast ranging information is included in RNG-RSP message.
   - Rendezvous time
   - CDMA code
   - Transmission opportunity offset
4. Serving BS allocates a UL slot for MS to do unicast ranging which means "dedicated ranging indicator" bit of the UL-MAP IE shall be set to 1.
5. When MS receives the RNG-RSP from serving BS, it shall send the allocated CDMA code at the assigned slot.
6. Serving BS 1 measures Timing Adjustment t_2
7. Serving BS sends autonomous MOB_SCN-RSP with scanning type = 0b10 (scan association with coordination) to force MS performing initial ranging after scan.
   - Rendezvous time
   - CDMA code
   - Transmission opportunity offset
8. 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 unicast ranging.
9. 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.
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

$$T_1 \quad (t_1 \quad t_2) \quad (t_1 \quad t_3)$$

G2 FRF = 1

Figure ~~I.4~~ 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.

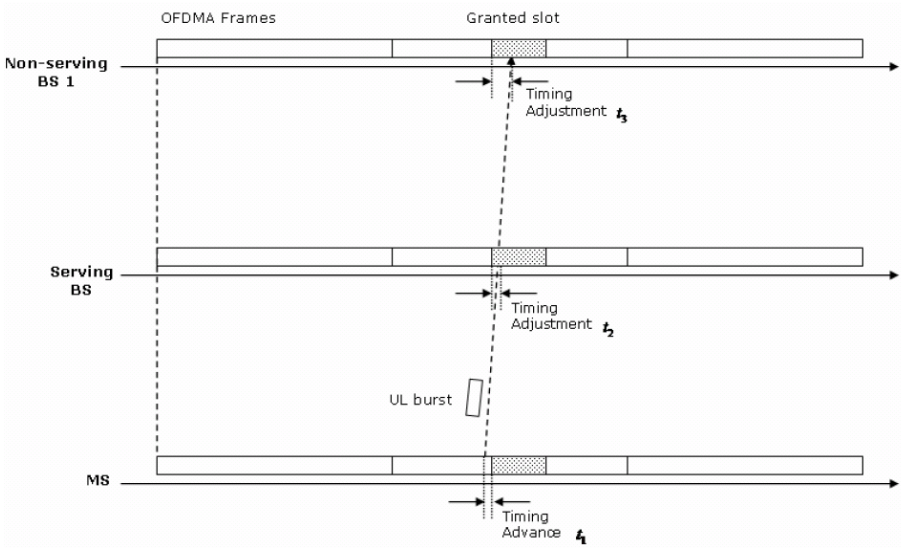

Figure G4 – U-TDOA Measurement Timing Diagram

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 U-TDOA can be measured even before the MS is successfully ranged. The propagation delay for non-serving BS II can be obtained from the same approach.

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

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

Therefore, TDOA can be shown as follows:

$$T_1 \quad (t_1 \quad t_2) \quad (t_1 \quad t_3) \qquad (8)$$

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

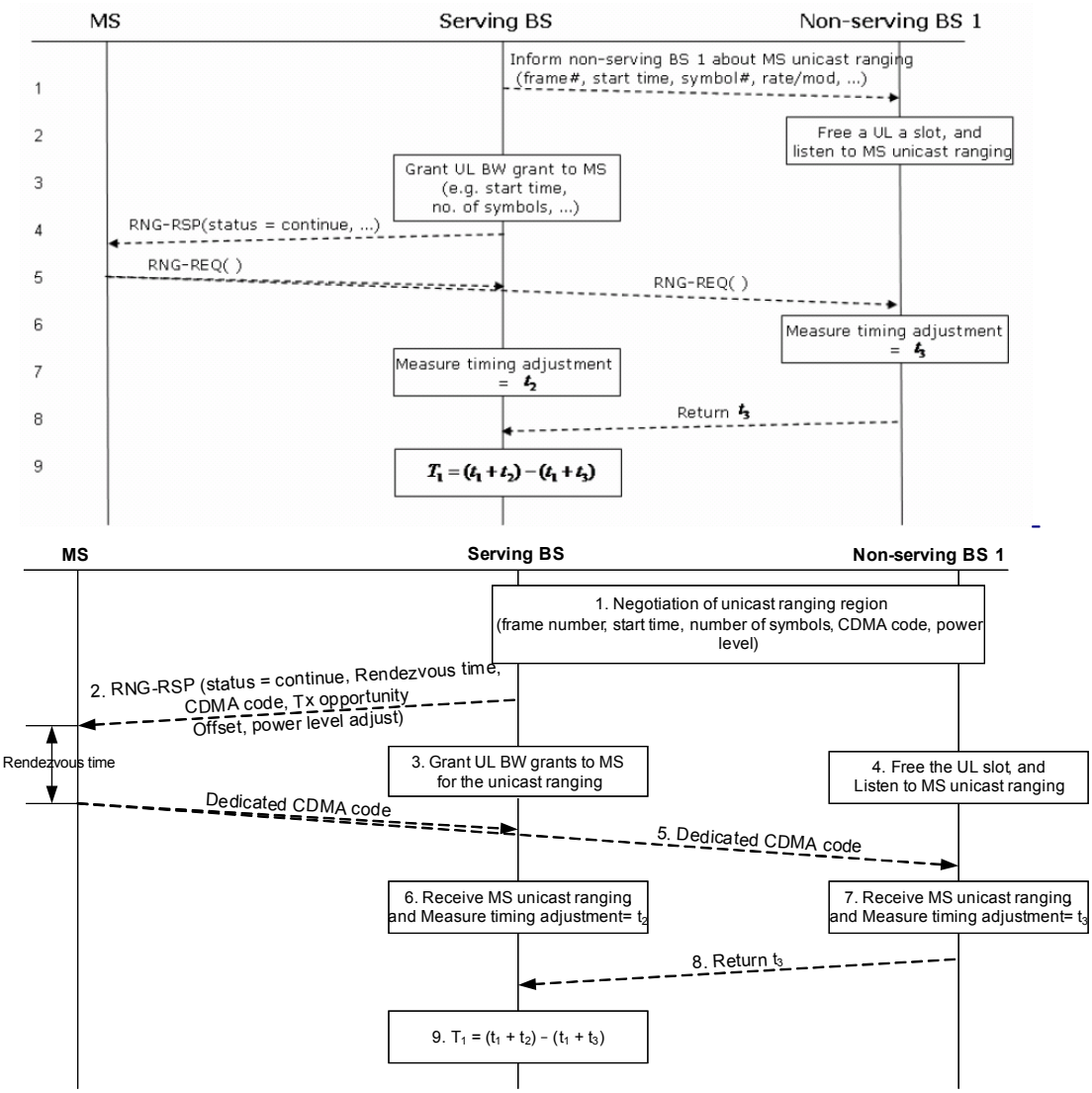

Figure G5 – U-TDOA Measurement Algorithm

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 the unicast ranging region for the MS.
   - Frame Number
   - Number of symbols
   - CDMA code
   - Power level

2. The serving BS sends an unsolicited RNG-RSP message to ask MS performing the unicast ranging. The unicast 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 unicast ranging at the pre-assigned rendezvous time and listens to the unicast ranging 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 unicast ranging 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