3GPP TSG-RAN WG1 Meeting #102-e***R1-20xxxxx***

e-Meeting, August 17 – 28, 2020

**Agenda item:** 7.2.8

**Source:** Moderator **(**Qualcomm Incorporated)

**Title:** Summary of Email Discussion [102-e-NR-Pos-03] NR positioning measurements

**Document for:**  Discussion and Decision

# 1. Introduction

This document summarizes the following email discussion:

[102-e-NR-Pos-03] Email discussion/approval on NR positioning measurements focusing on aspects 24, 25 and 27 in the FL summary [0] until 8/20; if necessary, endorse remaining TPs by 8/26 – Sven (Qualcomm)

The FL summary is provided in [0]:

Aspect #24: Timing Quality

Aspect #25: RTOA Definition

Aspect #27: Positioning Node Terminology

[0] R1-2006996, "Summary of Remaining Issues for NR Positioning".

[1] R1-2005357, "Remaining issues on DL RS for NR positioning", vivo.

[2] R1-2005358, "Remaining issues on physical layer procedure for NR positioning", vivo.

[3] R1-2005452, "Maintenance of NR positioning", ZTE.

[4] R1-2005681, "Remaining issues on DL PRS and measurements for NR Positioning", CATT.

[5] R1-2005682, "Remaining issues on UL SRS and UL procedures for NR Positioning" , CATT.

[6] R1-2005780, "Discussion on QCL for PRS", ZTE.

[7] R1-2005795, "NR positioning corrections", Huawei, HiSilicon.

[8] R1-2005806, "RAN1 inputs to RAN3 on SRS support", Huawei, HiSilicon.

[9] R1-2005978, "Remaining Issues on measurements and procedure for NR Positioning", OPPO.

[10] R1-2005979, "Remaining Issues on RS for Positioning", OPPO.

[11] R1-2006120, "On remaining issues for Rel.16 positioning", Samsung.

[12] R1-2006199, "Remaining issues on DL PRS processing order", CMCC.

[13] R1-2006372, "Discussion on remaining issues on simultaneous SRS transmission and PRS processing priority for NR positioning", LG Electronics.

[14] R1-2006373, "Discussion on remaining issues on QCL and spatial relation information for NR positioning", LG Electronics.

[15] R1-2006425, "Maintenance on measurements for NR positioning", Nokia, Nokia Shanghai Bell.

[16] R1-2006426, "Priority of Assistance Data", Nokia, Nokia Shanghai Bell.

[17] R1-2006784, "Maintenance on DL Reference Signals for NR Positioning", Qualcomm Incorporated.

[18] R1-2006911, "Maintenance of rel16 reference signals for NR positioning" , Ericsson.

[19] R1-2006912, "Maintenance of rel16 Physical-layer procedures to support UE - gNB measurements ", Ericsson.

# 2. Aspect #24: Timing Quality

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|  | Observations/Proposals | Specification Text Proposal |
| OPPO [10] | The quality of a timing values for NR measurement is defined as below in TS 37.355. However, the current version of TS 38.214 is not aligned with TS 37.355.  -- ASN1START  NR-TimingQuality-r16 ::= SEQUENCE {  timingQualityValue-r16 INTEGER (0..31),  timingQualityResolution-r16 ENUMERATED {mdot1, m1, m10, m30, ...},  ...  }  -- ASN1STOP  **Proposal 7:**  Modify the descriptions on the quality of a timing values for NR measurement in TS 38.214 to align with the configuration specified in TS 37.355. | TP for Clause 5.1.6.5 (PRS reception procedure) of TS 38.214:  […]  The UE may be configured to report quality metrics corresponding to the DL RSTD and UE Rx-Tx time difference measurements which include the following fields:  *- ~~timingMeasQualityValue-r16~~ timingQualityValue-r16* which provides the best estimate of the uncertainty of the measurement  *- ~~timingMeasQualityResolution-r16~~ timingQualityResolution-r16* which specifies the resolution levels used in the*~~timingMeasQualityValue-r16~~ timingQualityValue-r16* field.  The UE expects to be configured with higher layer parameter *nr-DL-PRS-expectedRSTD-r16*, which defines the time difference with respect to the received DL subframe timing the UE is expected to receive DL PRS, and *DL-PRS-expectedRSTD-uncertainty-r16*, which defines a search window around the *nr-DL-PRS-expectedRSTD-r16*.  […] |

FL Comment: In TS 37.355 the IE *NR-TimingQuality* can be used for multiple purposes; i.e., not necessarily for measurements only. It provides a quality indicator for a timing quantity, which may be a UE measurement or an assistance data element.

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| Company | Comments | Proposed Modifications (if any) |
| CATT | Fine with the TP. |  |
| Futurewei | OK |  |
| Huawei/HiSilicon | Support. |  |
| Nokia/NSB | Okay with the TP. |  |
| OPPO | Ok |  |
| ZTE | OK. |  |
| LG | OK with the TP. |  |
| SS | OK |  |
| Qualcomm | OK |  |
| Ericsson | OK |  |

# 3. Aspect #25: RTOA Definition

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|  | Observations/Proposals | Specification Text Proposal |
| Huawei [7] | In the reply LS from RAN3 [R1-2005216], RAN3 replied that they do not see a need and therefore have not included the UL RTOA reference time definition in RAN3 specification. Therefore, it should be captured in RAN1 spec.  In addition, since Rel-15 SRS can also be used for UL RTOA measurement, the restriction on SRS for positioning should be removed.  **Proposal 5:**  Endorse the following TP to TS 38.215. | TP for TS 38.215:  5.2.2 UL Relative Time of Arrival (TUL-RTOA)   |  |  | | --- | --- | | **Definition** | The UL Relative Time of Arrival (TUL-RTOA) is the beginning of subframe *i* containing SRS received in positioning node *j*, relative to the RTOA Reference Time.  The UL RTOA reference time is defined as , where  - is the nominal beginning time of SFN 0 provided by SFN Initialization Time [15, TS 38.455]  - , where and are the system frame number and the subframe number of the SRS, respectively.  Multiple SRS resources can be used to determine the beginning of one subframe containing SRS received at a positioning node.  The reference point for TUL-RTOA shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. | |

FL Comment: LS from RAN3 (R1-2005216):

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| […]  RAN3 would like to inform RAN1 that RAN3 has agreed to introduce the SFN Initialisation Time IE, corresponding to the nominal beginning time of SFN 0, as part of the SRS Configuration IE in both NRPPa and F1-AP specifications.  RAN3 considers that the above aligns with the RAN1 agreement and reflects how the UL RTOA reference time was first defined in both LPPa and SLmAP specifications. RAN3 did not see a need and therefore has not included the UL RTOA reference time definition in RAN3 specification.  […] |

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| Company | Comments | Proposed Modifications (if any) |
| CATT | Support the TP for the clarification. Strictly speaking, the reference time of the RTOA is not SFN0, but the timing of the closed SF. |  |
| Futurewei | Support |  |
| Huawei/HiSilicon | Support.  In reply to CATT: We think that the timing of the subframe containing the target SRS is calculated by . We do no need to mention “closest subframe” in the context. From gNB perspective, given the SFN initialization time, when to receive the SRS is deterministic. |  |
| OPPO | Support  It is good clarifition on the UL RTOA reference time |  |
| ZTE | Support. |  |
| LG | OK |  |
| SS | OK |  |
| Qualcomm | OK |  |
| Ericsson | OK |  |

# 4. Aspect #27: Positioning Node Terminology

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|  | Observations/Proposals | Specification Text Proposal |
| Nokia [15] | The common understanding in RAN1 seemed to be that this node could either be a TRP or a UL-positioning only RP or a DL-positioning only TP. 3GPP should define a positioning node as a TRP, UL-positioning only RP, or DL-positioning only TP which transmits and/or receives positioning signals.  **Proposal 1:**  RAN1 confirms necessity to define positioning nodes to avoid ambiguity on the measurement definitions.  **Proposal 2:**  RAN1 either sends an LS to RAN3 informing them of the need to define positioning node or defines a positioning node as described above in TS 38.215. |  |

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|  | Observations/Proposals | Specification Text Proposal |
| CATT [4] | The terminology ‘Positioning Node’ is used in TS 38.215, but it is undefined in the 3GPP specification.   * **Proposal 2:**   Replace the terminology ‘Positioning Node’ in TS 38.215 by ‘Transmission Point (TP)’ or ‘Reception Point (RP)’, or ‘Transmission and Reception Point (TRP)’ where applicable. The proposed TR is presented in Appendix A. | TP for TS 38.215: 5.1.29 DL reference signal time difference (DL RSTD)  |  |  | | --- | --- | | **Definition** | DL reference signal time difference (DL RSTD) is the DL relative timing difference between the node Transmission Point (TP) *j* and the reference TP *i*, defined as TSubframeRxj – TSubframeRxi,  Where:  TSubframeRxj is the time when the UE receives the start of one subframe from TP *j*.  TSubframeRxi is the time when the UE receives the corresponding start of one subframe from TP *i* that is closest in time to the subframe received from TP *j*.  Multiple DL PRS resources can be used to determine the start of one subframe from a TP.  For frequency range 1, the reference point for the DL RSTD shall be the antenna connector of the UE. For frequency range 2, the reference point for the DL RSTD shall be the antenna of the UE. | | **Applicable for** | RRC\_CONNECTED |  5.1.30 UE Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The UE Rx – Tx time difference is defined as TUE-RX –TUE-TX  Where:  TUE-RX is the UE received timing of downlink subframe #*i* from a TP, defined by the first detected path in time.  TUE-TX is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i received from the TP.  Multiple DL PRS resources can be used to determine the start of one subframe of the first arrival path of the TP.  For frequency range 1, the reference point for TUE-RX measurement shall be the Rx antenna connector of the UE and the reference point for TUE-TX measurement shall be the Tx antenna connector of the UE. For frequency range 2, the reference point for TUE‑RX measurement shall be the Rx antenna of the UE and the reference point for TUE‑TX measurement shall be the Tx antenna of the UE. | | **Applicable for** | RRC\_CONNECTED |  5.2.2 UL Relative Time of Arrival (TUL-RTOA)  |  |  | | --- | --- | | **Definition** | The UL Relative Time of Arrival (TUL-RTOA) is the beginning of subframe *i* containing SRS received in Reception Point (RP) *j*, relative to the RTOA Reference Time [16].  Multiple SRS resources for positioning can be used to determine the beginning of one subframe containing SRS received at a RP.  The reference point for TUL-RTOA shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. |  5.2.3 gNB Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The gNB Rx – Tx time difference is defined as TgNB-RX –TgNB-TX  Where:  TgNB-RX is the Transmission and Reception Point (TRP) received timing of uplink subframe #*i* containing SRS associated with UE, defined by the first detected path in time.  TgNB-TX is the TRP transmit timing of downlink subframe #*j* that is closest in time to the subframe #*i* received from the UE.  Multiple SRS resources for positioning can be used to determine the start of one subframe containing SRS.  The reference point for TgNB-RX shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector.  The reference point forgNB-TX shall be:  - for type 1-C base station TS 38.104 [9]: the Tx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Tx antenna (i.e. the centre location of the radiating region of the Tx antenna),  - for type 1-H base station TS 38.104 [9]: the Tx Transceiver Array Boundary connector. | |

FL Comment:

TS 38.305 defines:

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| […]  **Transmission Point (TP)**: A set of geographically co-located transmit antennas (e.g. antenna array (with one or more antenna elements)) for one cell, part of one cell or one DL-PRS-only TP. Transmission Points can include base station (ng-eNB or gNB) antennas, remote radio heads, a remote antenna of a base station, an antenna of a DL-PRS-only TP, etc. One cell can include one or multiple transmission points. For a homogeneous deployment, each transmission point may correspond to one cell.  **Reception Point (RP)**: A set of geographically co-located receive antennas (e.g. antenna array (with one or more antenna elements)) for one cell, part of one cell or one UL-SRS-only RP. Reception Points can include base station (ng-eNB or gNB) antennas, remote radio heads, a remote antenna of a base station, an antenna of a UL-SRS-only RP, etc. One cell can include one or multiple reception points. For a homogeneous deployment, each reception point may correspond to one cell.  […].  **Transmission-Reception Point (TRP)**: A set of geographically co-located antennas (e.g. antenna array (with one or more antenna elements)) supporting TP and/or RP functionality.  […] |

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| Company | Comments | Proposed Modifications (if any) |
| CATT | Support CATT’s TP. It seems simpler and cleaner to use the terms “TP/RP/TRP” already defined in TS 38.305 instead of introducing a new definition of the positioning node. Also, the current usage of “positioning node” does not contain the information related to the transmission side and/or the reception side in the measurement definition. |  |
| Futurewei | Support CATT TP |  |
| Huawei/HiSilicon | OK with CATT’s proposal in general.  Comment #1: Suggest to add reference to TS 38.305 where TP/RP/TRPs are defined.  Comment #2: A redundant “node” should be removed from 5.1.29 (DL RSTD) | TP for TS 38.215:  [16] 3GPP TS 38.455: "NR Positioning Protocol A (NRPPa)"  [17] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access"  [xx] 3GPP TS 38.305: “NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN”  ======================== Unchanged parts ========================== 5.1.29 DL reference signal time difference (DL RSTD)  |  |  | | --- | --- | | **Definition** | DL reference signal time difference (DL RSTD) is the DL relative timing difference between the Transmission Point (TP) [xx] *j* and the reference TP *i*, defined as TSubframeRxj – TSubframeRxi,  Where:  TSubframeRxj is the time when the UE receives the start of one subframe from TP *j*.  TSubframeRxi is the time when the UE receives the corresponding start of one subframe from TP *i* that is closest in time to the subframe received from TP *j*.  Multiple DL PRS resources can be used to determine the start of one subframe from a TP.  For frequency range 1, the reference point for the DL RSTD shall be the antenna connector of the UE. For frequency range 2, the reference point for the DL RSTD shall be the antenna of the UE. | | **Applicable for** | RRC\_CONNECTED |  5.1.30 UE Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The UE Rx – Tx time difference is defined as TUE-RX –TUE-TX  Where:  TUE-RX is the UE received timing of downlink subframe #*i* from a TP [xx], defined by the first detected path in time.  TUE-TX is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i received from the TP.  Multiple DL PRS resources can be used to determine the start of one subframe of the first arrival path of the TP.  For frequency range 1, the reference point for TUE-RX measurement shall be the Rx antenna connector of the UE and the reference point for TUE-TX measurement shall be the Tx antenna connector of the UE. For frequency range 2, the reference point for TUE‑RX measurement shall be the Rx antenna of the UE and the reference point for TUE‑TX measurement shall be the Tx antenna of the UE. | | **Applicable for** | RRC\_CONNECTED |  5.2.2 UL Relative Time of Arrival (TUL-RTOA)  |  |  | | --- | --- | | **Definition** | The UL Relative Time of Arrival (TUL-RTOA) is the beginning of subframe *i* containing SRS received in Reception Point (RP) [xx] *j*, relative to the RTOA Reference Time [16].  Multiple SRS resources for positioning can be used to determine the beginning of one subframe containing SRS received at a RP.  The reference point for TUL-RTOA shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. |  5.2.3 gNB Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The gNB Rx – Tx time difference is defined as TgNB-RX –TgNB-TX  Where:  TgNB-RX is the Transmission and Reception Point (TRP) [xx] received timing of uplink subframe #*i* containing SRS associated with UE, defined by the first detected path in time.  TgNB-TX is the TRP transmit timing of downlink subframe #*j* that is closest in time to the subframe #*i* received from the UE.  Multiple SRS resources for positioning can be used to determine the start of one subframe containing SRS.  The reference point for TgNB-RX shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector.  The reference point forgNB-TX shall be:  - for type 1-C base station TS 38.104 [9]: the Tx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Tx antenna (i.e. the centre location of the radiating region of the Tx antenna),  - for type 1-H base station TS 38.104 [9]: the Tx Transceiver Array Boundary connector. | |
| Nokia/NSB | Support the TPs from CATT and the comments from Huawei. |  |
| OPPO | Support the TPs and comments from CATT and Huawei |  |
| OPPO | Support the TPs and comments from CATT and Huawei |  |
| LG | Support the modified TP from Huawei |  |
| SS | Support HW and CATT’s TPs |  |
| Qualcomm | OK |  |
| Ericssson | OK. Also support suggested changes from Huawei. |  |

# 5. Summary

**Text Proposal 1**:

Specification: TS 38.214

Clauses affected: 5.1.6.5

Reason for Change: The description of the quality for NR measurements is not in agreement with TS 37.355.

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| […]  The UE may be configured to report quality metrics corresponding to the DL RSTD and UE Rx-Tx time difference measurements which include the following fields:  *- timingQualityValue-r16* which provides the best estimate of the uncertainty of the measurement  *- timingQualityResolution-r16* which specifies the resolution levels used in the *timingQualityValue-r16* field.  The UE expects to be configured with higher layer parameter *nr-DL-PRS-expectedRSTD-r16*, which defines the time difference with respect to the received DL subframe timing the UE is expected to receive DL PRS, and *DL-PRS-expectedRSTD-uncertainty-r16*, which defines a search window around the *nr-DL-PRS-expectedRSTD-r16*.  […] |

**Text Proposal 2:**

Specification: TS 38.215

Clauses affected: 5.2.2

Reason for Change: RTOA Reference Time is not defined, and RTOA measurement can also be performed using Rel-15 SRS.

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| 5.2.2 UL Relative Time of Arrival (TUL-RTOA)   |  |  | | --- | --- | | **Definition** | The UL Relative Time of Arrival (TUL-RTOA) is the beginning of subframe *i* containing SRS received in positioning node *j*, relative to the RTOA Reference Time.  The UL RTOA reference time is defined as , where  - is the nominal beginning time of SFN 0 provided by SFN Initialization Time [15, TS 38.455]  - , where and are the system frame number and the subframe number of the SRS, respectively.  Multiple SRS resources can be used to determine the beginning of one subframe containing SRS received at a positioning node.  The reference point for TUL-RTOA shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. | |

**Text Proposal 3:**

Specification: TS 38.215

Clauses affected: 2, 5.1.29, 5.1.30, 5.2.2, 5.2.3

Reason for Change: The term "Positioning Node" is undefined in 3GPP specifications.

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| 2 References  The following documents contain provisions which, through reference in this text, constitute provisions of the present document.  […]  [16] 3GPP TS 38.455: "NR Positioning Protocol A (NRPPa)"  [17] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access"  [xx] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN"  […] 5.1.29 DL reference signal time difference (DL RSTD)  |  |  | | --- | --- | | **Definition** | DL reference signal time difference (DL RSTD) is the DL relative timing difference between the Transmission Point (TP) [xx] *j* and the reference TP *i*, defined as TSubframeRxj – TSubframeRxi,  Where:  TSubframeRxj is the time when the UE receives the start of one subframe from TP *j*.  TSubframeRxi is the time when the UE receives the corresponding start of one subframe from TP *i* that is closest in time to the subframe received from TP *j*.  Multiple DL PRS resources can be used to determine the start of one subframe from a TP.  For frequency range 1, the reference point for the DL RSTD shall be the antenna connector of the UE. For frequency range 2, the reference point for the DL RSTD shall be the antenna of the UE. | | **Applicable for** | RRC\_CONNECTED |  5.1.30 UE Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The UE Rx – Tx time difference is defined as TUE-RX –TUE-TX  Where:  TUE-RX is the UE received timing of downlink subframe #*i* from a TP [xx], defined by the first detected path in time.  TUE-TX is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i received from the TP.  Multiple DL PRS resources can be used to determine the start of one subframe of the first arrival path of the TP.  For frequency range 1, the reference point for TUE-RX measurement shall be the Rx antenna connector of the UE and the reference point for TUE-TX measurement shall be the Tx antenna connector of the UE. For frequency range 2, the reference point for TUE‑RX measurement shall be the Rx antenna of the UE and the reference point for TUE‑TX measurement shall be the Tx antenna of the UE. | | **Applicable for** | RRC\_CONNECTED |  5.2.2 UL Relative Time of Arrival (TUL-RTOA)  |  |  | | --- | --- | | **Definition** | The UL Relative Time of Arrival (TUL-RTOA) is the beginning of subframe *i* containing SRS received in Reception Point (RP) [xx] *j*, relative to the RTOA Reference Time [16].  Multiple SRS resources for positioning can be used to determine the beginning of one subframe containing SRS received at a RP.  The reference point for TUL-RTOA shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. |  5.2.3 gNB Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The gNB Rx – Tx time difference is defined as TgNB-RX –TgNB-TX  Where:  TgNB-RX is the Transmission and Reception Point (TRP) [xx] received timing of uplink subframe #*i* containing SRS associated with UE, defined by the first detected path in time.  TgNB-TX is the TRP transmit timing of downlink subframe #*j* that is closest in time to the subframe #*i* received from the UE.  Multiple SRS resources for positioning can be used to determine the start of one subframe containing SRS.  The reference point for TgNB-RX shall be:  - for type 1-C base station TS 38.104 [9]: the Rx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),  - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector.  The reference point forgNB-TX shall be:  - for type 1-C base station TS 38.104 [9]: the Tx antenna connector,  - for type 1-O or 2-O base station TS 38.104 [9]: the Tx antenna (i.e. the centre location of the radiating region of the Tx antenna),  - for type 1-H base station TS 38.104 [9]: the Tx Transceiver Array Boundary connector. | |