**3GPP T****SG-RAN WG2 Meeting #124 R2-2313778**

**Chicago, USA: November 13-17, 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.305** | **CR** | **0154** | **rev** | **-** | **Current version:** | **17.6.0** |  |
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| *For* ***[HELP](http://www.3gpp.org/3G_Specs/CRs.htm" \l "_blank)*** *on using this form: comprehensive instructions can be found at  <http://www.3gpp.org/Change-Requests>.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Multi-RTT positioning in NTN | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Qualcomm Inc. | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_NTN\_enh-Core | | | | |  | ***Date:*** | | | 2023-11-03 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)*  *Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | To capture stage 2 description on the change in multi-RTT positioning for network verified UE location. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Following changes are captured.   * Abbreviation for NTN is added. * Information on additional measurement needed for NTN multi-RTT positioning is added. * Clarification added that in NTN, measurements can be from a single TRP (i.e., satellite) at different time instances. * Common TA parameters of TRPs added in Table 8.10.2.3-1 | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Stage 2 specification is not complete for network verified UE location in NTN. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.2, 4.3.11, 5.4.2, 5.4.4, 8.10.1, 8.10.2.2, 8.10.2.3, 8.10.4 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **Y** | Other core specifications | | | | TS/TR 37.355 CR 0428 | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

START OF CHANGE

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.501 "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 22.071: "Location Services (LCS); Service description, Stage 1".

[4] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

[5] IS-GPS-200, Revision D, Navstar GPS Space Segment/Navigation User Interfaces, March 7th, 2006.

[6] IS-GPS-705, Navstar GPS Space Segment/User Segment L5 Interfaces, September 22, 2005.

[7] IS-GPS-800, Navstar GPS Space Segment/User Segment L1C Interfaces, September 4, 2008.

[8] Galileo OS Signal in Space ICD (OS SIS ICD), Draft 0, Galileo Joint Undertaking, May 23rd, 2006.

[9] Global Navigation Satellite System GLONASS Interface Control Document, Version 5, 2002.

[10] IS-QZSS, Quasi Zenith Satellite System Navigation Service Interface Specifications for QZSS, Ver.1.0, June 17, 2008.

[11] Specification for the Wide Area Augmentation System (WAAS), US Department of Transportation, Federal Aviation Administration, DTFA01-96-C-00025, 2001.

[12] RTCM 10402.3, RTCM Recommended Standards for Differential GNSS Service (v.2.3), August 20, 2001.

[13] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[14] 3GPP TS 38.331: "NR Radio Resource Control (RRC) protocol specification".

[15] OMA-AD-SUPL-V2\_0: "Secure User Plane Location Architecture Approved Version 2.0".

[16] OMA-TS-ULP-V2\_0\_6: "UserPlane Location Protocol Approved Version 2.0.6".

[17] 3GPP TS 36.214: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer – Measurements".

[18] 3GPP TS 36.302: "Evolved Universal Terrestrial Radio Access (E-UTRA); Services provided by the physical layer".

[19] 3GPP TS 36.355: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP)".

[20] BDS-SIS-ICD-B1I-3.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I (Version 3.0)", February, 2019.

[21] IEEE 802.11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications"

[22] Bluetooth Special Interest Group: "Bluetooth Core Specification v4.2", December 2014.

[23] ATIS-0500027: "Recommendations for Establishing Wide Scale Indoor Location Performance", May 2015.

[24] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation".

[25] 3GPP TS 36.305: "Stage 2 functional specification of User Equipment (UE) positioning in E‑UTRA".

[26] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[27] 3GPP TS 38.455: "NG-RAN; NR Positioning Protocol A (NRPPa)".

[28] 3GPP TS 29.518: "5G System; Access and Mobility Management Services; Stage 3".

[29] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[30] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[31] RTCM 10403.3, "RTCM Recommended Standards for Differential GNSS Services (v.3.3)", October 7, 2016.

[32] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[33] 3GPP TS 29.572: "Location Management Services; Stage 3".

[34] BDS-SIS-ICD-B1C-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C (Version 1.0)", December, 2017

[35] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[36] IS-QZSS-L6-001, Quasi-Zenith Satellite System Interface Specification – Centimetre Level Augmentation Service, Cabinet Office, November 5, 2018.

[37] 3GPP TS 38.215: "NR; Physical layer – Measurements".

[38] 3GPP TS 38.401: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NG-RAN; Architecture description".

[39] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[40] 3GPP TS 38.212: "NR; Multiplexing and channel coding".

[41] 3GPP TS 24.571: "Control plane Location Services (LCS) procedures".

[42] 3GPP TS 37.355: "Technical Specification Group Radio Access Network; LTE Positioning Protocol (LPP)".

[43] IRNSS Signal-In-Space (SPS) Interface Control Document (ICD) for standard positioning service version 1.1, August 2017.

[44] BDS-SIS-ICD-B2a-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B2a (Version 1.0)", December, 2017.

[45] BDS-SIS-ICD-B3I-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B3I (Version 1.0)", February, 2018.

[x] 3GPP TS 38.300: "NR; NR and NR-RAN Overall Description; Stage 2".

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3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

5GC 5G Core Network

5GS 5G System

A-AoA Azimuth-Angle of Arrival

ADR Accumulated Delta Range

AL Alert Limit

AoA Angle of Arrival

AP Access Point

ARP Antenna Reference Point

BDS BeiDou Navigation Satellite System

BSSID Basic Service Set Identifier

CID Cell-ID (positioning method)

CLAS Centimetre Level Augmentation Service

DL-AoD Downlink Angle-of-Departure

DL-PRS Downlink Positioning Reference Signal

DL-TDOA Downlink Time Difference Of Arrival

DNU Do Not Use

E-SMLC Enhanced Serving Mobile Location Centre

E-CID Enhanced Cell-ID (positioning method)

ECEF Earth-Centered, Earth-Fixed

ECI Earth-Centered-Inertial

EGNOS European Geostationary Navigation Overlay Service

E-UTRAN Evolved Universal Terrestrial Radio Access Network

FDMA Frequency Division Multiple Access

FKP Flächenkorrekturparameter (Engl: Area Correction Parameters)

GAGAN GPS Aided Geo Augmented Navigation

GLONASS GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (Engl.: Global Navigation Satellite System)

GMLC Gateway Mobile Location Centre

GNSS Global Navigation Satellite System

GPS Global Positioning System

GRS80 Geodetic Reference System 1980

HESSID Homogeneous Extended Service Set Identifier

LCS LoCation Services

LMF Location Management Function

LPP LTE Positioning Protocol

MAC Master Auxiliary Concept

MBS Metropolitan Beacon System

MO-LR Mobile Originated Location Request

MT-LR Mobile Terminated Location Request

Multi-RTT Multi-Round Trip Time

NavIC NAVigation with Indian Constellation

NG-C NG Control plane

NG-AP NG Application Protocol

NI-LR Network Induced Location Request

N-RTK Network – Real-Time Kinematic

NRPPa NR Positioning Protocol A

NTN Non-Terrestrial Network

OTDOA Observed Time Difference Of Arrival

PDU Protocol Data Unit

posSI Positioning System Information

posSIB Positioning SIB

PPP Precise Point Positioning

PPP-RTK Precise Point Positioning – Real-Time Kinematic

PRS Positioning Reference Signal (for E-UTRA)

PRU Positioning Reference Unit

QZSS Quasi-Zenith Satellite System

RP Reception Point

RRM Radio Resource Management

RSRP Reference Signal Received Power

RSRPP Reference Signal Received Path Power

RSRQ Reference Signal Received Quality

RSSI Received Signal Strength Indicator

RSTD Reference Signal Time Difference

RTK Real-Time Kinematic

SBAS Space Based Augmentation System

SDT Small Data Transmission

SET SUPL Enabled Terminal

SIB System Information Block

SLP SUPL Location Platform

SP Semi-Persistent

SRS Sounding Reference Signal

SSB Synchronization Signal Block

SSID Service Set Identifier

SSR State Space Representation

STEC Slant TEC

SUPL Secure User Plane Location

TADV Timing Advance

TBS Terrestrial Beacon System

TEC Total Electron Content

TEG Timing Error Group

TP Transmission Point

TRP Transmission-Reception Point

TTA Time To Alert

TxTEG Tx Timing Error Group

UE User Equipment

UL-AoA Uplink Angle of Arrival

UL-RTOA Uplink Relative Time of Arrival

UL-SRS Uplink Sounding Reference Signal

UL-TDOA Uplink Time Difference of Arrival

URA User Range Accuracy

WAAS Wide Area Augmentation System

WGS-84 World Geodetic System 1984

WLAN Wireless Local Area Network

Z-AoA Zenith Angles of Arrival

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4.3.11 Multi-RTT positioning

The Multi-RTT positioning method makes use of the UE Rx-Tx time difference measurements (and optionally DL-PRS-RSRP and/or DL-PRS-RSRPP) of downlink signals received from multiple TRPs, measured by the UE and the measured gNB Rx-Tx time difference measurements (and optionally UL-SRS-RSRP and/or UL-SRS-RSRPP) at multiple TRPs of uplink signals transmitted from UE.

The UE measures the UE Rx-Tx time difference measurements (and optionally DL-PRS-RSRP and/or DL-PRS-RSRPP of the received signals) using assistance data received from the positioning server, and the TRPs measure the gNB Rx-Tx time difference measurements (and optionally UL-SRS-RSRP and/or UL-SRS-RSRPP of the received signals) using assistance data received from the positioning server. The measurements are used to determine the RTT at the positioning server which are used to estimate the location of the UE.

For network verification of UE location in NTN, the Multi-RTT positioning method makes use of the UE Rx-Tx time difference measurements (and optionally DL-PRS-RSRP and/or DL-PRS-RSRPP) of downlink signals received from a single TRP (i.e., satellite) at different time instances, measured by the UE and the measured gNB Rx-Tx time difference measurements (and optionally UL-SRS-RSRP and/or UL-SRS-RSRPP) at a single TRP (i.e., satellite) at different time instances of uplink signals transmitted from UE. Together with each UE RX-Tx time difference measurement, the UE also reports the UE Rx – Tx time difference subframe offset measurement in unit of subframe and the DL timing drift due to Doppler onservice link

The operation of the Multi-RTT positioning method is described in clause 8.10.

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5.4 Functional Description of Elements Related to UE Positioning in NG-RAN

<<Skipped>>

5.4.2 gNB

The gNB is a network element of NG-RAN that may provide measurement information for a target UE and communicates this information to an LMF.

To support NR RAT-Dependent positioning, the gNB may make measurements of radio signals for a target UE, and provide measurement results for position estimation. A gNB may serve several TRPs, including for example remote radio heads, and UL-SRS only RPs and DL-PRS-only TPs. For NTN, a TRP may be located on board the satellite.

A gNB may broadcast assistance data information, received from an LMF, in positioning System Information messages.

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5.4.4 Location Management Function (LMF)

The LMF manages the support of different location services for target UEs, including positioning of UEs and delivery of assistance data to UEs. The LMF may interact with the serving gNB or serving ng-eNB for a target UE in order to obtain position measurements for the UE, including uplink measurements made by an NG-RAN and downlink measurements made by the UE that were provided to an NG-RAN as part of other functions such as for support of handover.

The LMF may interact with a target UE in order to deliver assistance data if requested for a particular location service, or to obtain a location estimate if that was requested.

The LMF may interact with multiple NG-RAN nodes to provide assistance data information for broadcasting. The assistance data information for broadcast may optionally be segmented and/or ciphered by the LMF. The LMF may also interact with AMFs to provide ciphering key data information to the AMF as described in greater detail in TS 23.273 [35].

For positioning of a target UE, the LMF decides on the position methods to be used, based on factors that may include the LCS Client type, the required QoS, UE positioning capabilities, gNB positioning capabilities and ng-eNB positioning capabilities. The LMF then invokes these positioning methods in the UE, serving gNB and/or serving ng‑eNB. The positioning methods may yield a location estimate for UE-based position methods and/or positioning measurements for UE-assisted and network-based position methods. The LMF may combine all the received results and determine a single location estimate for the target UE (hybrid positioning). Additional information like accuracy of the location estimate and velocity may also be determined.

The LMF may interact with the AMF to provide (updated) UE Positioning Capability to AMF and to receive stored UE Positioning Capability from AMF as described in TS 23.273 [35].

For NTN, the LMF is configured by the OAM with satellite related information (described in TS 38.300 [x]), as well as the association between TRP(s) and satellite(s).

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8.10 Multi-RTT positioning

8.10.1 General

In the Multi-RTT positioning method, the UE position is estimated based on measurements performed at both, UE and TRPs. The measurements performed at the UE and TRPs are UE/gNB Rx-Tx time difference measurements (and optionally DL-PRS-RSRP, DL-PRS-RSRPP, UL-SRS-RSRP, and/or UL-SRS-RSRPP) of DL-PRS and UL-SRS, which are used by an LMF to determine the RTTs.

For network verification of UE location in NTN, the measurements can be performed at a single TRP (i.e., satellite) at different time instances. The additional measurements performed at UE are the UE Rx – Tx time difference subframe offset in unit of subframe and the DL timing drift due to Doppler in service link between TRP (i.e., satellite) position and UE’s position.

The UE may require measurement gaps to perform the Multi-RTT measurements from NR TRPs. The UE may request measurement gaps from a gNB using the procedure described in clause 7.4.1.1. The UE may also request to activate pre-configured measurement gaps as described in clause 7.7.2.

8.10.2 Information to be transferred between NG-RAN/5GC Elements

This clause defines the information that may be transferred between LMF and UE/gNB.

8.10.2.1 Information that may be transferred from the LMF to UE

The information that may be transferred from the LMF to the UE are listed in Table 8.10.2.1-1.

**Table 8.10.2.1-1: Assistance data that may be transferred from LMF to the UE**

|  |
| --- |
| **Information** |
| Physical cell IDs (PCIs), global cell IDs (GCIs), and PRS IDs, ARFCNs of candidate NR TRPs for measurement |
| Timing relative to the serving (reference) TRP of candidate NR TRPs |
| DL-PRS configuration of candidate NR TRPs |
| SSB information of the TRPs (the time/frequency occupancy of SSBs) |
| PRS-only TP indication |
| On-Demand DL-PRS-Configurations |
| Validity Area of the Assistance Data |

8.10.2.2 Information that may be transferred from the UE to LMF

The information that may be signalled from UE to the LMF is listed in Table 8.10.2.2-1. The individual UE measurements are defined in TS 38.215 [37].

**Table 8.10.2.2-1: Measurement results that may be transferred from UE to the LMF**

|  |
| --- |
| **Information** |
| PCI, GCI, and PRS ID, ARFCN, PRS resource ID, PRS resource set ID for each measurement |
| DL-PRS-RSRP measurement |
| UE Rx-Tx time difference measurement |
| Time stamp of the measurement |
| Quality for each measurement |
| TA offset used by UE |
| UE Rx TEG IDs, UE Tx TEG IDs, and UE RxTx TEG IDs associated with UE Rx-Tx time difference measurements |
| LOS/NLOS information for UE measurements |
| DL-PRS-RSRPP measurement |
| The association of UE Tx TEG ID and SRS |
| UE Rx – Tx time difference subframe offset |
| DL timing drift |

8.10.2.3 Information that may be transferred from the gNB to LMF

The assistance data that may be transferred from gNB to the LMF is listed in Table 8.10.2.3-1.

**Table 8.10.2.3-1: Assistance data that may be transferred from gNB to the LMF**

|  |
| --- |
| **Information** |
| PCI, GCI, ARFCN and TRP IDs of the TRPs served by the gNB |
| Timing information of TRPs served by the gNB |
| DL-PRS configuration of the TRPs served by the gNB |
| SSB information of the TRPs (the time/frequency occupancy of SSBs) |
| Spatial direction information of the DL-PRS Resources of the TRPs served by the gNB |
| Geographical coordinates information of the DL-PRS Resources of the TRPs served by the gNB |
| TRP type |
| On-demand DL-PRS information |
| TRP Tx TEG association information |
| Common TA parameters of TRPs |

The configuration data for a target UE that may be transferred from the serving gNB to the LMF is listed in Table 8.10.2.3-2.

**Table 8.10.2.3-2: UL information/UE configuration data that may be transferred from serving gNB to the LMF**

|  |
| --- |
| **UE configuration data** |
| UE SRS configuration |
| SFN initialization time for the SRS configuration |
| SRS Transmission Status |

The measurement results that may be signalled from gNBs to the LMF is listed in Table 8.10.2.3-3.

**Table 8.10.2.3-3: Measurement results that may be transferred from gNBs to the LMF**

|  |
| --- |
| **Measurement results** |
| NCGI and TRP ID of the measurement |
| gNB Rx-Tx time difference measurement |
| UL-SRS-RSRP |
| UL-SRS-RSRPP |
| UL Angle of Arrival (azimuth and/or elevation) NOTE 1 |
| Multiple UL Angle of Arrival (azimuth and/or elevation) NOTE 1 |
| SRS Resource Type |
| Time stamp of the measurement |
| Quality for each measurement |
| Beam Information of the measurement |
| LoS/NLoS information for each measurement |
| ARP ID of the measurement |
| NOTE 1: When used with UL-AoA for hybrid positioning. |

8.10.2.4 Information that may be transferred from the LMF to gNBs

The requested UL-SRS transmission characteristics information that may be signalled from the LMF to the gNB is listed in Table 8.10.2.4-1.

**Table 8.10.2.4-1: Requested UL-SRS transmission characteristics information that may be transferred from LMF to gNB.**

|  |
| --- |
| **Information** |
| Number Of Transmissions/duration for which the UL-SRS is requested |
| Bandwidth |
| Resource type (periodic, semi-persistent, aperiodic) |
| Number of requested SRS resource sets and SRS resources per set |
| Pathloss reference:  - PCI, SSB Index  - DL-PRS ID, DL-PRS Resource Set ID, DL-PRS Resource ID |
| Spatial relation info  - PCI, SSB Index  - DL-PRS ID, DL-PRS Resource Set ID, DL-PRS Resource ID  - NZP CSI-RS Resource ID  - SRS Resource ID  - Positioning SRS Resource ID |
| Periodicity of the SRS for each SRS resource set |
| SSB Information |
| Carrier frequency of SRS transmission bandwidth |

The TRP measurement request information that may be signalled from the LMF to the gNBs is listed in Table 8.10.2.4-2.

**Table 8.10.2.4-2: TRP Measurement request information that may be transferred from LMF to gNBs.**

|  |
| --- |
| **Information** |
| TRP ID, and NCGI of the TRP to receive UL-SRS |
| UE-SRS configuration |
| UL timing information together with timing uncertainty, for reception of SRS by candidate TRPs |
| Report characteristics for the measurements |
| Measurement Quantities |
| Measurement periodicity |
| Measurement beam information request |
| Search window information |
| Expected UL AoA/ZoA and uncertainty range |
| Number of TRP Rx TEGs |
| Number of TRP RxTx TEGs |
| Response time |
| Measurement characteristics request indicator |
| Measurement time occasions for a measurement instance |

The Positioning Activation/Deactivation request information that may be signalled from the LMF to the gNB is listed in Table 8.10.2.4-3.

**Table 8.10.2.4-3: Requested positioning activation/deactivation information that may be transferred from LMF to gNB.**

|  |
| --- |
| **Information** |
| SP UL-SRS:  - Activation or Deactivation request  - Positioning SRS Resource Set ID which is to be activated/deactivated  - Spatial relation for Resource IDi  - Activation Time |
| Aperiodic UL-SRS  - Aperiodic SRS Resource Trigger List  - Activation Time |
| UL-SRS:  - Release all |

8.10.3 Multi-RTT Positioning Procedures

The procedures described in this clause support Multi-RTT positioning measurements obtained by the UE and TRPs/gNB.

8.10.3.1 Procedures between LMF and UE

8.10.3.1.1 Capability Transfer Procedure

The Capability Transfer procedure for Multi-RTT positioning is described in clause 7.1.2.1.

8.10.3.1.2 Assistance Data Transfer Procedure

8.10.3.1.2.1 Assistance Data Transfer between LMF and UE

The purpose of this procedure is to enable the LMF to provide assistance data to the UE (e.g., as part of a positioning procedure) and the UE to request assistance data from the LMF (e.g., as part of a positioning procedure). The LMF may provide the pre-configured DL-PRS assistance data (with associated validity criteria) to the UE (before or during an ongoing LPP positioning session), to be utilized for potential positioning measurements at a future time. Pre-configured DL-PRS assistance data may consist of multiple instances, where each instance is applicable to a different area within the network. One or more assistance data instances may be provided. Each instance is provided in one LPP Assistance Data messages.

If a UE receives assistance data for a TRP for which it has already stored assistance data, it overwrites the stored assistance data, whereas if a UE receives assistance data for a TRP for which it has not stored assistance data, it stores the assistance data for the TRP and maintains the already stored assistance data for other TRPs. The TRPs are uniquely identified using a combination of PRS-ID and Cell-ID. The number TRPs for which the UE can store Assistance Data is a UE capability and is indicated by the number of areas a UE can support.

8.10.3.1.2.1.1 LMF initiated Assistance Data Delivery

Figure 8.10.3.1.2.1.1-1 shows the Assistance Data Delivery operations for the Multi-RTT positioning method when the procedure is initiated by the LMF.

****

**Figure 8.10.3.1.2.1.1-1: LMF-initiated Assistance Data Delivery Procedure**

(1) The LMF determines that assistance data needs to be provided to the UE (e.g., as part of a positioning procedure) and sends an LPP Provide Assistance Data message to the UE. This message may include any of the Multi-RTT positioning assistance data defined in Table 8.10.2.1-1.

8.10.3.1.2.1.2 UE initiated Assistance Data Transfer

Figure 8.10.3.1.2.1.2-1 shows the Assistance Data Transfer operations for the Multi-RTT positioning method when the procedure is initiated by the UE.

****

**Figure 8.10.3.1.2.1.2-1: UE-initiated Assistance Data Transfer Procedure**

(1) The UE determines that certain Multi-RTT positioning assistance data are desired (e.g., as part of a positioning procedure when the LMF provided assistance data are not sufficient for the UE to fulfil the request) and sends an LPP Request Assistance Data message to the LMF. This request includes an indication of which specific Multi-RTT assistance data are requested. Additional information concerning the UE's approximate location and serving and neighbour cells may also be provided in the Request Assistance Data message and/or in an accompanying Provide Location Information message to help the LMF provide appropriate assistance data. This additional data may include the UE's last known location if available, the cell IDs of the UE serving NG-RAN node and possibly neighbour NG-RAN nodes, as well as NR E-CID measurements.

(2) The LMF provides the requested assistance in an LPP Provide Assistance Data message, if available at the LMF. If any of the UE requested assistance data in step (1) are not provided in step 2, the UE shall assume that the requested assistance data are not supported, or currently not available at the LMF. If none of the UE requested assistance data in step (1) can be provided by the LMF, return any information that can be provided in an LPP message of type Provide Assistance Data which includes a cause indication for the not provided assistance data.

8.10.3.1.3 Location Information Transfer Procedure

The purpose of this procedure is to enable the LMF to request position measurements from the UE, or to enable the UE to provide location measurements to the LMF for position calculation.

8.10.3.1.3.1 LMF-initiated Location Information Transfer Procedure

Figure 8.10.3.1.3.1-1 shows the Location Information Transfer operations for the Multi-RTT positioning method when the procedure is initiated by the LMF.

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**Figure 8.10.3.1.3.1-1: LMF-initiated Location Information Transfer Procedure**

(1) The LMF sends an LPP Request Location Information message to the UE. This request includes indication of Multi-RTT measurements requested, including any needed measurement configuration information, and required response time.

(2) The UE obtains Multi-RTT measurements as requested in step 1. The UE then sends an LPP Provide Location Information message to the LMF, before the Response Time provided in step (1) elapsed, and includes the obtained Multi-RTT measurements. If the UE is unable to perform the requested measurements, or the Response Time elapsed before any of the requested measurements were obtained, the UE returns any information that can be provided in an LPP message of type Provide Location Information which includes a cause indication for the not provided location information.

8.10.3.1.3.2 UE-initiated Location Information Delivery procedure

Figure 8.10.3.1.3.2-1 shows the Location Information Delivery procedure operations for the Multi-RTT positioning method when the procedure is initiated by the UE.

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**Figure 8.10.3.1.3.2-1: UE-initiated Location Information Delivery Procedure.**

(1) The UE sends an LPP Provide Location Information message to the LMF. The Provide Location Information message may include any UE Multi-RTT measurements already available at the UE.

8.10.3.2 Procedures between LMF and gNB

8.10.3.2.1 Assistance Data Delivery between LMF and gNB

The purpose of these procedures is to enable the gNB to provide assistance data described in Table 8.10.2.3-1 to the LMF, for subsequent delivery to the UE using the procedures of clause 8.10.3.1.2.1 or for use in the calculation of positioning estimates at the LMF or enable the LMF to request UL-SRS configuration information from the serving gNB of a target UE.

Figure 8.10.3.2.1-1 shows the TRP Information Exchange operation from the gNB to the LMF for the Multi-RTT positioning method.

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**Figure 8.10.3.2.1-1: LMF-initiated TRP Information Exchange Procedure**

(1) The LMF determines that certain TRP configuration information is desired (e.g., as part of a periodic update or as triggered by OAM) and sends an NRPPa TRP INFORMATION REQUEST message to the gNB. This request includes an indication of which specific TRP configuration information is requested.

(2) The gNB provides the requested TRP information in an NRPPa TRP INFORMATION RESPONSE message, if available at the gNB. If the gNB is not able to provide any information, it returns an TRP INFORMATION FAILURE message indicating the cause of the failure.

Figure 8.10.3.2.1-2 shows the UL information Delivery operation from the serving gNB to the LMF.

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**Figure 8.10.3.2.1-2: LMF-initiated UL Information Request Procedure**

(1) The LMF sends a NRPPa message POSITIONING INFORMATION REQUEST to the serving gNB of the target UE to request UE SRS configuration information. If the message includes the Requested UL-SRS Transmission Characteristics as listed in Table 8.10.2.4-1, the gNB should take this information into account when configuring UL-SRS transmissions for the UE.

(2) The serving gNB determines the UE SRS configuration to be allocated for the UE and sends NRPPa message POSITIONING INFORMATION RESPONSE to the LMF that includes the UE SRS configuration defined in Table 8.10.2.3-2. If the serving gNB is not able to provide the requested information, it returns a failure message indicating the cause of the failure.

(3) If a change has occurred in the UE SRS configuration during the UE SRS time duration requested at step 1, the gNB sends a POSITIONING INFORMATION UPDATE message to the LMF. This message contains, in the case of a change in UE SRS configuration parameters, the UE SRS configuration information for all cells with UE SRS configured, or an update in SRS transmission status.

8.10.3.2.2 Location Information Transfer/Assistance Data Transfer Procedure

The purpose of this procedure is to enable the LMF to request position measurements from a gNB for position calculation of the UE and also provide necessary assistance data to the gNB.

Figure 8.10.3.2.2-1 shows the messaging between the LMF and the gNB to perform this procedure.

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**Figure 8.10.3.2.2-1: LMF-initiated Location Information Transfer Procedure**

(1) The LMF sends a NRPPa message to the selected gNB to request Multi-RTT measurement information. The message includes any information required for the gNB to perform the measurements as defined in Table 8.10.2.4-2.

(2) If the report characteristics in step 1 is set to "on demand", the gNB obtains the requested Multi-RTT measurements and returns them in a Measurement Response message to the LMF. The Measurement Response message includes the obtained Multi-RTT measurements as defined in Table 8.10.2.3-3.

If the report characteristics in step 1 is set to "periodic", the gNB replies with a Measurement Response message without including any measurements in the message. The gNB then periodically initiates the Measurement Report procedure in step 3 for the Multi-RTT measurements, with the requested reporting periodicity.  
  
If the gNB is not able to accept the Measurement Request message in step 1, the gNB returns a failure message indicating the cause of the failure.

(3) The gNB periodically provides the Multi-RTT measurements as defined in Table 8.10.2.3-3. to the LMF if that was requested at step 1.

(4) At any time after step 2, the LMF may send a Measurement Update message to the gNB providing updated information required for the gNB to perform the Multi-RTT measurements as defined in Table 8.10.2.4-2. Upon receiving the message, the gNB overwrites the previously received measurement configuration information.

(5) If the previously requested Multi-RTT measurements can no longer be reported, the gNB notifies the LMF by sending a Measurement Failure Indication message.

(6) When the LMF wants to abort an ongoing Multi-RTT measurement it sends a Measurement Abort message to the gNB.

8.10.3.2.3 Positioning Activation/Deactivation Procedure

The purpose of this procedure is to enable the LMF to request activation and deactivation of UL-SRS transmission of the target UE.

Figure 8.10.3.2.3-1 shows the messaging between the LMF and the gNB to perform this procedure.

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**Figure 8.10.3.2.3-1: Positioning Activation/Deactivation Procedure.**

(1) The LMF sends the NRPPa Positioning Activation Request message to the serving gNB of the target UE to request UL-SRS activation for the target UE. For a semi-persistent UL-SRS, the message includes an indication of an UL-SRS resource set to be activated and may include information that indicates the spatial relation for the semi-persistent UL-SRS resource to be activated, as listed in Table 8.10.2.4-3. For an aperiodic UL-SRS, the message may include aperiodic SRS Resource trigger list to indicate the UL-SRS resource to be activated.

(2) For semi-persistent UL-SRS, the serving gNB may then activate the configured semi-persistent UL-SRS resource sets by sending the SP Positioning SRS Activation/Deactivation MAC CE command as specified in TS 38.321 [39]. For aperiodic UL-SRS, the serving gNB may then activate the configured aperiodic UL-SRS resource sets by sending the DCI as specified in TS 38.212 [40].  
If the UL-SRS has been successfully activated as requested in step 1, the gNB sends the NRPPa Positioning Activation Response message to the LMF. The serving gNB may include a system frame number and a slot number in the NRPPa Positioning Activation Response message to the LMF. If the serving gNB is not able to fulfil the request from step 1, it returns the Positioning Activation Failure message indicating the cause of the failure.

(3) If a previously activated UL-SRS should be deactivated, or the UL-SRS transmission should be released, the LMF sends the NRPPa Positioning Deactivation message to the serving gNB of the target device to request deactivation of UL-SRS resource sets, or release all the UL-SRS resources. This message includes an indication of the UL-SRS resource set to be deactivated, or an indication of releasing all UL-SRS resources.

8.10.4 Sequence of Procedure for Multi-RTT positioning

Figure 8.10.4-1 shows the messaging between the LMF, the gNBs and the UE to perform LMF-initiated Location Information Transfer Procedure for Multi-RTT.

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**Figure 8.10.4-1: Multi-RTT positioning procedure**

0. The LMF may use the procedure in Figure 8.10.3.2.1-1 to obtain the TRP information required for Multi-RTT positioning.

1. The LMF may request the positioning capabilities of the target device using the LPP Capability Transfer procedure described in clause 8.10.3.1.1.

2. The LMF sends a NRPPa POSITIONING INFORMATION REQUEST message to the serving gNB to request UL information for the target device as described in Figure 8.10.3.2.1-2.

3. The serving gNB determines the resources available for UL-SRS and configures the target device with the UL-SRS resource sets at step 3a.

4. The serving gNB provides the UL-SRS configuration information to the LMF in a NRPPa POSITIONING INFORMATION RESPONSE message.

NOTE: It is up to implementation on whether SRS configuration is provided earlier than DL-PRS configuration.

5. In the case of semi-persistent or aperiodic SRS, the LMF may request activation of UE SRS transmission by sending a NRPPa Positioning Activation Request message to the serving gNB of the target device as described in clause 8.10.3.2.3. The gNB then activates the UE SRS transmission and sends a NRPPa Positioning Activation Response message. The target device begins the UL-SRS transmission according to the time domain behavior of UL-SRS resource configuration.

6. The LMF provides the UL information to the selected gNBs in a NRPPa MEASUREMENT REQUEST message as described in clause 8.10.3.2.2. The message includes all information required to enable the gNBs/TRPs to perform the UL measurements.

7. The LMF sends a LPP Provide Assistance Data message to the target device as described in clause 8.10.3.1.2.1. The message includes any required assistance data for the target device to perform the necessary DL-PRS measurements.

8. The LMF sends a LPP Request Location Information message to request Multi-RTT measurements.

9a: The target device performs the DL-PRS measurements from all gNBs provided in the assistance data at step 7. In NTN, the target device performs the DL-PRS measurements from a single TRP (i.e., satellite) at different time instances.

9b: Each gNB configured at step 6 measures the UE SRS transmissions from the target device.

10. The target device reports the DL-PRS measurements for Multi-RTT to the LMF in a LPP Provide Location Information message.

11. Each gNB reports the UE SRS measurements to the LMF in a NRPPa Measurement Response message as described in clause 8.10.3.2.2.

12. The LMF sends a NRPPa POSITIONING DEACTIVATION message to the serving gNB as described in clause 8.10.3.2.3.

13. The LMF determines the RTTs from the UE and gNB Rx-Tx time difference measurements for each gNB for which corresponding UL and DL measurements were provided at steps 10 and 11 and calculates the position of the target device.

END OF CHANGE