**3GPP TSG-RAN WG2 Meeting #131 *R2-250xxxx***

**Bengaluru, India, Aug. 25th – 29th 2025**

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| --- |
| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  | **38.305** | **CR** | **Draft** | **rev** | **-** | **Current version:** | **18.6.0** |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network | **x** |

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|  |
| ***Title:***  | 38.305 running CR for AIML Positioning |
|  |  |
| ***Source to WG:*** | CATT |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_AIML\_air-Core |  | ***Date:*** | 2025-08-15 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-19 |
|  | *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 canbe 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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Introduction of UE-based DL AI/ML positioning with UE-side model in Rel-19. Only the specification changes for AI/ML positioning Case 1 (UE-based positioning with UE-side model) are captured in this running CR.Note: RAN3 is working on AI/ML positioning Case 3a/3b, and RAN2 is supposed to merge RAN3 stage-2 TPs later. |
|  |  |
| ***Summary of change:*** | Introduction of UE-based DL AI/ML positioning with UE-side model in Rel-19. |
|  |  |
| ***Consequences if not approved:*** | UE-based AI/ML positioning with UE-side model is not supported in Rel-19. |
|  |  |
| ***Clauses affected:*** | 3.1, 3.2, 4.3.1, 4.3.X, 5.4.1, 7.13.1, 8.X |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **x** |  |  Other core specifications  | TS/TR 37.355 CR xxxx |
| ***affected:*** |  | **x** |  Test specifications | TS/TR ... CR ... |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | RAN2#129bis: initial version in R2-2501920RAN2#130: endorsed in R2-2503587, which is updated based on [POST129bis][014][AI PHY] 38.305 Running CR (CATT), and the main changes include:1. Remove separate sub-clause for applicability reporting, and add the corresponding description to “Capability Transfer Procedure”
2. Remove the corresponding description for positioning integrity
3. Add the content of “Information that may be transferred from the LMF to UE” based on available RAN1 agreement

RAN2#131: updated based on [POST130][023][AI PHY] 38.305 CR (CATT), and the main changes include:1. add the corresponding description for positioning integrity
2. update “Information that may be transferred from the LMF to UE” and “Information that may be transferred from the UE to LMF”
3. add “Assistance Data Transfer Procedure” in “Procedures between LMF and UE”
4. add “Procedures between LMF and gNB” and “Information that may be transferred from the gNB to LMF”
 |

*START OF CHANGES*

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

As used in this document, the suffixes "-based" and "-assisted" refer respectively to the node that is responsible for making the positioning calculation (and which may also provide measurements) and a node that provides measurements (but which does not make the positioning calculation). Thus, an operation in which measurements are provided by the UE to the LMF to be used in the computation of a position estimate is described as "UE-assisted" (and could also be called "LMF-based"), while one in which the UE computes its own position is described as "UE-based". For sidelink positioning, an operation in which measurements are provided by a SL Target UE to a server (SL Server UE or LMF) to be used in the computation of a position estimate is described as "SL Target UE-assisted" (and could also be called "server-based"), while one in which the SL Target UE computes its own position is described as "SL Target UE-based".

**Alert Limit (AL)**: The maximum allowable positioning error for the purpose of integrity. If the positioning error is beyond this limit, the integrity results of the calculated location may not meet the integrity requirement.

*Editor's Note: FFS whether we need a definition for applicable functionality, considering the term “(positioning) functionality” is already used at multiple places in TS 38.305.*

**Mobile TRP:** a TRP belonging to a mobile IAB-node.

**Positioning integrity**: A measure of the trust in the accuracy of the position-related data and the ability to provide associated alerts.

**Pre-configured assistance data**: Refers to the DL-PRS assistance data (with associated validity criteria) that can be provided to the UE (before or during an ongoing LPP positioning session), to be then utilized for potential positioning measurements at a future time (e.g. for deferred MT-LR). Pre-configured DL-PRS assistance data may consist of multiple instances, where each instance is applicable to a different area within the network.

**Protection Level (PL):** A statistical upper-bound of the Positioning Error (PE) that ensures that, the probability per unit of time of the true error being greater than the AL and the PL being less than or equal to the AL, for longer than the TTA, is less than the TIR, i.e., the PL satisfies the following inequality:
 *Prob per unit of time* [((*PE>AL*) & (*PL<=AL*)) *for longer than TTA*] *< TIR*
When the PL bounds the positioning error in the horizontal plane or on the vertical axis then it is called Horizontal Protection Level (HPL) or Vertical Protection Level (VPL) respectively.
A specific equation for the PL is not specified as this is implementation-defined. For the PL to be considered valid, it must simply satisfy the inequality above.

NOTE 1: the PL inequality is valid for all values of the AL.

NOTE 2: the TIR may correspond to the achievable TIR in the case that the requested TIR cannot be satisfied.

**PRS-only TP**: A TP which only transmits PRS, DL-PRS signals and is not associated with a cell.

**PRS Processing Window (PPW):** The PRS Processing Window is configured by the network to a UE for NR DL-PRS measurements without measurement gap.

**Ranging/SL Positioning Protocol (RSPP):** RSPP comprises SLPP messages defined in TS 38.355 [47], Supplementary Services messages defined in TS 24.080 [53], and Supplementary RSPP signalling messages defined in TS 24.514 [54].

**Ranging:** Refers to the determination of the distance between two UEs or more UEs and/or the direction of one UE from another UE via sidelink interface.

**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.

**Relative Position:** An estimate of the UE position relative to other network elements or relative to other UEs.

**Rx Time Delay:** From a signal reception perspective, there will be a time delay from the time when the RF signal arrives at the Rx antenna to the time when the signal is digitized and time-stamped at the baseband.

**Rx Timing Error:** Result of Rx time delay involved in the reception of a signal before reporting measurements that are obtained from the signal. It is the uncalibrated Rx time delay, or the remaining delay after the UE/TRP internal calibration/compensation of the Rx time delay, involved in the reception of the DL-PRS/UL SRS signals. The calibration/compensation may also include the calibration/compensation of the relative time delay between different RF chains in the same UE/TRP and may also possibly consider the offset of the Rx antenna phase centre to the physical antenna centre.

**Sidelink Positioning:** A functionality which determines geographical or relative location and possibly velocity using sidelink measurements.

**SL Anchor UE:** A UE, supporting positioning of target UE, e.g. by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc. using Sidelink.

**SL Server UE:** A UE offering position method determination, assistance data distribution and/or location calculation functionalities for sidelink positioning and ranging based services. It interacts with other UEs over PC5 as necessary in order to determine a ranging/SL position method, distribute assistance data and calculate the location of the target UE. A Target UE or SL Anchor UE can act as SL Server UE if any of the functionalities is supported.

**SL Target UE:** A UE whose distance, direction and/or position is measured with the support from one or multiple SL Anchor UEs using sidelink.

**SRS-only RP**: An RP which only receives UL-SRS signals and is not associated with a cell.

**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.

**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.

**TRP Rx 'Timing Error Group' (TRP Rx TEG):** Rx timing errors, associated with TRP reporting of one or more UL measurements, that are within a certain margin.

**TRP RxTx 'Timing Error Group' (TRP RxTx TEG):** Rx timing errors and Tx timing errors, associated with TRP reporting of one or more gNB Rx-Tx time difference measurements, which have the 'Rx timing errors+Tx timing errors' differences within a certain margin.

**TRP Tx 'Timing Error Troup' (TRP Tx TEG):** Tx timing errors, associated with TRP transmissions on one or more DL-PRS resources, that are within a certain margin.

**Tx Time Delay:** From a signal transmission perspective, the time delay from the time when the digital signal is generated at baseband to the time when the RF signal is transmitted from the Tx antenna.

**Tx Timing Error:** Result of Tx time delay involved in the transmission of a signal. It is the uncalibrated Tx time delay, or the remaining delay after the TRP/UE internal calibration/compensation of the Tx time delay, involved in the transmission of the DL-PRS/UL SRS signals. The calibration/compensation may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE and may also possibly consider the offset of the Tx antenna phase centre to the physical antenna centre.

**U2N Relay UE**: A UE that provides functionality to support connectivity to the network for U2N Remote UE(s).

**U2N Remote UE**: A UE that communicates with the network via a U2N Relay UE.

**UE Rx 'Timing Error Group' (UE Rx TEG):** Rx timing errors, associated with UE reporting of one or more DL measurements (RSTD), that are within a certain margin.

**UE RxTx 'Timing Error Group' (UE RxTx TEG):** Rx timing errors and Tx timing errors, associated with UE reporting of one or more UE Rx-Tx time difference measurements, which have the 'Rx timing errors+Tx timing errors' differences within a certain margin.

**UE Tx 'Timing Error Group' (UE Tx TEG):** Tx timing errors, associated with UE transmissions on one or more UL SRS resources for positioning purpose, that are within a certain margin.

*NEXT CHANGE*

## 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

AI Artificial Intelligence

AL Alert Limit

AoA Angle of Arrival

AP Access Point

APC Antenna Phase Center

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-RSCP Downlink Reference Signal Carrier Phase

DL-RSCPD Downlink Reference Signal Carrier Phase Difference

DL-TDOA Downlink Time Difference Of Arrival

DNU Do Not Use

DRX Discontinuous Reception

E-SMLC Enhanced Serving Mobile Location Centre

E-CID Enhanced Cell-ID (positioning method)

ECEF Earth-Centered, Earth-Fixed

ECI Earth-Centered-Inertial

eDRX Extended Discontinuous Reception

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

GCS Global Coordinate System (as defined in TR 38.901 [55])

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

IOD Issue of Data

LCS LoCation Services

 Local Coordinate System (as defined in TR 38.901 [55])

LCS-UP Location Services User Plane

LCS-UPP Location Services User Plane Protocol

LMF Location Management Function

LPP LTE Positioning Protocol

MAC Master Auxiliary Concept

MBS Metropolitan Beacon System

ML Machine Learning

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

PCO Phase Center Offset

PCV Phase Center Variation

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

RSPP Ranging/SL Positioning Protocol

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

RTD Relative Time Difference

RTK Real-Time Kinematic

SBAS Space Based Augmentation System

SDT Small Data Transmission

SET SUPL Enabled Terminal

SIB System Information Block

SL Sidelink

SL-PRS Sidelink Positioning Reference Signal

SL-PRS-RSRP Sidelink PRS Reference Signal Received Power

SL-PRS-RSRPP Sidelink PRS Reference Signal Received Path Power

SL-RSTD Sidelink Reference Signal Time Difference

SL-RTOA Sidelink Relative Time of Arrival

SLP SUPL Location Platform

SLPP Sidelink Positioning Protocol

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-RSCP Uplink Reference Signal Carrier Phase

UL-RTOA Uplink Relative Time of Arrival

UL-SRS Uplink Sounding Reference Signal

UL-TDOA Uplink Time Difference of Arrival

UPF User Plane Function

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

*NEXT CHANGE*

## 4.3 Standard UE Positioning Methods

### 4.3.1 Introduction

The standard positioning methods supported for NG-RAN access are:

- network-assisted GNSS methods;

- observed time difference of arrival (OTDOA) positioning based on LTE signals;

- enhanced cell ID methods based on LTE signals;

- WLAN positioning;

- Bluetooth positioning;

- terrestrial beacon system (TBS) positioning;

- sensor based methods:

- barometric Pressure Sensor;

- motion sensor.

- NR enhanced cell ID methods (NR E-CID) based on NR signals;

- Multi-Round Trip Time Positioning (Multi-RTT based on NR signals);

- Downlink Angle-of-Departure (DL-AoD) based on NR signals;

- Downlink Time Difference of Arrival (DL-TDOA) based on NR signals;

- Uplink Time Difference of Arrival (UL-TDOA) based on NR signals;

- Uplink Angle-of-Arrival (UL-AoA), including A-AoA and Z-AoA based on NR signals;

- SL positioning and Ranging based on sidelink signals, incl.:

- Sidelink Round Trip Time Positioning (SL-RTT);

- Sidelink Angle-of-Arrival (SL-AoA);

- Sidelink Time Difference of Arrival (SL-TDOA);

- Sidelink Time of Arrival (SL-TOA).

- Downlink AI/ML positioning based on NR signals.

Hybrid positioning using multiple methods from the list of positioning methods above is also supported.

Standalone mode (e.g. autonomous, without network assistance) using one or more methods from the list of positioning methods above is also supported.

These positioning methods (except SL positioning and ranging methods) may be supported in UE-based, UE-assisted/LMF-based, and NG-RAN node assisted versions. Table 4.3.1-1 indicates which of these versions are supported in this version of the specification for the standardised positioning methods.

Table 4.3.1-1: Supported versions of UE positioning methods

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Method | UE-based | UE-assisted, LMF-based | NG-RAN node assisted | SUPL Note 8 |
| A-GNSS | Yes | Yes | No | Yes |
| OTDOA Note1, Note 2 | No | Yes | No | Yes |
| E-CID Note 4, Note 7  | No | Yes | Yes | Yes for E-UTRA |
| Sensor | Yes | Yes | No | No |
| WLAN | Yes | Yes | No | Yes  |
| BluetoothNote 9 | Yes | Yes | No | No |
| TBS Note 5 | Yes | Yes | No | Yes (MBS) |
| DL-TDOA | Yes | Yes | No | Yes |
| DL-AoD | Yes | Yes | No | Yes |
| Multi-RTT | No | Yes | Yes | Yes |
| NR E-CID  | No | Yes | Yes | Yes (DL NR E-CID) |
| UL-TDOA | No | No | Yes | Yes |
| UL-AoA | No | No | Yes | Yes |
| DL AI/ML | Yes | No | No | N/A |
| NOTE 1: This includes TBS positioning based on PRS signals.NOTE 2: In this version of the specification only OTDOA based on LTE signals is supported.NOTE 3: VoidNOTE 4: This includes Cell-ID for NR method when UE is served by gNB.NOTE 5: In this version of the specification only for TBS positioning based on MBS signals.NOTE 6: VoidNOTE 7: Enhanced Cell ID based on LTE signals.NOTE 8: This shows whether the positioning method is supported by SUPL ULP [16].NOTE 9: UE-based positioning mode is supported only for Bluetooth AoD positioning method. |

Sensor, WLAN, Bluetooth, and TBS positioning methods based on MBS signals are also supported in standalone mode, as described in the corresponding clauses.

The SL positioning and ranging methods may be supported in SL-Target UE-based or SL-Target UE-assisted/server-based mode, where "server" may be a SL Server UE or LMF. Table 4.3.1-2 indicates which of these versions are supported in this version of the specification for the SL positioning and ranging methods.

Table 4.3.1-2: Supported versions of SL positioning and ranging methods.

|  |  |  |
| --- | --- | --- |
| Method | SL-Target UE-based | SL-Target UE-assisted, server-based |
| SL-RTTNOTE 1 | Yes | Yes |
| SL-AoANOTE 2 | Yes | Yes |
| SL-TDOA | Yes | Yes |
| SL-TOA | Yes | Yes |
| NOTE 1: The SL-RTT method may also be used for ranging between UEs.NOTE 2: The SL-AoA method may also be used to obtain direction between UEs. |

*NEXT CHANGE*

### 4.3.X DL AI/ML positioning

The DL AI/ML positioning method makes use of the downlink signals received from multiple TPs to determine AI/ML model input, at the UE. The UE performs AI/ML model inference using assistance data received from the positioning server, and other configuration information to locate the UE.

The operation of the UE-based DL AI/ML positioning method is described in clause 8.X.

*NEXT CHANGE*

### 5.4.1 User Equipment (UE)

The UE may make measurements of downlink signals from NG-RAN, sidelink signals from other UEs, and other sources such as E-UTRAN, different GNSS and TBS systems, WLAN access points, Bluetooth beacons, UE barometric pressure and motion sensors. The measurements to be made will be determined by the chosen positioning method.

The UE may also contain LCS applications, or access an LCS application either through communication with a network accessed by the UE or through another application residing in the UE. This LCS application may include the needed measurement and calculation functions to determine the UE's position with or without network assistance. This is outside of the scope of this specification.

The UE may also, for example, contain an independent positioning function (e.g., GPS) and thus be able to report its position, independent of the NG-RAN transmissions. The UE with an independent positioning function may also make use of assistance information obtained from the network.

The UE may host AI/ML models to infer the UE location from radio signals transmitted by the gNB(s). The AI/ML model that is used for inference by the UE may have been trained by the UE.

*NEXT CHANGE*

## 7.13 Positioning Integrity

### 7.13.1 General

Positioning Integrity is supported for the following positioning methods:

- GNSS positioning methods as specified in clause 8.1;

- Multi-RTT positioning as specified in clause 8.10;

- DL-AoD positioning as specified in clause 8.11;

- DL-TDOA positioning as specified in clause 8.12;

- UL-TDOA positioning as specified in clause 8.13;

- UL-AoA positioning as specified in clause 8.14;

- DL AI/ML positioning as specified in clause 8.X.

NOTE: The local errors/threats associated with the UE and TRP measurements are implementation dependent. For UE-based mode, local UE errors/threats may be addressed by the UE when determining protection levels.
For UE-assisted mode and network-based positioning, an LMF may address the UE and TRP local errors from UE and/or TRP measurement results. A specific method for determining local UE and TRP errors/threats is not specified as this is implementation defined.

*NEXT CHANGE*

# 8 Positioning methods and Supporting Procedures

## 8.X UE-based DL AI/ML positioning

### 8.X.1 General

In the DL AI/ML positioning method, the UE position is inferred as an output of the AI/ML model.

The inference technique using AI/ML model for UE positioning is up to implementation and beyond the scope of this specification.

### 8.X.2 Information to be transferred between NG-RAN/5GC Elements

#### 8.X.2.0 General

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

#### 8.X.2.1 Information that may be transferred from the LMF to UE

##### 8.X.2.1.0 General

*Editor's note: Information that may be transferred from the LMF to UE depends on RAN1 agreements and future parameter list.*The information that may be transferred from the LMF to the UE are listed in table 8.X.2.1.0-1.

Table 8.X.2.1.0-1: Assistance data that may be transferred from LMF to the UE

|  |
| --- |
| Information  |
| Physical cell IDs (PCIs), global cell IDs (GCIs), ARFCN, and PRS IDs of candidate NR TRPs for measurement |
| Timing relative to the serving (reference) TRP of candidate NR TRPs |
| DL-PRS configuration of candidate NR TRPs |
| Indication of which DL-PRS Resource Sets across DL-PRS positioning frequency layers are linked for DL-PRS bandwidth aggregation |
| SSB information of the TRPs (the time/frequency occupancy of SSBs) |
| Spatial direction information (e.g. azimuth, elevation etc.) of the DL-PRS Resources of the TRPs served by the gNB |
| Explicit parameters for the TRPs served by the gNB, i.e., geographical coordinates of the TRPs served by the gNB (include a transmission reference location for each DL-PRS Resource ID, reference location for the transmitting antenna of the reference TRP, relative locations for transmitting antennas of other TRPs); or implicit parameters for the TRPs served by the gNB, e.g., associated ID |
| Fine Timing relative to the serving (reference) TRP of candidate NR TRPs |
| PRS-only TP indication |
| The association information of DL-PRS resources with TRP Tx TEG ID |
| LOS/NLOS indicators |
| On-Demand DL-PRS-Configurations, possibly together with information on which configurations are available for DL-PRS bandwidth aggregation |
| Validity Area of the Assistance Data |
| PRU measurements together with the location information of the PRU |
| Data facilitating the integrity results determination of the calculated location |

##### 8.X.2.1.1 Mapping of integrity parameters

Table 8.X.2.1.1-1 shows the mapping between the integrity fields and the assistance data according to the Integrity Principle of Operation (Clause 7.13.2). The corresponding field descriptions for each of the field names listed in Table 8.X.2.1.1-1 are specified in TS 37.355 [42].

Table 8.X.2.1.1-1: Mapping of Integrity Parameters

|  |  |  |
| --- | --- | --- |
| Error | NR Assistance Data | Integrity Fields |
| Integrity Alerts | Integrity Bounds (Mean) | Integrity Bounds (StdDev) | Residual Risks | Integrity Correlation Times |
| TRP location | *NR-TRP-LocationInfo* | TRP DNU | Mean TRP/ARP location error | Standard deviation TRP/ARP location error | Probability of Onset of TRP faultMean TRP fault duration | TRP/ARP location error correlation time |
| Inter-TRP synchronization | *NR-RTD-Info* | RTD DNU | Mean RTD error | Standard deviation RTD error | RTD error correlation time |

Note: Integrity Operation is applicable only when NW is providing TRP location explicitly in Assistance Data. However, if TRP location is provided implictly then Integrity Operation is inapplicable.

#### 8.X.2.2 Information that may be transferred from the UE to LMF

##### 8.X.2.2.0 General

The information that may be signalled from UE to the LMF is listed in Table 8.X.2.2.0-1.

Table 8.X.2.2.0-1: Measurement results that may be transferred from UE to the LMF

|  |
| --- |
| Information  |
| Latitude/Longitude/Altitude, together with uncertainty shape |
| Time stamp of location estimate |
| Protection Level, optionally together with achievable Target Integrity Risk |

*Editor's note: FFS what other information may need to be transferred from the UE to LMF except for the information listed above in the table, which depends on RAN1 parameter list or RAN2 further discussion.*

#### 8.X.2.3 Information that may be transferred from the gNB to LMF

##### 8.X.2.3.0 General

The assistance data that may be transferred from gNB to the LMF is listed in Table 8.X.2.3.0-1.

Table 8.X.2.3.0-1: 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 |
| Indication of which DL-PRS Resource Sets across DL-PRS positioning frequency layers are linked for DL-PRS bandwidth aggregation |
| 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, possibly together with information on which configurations are available for DL-PRS bandwidth aggregation |
| TRP Tx TEG association information |
| Mobile TRP Location Information |
| Mobile IAB-MT UE ID NOTE 1 |
| NOTE 1: If TRP Type is Mobile TRP. |

### 8.X.3 DL AI/ML Positioning Procedures

#### 8.X.3.0 General

The procedures described in this clause support UE-based DL AI/ML positioning.

#### 8.X.3.1 Procedures between LMF and UE

##### 8.X.3.1.1 Capability Transfer Procedure

The Capability Transfer procedure for DL AI/ML positioning is described in clause 7.1.2.1.

The unsolicited capability transfer procedure is also to enable the UE to provide information to LMF regarding whether the DL AI/ML positioning method is applicable or not (e.g., as part of a positioning procedure).

Figure 8.X.3.1.1-1 shows the Applicability reporting Transfer operations for the DL AI/ML positioning method when the procedure is initiated by the UE.



Figure 8.X.3.1.1-1: UE-initiated Applicability reporting Transfer Procedure

(1) UE may send an unsolicited LPP Provide Capabilities message to the LMF when the applicability of DL AI/ML positioning method changes.

##### 8.X.3.1.2 Assistance Data Transfer Procedure

###### 8.X.3.1.2.0 General

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 message.

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.X.3.1.2.1 LMF initiated Assistance Data Delivery

Figure 8.X.3.1.2.1-1 shows the Assistance Data Delivery operations for the DL AI/ML positioning method when the procedure is initiated by the LMF.



Figure 8.X.3.1.2.1-1: 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 DL AI/ML positioning assistance data defined in Table 8.X.2.1.0-1.

###### 8.X.3.1.2.2 UE initiated Assistance Data Transfer

Figure 8.X.3.1.2.2-1 shows the Assistance Data Transfer operations for the DL AI/ML positioning method when the procedure is initiated by the UE.



Figure 8.X.3.1.2.2-1: UE-initiated Assistance Data Transfer Procedure

(1) The UE determines that certain DL AI/ML 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 AI/ML 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.X.3.1.3 Location Information Transfer Procedure

###### 8.X.3.1.3.0 General

The purpose of this procedure is to enable the LMF to request location estimate from the UE.

###### 8.X.3.1.3.1 LMF-initiated Location Information Transfer Procedure

Figure 8.X.3.1.3.1-1 shows the Location Information Transfer operations for the DL AI/ML positioning method when the procedure is initiated by the LMF.



Figure 8.X.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 an indication of AI/ML model inference for positioning.

(2) The UE then sends an LPP Provide Location Information message to the LMF, and includes the inferred location coordinates. If the UE is unable to perform the DL AI/ML positioning, the UE returns LPP Provide Location Information message with error cause

*Editor’s note: whether the UE behaviour for activating AI/ML positioning functionality needs to be captured in stage-2.*

#### 8.X.3.2 Procedures between LMF and gNB

##### 8.X.3.2.1 Assistance Data Delivery procedure

###### 8.X.3.2.1.0 General

The purpose of this procedure is to enable the gNB to provide assistance data to the LMF, for subsequent delivery to the UE using the procedures of clause 8.X.3.1.2.

###### 8.12.3.2.1.1 LMF-initiated assistance data delivery to the LMF

Figure 8.X.3.2.1.1-1 shows the TRP Information Exchange operation from the gNB to the LMF for the DL AI/ML positioning method.



Figure 8.X.3.2.1.1-1: 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.

*END OF CHANGES*

# Annex of meeting agreements:

## RAN2#125bis

**Agreements:**

1. For POS, RAN2 assumes gNB or LMF could perform performance monitoring for case 3a and LMF is responsible for the performance monitoring for case 3b and wait for any further inputs from other WGs
2. For POS, RAN2 assumes that NRPPa is used for the signalling between gNB and LMF for case 3a and 3b and the detailed signalling design is up to RAN3.

Agreements

1. Which AI/ML-enabled Features/FGs and functionalities are supported should be standardized. The details wait for RAN1’s progress. “supported” means that the UE is capable of supporting the functionality and doesn’t mean neccesarily that the UE has the model available. FFS what functionality refers to.
2. Supported AI/ML-enabled Features/FGs and supported functionalities are included in UE capability.

**Agreements for positioning and beam management**

1. Support proactive reporting of UE-sided applicable functionality, e.g., the UE reports its applicable AI/ML functionalities via UAI message/LPP message.
2. Support reactive reporting of UE-sided applicable functionality. The NW configures AI/ML functionalities via RRC/LPP message. FFS what the configuration contains. FFS how to report applicable functionality and what is applicable functionality

3 FFS how the two approaches will be specified and whether we can combine them into one procedure. FFS how to report applicable functionality, what is applicable functionality, how the UE determines which function is applicable or not (if it is needed)

## RAN2#126

**Agreements**

2 We will work offline on the definitions for functionality types and define what is availability.

3 The UE will indicate the gNB/LMF whether the AI/ML functionality is available/applicable. For a functionality to be applicable at least there should at least one model available within it. FFS other details on what is applicability/non-applicability.

**Agreements for NWside model**

1 RAN2 to await RAN1 progress to determine need for any specification work on AI/ML positioning Case 3a and Case 3b.

**Agreements**

1. The LPP Capability Transfer procedures (RequestCapabilities/ProvideCapabilities messages) are used to indicate supported AI/ML positioning capabilities. FFS how to handle dynamic capabilities, depending on further RAN1 progress and understanding of the functionality.
2. wait for RAN1 for associate ID discussion
3. At least for Case 1, existing LPP procedures related to Location Information Transfer (RequestLocationInformation/ ProvideLocationInformation messages) are used for providing the results of the UE sided model inference operation. FFS further details on signaling enhancements

## RAN2#127

“General principle” without distinguishing use case in BM case item:

**Agreements on definitions**

1. Supported functionalities refer to functionalities that UE can indicate by using UE capability information (via RRC/LPP signalling)
2. Applicable functionalities refers to functionalities that the UE is ready to apply for inference
3. Activated functionalities refers to functionalities already enabled for performing inference

**Agreements on definitions**

* UE decides the applicable functionalities based on NW-side additional conditions (if provided), UE-side additional conditions (internally known by UE) and model availability in device. FFS whether other configuration can considered by UE (e.g. inference configuration). FFS how the applicable functionality is decided if NW-side additional condition is not provided in step 3.

## RAN2#127bis

**Agreements:**

1: The following procedures for LCM for UE sided model for AI positioning case 1 is the baseline:

 Step 1: LMF may request the UE to report the supported functionalities at the UE side by *LPP request capabilities* message.

 Step 2: UE sends *LPP provide capabilities* message to LMF with the supported functionalities at the UE side.

 Step 3: LMF sends the *LPP provide assistance data* message (which may contain network side additional condition).

 Step 4: UE reports the applicable functionality to the LMF by the *LPP provide capabilities* message.

 Step 5: The LMF requests the inferred location information using the *LPP request location information* message.

 Step 6: UE reports the inferred location using *LPP provide location information* message.

2: Whether the inference configuration is provided in step 3 or/and step 5 is FFS (to be revised based on RAN1 progress).

3: Whether network side additional condition is needed and what it contains is FFS (to be revised based on RAN1 progress).

4: FFS whether LMF controls the UE sending unsolicited LPP provide capabilities (i.e. whether step4 is sent reactively or proactively). FFS the signalling details.

5: RAN2 will decide whether AI positioning will be a new method after further details from RAN1 are received.

## RAN2#128

**Agreements**

1 For POS Case 1, RAN2 confirm that the existing unsolicited UE capability report mechanism in LPP can support UE to report the applicable functionality in both “proactive” and “reactive” as a baseline.

 - Proactive case: When the applicability change, UE can send an unsolicited LPP ProvideCapabilities message to LMF .

 - Reactive case: If the applicability changes based on the configuration in LPP ProvideAssistanceData message in step 3, UE can send an unsolicited LPP ProvideCapabilities message to LMF. Configuration details are FFS

2 As a baseline, If the AIML based positioning method becomes non-applicable when LMF requests UE location estimation, UE cannot perform the AIML based positioning, and reply with LPP Providelocationinformation message with error cause. FFS if other fallback options are considered

## RAN2#129

**Agreements**

1: Introduce AI/ML positioning Case 1 as a new positioning method.

2: Existing LPP procedures related to Location Information Transfer (RequestLocationInformation/ ProvideLocationInformation messages) are used for providing and requesting the results of the UE sided model inference operation. The detail stage 3 message extention can be disucssed while drafting the stage 3 CR.

3: FFS UE autonomous switching between AI/ML and non-AI/ML methods is not allowed. FFS if this is unconditional or linked to condition of multiple positioning method are not configured in RequestLocationInformation,

4: The content of error cause is discussed while drafting stage3 CRs.

5: As a baseline, UE receives the needed assistance data for calculating UE location for AI/ML in step3 (ProvideAssistanceData) and UE receives the instruction to perform the inference in step 5 (RequestLocationInformation). The content of Assistance Data and the content of request location information is based upon RAN1 parameter list.

6: UE reports the applicable functionality to the LMF by the LPP provide capabilities message if there is a change of applicable functionality. FFS if any additional LMF control is needed.

## RAN2#129bis

**Agreements for positioning case 1**

1. LMF is responsible for functionality management
2. UE reports the applicable functionality to the LMF by the LPP provide capabilities message without any additional LMF control.
3. Switching/fallback to non-AI/ML positioning can be supported by including multiple positioning methods in a LPP Request Location Information message. No additional specification work is foreseen specifically for supporting "switching/fallback operation".
4. An AIML positioning functionality is considered “activated” once UE receives an LPP RequestLocationInformation from the LMF requesting inferred location information.
5. For triggered and periodical reporting, we rely on existing positioning framework mechanisms to deactivate AI/ML positioning (no spec impact is foreseen)

## RAN2#130

**Agreements**

1 The field dl-PRS-ResourcePrioritySubset in IE NR-DL-PRS-Info should be ignored for NR AI/ML positioning. Remove corresponding 'Editor's Note' from the running CR.

2 Regarding the applicability of IE NR-DL-PRS-ProcessingCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now.

3 Regarding the applicability of IE NR-DL-PRS-QCL-ProcessingCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now.

4 Regarding the applicability of IE NR-DL-PRS-ResourcesCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now.

5 The IE NR-On-Demand-DL-PRS-Configurations-Selected-IndexList is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3, 6.5.10.1, and 6.5.11.1 can be removed.

6 The IE NR-AI-ML-PositioningProvideAssistanceData contains (at least) all assistance data elements from UE-based DL-TDOA as starting point. This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now.

7 The IE NR-AI-ML-PositioningRequestAssistanceData contains (at least) all assistance data elements from UE-based DL-TDOA as starting point. This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now.

8 The IE NR-AI-ML-PositioningProvideLocationInformation contains (at least) the time stamp for the location coordinates (which are reported in CommonIEsProvideLocationInformation). This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now.

9 The IE NR-AI-ML-PositioningRequestLocationInformation contains (at least) the AssistanceAvailability flag. Additional details/information can be discussed via company contributions.

10 The IE NR-AI-ML-PositioningProvideCapabilities contains (at least) all capabilities from UE-based DL-TDOA as starting point, except the capability related to DL-PRS processing (see #LPP-2/3/4). This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now.

11 (LPP-17): A target UE can obtain the "ground-truth label" information via existing MO-LR procedures. No additional RAN2 specification impacts are foreseen

12 Reuse the existing NR-DL-TDOA-LocationServerErrorCauses structure for AI/ML positioning Case 1, and do not introduce additional error causes in NR-DL-AI-ML-LocationServerErrorCauses.

13 Introduce ‘DL AIML positioning not available’ as new target device error cause for AI/ML positioning case 1, to indicate UE cannot perform positioning method (e.g. model not available and performance monitoring outcome not available).

14 (LPP-15) positioning Integrity is supported for AI/ML positioning Case 1

15 No new LPP message is introduced for performance monitoring purposes

16 [LPP-6] The IE NR-PRU-DL-Info is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3 can be removed. FFS if more PRUs are needed to be included for training purposes

17 NR-SelectedDL-PRS-IndexList is applicable to AI/ML positioning Case 1.

18 To ensure the consistency between training and inference, the UE should be able to request assistance data associated with a specific group of TRPs. FFS the request associated information in on demand prs request.