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Contents

Foreword

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1 Scope

The present document specifies the stage 2 of the UE Positioning function of NG-RAN which provides the mechanisms to support or assist the calculation of the geographical position of a UE. UE position knowledge can be used, for example, in support of Radio Resource Management functions, as well as location-based services for operators, subscribers, and third-party service providers. The purpose of this stage 2 specification is to define the NG-RAN UE Positioning architecture, functional entities and operations to support positioning methods. This description is confined to the NG-RAN Access Stratum. It does not define or describe how the results of the UE position calculation can be utilised in the Core Network (e.g., LCS) or in NG-RAN (e.g., RRM).

UE Positioning may be considered as a network-provided enabling technology consisting of standardised service capabilities that enable the provision of location applications. The application(s) may be service provider specific. The description of the numerous and varied possible location applications which are enabled by this technology is outside the scope of the present document. However, clarifying examples of how the functionality being described may be used to provide specific location services may be included.

This stage 2 specification covers the NG-RAN positioning methods, state descriptions, and message flows to support UE Positioning.

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_4: "UserPlane Location Protocol Approved Version 2.0.4".

[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-2.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal (Version 2.0)", December 2013.

[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".

3 Definitions, symbols and abbreviations

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".

Transmission Point (TP): A set of geographically co-located transmit antennas for one cell, part of one cell or one 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 PRS-only TP, etc. One cell can be formed by one or multiple transmission points. For a homogeneous deployment, each transmission point may correspond to one cell.

PRS-only TP: A TP which only transmits PRS signals for PRS-based TBS positioning for E-UTRA and is not associated with a cell.

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
ADR	Accumulated Delta Range
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)
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 Center
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
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
OTDOA	Observed Time Difference Of Arrival
PDU	Protocol Data Unit
PPP	Precise Point Positioning
PRS	Positioning Reference Signal (for E-UTRA)
QZSS	Quasi-Zenith Satellite System
RRM	Radio Resource Management
RSSI	Received Signal Strength Indicator
RTK	Real-Time Kinematic

SBAS	Space Based Augmentation System
SET	SUPL Enabled Terminal
SLP	SUPL Location Platform
SSID	Service Set Identifier
SSR	State Space Representation
SUPL	Secure User Plane Location
T_{ADV}	Timing Advance
TBS	Terrestrial Beacon System
TP	Transmission Point
UE	User Equipment
WAAS	Wide Area Augmentation System
WGS-84	World Geodetic System 1984
WLAN	Wireless Local Area Network

4 Main concepts and requirements

4.1 Assumptions and Generalities

The stage 1 description of LCS at the service level is provided in TS 22.071 [3]; the stage 2 LCS functional description, including the LCS system architecture and message flows, is provided in TS 23.501 [2] and TS 23.502 [26].

Positioning functionality provides a means to determine the geographic position and/or velocity of the UE based on measuring radio signals. The position information may be requested by and reported to a client (e.g., an application) associated with the UE, or by a client within or attached to the core network. The position information shall be reported in standard formats, such as those for cell-based or geographical co-ordinates, together with the estimated errors (uncertainty) of the position and velocity of the UE and, if available, the positioning method (or the list of the methods) used to obtain the position estimate.

Restrictions on the geographic shape encoded within the 'position information' parameter may exist for certain LCS client types. The 5GS, including NG-RAN, shall comply with any shape restrictions defined in 5GS and, in a particular country, with any shape restrictions defined for a specific LCS client type in relevant national standards. For example, in the US, national standard J-STD-036-C-2 restricts the geographic shape for an emergency services LCS client to minimally either an "ellipsoid point" or an "ellipsoid point with uncertainty circle" as defined in TS 23.032 [4].

It shall be possible for the majority of the UEs within a network to use the LCS feature without compromising the radio transmission or signalling capabilities of the NG-RAN.

The uncertainty of the position measurement shall be network-implementation-dependent, at the choice of the network operator. The uncertainty may vary between networks as well as from one area within a network to another. The uncertainty may be hundreds of metres in some areas and only a few metres in others. In the event that a particular position measurement is provided through a UE-assisted process, the uncertainty may also depend on the capabilities of the UE. In some jurisdictions, there is a regulatory requirement for location service accuracy that is part of an emergency service. Further details of the accuracy requirements can be found in TS 22.071 [3].

The uncertainty of the position information is dependent on the method used, the position of the UE within the coverage area and the activity of the UE. Several design options of the NG-RAN system (e.g., size of cell, adaptive antenna technique, pathloss estimation, timing accuracy, ng-eNB and gNB surveys) shall allow the network operator to choose a suitable and cost-effective UE positioning method for their market.

There are many different possible uses for the positioning information. The positioning functions may be used internally by the 5GS, by value-added network services, by the UE itself or through the network, and by "third party" services. The feature may also be used by an emergency service (which may be mandated or "value-added"), but the location service is not exclusively for emergencies.

Design of the NG-RAN positioning capability as documented in this specification includes position methods, protocols and procedures that are either adapted from capabilities already supported for E-UTRAN, UTRAN and GERAN, or created separately from first principles. In contrast to GERAN and UTRAN but similarly to E-UTRAN, the NG-RAN positioning capabilities are intended to be forward compatible to other access types and other position methods, in an effort to reduce the amount of additional positioning support needed in the future. This goal also extends to user plane