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**LTE;
Evolved Universal Terrestrial
Radio Access Network (E-UTRAN);
Stage 2 functional specification of User Equipment (UE)
positioning in E-UTRAN
(3GPP TS 36.305 version 15.6.0 Release 15)**



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1 Scope

The present document specifies the stage 2 of the UE Positioning function of E-UTRAN, 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 E-UTRAN UE Positioning architecture, functional entities and operations to support positioning methods. This description is confined to the E-UTRAN 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 E-UTRAN (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 E-UTRAN positioning methods, state descriptions, and message flows to support UE Positioning.

2 References

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

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] apply.

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 E-SMLC to be used in the computation of a position estimate is described as "UE-assisted" (and could also be called "E-SMLC-based"), while one in which the UE computes its own position is described as "UE-based".

Both standalone LMU and LMU integrated into an eNB are supported. As used in this document, LMU refers to both cases of a standalone LMU and an LMU integrated into an eNodeB unless explicitly mentioned otherwise.

State Space Representation (SSR): The state space representation provides information on the status of individual GNSS error sources. State parameter values are transmitted to UE. The user corrects his own observations of a single GNSS receiver with SSR corrections computed from these state parameters for his individual position, and performs RTK positioning with corrected observations. This contrasts with Observation Space Representation (OSR) which uses a lump-sum of distance-dependent GNSS errors instead of individual GNSS error sources. For OSR the representation of RTK network corrections in the observation space always uses GNSS observation of an actual reference station, which are then applied by the user to the conventional RTK algorithm.

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 (eNode B) 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 and is not associated with a cell.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply.

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)
CIoT	Cellular IoT
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
IoT	Internet of Things
LCS	LoCation Services
LCS-AP	LCS Application Protocol
LMU	Location Measurement Unit
LPP	LTE Positioning Protocol
LPPa	LTE Positioning Protocol Annex
MAC	Master Auxiliary Concept
MBS	Metropolitan Beacon System
MO-LR	Mobile Originated Location Request
MT-LR	Mobile Terminated Location Request
NB-IoT	NarrowBand Internet of Things

NI-LR	Network Induced Location Request
N-RTK	Network – Real-Time Kinematic
OTDOA	Observed Time Difference Of Arrival
PDU	Protocol Data Unit
posSIB	Positioning SIB
PPP	Precise Point Positioning
PRS	Positioning Reference Signal
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
SIB	System Information Block
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
UTDOA	Uplink Time Difference of Arrival
WAAS	Wide Area Augmentation System
WGS-84	World Geodetic System 1984
WLAN	Wireless Local Area Network

iTeH STANDARD PREVIEW

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 23.271 [2].

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 EPS, including E-UTRAN, shall comply with any shape restrictions defined in LTE 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-B restricts the geographic shape for an emergency services LCS client to minimally either an "ellipsoid point" or an "ellipsoid point with uncertainty circle and confidence" as defined in TS 23.032 [4].

It shall be possible for the majority of the UEs (active or inactive) within a network to use the LCS feature without compromising the radio transmission or signalling capabilities of the E-UTRAN.

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 E-UTRAN system (e.g., size of cell, adaptive antenna

technique, pathloss estimation, timing accuracy, eNode B 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 EPS, 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.

The E-UTRAN is a new radio system design without a pre-existing deployment of "legacy" UEs operating according to the radio interface. This freedom from legacy equipment enables the location service feature design to make use of appropriate techniques to provide the most accurate results. The technique must also be a cost-effective total solution, must allow evolution to meet evolving service requirements, and must be able to take advantage of advances in technology over the lifetime of E-UTRAN deployments.

Design of the E-UTRAN positioning capability as documented in this specification includes position methods, protocols and procedures that are either adapted from capabilities already supported for UTRAN and GERAN, or created separately from first principles. The proportion of the latter is higher than if the UTRAN and GERAN capabilities had been designed to provide forward compatibility to other access types. In contrast to GERAN and UTRAN, the E-UTRAN 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 location solutions such as OMA SUPL ([17], [18]), for which E-UTRAN positioning capabilities are intended to be compatible where appropriate.

As a basis for the operation of UE Positioning in E-UTRAN, the following assumptions apply:

- both TDD and FDD will be supported;
- the provision of the UE Positioning function in E-UTRAN and EPC is optional through support of the specified method(s) in the eNode B and the E-SMLC;
- UE Positioning is applicable to any target UE, whether or not the UE supports LCS, but with restrictions on the use of certain positioning methods depending on UE capability (as defined within the LPP protocol);
- the positioning information may be used for internal system operations to improve system performance;
- the UE Positioning architecture and functions shall include the option to accommodate several techniques of measurement and processing to ensure evolution to follow changing service requirements and to take advantage of advancing technology;
- LMU aspects are left for implementation and are not standardized in this release.

4.2 Role of UE Positioning Methods

The E-UTRAN may utilise one or more positioning methods in order to determine the position of an UE.

Positioning the UE involves two main steps:

- signal measurements; and
- Position estimate and optional velocity computation based on the measurements.

The signal measurements may be made by the UE or the eNode B. The basic signals measured for terrestrial position methods are typically the E-UTRA radio transmissions; however, other methods may make use of other transmissions such as general radio navigation signals including those from Global Navigation Satellites Systems (GNSSs).

The positioning function should not be limited to a single method or measurement. That is, it should be capable of utilising other standard methods and measurements, as such methods and measurements are available and appropriate, to meet the required service needs of the location service client. This additional information could consist of readily available E-UTRAN measurements.

The position estimate computation may be made by the UE or by the E-SMLC.

4.3 Standard UE Positioning Methods

The standard positioning methods supported for E-UTRAN access are:

- network-assisted GNSS methods;
- downlink positioning;
- enhanced cell ID method;
- uplink positioning;
- WLAN method;
- Bluetooth method;
- Terrestrial Beacon System method;
- Sensor based methods:
 - Barometric Pressure Sensor;
 - Motion sensor.

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 may be supported in UE-based, UE-assisted/E-SMLC-based, eNB-assisted, and LMU-assisted/E-SMLC-based versions. Table 4.3-1 indicates which of these versions are supported in this version of the specification for the standardised positioning methods.

Table 4.3-1: Supported versions of UE positioning methods

Method	UE-based	UE-assisted, E-SMLC-based	eNB-assisted	LMU-assisted/ E-SMLC-based	SUPL
A-GNSS	Yes	Yes	No	No	Yes (UE-based and UE-assisted)
Downlink Note 1	No	Yes	No	No	Yes (UE-assisted)
E-CID	No	Yes	Yes	No	Yes (UE-assisted)
Uplink	No	No	No	Yes	No
Sensor	Yes	Yes	No	No	No
WLAN	Yes	Yes	No	No	Yes
Bluetooth	No	Yes	No	No	No
TBS Note 2	Yes	Yes	No	No	Yes (MBS)
NOTE 1: This includes TBS positioning based on PRS signals.					
NOTE 2: In this version of the specification only for TBS positioning based on MBS signals.					

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

4.3.1 Network-assisted GNSS Methods

These methods make use of UEs that are equipped with radio receivers capable of receiving GNSS signals. In 3GPP specifications the term GNSS encompasses both global and regional/augmentation navigation satellite systems.

Examples of global navigation satellite systems include GPS, Modernized GPS, Galileo, GLONASS, and BeiDou Navigation Satellite System (BDS). Regional navigation satellite systems include Quasi Zenith Satellite System