ETSI TS 143 059 V18.0.0 (2024-05)

Digital cellular telecommunications system (Phase 2+) (GSM); Functional stage 2 description of Location Services (LCS) in GERAN (3GPP TS 43.059 version 18.0.0 Release 18)

A GLOBAL INITIATIVE
GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

Reference
RTS/TSGR-0043059vi00

Keywords
GSM

ETSI

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Contents

Foreword

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1 Scope

The present document specifies the stage 2 of the LoCation Services (LCS) feature in GERAN, which provides the mechanisms to support mobile location services for operators, subscribers and third party service providers.

The purpose of this stage 2 specification is to define the GERAN LCS architecture, functional entities and operations to support location methods. This description is confined to the aspects of LCS within the GERAN and does not define nor describe the LCS entities or operations within the Core Network.

Location Services may be considered as a network provided enabling technology consisting of standardised service capabilities, which 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 are 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 GERAN LCS functional model and entities, the location methods, state descriptions, and message flows.

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 22.071: "Location Services (LCS); Service description - Stage 1".

[3] 3GPP TS 22.101: "Service aspects; Service principles".

[4] 3GPP TS 23.007: "Restoration procedures".

[5] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

[6] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[7] 3GPP TS 23.271: "Functional stage 2 description of location services".

[8] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specificiation; Core Network Protocols; Stage 3".

[9] 3GPP TS 24.030: "Location Services (LCS); Supplementary service operations; Stage 3".

[10] 3GPP TS 24.080: "Mobile radio Layer 3 Supplementary Services specification; Formats and coding".

[11] 3GPP TS 43.051: "GSM/EDGE Radio Access Network (GERAN) overall description; Stage 2".

[12] 3GPP TS 44.006: "Mobile Station - Base Station System (MS - BSS) interface; Data Link (DL) layer specification".

[13] 3GPP TS 44.012: "Short Message Service Cell Broadcast (SMSCB) Support on the Mobile Radio Interface".

[14] 3GPP TS 44.018: "Mobile radio interface layer 3 specification; Radio Resource Control Protocol".

[15] 3GPP TS 44.031: "Location Services (LCS); Mobile Station (MS) - Serving Mobile Location Centre (SMLC) Radio Resource LCS Protocol (RRLP)".

[16] 3GPP TS 44.035: "Location Services (LCS); Broadcast Network Assistance for Enhanced Observed Time Difference (E-OTD) and Global Positioning System (GPS) Positioning Methods".

[17] 3GPP TS 44.071: "Location Services (LCS); Mobile Radio Interface Layer 3 Location Services (LCS) specification".

[18] 3GPP TS 48.008: "Mobile-services Switching Centre - Base Station System (MSC - BSS) interface; Layer 3 specification".

[19] 3GPP TS 48.031: "Location Services (LCS); Serving Mobile Location Centre - Serving Mobile Location Centre (SMLC - SMLC); SMLCPP specification".

[20] 3GPP TS 48.058: "Base Station Controller - Base Transceiver Station (BSC - BTS) interface; Layer 3 specification".

[21] 3GPP TS 48.071: "Serving Mobile Location Center – Base Station System (SMLC-BSS) interface; Layer 3 specification".

[22] 3GPP TS 49.031: "Location Services (LCS); Base Station System Application Part LCS Extension (BSSAP-LE)".

[23] TIA/EIA/IS-J-STD-036 (2000): "Emergency Services Data Communications".

[24] 3GPP TS 48.016: "General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN) interface; Network Service".

[25] 3GPP TS 48.018: "General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN); BSS GPRS Protocol (BSSGP)".

[26] 3GPP TS 44.064: "Mobile Station - Serving GPRS Support Node (MS-SGSN) Logical Link Control (LLC) layer specification".

[27] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[28] 3GPP TS 44.060: "General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol".

[29] 3GPP TS 25.410: "UTRAN Iu Interface: General Aspects and Principles".

[30] 3GPP TS 25.411: "UTRAN Iu Interface Layer 1".

[32] 3GPP TS 25.412: "UTRAN Iu Interface signalling transport".

[33] 3GPP TS 25.413: "UTRAN Iu Interface RANAP signalling".

[34] Void.

[35] IETF STD 51, RFC 1661(07/1994): "The Point-To-Point Protocol (PPP)".

[36] IETF STD 51, RFC 1662(07/1994): "PPP in HDLC-like Framing".

[37] IETF RFC 2507(02/1999): "IP header compression".

[38] IETF RFC 1990(07/1994): "The PPP Multilink Protocol (MP)".

[39] IETF RFC 2686(09/1999): "The Multi-Class Extension to Multi-Link PPP".

[40] IETF RFC 2509(02/1999): "IP Header Compression over PPP".

[41] 3GPP TS 43.064: "General Packet Radio Service (GPRS); Overall description of the GPRS radio interface; Stage 2".

[42] 3GPP TS 45.010: "Radio subsystem synchronization".

[43] 3GPP TS 43.020. “Security related network functions”.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document the following terms and definitions apply and the terms and definitions given in 3GPP TS 22.101.

A/Gb mode: see 3GPP TS 43.051 [11].

Coverage Class: see 3GPP TS 43.064 [41].

EC-GSM-IoT: see 3GPP TS 43.064 [41].

EC operation: see 3GPP TS 43.064 [41].

Iu mode: see 3GPP TS 43.051 [11].

LCS (LoCation Services): LCS is a service concept in system standardisation. LCS specifies all the necessary network elements and entities, their functionality, interfaces, as well as communication messages, necessary to implement the positioning functionality in a cellular network.

NOTE 1: LCS does not specify any location based (value added) services except locating of emergency calls.

LCS Client: software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the Mobile Station (MS).

LCS Server: software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components, which are distributed to one or more PLMN and/or service provider.

Location Estimate: geographic location of an MS and/or valid Mobile Equipment (ME), expressed in latitude and longitude data. The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.

Location Request: request for a Location Estimate and optionally a Velocity Estimate.

Mobile Assisted positioning: any mobile centric positioning method (e.g. E-OTD, A-GNSS) in which the MS provides position measurements to the network for computation of a location estimate by the network. The network may provide assistance data to the MS to enable position measurements and/or improve measurement performance.

Mobile Based positioning: any mobile centric positioning method (e.g. E-OTD, A-GNSS) in which the MS performs both position measurements and computation of a location estimate and where assistance data useful or essential to one or both of these functions is provided to the MS by the network. Position methods where an MS performs measurements and location computation without network assistance data are not considered within this category.

Mobile Station: consists of Mobile or User Equipment (ME or MS) with a valid SIM or USIM attached.

Positioning (/location detecting): positioning is a functionality, which detects a geographical location (of e.g. a mobile terminal).

Positioning technology (/locating technology): technology or system concept including the specifications of RF interfaces, data types, etc. to process the estimation of a geographical location, e.g. A-GNSS and E-OTD.

Radio Interface Timing: Comprise Absolute Time Differences (ATDs) or Real Time Differences (RTDs) of the signals transmitted by Base Stations, where timing differences are measured relative to either some absolute time difference (ATD) or the signals of another Base Station (RTD).

RRLP maximum PDU size: maximum PDU size for the RRLP protocol, which is 242 octets.

RRLP pseudo-segmentation: use of several RRLP data messages to deliver a large amount of information.

Target MS: Mobile Station being positioned.

Type A LMU: accessed exclusively over the air interface (Um interface): there is no wired connection to any other network element.

Type B LMU: is accessed over the Abis interface from a BSC. The LMU may be either a standalone network element addressed using some pseudo-cell ID or connected to or integrated in a BTS.

Velocity Estimate: speed and bearing of an MS and/or valid Mobile Equipment (ME), expressed as speed in kilometres per hour and bearing in degrees measured clockwise from North.

NOTE 2: Abis interface is beyond the scope of the present document.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations and the abbreviations given in 3GPP TS 21.905 apply.

2G-	Second Generation
3G-	Third Generation
A	Interface between GERAN BSS and MSC
A-GNSS	Assisted GNSS
A-GPS	Assisted GPS
ATD	Absolute Time Difference
BDS	BeiDou Navigation Satellite System
BSSLAP	Base Station System Application Part
BSSAP-LE	Base Station System Application Part LCS Extension
CBC-BSC	Interface between CBC and BSC
CBC-SMLC	Interface between CBC and SMLC
D-GPS	Differential GPS
E-OTD	Enhanced Observed Time Difference
GNSS	Global Navigation Satellite System (e.g. GPS, Galileo)
Iu	Interface between GERAN BSS and 3G Core Network
Iu-cs	Interface between GERAN BSS and 3G MSC
Iu-ps	Interface between GERAN BSS and 3G SGSN
Gb	Interface between GERAN BSS and SGSN
Lb	Interface between SMLC and BSC
LCCF	Location Client Control Function
LCF	Location Client Function
LSBcF	Location System Broadcast Function
LSCF	Location System Control Function
LSOF	Location System Operation Function
MTA	Multilateration Timing Advance
PCF	Position Calculation Function
PRCF	Positioning Radio Co-ordination Function
PRRM	Positioning Radio Resource Management
PSMF	Positioning Signal Measurement Function
RIT	Radio Interface Timing
RRLP	Radio Resource Link Protocol
RTD	Real Time Difference
SMSCB	Short Message Service Cell Broadcast
SMLCPP	Serving Mobile Location Center Peer Protocol
TA	Timing Advance
UDT	SCCP Unitdata message
Um	GERAN Air Interface
UTC	Universal Coordinated Time
U-TDOA	Uplink Time Difference of Arrival

4 Main concepts

A general description of location services and the service requirements is given in the specification 3GPP TS 22.071. By measuring radio signals the capability to determine the geographic location of the mobile station (MS) shall be provided. The location information may be requested by and reported to a client (application) associated with the MS, or by a client within or attached to the Core Network. The location information may also be utilised internally by GERAN, for example to support features such as home location billing. The location information shall be reported in standard formats, such as those for cell based or geographical coordinates of the location of the MS.

It shall be possible for the majority of the MS (active or idle) within a network to use the feature without compromising the radio transmission or signalling capabilities of the GERAN.

Five positioning mechanisms are supported for LCS: Timing Advance (TA), Enhanced Observed Time Difference (E-OTD), Global Navigation Satellite System (GNSS) based positioning (A-GNSS), Uplink Time Difference Of Arrival (U-TDOA), and Multilateration based positioning.

4.1 Assumptions

- SMLC is either an integrated functionality in BSS or a standalone network element within GERAN.
- LMU is either an integrated functionality in BTS (Type B LMU) or a standalone network element (Type A LMU) where communication is over the Um interface.

4.2 Standard LCS Methods

4.2.1 Timing Advance

The TA is based on the existing Timing Advance (TA) parameter. The TA value is known for the serving BTS. To obtain TA values in case the MS is in idle mode a special procedure, not noticed by the GSM subscriber (no ringing tone), is set up. The cell-ID of the serving cell and the TA is returned as the result of the TA.

TA may be used to assist all positioning mechanisms.

4.2.2 Enhanced Observed Time Difference (E-OTD) positioning mechanism

The E-OTD method is based on measurements in the MS of the Enhanced Observed Time Difference of arrival of bursts of nearby pairs of BTSs. For E-OTD measurement synchronization, normal and dummy bursts are used. When the transmission frames of BTSs are not synchronized, the network needs to measure the Real or Absolute Time Differences (RTDs or ATDs) between them. To obtain accurate trilateration, E-OTD measurements and, for non-synchronized BTSs, RTD or ATD measurements are needed for at least three distinct pairs of geographically dispersed BTSs. Based on the measured E-OTD values the location of MS can be calculated either in the network or in the MS itself, if all the needed information is available in MS.

4.2.3 Global Navigation Satellite System (GNSS) based positioning mechanism

Global Navigation Satellite System (GNSS) refers to satellite systems that are set up for positioning purposes. Systems belonging to this category, that are operational today or will be in the near future are e.g., GPS, Galileo, Satellite Based Augmentation Systems (SBAS), Modernized GPS, Quasi Zenith Satellite System (QZSS), GLONASS and BDS.

A mobile station with GNSS measurement capability may operate in an autonomous mode or in an assisted mode for example MS-assisted or MS-based mode. In autonomous mode MS determines its position based on signals received from GNSS without assistance from network. In assisted mode, MS receives assistance data from network. MS may support one or several GNSSs and the assistance data content may vary depending on this capability.

A-GNSS refers to a concept which supports several global navigation satellite systems and their different navigation signals, including e.g. GPS, Galileo, Satellite Based Augmentation Systems (SBAS), Modernized GPS, Quasi Zenith

Satellite System (QZSS), GLONASS and BDS. The assistance data shall enable combined usage of satellite signals belonging to different GNSS or simple usage of one GNSS system independently from the other.

4.2.4 Uplink Time Difference of Arrival (U-TDOA) positioning mechanism

The U-TDOA positioning method is based on network measurements of the Time Of Arrival (TOA) of a known signal sent from the mobile and received at three or more LMUs. The known signal is the normal bursts generated by a mobile while in the dedicated mode; either on the SDCCH or TCH. The method requires LMUs in the geographic vicinity of the mobile to be positioned to accurately measure the TOA of the bursts. Since the geographical coordinates of the measurement units are known, the mobile position can be calculated via hyperbolic trilateration. This method will work with existing mobiles without any modification.

4.2.5 Multilateration Positioning Methods

4.2.5.1 Multilateration Timing Advance

This positioning method is based on one or more BSS acquiring Timing Advance (TA) information from a set of cells selected by the MS wherein the MS is triggered to perform MTA as a result of receiving a RRLP message from an SMLC indicating the MTA positioning method is to be used (see sub-clause 9.6.2). The MS sends a Multilateration access request in each of the cells it selects for performing the Multilateration Timing Advance procedure.

4.2.5.2 Multilateration OTD

This positioning method is based on measurements in the MS of the Observed Time Difference of arrival of bursts of a set of nearby BTSs relative to the serving BTS and reporting of these measurements to the serving BTS, similar as for the E-OTD positioning method, see subclause 4.2.2. The network provides assistance information to the MS about the co-sited neighbour cells to optimise the OTD measurements at MS. No LMUs are required for this positioning method. Based on the measured Multilateration OTD values and timing advance estimated with the serving base station, the location of the MS is calculated in the network.

5 GERAN LCS Architecture

Figure 1 shows the general arrangement of the Location Service feature. This illustrates, generally, the relation of LCS Clients and servers in the core network with the GERAN. The definition and operation of LCS entities operating in the core network is outside the scope of the present document. The LCS entities within the GERAN communicate with the Core Network (CN) across the A, Gb and Iu interfaces.

Communication among the GERAN LCS entities makes use of the messaging and signalling capabilities of the GERAN.

As part of their service or operation, the LCS Clients may request the location information of Mobile Station. There may be more than one LCS client. These may be associated with the core network, associated with the GERAN, operated as part of a MS application or accessed by the MS through its access to an application (e.g. through the Internet).

Within the GERAN, the BSC receives authenticated requests for LCS information from the core network across the A, Gb or Iu interface and passes these to the SMLC. The SMLC may be a standalone network element or functionality that is integrated to the BSC. LCS entities then manage the GERAN resources, including the base station, the LMU, the MS and calculation functions, to estimate the location of the MS and return the result to the Core Network.