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Functional stage 2 description of
Location Services (LCS) in GERAN
(3GPP TS 43.059 version 13.2.0 Release 13)

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GSM® GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

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Contents

Intellectual Property Rights 2
Foreword 2
Modal verbs terminology 2
Foreword 7
1 Scope 8
2 References 8
3 Definitions and abbreviations 10
3.1 Definitions 10
3.2 Abbreviations 11
4 Main concepts 12
4.1 Assumptions 12
4.2 Standard LCS Methods 12
4.2.1 Timing Advance 12
4.2.2 Enhanced Observed Time Difference (E-OTD) positioning mechanism 12
4.2.3 Global Navigation Satellite System (GNSS) based positioning mechanism 12
4.2.4 Uplink Time Difference of Arrival (U-TDOA) positioning mechanism 13
5 GERAN LCS Architecture 13
5.1 LCS Operations 14
5.2 High-Level Functions 15
5.2.1 Co-ordination, Measurement and Calculation Functions 15
5.3 GERAN LCS Functional Entities 16
5.3.1 Internal Client Group 16
5.3.1.1 Internal GERAN Location Client Function (LCF) 16
5.3.2 GERAN System Handling group 16
5.3.2.1 GERAN Location System Control Function (LSCF) 16
5.3.2.2 GERAN Location System Operations Function (LSOF) 16
5.3.2.3 Location System Broadcast Function (LSBcF) 16
5.3.3 Positioning group 17
5.3.3.1 GERAN Position Radio Co-ordination Function (PRCF) 17
5.3.3.2 GERAN Position Calculation Function (PCF) 17
5.3.3.3 GERAN Position Signal Measurement Function (PSMF) 18
5.3.3.4 GERAN Position Radio Resource Management (PRRM) 18
5.4 Assignment of LCS Functional Entities to GERAN Elements 18
5.5 Functional Description of GERAN LCS Network Elements 18
5.5.1 BSC 18
5.5.2 SMLC 18
5.5.3 CBC 19
5.5.4 LMU 19
5.5.5 MS 19
6 Signalling Protocols and Interfaces 19
6.1 Protocol layering in A/Gb mode 19
6.1.1 Generic Signalling Model 19
6.1.2 Message Segmentation in A/Gb mode 20
6.1.2.1 Network Level Segmentation 20
6.1.2.2 Intermediate Level Segmentation 21
6.1.2.3 RRLP Pseudo-Segmentation 21
6.1.3 Signalling between an SMLC, MSC and BSC 21
6.1.3a Signalling between an SMLC, SGSN and BSS 21
6.1.4 Signaling between SMLC and MS 22
6.1.5 SMLC Signalling to a Type A LMU 23
6.1.5.1 Circuit Switched Signalling using an SDCCH 23

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6.1.5.2 Signalling using a TCH 23
6.1.6 SMLC signalling to a Type B LMU 24
6.1.7 SMLC Signalling to a peer SMLC 25
6.2 Protocol layering in Iu mode 25
6.2.1 Signalling between SMLC and MSC/SGSN 25
6.2.2 Signalling between SMLC and MS 26
6.2.3 SMLC signalling to a Type A LMU 27
6.2.4 SMLC signalling to a Type B LMU 27
6.2.5 SMLC signalling to a peer SMLC 27

7 GERAN Network Location Procedures 27
7.1 State description for SMLC 27
7.1.1 SMLC States 27
7.1.1.1 NULL State 27
7.1.1.2 LOCATION State 27
7.1.2 State Functionality 28
7.1.2.1 State Transitions 28
7.1.2.2 LOCATION Timer Function 28
7.2 State Description for the BSC 28
7.2.1 BSC States 28
7.2.1.1 IDLE State 28
7.2.1.2 LOCATION State 28
7.2.2 State Functionality 29
7.2.2.1 State Transitions 29
7.2.2.2 LOCATION Timer Function 29
7.3 Usage of SCCP Connection on the Lb interface in the CS domain in A/Gb mode 29
7.3.1 SCCP Connection for positioning of a target MS 29
7.3.2 SCCP connection to access a Type A LMU 30
7.4 Usage of SCCP Connection on the Lb interface in the PS domain in A/Gb mode 30
7.4.1 SCCP Connection for positioning of a target MS 30

8 Common Procedures to Support Positioning 31
8.1 Information Transfer between an SMLC and a Target MS in the CS Domain in A/Gb mode for E-OTD and A-GNSS positioning methods 31
8.1a Information Transfer between an SMLC and a Target MS in the PS Domain in A/Gb mode 32
8.1b Information Transfer between an SMLC and a Target MS in Iu Mode 33
8.2 Information Transfer between an SMLC and a BSC 34
8.3 Common Procedures to Support Access to an LMU 34
8.3.1 Location Update Procedure between an SMLC and a Type A LMU 35
8.3.2 IMSI Detach Procedure between an SMLC and a Type A LMU 35
8.3.3 LCS Information Transfer between an SMLC and a Type A LMU 36
8.3.3.1 Information Transfer using an SDCCH 36
8.3.3.2 Information Transfer using a TCH 38
8.3.4 LCS Information Transfer between an SMLC and a Type B LMU 39
8.4 Common Control Procedures for LMUs 39
8.4.1 Reset Procedure 40
8.4.2 Status Query Procedure 40
8.4.3 Status Update Procedure 40
8.5 Exception Procedures 41
8.5.1 Procedures in the SMLC 41
8.5.2 Procedures in an LMU 42
8.5.3 Procedures in the BSC in the CS Domain 42
8.5.3.1 General Procedures 42
8.5.3.2 Rejection of an SMLC Positioning Request 42
8.5.3.3 Interaction with Inter-BSC Handover 42
8.5.3.4 Interaction with Intra-BSC Handover and other RR Management Procedures 43
8.5.3.5 Priority of Handover and Other RR Management Procedures 43
8.5.3.6 Interaction with Segmentation support for Legacy MS 43
8.5.3.7 Overload 43
8.5.4 Procedures in the BSS in the PS Domain 44
8.5.4.1 General Procedures 44
8.5.4.2 Rejection of an SMLC Positioning Request 44

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8.5.4.3 Overload 44
8.5.4.4 Inter BSS Cell Change 44
8.5.5 Void 45
8.6 Procedures in the Target MS 45
8.7 Further Procedures for Handover 45

9 Positioning procedures 45
9.1 Positioning Procedure Initiation 45
9.1.1 Core Network Position Procedure Initiation over the A interface 45
9.1.2 Positioning Procedure Initiation from an Internal LCS Client for the CS Domain (A/Gb mode) 46
9.1.3 Core Network Position Procedure Initiation over the Gb interface 46
9.1.4 Positioning Procedure Initiation from Core Network (Iu mode) 47
9.1.5 Positioning Procedure Initiation from Internal LCS Client (Iu mode) 47
9.2 Common Positioning Procedure for CS Domain in A/Gb mode 47
9.2a Common Positioning Procedure for PS Domain in A/Gb mode 48
9.2b Common Positioning Procedure for Iu mode 49
9.2c GPRS Cell Change for the PS Domain in A/Gb mode 50
9.2c.1 Intra-BSS Cell Change 50
9.2c.2 Inter-BSS Cell Change 50
9.3 TA Based Positioning in CS Domain for A/Gb-mode 51
9.3.1 Definition of TA states 51
9.3.1.1 MS in IDLE State 51
9.3.1.2 MS in DEDICATED State 51
9.3.2 TA Positioning Procedure 52
9.3.3 Unsuccessful TA positioning procedure in BSC 52
9.3a TA Based Positioning in PS Domain for A/Gb-mode 52
9.3a.1 Definition of PS Domain TA Modes 53
9.3a.1.1 MS in Packet Idle Mode 53
9.3a.1.2 MS in Packet Transfer Mode 53
9.3a.2 TA Positioning Procedure 53
9.3a.2a TA Positioning Procedure for an MS in EC operation 54
9.3a.3 Unsuccessful TA positioning procedure in BSS 55
9.4 E-OTD and A-GNSS Positioning Procedures 55
9.4.1 General procedures 55
9.4.2 Positioning Request 55
9.4.3 Assistance Data Delivery 56
9.4.3a Positioning Capability Transfer 57
9.4.4 Error Handling for E-OTD and A-GNSS in CS Domain 58
9.4.5 Error Handling for the SMLC in CS Domain 59
9.4.5a Error Handling for E-OTD and A-GNSS in PS Domain 59
9.4.6 Broadcast of Assistance Data 60
9.4.6.1 Point-To-Multipoint Assistance Data Broadcast Flow 60
9.4.6.2 Ciphering 61
9.4.6.2.1 Algorithm 61
9.4.6.3 Deciphering key control and delivery to MS 62
9.5 U-TDOA Positioning Procedures 64
9.5.0 General 64
9.5.1 U-TDOA Positioning in CS Domain for A/Gb-mode 64
9.5.1.1 General Procedures 64
9.5.1.2 CS U-TDOA Messages and Procedures on the Lb Interface 64
9.5.1.3 RR Procedure effecting the CS U-TDOA channel description 65
9.5.1.4 BSC Error Handling during CS U-TDOA Positioning Procedure 66
9.5.2 U-TDOA Positioning in PS Domain for A/Gb-mode 66
9.5.2.1 Introduction 66
9.5.2.2 General Procedures 66
9.5.2.2.1 MS in packet idle mode 67
9.5.2.2.2 MS in packet transfer mode 67
9.5.2.3 PS U-TDOA Messages and Procedures on the Lb Interface 67
9.5.2.4 RLC/MAC Procedure affecting the PS U-TDOA TBF description 68
9.5.2.5 Error Handling during PS U-TDOA Positioning Procedure 68

10 Information storage 69

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https://standards.iteh.ai/catalog/standards/sist/0ccc453c-c360-4f09-86e3-66ddd6200f7/etsi-ts-143-059-v13.2.0-2016-08

10.1 SMLC 69
10.2 Recovery and Restoration Procedures 70

Annex A (informative): Change history 71

History 73

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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".

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[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] 3GPP TS 44.118: "Mobile radio interface layer 3 specification; Radio Resource Control (RRC) Protocol Iu Mode".

[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".

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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.

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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
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

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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.

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

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.

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Full standard:
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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