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Part 4: Requirements for location data exchange protocols

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document is part 4 of a multi-part deliverable covering the GNSS based location systems, as identified below:

Part 1: "Functional requirements";

Part 2: "Reference Architecture";

Part 3: "Performance requirements";

Part 4: "Requirements for location data exchange protocols";

Part 5: "Performance Test Specification".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The increasing expansion of location-based applications aims to satisfy more and more complex and diversified user requirements: this is highlighted for example by the widespread adoption of multi-functional smart-phones or by the ever wider adoption of tracking devices (e.g. in transport), etc. This requirement for new and innovative location-based applications is generating a requirement for increasingly complex location systems.

The wide spectrum of location-based applications identified in ETSI TR 103 183 [i.1] calls for a new and broader concept for location systems, taking into account solutions in which GNSS technologies are complemented with other technologies to improve robustness and performance. The notion of ***GNSS-based location systems*** is introduced and defined in the present document.

Additional clauses and information related to the implementation in ***GNSS-based location systems*** of the various differential GNSS technologies, namely D-GNSS, RTK and PPP are also included in order to facilitate the use of this multi part deliverable by manufacturers and service providers.

1 Scope

The present document defines the requirements for data elements that may need to be exchanged within the GBLS and externally to applications using the GBLS.

The present document also specifies data exchange models for these data elements which may form the basis of protocols (or for modification of protocols) and which may be used for the exchange of location-related data within complex GBLS, as well as between the GBLS and external applications.

The present document defines the procedures and messages associated with these data exchange models.

The GBLS data exchange models are defined to be independent of their underlying transport mechanisms. Nevertheless, on certain GBLS interfaces, transport protocols are recommended.

ETSI TS 103 246 parts 1 [1], 2 [2], 3 [3] and 5 [i.8] address integrated GNSS based location systems (GBLS) that combine Global Navigation Satellite Systems (GNSS), with other navigation technologies, as well as with telecommunication networks in order to deliver location-based services to users. As a consequence the present document is not applicable to GNSS only receivers.

ETSI TS 103 246 parts 1 [1], 2 [2], 3 [3] and 5 [i.8] propose a list of functional and performance requirements and related test procedures. For each performance requirement, different classes are defined allowing the benchmark of different GBLS addressing the same applications.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 103 246-1: "Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 1: Functional requirements".

[2] ETSI TS 103 246-2: "Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 2: Reference Architecture".

[3] ETSI TS 103 246-3: "Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 3: Performance requirements".

[4] OMA-TS-MLP-V3.5: "Mobile Location Protocol".

[5] OMA-TS-LPPe-V2.0: "LPP Extensions Specification".

[6] ETSI TS 136 355: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP) (3GPP TS 36.355)".

[7] RTCM 10402.3: "Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service".

[8] RTCM 10403.2: " Differential GNSS (Global Navigation Satellite Systems) Services".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 103 183: "Satellite Earth Stations and Systems (SES); Global Navigation Satellite Systems (GNSS) based applications and standardisation needs".

[i.2] OMA-TS-ULP-V3: "User Plane Location Protocol".

[i.3] OMA-AD-LOCSIP-V1: "Location in SIP/IP core Architecture".

[i.4] ETSI ES 201 915 (all parts): "Open Service Access (OSA); Application Programming Interface (API)".

[i.5] 3GPP2 C.S0022-B: "Position Determination Service for cdma2000 Spread Spectrum Systems".

[i.6] ETSI TS 125 331: "Universal Mobile Telecommunications System (UMTS); Radio Resource Control (RRC); Protocol specification (3GPP TS 25.331)".

[i.7] ETSI TS 144 031: "Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Mobile Station (MS) - Serving Mobile Location Centre (SMLC) Radio Resource LCS Protocol (RRLP) (3GPP TS 44.031)".

[i.8] ETSI TS 103 246-5: "Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 5: Performance Test Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TS 103 246-1 [1] and ETSI TS 103 246-2 [2] apply.

3.2 Symbols

Void.

3.3 Abbreviations

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

3GPP	3rd Generation Partnership Project
API	Application Programming Interface
ASN	Abstract Syntax Notation
BFN	Beam Forming Network
CL	Confidence Level
CNR	Carrier-to-Noise Ratio
D-GNSS	Differential GNSS
DoA	Direction of Arrival
DTD	Document Type Definition
ECID	Enhanced Cell ID
EMI	ElectroMagnetic Interference

EOTD	Enhanced Observed Time Difference
EPDD	External Protocol for Differential Data
EPDU	Extension Protocol Data Unit
E-SMLC	Enhanced Serving Mobile Location Centre
FFS	For Further Study
FKP	Flächen Korrekctur Parameter (German)
GBLS	GNSS Based Location System
GGTO	GPS-Galileo Time Offset
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSM	Global System for Mobile communications
HTTP	HyperText Transfer Protocol
HTTPS	HTTP Secure
IE	Information Element
IMSI	International Mobile Station Identifier
INS	Inertial Navigation Sensor
LCS	Location Services
LOCSIP	LOCation in SIP
LPP	LTE Positioning Protocol
LPPe	LTE Positioning Protocol extensions
LSEP	Location System External Protocol
LSIP	Location System Internal Protocol
LTE	Long-Term Evolution
MAC	Master Auxiliary Corrections
MLP	Mobile Location Protocol
MLS	Mobile Location System
MS	Mobile Station
MSID	Mobile Station Identifier
NRTK	Network RTK
OMA	Open Mobile Alliance
OTDOA	Observed Time Difference Of Arrival
PPP	Precise Point Positioning
PVT	Position Velocity Time
QoS	Quality of Service
RF	Radio Frequency
RRC	Radio Resource Control
RRLP	Radio Resource Location services (LCS) Protocol
RT	Real-Time
RTCM	Radio Technical Commission for Maritime services
RTK	Real Time Kinematic
SET	SUPL Enabled Terminal
SIP	Session Initiation Protocol
SLP	Server Location Provider
SMLC	Serving Mobile Location Centre
SOAP	Simple Object Access Protocol
SRN	Short Range Node
SSL	Secure Socket Layer
TCP/IP	Transmission Control Protocol over Internet Protocol
TLS	Transport Layer Security
UE	User Equipment
ULP	User-plane Location Protocol
UMTS	Universal Mobile Telecommunications System
UTC	Coordinated Universal Time
UTRA	UMTS Terrestrial Radio Access
WLAN	Wireless Local Area Network
XML	Extensible Markup Language

4 Data Exchange Requirements

4.1 Context

The GBLS data that shall or may be exchanged is defined in ETSI TS 103 246-2 [2] in general terms for two main mandatory cases and one optional case:

1) externally to applications using the GBLS (mandatory);

2) externally to external D-GNSS service provider (optional, required when external D-GNSS services are used as defined in ETSI TS 103 246-2 [2]);

3) internally between modules of the GBLS (mandatory).

When the D-GNSS service provision is an internal service, the GNSS differential data will be included in the data exchanges of the type "internally between modules of the GBLS".

The specific requirements for this data are defined further in clauses 5, 6 and 7.

In addition, data exchange models are defined herein as a basis for protocols that may be used to transfer the GBLS data.

Figure 4.1 shows these defined protocol models and their relevant interfaces applied to the GNSS Based Location System (GBLS) and its functional entities as defined in ETSI TS 103 246-2 [2], within an end-to-end system.

NOTE: Throughout the present document, the word "protocol" is used for brevity, when defining a GBLS "data exchange model". The specifications herein are of data exchange models that may form the basis of protocols.

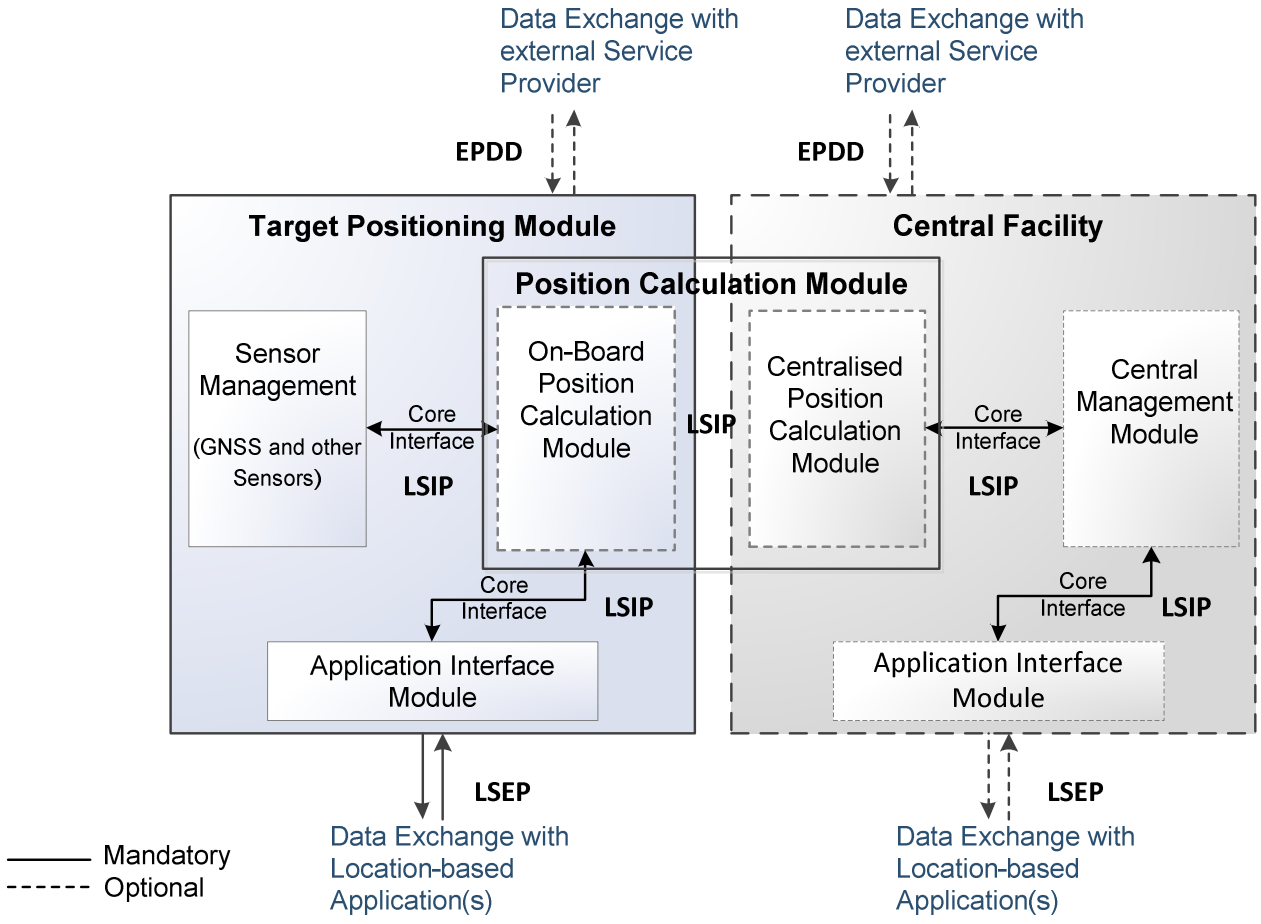

Figure 4.1: Use of LSEP and LSIP in the GBLS architecture

The protocols defined are:

- **LSEP** (Location System External Protocol)**:** between the GBLS and an external application (requesting entity).
- **LSIP** (Location System Internal Protocol): between internal components of the GBLS.
- **EPDD (External Protocol for Differential Data) as an optional protocol for differential GNSS data exchanged with external Differential Service provider.**

The two first protocols shall transfer the location-related data defined in ETSI TS 103 246-2 [2].

The third protocol is reserved for differential GNSS data transfer, if required, and therefore remains an option.

The Protocol definitions in clauses 4.2.1 to 4.2.4 address the following aspects:

1) protocol procedures;
2) message definitions from a semantic point of view i.e. the information they shall contain, and how this information is structured;
3) information elements within messages and a set of relationships between them.

The definitions do not cover:

- Message syntax. Thus no encoding scheme or data representation is given.
- Underlying transport mechanisms for the messages.

4.2 Protocol Choice and Compatibility

4.2.1 LSEP (MLP)

LSEP is based on the procedures, messages and elements of OMA MLP [4]. Annex A provides a rationale for this choice.

MLP is intended for a Mobile Location Service (MLS) Client (e.g. a GBLS external application) to obtain the related data of a location target (e.g. mobile terminal, GBLS Positioning Module, etc.) from a Location Server (e.g. the GBLS).

MLP is defined at the application layer of the protocol stack. Its messages are defined in XML and it is intended to be transported over HTTP or other protocols (e.g. SOAP). For security reasons Secure Socket Layer (SSL) or Transport Layer Security (TLS) cryptographic protocols can be used to carry HTTP (or HTTPS).

4.2.2 LSIP (LPPe)

4.2.2.1 General

LSIP is defined as an extension to LPP and relies also on the procedures, messages and elements of LPPe [5]. Annex A provides a rationale for this choice.

As LPPe is also defined as an extension to, and relies on the main elements of LPP [6] then LSIP is in effect based on both of these protocols.

LPPe is intended to provide transactions for location-related data in a client-server model, and specifically between a SET and SLP ("target" and "server" in LPPe). However LPPe allows many of its messages to be transacted in reversed mode also.

In the GBLS, LSIP is defined for interfaces between all internal functional blocks. Clause A.3 describes implementation options.

LSIP as defined herein defines the global set of necessary location-related data required for the overall functioning of the GBLS as defined in ETSI TS 103 246-2 [2].

In addition, when the GBLS requires to internally implement a differential GNSS service (either a local service with one reference station or a network of service), some specific differential data encapsulated in the LSIP should be considered.

4.2.2.2 LSIP Data Exchange Requirements

A summary of additional data for LSIP (i.e. not included in LPPe) requiring to be transferred over the GBLS interfaces defined in ETSI TS 103 246-2 [2] is shown in table 4.1 (defined for each type of LSIP procedure: Location information exchange and Assistance data exchange).

Table 4.1: Extension data for LSIP procedures

Interface	Location information exchange	Assistance or differential data exchange
	LSIP-Specific data	**LSIP-Specific data**
1 (GNSS)	Observables (pseudo range, accumulated Doppler range), RF samples, Navigation Message data, error on PVT and observables.	A-GNSS assistance data (models (nav, GGTO, UTC), RT integ, diff corr, data bit assist, acq assist, almanac, aux. info). Authentication flag.
2 (Telco)	N/A.	N/A.
3 (INS)	Gyro/accelerometer measurements + error estimates.	N/A.
4 (Magneto)	Magnetic field + error estimates.	Temperature (for calibration).
5 (odom)	Speed, distance, + error estimates.	Wheel diameter.
6 (BFN)	Body orientation, jammer characteristics: number, power, direction of arrival (DoA).	N/A.
7 (map)	FFS.	N/A.
8	Location information consistent with "location-related data" defined in LSEP: • Position (horizontal, vertical), velocity (linear/angular) acceleration (linear/angular), heading. • QoS estimation (estimated accuracy of the above parameters). • Integrity and Authentication parameters.	N/A.
9	All location data identified on I/F 10.	All assistance data from Assistance Server. D-GNSS differential data according to the D-GNSS method.
10	All location-related data above from sensor interfaces (1 to 6), and dedicated to central processing (in centralized position calculation module). Additionally, any "processed" location information from the On-Board position calculation Module, and needing to be forwarded to the Central Facility.	All location data present an interfaces 1 to 8. D-GNSS differential data according to the D-GNSS method and architecture.
11	N/A	Assistance data: UTC time.
12	N/A	N/A.

For memory, the architecture level 3 with the corresponding interfaces in ETSI TS 103 246-2 [2] is described as follows.

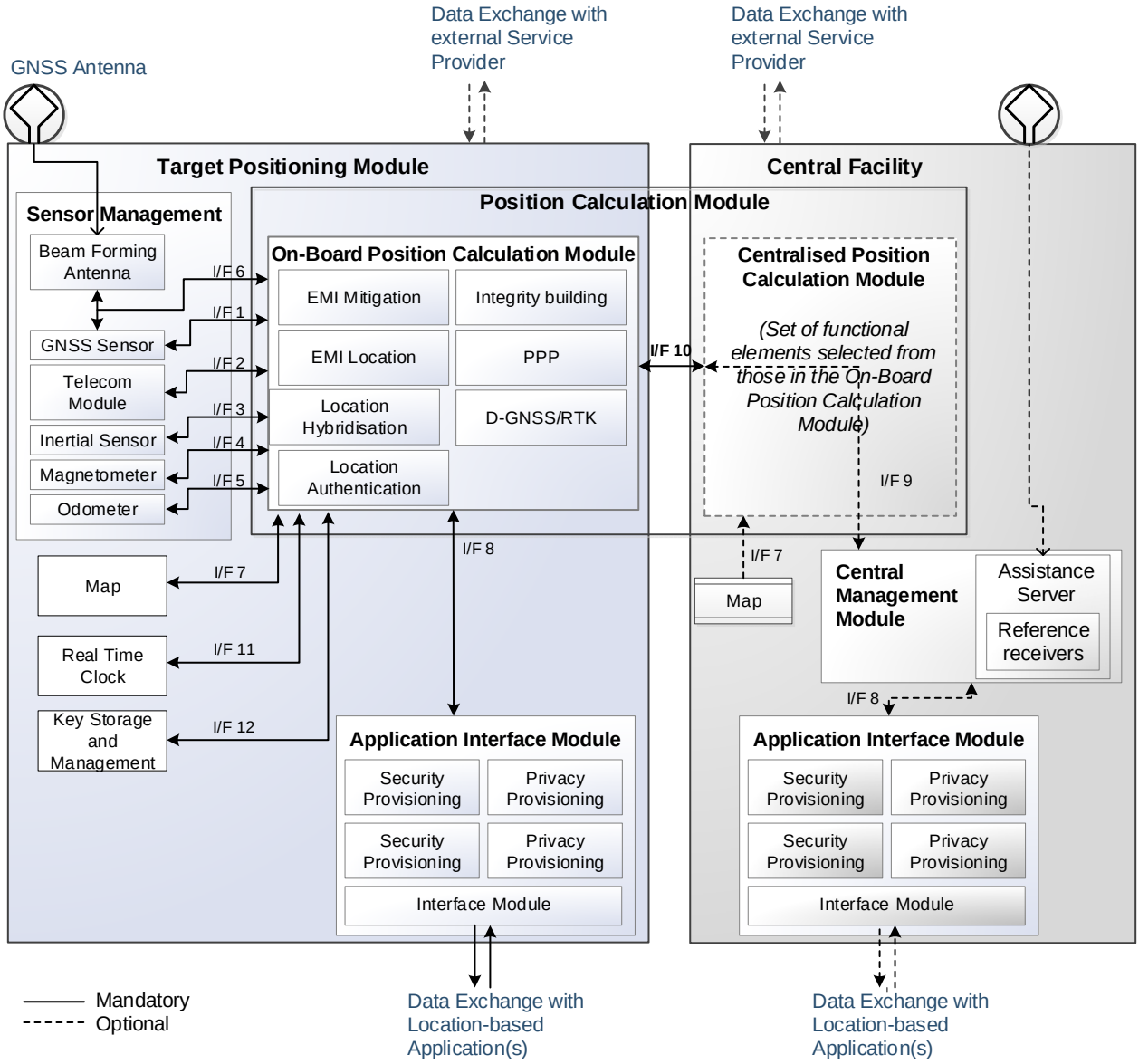

Figure 4.2: GBLS detailed architecture

Table 4.2 shows the data to be made available for GBLS external interface (i.e. for an application) and which should therefore be consistent with LSEP data elements. The relevant source protocols and the LSIP extension IEs are also shown.

Table 4.2: LSIP/LPP IEs for GBLS external interfaces (Application) with applicable protocol extensions

Elementary information	LSIP/LPP Data type	Request	Provide	Protocol
Hybridised Location-related data (i.e. as final products)				
Time	LocInfo	x	x	LPP
HorPos	LocInfo	x	x	LPP
VertPos	LocInfo	x	x	LPP
Velocity	LocInfo	x	x	LPP
Acceleration	LocInfo	x	x	LPPe
Heading	LocInfo	x	x	LPPe
Detected no. of jammers	LocInfo	x	x	LSIP
Jammer ID	LocInfo		x	LSIP
Jammer Power	LocInfo	x	x	LSIP
Jammer DoA	LocInfo	x	x	LSIP
Hybrid type/Location source	LocInfo	x	x	LPPe
Hybridised QoS indicators (i.e. as final products)				
Time unc	LocInfo	x	x	LPP
HorPos ConfLev	LocInfo	x	x	LPP
HorPos unc	LocInfo	x	x	LPP
HorPos qos class	LocInfo	x		LSIP
HorPos unc not met	LocInfo		x	LSIP
int. alert (HorPos)	LocInfo		x	LSIP
Vertpos ConfLev	LocInfo	x	x	LPP
Vertpos unc	LocInfo	x	x	LPP
Vertpos qos class	LocInfo	x		LPP
Vertpos unc not met	LocInfo		x	LSIP
int. alert (Vertpos)	LocInfo		x	LSIP
Authentication flag	LocInfo	x	x	LSIP
Velocity ConfLev	LocInfo	x	x	LSIP
Velocity unc	LocInfo	x	x	LPP
Velocity qos class	LocInfo	x		LPP
Velocity unc not met	LocInfo		x	LSIP
int. alert (Velocity)	LocInfo		x	LSIP
Accel ConfLev	LocInfo	x	x	LSIP
Accel unc	LocInfo	x	x	LSIP
Accel unc not met	LocInfo		x	LSIP
Heading ConfLev	LocInfo	x	x	LSIP
Heading ConfClass	LocInfo	x	x	LSIP
Heading unc	LocInfo	x		LSIP
Heading qos class	LocInfo	x		LSIP
Heading unc not met	LocInfo		x	LSIP
int. alert (Heading)	LocInfo		x	LSIP

Table 4.3 summarizes the LSIP/LPPe IEs for GBLS internal sensor interfaces, and identifies particularly the new IEs needed in LSIP.

Table 4.3: LSIP/LPP IEs for GBLS internal sensor interfaces (with applicable protocol extensions)

Elementary information	LSIP/LPP Data type	Request	Provide	Protocol
Control parameters; needed to implement the internal GBLS reporting scheme				
Event trigger req	LocInfo	x		LSIP
GNSS				
GNSS RF samples	LocInfo	x	x	LSIP
GNSS measurements (timestamped pseudo range, carrier phase measurements, Doppler, measurement Status, Loss of Lock indicator, C/N0)	LocInfo	x	x	LSIP
GNSS Navigation Message Data	LocInfo	x	x	LSIP
Authentication flag	LocInfo	x	x	LSIP
Telco **OTDOA, EOTD, OTDOA-UTRA, LTE, LTE ECID, GSM ECID, UTRA ECID, WLAN, WiMax™, SRN**				
Existing				LPPe
Internal INS data				
Existing				LPPe
Magnetometer				
Existing				LPPe
Odometer				
Wheel size	LocInfo	x	x	LSIP
Travelled distance	LocInfo	x	x	LSIP
Speed	LocInfo	x	x	LSIP
BFN				
maxNbrofjammers	LocInfo	x		LSIP
detected no. of jammers	LocInfo		x	LSIP
jammer ID	LocInfo		x	LSIP
jammer Power	LocInfo	x	x	LSIP
jammer DoA	LocInfo	x	x	LSIP
Map				
FFS		x	x	LSIP

4.2.2.3 Additional LSIP IEs for GBLS using differential GNSS positioning methods

The present document should consider a maximal compatibility with RTCM standards 10402.3 [7] and 10403.2 [8] and should thus consider RTCM messages as new extension to the LPPe.

The RTCM message exchanges will essentially depend on the D-GNSS methods and also with the architecture but generalities can be put here:

- RTCM 10402.3 standard [7] is applicable for conventional D-GNSS positioning method, while RTCM 10403.2 standard [8] is applicable for RTK, NRTK and PPP differential positioning methods.

- In the case of a D-GNSS or RTK architecture, where the reference station can be considered as one unique local infrastructure (possibly monitored by the integrity monitoring station), the reference station is the provider of its corrections (conventional D-GNSS) or measurements (RTK) under RTCM messages format to the location module in charge of the location target positioning (either on board or in the central facility). In parallel, the reference station provides its surveyed location, antenna features, etc. If this station is internally operated, the central facility location module should prepare and format the RTCM messages from the reference sensor measurements and provide them to the location module in charge of the location target positioning (either on board or in the central facility).

- The rover GNSS sensor is the provider of its measurements and raw ephemeris to the location module (either on board or in the central facility).

- In the case of a network of reference stations (NRTK, PPP), the central management module is the provider of the GNSS differential data under RTCM message format to the location module in charge of the location target positioning (either on board or in the central facility).

More details about IE are provided in clause 8.

4.2.3 EPDD (RTCM 104)

In the particular case where GBLS shall take benefits from differential GNSS services as provided by an external differential service provider, to meet its requirements, the GBLS protocol EPDD should preferably conform to the existing external GNSS service provider data protocols.

Since the existing GNSS service provider generally conforms to the RTCM 104 standards, the GBLS EPDD should directly meet the requirements of the RTCM 10402.3 standard [7] for the conventional D-GNSS positioning method or the RTCM 10403.2 standard [8] for the RTK, NRTK and PPP positioning methods.

The data exchanges will take place in the positioning module in GBLS (either embedded or central facility according to the implementation).

The RTCM 104 standards are mainly oriented so that the D-GNSS service provider broadcasts the required differential data, and the main protocol will thus simply consist of receiving the selected broadcast stream, corresponding to the service subscription instructions. One exception exists for NRTK/VRS which foresees just a possibility for the subscriber to send a message (containing its coarse location) towards the differential service provider in order for the subscriber to receive dedicated data. More details about IEs are provided in clause 9.

4.2.4 LSEP/MLP and LSIP/LPPe Terminology

Table 4.4 defines the correspondence between GBLS and 3GPP/OMA MLP/LPPe terminology.

Table 4.4: MLP/LPPe and LSEP/LSIP terminology relationships

MLP/LPPe		LSEP/LSIP	
Term	**Definition**	**Term**	**Definition**
MS	Mobile Station	Location Target Positioning Module	See definition in ETSI TS 103 246-2 [2]
MSID	MS identifier	MSID	Identifier for location targets
Mobile subscriber	Owner of the MS who has subscribed to a communication service. Target of the Location service	Location Target user	Optional and minor role in GBLS context. Target of the location service is the Location Target, rather than its user
MLS Client	The application, seen as a client of the Mobile Location Service	Application	See definition in ETSI TS 103 246-2 [2]
LCS Client	The application, seen as a client of the Location Service	Application	See definition in ETSI TS 103 246-2 [2]
Location Server	The server which provides location data of the MS to the Client (normal mode) or LPPe client (reversed mode)	GBLS Location Server	The Server which provides location data of the Location Target to the Application, and the assistance data to the Location target or Positioning Module or LPPe client (reversed mode)
Target (LPPe)	LPPe client (normal mode) or LPPe server (reversed mode)	Location Target Positioning Module	See definition in ETSI TS 103 246-2 [2] or LPPe server (reversed mode)

5 LSEP Requirements

5.1 LSEP Services and Procedures

LSEP data transactions (i.e. between the GBLS and an external application) shall use the service schemes as defined for MLP [4] including the messages as follows:

1) Standard Location Immediate Service consisting:

   - Standard Location Immediate Request.
   - Standard Location Immediate Answer.
   - Standard Location Immediate Report.

2) Emergency Location Immediate Service:

   - Emergency Location Immediate Request.
   - Emergency Location Immediate Answer.
   - Emergency Location Immediate Report.

3) Standard Location Reporting Service:

   - Standard Location Report.
   - Standard Location Report Answer.

4) Emergency Location Reporting Service:

   - Emergency Location Report.

5) Triggered Location Reporting Service:

   - Triggered Location Reporting Request.
   - Triggered Location Reporting Answer.
   - Triggered Location Report.
   - Triggered Location Reporting Stop Request.
   - Triggered Location Reporting Stop Answer.
   - Triggered Location Reporting Pause Report.
   - Triggered Location Reporting Query Request.
   - Triggered Location Reporting Query Answer.
   - Triggered Location Query Report.

6) Historic Location Immediate Service:

   - Historic Location Immediate Request.
   - Historic Location Immediate Answer.
   - Historic Location Immediate Report.

LSEP services shall be identical to those in MLP, except when an LSEP client (application) attempts to invoke a service not defined in the present document, the GBLS shall return a General Error Message. The General Error Message is equivalent to that described in MLP (see clause 5 of OMA-TS-MLP-V3.5 [4]).

The extension Elements (parameters) of MLP services for LSEP are defined in clause 6.3.

5.2 Extension of MLP for LSEP

The MLP specification has been designed with extensibility in mind. Design principles employed to achieve this include:

- Separate DTDs for definitions that are common to all messages, e.g. client address and shapes, so they can be re-used.
- A parameter (Element) extension mechanism allowing the addition of new parameters to existing messages. This mechanism works by specifying an entity parameter, '%extension', referring to an extension DTD. The extension DTD shall contain another entity parameter, '%extension.param', containing the definition of the extension as a string together with the actual messages being added.

In order to use the extension, the extension DTD shall be explicitly referenced in the XML document.

Duplication of information sent in MLP Request messages using LSEP should be avoided by external entities.

LSEP messages shall take precedence over any contradictory information (from MLP) received by the GBLS.

The GBLS shall avoid sending any contradictory information via LSEP and MLP messages in an MLP Answer or Report.

NOTE: A new defined version of MLP incorporating LSEP extensions may be required in order to make LSEP more universally accepted.

5.3 LSEP Data Exchange Message Definition

The LSEP Element (parameter) extensions to MLP messages are shown in table 5.1.

Table 5.1: LSEP Element extensions for MLP messages

MLP Message	LSEP parameter extensions
Standard Location Immediate Request	LSEP_msids LSEP_eqop LSEP_req_info
Standard Location Immediate Answer	LSEP_pd
Standard Location Immediate Report	LSEP_pd
Emergency Location Immediate Request	LSEP_eqop
Triggered Location Reporting Request	LSEP_msids LSEP_qop LSEP_req_info
Triggered Location Report	LSEP_pd
Triggered Location Reporting Stop Request	LSEP_msids
Triggered Location Reporting Stop Answer	LSEP_msids
Historic Location Immediate Request	LSEP_qop

For definition of these elements see clause 7.

LSEP messages shall take precedence over any contradictory information (e.g. from MLP) received by the GBLS.

Duplication of information sent in MLP-based messages using LSEP shall be avoided by the GBLS and should be avoided by external entities.

6 LSIP Requirements

6.1 LSIP Services and Procedures

LSIP data transactions (i.e. between internal modules of the GBLS) shall use the service schemes as defined for LPPe, see OMA-TS-LPPe [5] as follows:

1) LPP Provide/Request Capabilities (plus LPPe reversed mode).

2) LPP Provide/Request Assistance Data.

3) LPP Provide/Request Location Information (plus LPPe reversed mode).

4) LPP Abort.

5) LPP Error.

6) LPPe Periodic/Triggered Assistance Data Transfer with Update.

7) LPPe Periodic/Triggered Location Information Transfer with Update.

8) LPPe Segmented Assistance Data Transfer.

9) LPPe Segmented Location Information Transfer.

10) LPPe Broadcast of Assistance Data.

11) LPPe Crowdsourcing.

LSIP services shall be identical to those defined for LPPe. However the Information Elements of these services will be extended for the GBLS as defined in clauses 6.2 and 6.3.

6.2 Extension of LPPe/LPP for LSIP

LSIP (and LPPe) make use of the option included in LPP messages to define extensions to these messages by means of the EPDU container. Within this EPDU, the Identifier may be defined as follows:

- EPDU-ID: 2
- EPDU Defining entity ETSI Technical Committee SES
- Method name GBLS LSIP
- Reference LSIP

NOTE 1: This EPDU will need to be submitted to 3GPP.

LSIP specifies an extension to the LPP Provide/Request Assistance Data and Location Information messages above.

LSIP messages shall take precedence over any contradictory information (e.g. from LPPe/LPP) received by the GBLS.

LSIP extensions are defined to include LPPe extensions. Duplication of information sent in LPP-based messages using LPPe and LSIP shall be avoided by the GBLS and should be avoided by external entities. When encoding the LSIP/LPP/LPPe message, the LSIP extension for the message shall be parsed first, and LPPe extensions secondly, and the resulting ASN.1-coded binary stream included in the EPDU-Body of the EPDU in the appropriate message.

NOTE 2: A new defined version of LPP (or LPPe) combining LSIP and LPPe extensions may be required in order to make LSIP more universally accepted.

6.3 LSIP Data Exchange Message Definition

6.3.1 General

LSIP re-uses the message and data definitions from LPP/LPPe. In addition the contents of each LSIP IE extension to LPP messages are specified in clauses 6.3.2 and 6.3.3, using ASN.1 to specify the syntax and using tables, when needed, to provide information on the fields and parameters in the message. The information elements carried within the message extensions are specified as IEs in clause 8.

NOTE: Where the IEs of LSIP messages are optional, only the IEs needed may be issued.

6.3.2 IE Extensions of LPP/LPPe for LSIP

6.3.2.1 Message Extensions

The IE *LSIP-MessageExtension* carries version information and the message data carried in the extension. A single *LSIP-MessageExtension* carries one extension message and all the LSIP information associated with that type. One *LSIP-MessageExtension* data type is carried within one EPDU-Body OCTET STRING parameter in an LPP message.

```
-- ASN1START

LSIP-MessageExtension ::= SEQUENCE {
     lsipCompatibilityLevel          LSIP-LSIPCompatibilityLevel,
     lsipVersion                     LSIP-LSIPVersion,
     LPPeMode                        OMA-LPPe-LPPeMode,
     messageExtensionBody            LSIP-MessageExtensionBody,
     ...
```

```
}
LSIP-LSIPCompatibilityLevel ::= INTEGER (0..15)

LSIP-LSIPVersion ::= SEQUENCE {
     majorVersion      INTEGER(0..255),
     minorVersion      INTEGER(0..255),
     ...
}
OMA-LPPe-LPPeMode ::= ENUMERATED {
     normal,
     reversed,
     ...
}
LSIP-MessageExtensionBody ::= CHOICE {
          requestAssistanceData      LSIP-RequestAssistanceData,
                                     --Shall only be used in the EPDU in LPP RequestAssistanceData
          provideAssistanceData      LSIP-ProvideAssistanceData,
                                     --Shall only be used in the EPDU in LPP ProvideAssistanceData
          requestLocationInformation LSIP-RequestLocationInformation,
                                     --Shall only be used in the EPDU in LPP RequestLocationInformation
          provideLocationInformation LSIP-ProvideLocationInformation,
                                     --Shall only be used in the EPDU in LPP ProvideLocationInformation
          error                      LSIP-Error, --Shall only be used in the EPDU in LPP Error
          abort                      LSIP-Abort, --Shall only be used in the EPDU in LPP Abort
          ...
}
-- ASN1STOP
```

LSIP-Message Extension field descriptions
lsipCompatibilityLevel This field provides the compatibility level of the LSIP Extensions Release. The compatibility level in this version of LSIP is zero.
lsipVersion This field provides the version of LSIP Release that includes majorVersion and minorVersion. • majorVersion is x element in the x,y version notation. The major version in this release is 0. • minorVersion is y element in the x,y version notation. The minor version in this release is 0.
messageExtensionBody This parameter provides the body of the message extension for all LPP messages.
lPPeMode This field qualifies the server and target roles defined in the LPP transaction ID.

6.3.2.2 LPPe data type imports

LSIP uses as far as possible the data definitions from [5] in order to avoid duplication. This ASN.1 snippet defines these imports.

```
-- ASN1START

LSIP DEFINITIONS AUTOMATIC TAGS ::=
BEGIN

IMPORTS GNSS-ID, GNSS-SignalID, GNSS-SignalIDs, GNSS-SystemTime, SV-ID,
ECID-SignalMeasurementInformation, CellGlobalIdGERAN, CellGlobalIdEUTRA-AndUTRA,
OTDOA-ReferenceCellInfo, OTDOA-NeighbourCellInfoElement, maxFreqLayers, ARFCN-ValueEUTRA,
Ellipsoid-Point, EllipsoidPointWithAltitude, EllipsoidPointWithAltitudeAndUncertaintyEllipsoid,
NetworkTime, GNSS-ID-Bitmap, ARFCN-ValueUTRA, GNSS-ReferenceTime, LPP-Message,
Ellipsoid-PointWithUncertaintyCircle, EllipsoidPointWithUncertaintyEllipse, EllipsoidArc, Polygon,
ARFCN-ValueEUTRA-v9a0, Velocity

FROM OMA-LPPe-PDU-Definitions;

-- ASN1STOP
```

6.3.3 LSIP Extension Messages

6.3.3.1 Request Assistance Data

The *LSIP-RequestAssistanceData* message is used by the "*target*" entity to request assistance data from the "*server*" entity.

```
-- ASN1START

LSIP-RequestAssistanceData::= SEQUENCE {
    odometer-ProvideAssistanceData          LSIP-Odometer-RequestAssistanceData         OPTIONAL,
    ...
}
-- ASN1STOP
```

LSIP-RequestAssistanceData information elements are defined in clause 8.

6.3.3.2 Provide Assistance Data

The *LSIP-ProvideAssistanceData* message is used by the "*server*" entity to provide assistance data to the "*target*" entity either in response to a request from the "*target*" entity or in an unsolicited manner.

```
-- ASN1START

LSIP-ProvideAssistanceData::= SEQUENCE {
    odometer-ProvideAssistanceData          LSIP-Odometer-ProvideAssistanceData         OPTIONAL,
    ...
}

-- ASN1STOP
```

Descriptions of the *LSIP-ProvideAssistanceData* individual components are given in clause 8.

6.3.3.3 Request Location Information

The *LSIP-RequestLocationInformation* message is used by the "*server*" entity to request location-related data to "*target*" entity.

```
-- ASN1START
LSIP-RequestLocationInformation::= SEQUENCE {
    commonIEsRequestLocationInformation         LSIP-CommonIEsRequestLocationInformation
    OPTIONAL,
    gnss-RequestLocationInformation             LSIP-GNSS-RequestLocationInformation
    OPTIONAL,
    odometer-RequestLocationInformation         LSIP-Odometer-RequestLocationInformation
    OPTIONAL,
    bfn-RequestLocationInformation              LSIP-BFN-RequestLocationInformation
    OPTIONAL,
...
}
-- ASN1STOP
```

Descriptions of the *LSIP-RequestLocationInformation* components are given in clause 8.

6.3.3.4 Provide Location Information

The *LSIP-ProvideLocationInformation* message is used by a "*target*" entity to provide location-related data to a "*server*" entity.

```
-- ASN1START

LSIP-ProvideLocationInformation::= SEQUENCE {
    commonIEsProvideLocationInformation         LSIP-CommonIEsProvideLocationInformation
    OPTIONAL
    gnss-ProvideLocationInformation             LSIP-GNSS-ProvideLocationInformation
    OPTIONAL,
    odometer-ProvideLocationInformation         LSIP-Odometer-ProvideLocationInformation
    OPTIONAL,
    bfn-ProvideLocationInformation              LSIP-BFN-ProvideLocationInformation
    OPTIONAL,
```

```
    ...
}

-- ASN1STOP
```

Descriptions of the *LSIP-ProvideLocationInformation* individual components are given in clause 8.

7 LSEP Element Definitions

7.1 Overview

MLP extension elements (parameters) for LSEP messages (see clause 5) are defined in clauses 7.2 and 7.3, using XML DTD representation. Other elements defined for LSEP messages and not listed below are the same as in MLP [4], but any associated syntax shall be ignored.

Elements are defined from a semantic point of view only. Some details of the syntax are however provided for simple elements, such as Boolean or character string, whose content is easily identifiable (i.e. with a predefined/limited number of values).

Elements defined below are:

1) DTD Child elements defined in LSEP messages.

2) DTD Sub-child elements defined in Child (or message) elements.

7.2 LSEP Child Elements

7.2.1 Identity elements

```
<!ENTITY    % extension.param                    "LSEP_msids">
<!ELEMENT   LSEP_msids                          (emi_srcs)>
<!ELEMENT   emi_srcs                            (#PCDATA)>
```

7.2.2 Location elements

```
<!ENTITY    % extension.param                    "LSEP_req_info">
<!ELEMENT   LSEP_req_info                       (auth_req?, accel_req?, emidata_req)>
<!ELEMENT   auth_req                            EMPTY>
            auth_req ( YES | NO )               "NO">
<!ELEMENT   accel_req                           EMPTY>
<!ATTLIST   accel_req
            info_type ( LINEAR | ANGULAR )      "LINEAR">
<!ELEMENT   emidata_req ( YES | NO )            "NO">
```

The following rules apply to the elements content and structure:

- "*emidata_req"*: this optional attribute becomes mandatory if the location request (*slir* or *tlrr*) identifies the location targets as being EMI sources. It identifies the required EMI-related information.

- usage of "*auth_req"*: when this flag is set to "YES" for element in a location request (*slir* or *tlrr*), the optional element "*auth_flag*" in the subsequent answer or report(s) (*slia*, *slir* or *tlrep*) becomes mandatory.

```
<!ENTITY    % extension.param                    "LSEP_pd">
<!ELEMENT   LSEP_pd                             (h_qos?, v_qos?, vel_qos?, head_qos?,
                                                (accel,|accel_qos?)?, emidata?,
                                                LSEP_qos_status?)>
<!ELEMENT   h_qos                               (h_conf_lev?)>
<!ELEMENT   h_conf_lev                          (#PCDATA)>
<!ELEMENT   v_qos                               (v_conf_lev?)>
<!ELEMENT   v_conf_lev                          (#PCDATA)>
<!ELEMENT   vel_qos                             (vel_unc, vel_conf_lev?,?)>
<!ELEMENT   vel_unc                             (#PCDATA)>
<!ELEMENT   vel-conf_lev                        (#PCDATA)>
<!ELEMENT   head_qos                            (head_unc, head_conf_lev?)>
<!ELEMENT   head_unc                            (#PCDATA)>
<!ELEMENT   head-conf_lev                       (#PCDATA)>
<!ELEMENT   accel                               (#PCDATA)>
<!ELEMENT   accel_qos                           (accel_unc, accel_conf_lev?)>
<!ELEMENT   accel_unc                           (#PCDATA)>
<!ELEMENT   accel-conf_lev                      (#PCDATA)>
<!ELEMENT   emidata                             (No_of_jammers?, Jammer_DoA)>
<!ELEMENT   No_of_jammers                       (#PCDATA)>
<!ELEMENT   Jammer_DoA                          (#PCDATA)>
<!ATTLIST   Jammer_DoA
            direction                           >
```

The following rules apply to the elements content and structure:

1) "*conf_lev* ": a location request (*slir*, *tlrr*) can require a specific quality of position (defined in elements or *eqop*, *qop*).

2) If optional element "*h_conf_lev*" (or "*v_conf_lev*" and/or "*vel_conf_lev*") is present with **attribute "*conf_class*" set to "ALERT"**, it shall be interpreted as a request to the location system to implement **integrity determination** on the horizontal position, etc. The Integrity concept is defined in ETSI TS 103 246-3 [3]. Element "*h_conf_lev*" (or "*v_conf_lev*" and/or "*vel_conf_lev*") then defines the integrity risk required to be respected by the location system. The corresponding protection level determined by the GBLS is given as follows:

   - for integrity of location target **horizontal position**, position shall be reported in the subsequent answer or report(s) through a "*CircularArea*" shape: protection level is given by the shape radius (element of the "*CircularArea*"). As a consequence, attribute "*requested_positiondata*" of element "*geo_info*" in the location request (*slir* or *tlrr*) shall have values "SHAPE" or "SHAPE_AND_CIVICLOC";

   - for integrity of location target **vertical position**, protection level shall be given by the element "*v_unc*";

   - for integrity of location target **velocity**, protection level shall be given by the element "*vel_unc*";

   - "h_conf_lev" (or "v_conf_lev" and/or "vel_conf_lev") in the subsequent answer or report(s) shall either be absent, or equal to the required integrity risk.

3) In case of identified misleading information (i.e. causing non-integrity), the GBLS shall inform the application by sending element "h_int_alert" (or "v_int_alert" and/or "vel_int_alert") under element "LSEP_qos_status".

4) If optional element "*h_conf_lev*" (or "*v_conf_lev*", "*vel_conf_lev*") is present with attribute "*conf_class*" set to "INFO", or element "*accel_conf_lev*" (or "*head_conf_lev*"), it shall be interpreted as a request to the location system to provide an estimate of the horizontal position error (or vertical position error, velocity error, acceleration error, heading error):

   - for horizontal position error estimation, the error estimate shall be reported in the subsequent answer or report(s) through a "*CircularArea*" shape: error estimate is given by the radius (element of the "*CircularArea*"). As a consequence, attribute "*requested_positiondata*" of element "*geo_info*" in the location request (*slir* or *tlrr*) shall have values "SHAPE" or "SHAPE_AND_CIVICLOC";

   - for other error estimation, the error estimate shall be given by the element "*v_unc*" (or "*vel_unc*", "*accel_unc*", "*head_unc*").

5) Element "*h_conf_lev*" (or "*v_conf_lev*", "*vel_conf_lev*", "*accel_conf_lev*", "*head_conf_lev*") is then the targeted level of reliability of the error estimate required to the location system. The level of reliability is defined as:

$$P(\varepsilon > \varepsilon^{*}) < Lr \quad (1)$$

where $P(\varepsilon > \varepsilon^{*})$ is the probability that the error exceeds the error estimate, and Lr is the level of reliability.

6) The location system can provide an error estimate using a different level of reliability. In that case, element "*conf_lev*" under "*hor_qos*" (or "*v_qos*", "*vel_qos*", "*accel_qos*", "*head_qos*" and/or "*synch_status*") in the subsequent answer or report(s) shall contain the confidence level achievable by the location system.

7) Usage of "*ll_acc*", "*hor_acc*", "*v_acc*", "*vel_acc*": when these are present in a location request (under element "*eqop*" or "*qop*"), these elements:

- indicate the level of accuracy expected by the application. Value of attribute "qos_class" indicates the expected behaviour of the location system in case the location-related data does not fulfil the required accuracy (see clause 8.1.2; *qos_class* definition);
- preclude integrity determination by the location system.

7.2.3 Quality of Position elements

```
<!ENTITY     % extension.param                "LSEP_eqop">
<!ELEMENT    LSEP_eqop                         (h_conf_lev?, v_conf_lev?, (vel_acc | vel_conf_lev)?,
                                               accel_conf_lev?, head_conf_lev?
<!ENTITY     % extension.param                "LSEP_qop">
<!ELEMENT    LSEP_qop                          (h_conf_lev?, v_conf_lev?, (vel_acc | vel_conf_lev)?,
                                               accel_conf_lev?, head_conf_lev?
<!ELEMENT    h_conf_lev                        (#PCDATA)>
<!ATTLIST    h_conf_lev
             conf_class ( INFO | ALERT )       "INFO">
<!ELEMENT    v_conf_lev                        (#PCDATA)>
<!ATTLIST    v_conf_lev
             conf_class ( INFO | ALERT )       "INFO">
<!ELEMENT    vel_acc                           (#PCDATA)>
<!ATTLIST    vel_acc
<!ELEMENT    vel_conf_lev                      (#PCDATA)>
<!ATTLIST    vel_conf_lev
             conf_class ( INFO | ALERT )       "INFO">
<!ELEMENT    accel_conf_lev                    (#PCDATA)>
<!ELEMENT    head_conf_lev                     (#PCDATA)>
<!ELEMENT    auth_flag                         YES/NO/UNKNOWN
<!ELEMENT    LSEP_qos_status                   (h_acc_not_met?, v_acc_not_met?, vel_acc_not_met?,
                                               h_int_alert?, v_int_alert?, vel_int_alert?)>
<!ELEMENT    h_acc_not_met                     (#PCDATA)>
<!ELEMENT    v_acc_not_met                     (#PCDATA)>
<!ELEMENT    vel_acc_not_met                   (#PCDATA)>
<!ELEMENT    h_int_alert                       (#PCDATA)>
<!ELEMENT    v_int_alert                       (#PCDATA)>
<!ELEMENT    vel_int_alert                     (#PCDATA)>
```

7.3 LSEP Sub-Child Elements

7.3.1 accel

Definition	
The acceleration of the location target, in m/s². When used for relative location, this parameter expresses the acceleration relative to the Reference Point.	
DTD type:	Element
Format:	Signed decimal value, resolution 0,1
Defined values:	range: [-50; 50]
Default value:	N/A
Example in XML:	`<accel>2.5</accel>`
Note:	This element is present if required by element "*req_info*" in the corresponding location request.

7.3.2 accel_conf_lev

Definition	
This element is the level of reliability required by the application regarding the acceleration accuracy estimate provided by the location system. It is expressed as log10(Level of reliability).	
DTD type:	Element
Format:	Negative decimal value, resolution 0,01
Defined values:	range: [-10; 0]
Default value:	-
Example in XML:	`<accel_conf_lev>-2</accel_conf_lev>`
Note:	When this element is present in a location request, it implicitly indicates that an estimate of the acceleration accuracy is required (this accuracy estimation being reliable with the required level of reliability). In the subsequent answer/report(s), the position information definition (element "*pd*") shall contain element "*accel_unc*", or an appropriate error message.

7.3.3 accel_unc

Definition	
Estimate of the acceleration uncertainty, in m/s².	
DTD type:	Element
Format:	Positive decimal value, resolution 0,1
Defined values:	range: [0; 10]
Default value:	
Example in XML:	`<accel_unc>1</accel_unc>`
Note:	

7.3.4 accel_req

Definition	
This element indicates that the acceleration information of the location target identified by MSID is required.	
DTD type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	`<accel_req />`
Note:	-

7.3.5 auth_flag

Definition		
Defines the authentication status of PVT location-related data.		
DTD Type:	Element	
Format:	Char string	
Defined values:	NO	Spoofing attempt is detected
	YES	Location-related data is authentic
	UNKNOWN	Authentication procedure could not conclude
Default value:	-	
Example in XML:	`<auth_flag>YES</auth_flag>`	
Note:	-	

7.3.6 auth_req

Definition		
Indicates if the location system is required to provide the related (parent) location-related data with associated authentication information.		
Type:	Attribute	
Format:	Boolean	
Defined values:	YES	Authenticity of the location-related data shall be determined and provided.
	NO	Authenticity of the location-related data shall not be determined and provided.
Default value:	NO	
Example:	`< accel_req auth_req ="NO" />`	
Note:	-	

7.3.7 conf_class

Definition		
Determines whether the parent confidence level provided shall be interpreted as an integrity risk or a level of reliability.		
DTD Type:	attribute	
Format:	Char string	
Defined values:	INFO	Parent confidence level shall be interpreted as the level of reliability of the required error estimate.
	ALERT	Parent confidence level shall be interpreted as the integrity risk which shall be used by the location system in its integrity determination process.
Default value:	[INFO]	
Example in XML:	`<h_conf_lev conf_class ="INFO">-2</h_conf_lev>`	
Note:	Value INFO shall be interpreted as a request to the location system to provide an horizontal position error estimate (or vertical position or velocity). Value ALERT shall be interpreted as a request to the location system to carry out integrity determination for horizontal position (or vertical position or velocity).	

7.3.8 emidata_req

Definition	
Indicates that the Direction of Arrival of an EMI source is required.	
DTD Type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	`< emidata_req />`
Note:	-

7.3.9 h_acc

Definition	
Accuracy of horizontal position in metres.	
DTD Type:	Element
Format:	Positive decimal value, resolution 0,001
Defined values:	range: [0; 10 000]
Default value:	-
Example in XML:	`<h_acc>0.1</h_acc>`
Note:	

7.3.10 h_acc_not_met

Definition	
Indication that the requested horizontal position QoS was not met, if needed.	
DTD Type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	-
Note:	Only applicable if the request was for best effort class, i.e. a horizontal position estimate is returned (rather than an error) although the requested QoS requirement (given in ll_acc or hor_acc) could not be fulfilled.

7.3.11 h_conf_lev

Definition	
Depending on the value of attribute "conf_class", it represents either the required integrity risk which shall be used by the location system in its integrity determination process, or the preferred level of reliability of the horizontal position error estimate. It is expressed as log10(Level of reliability) or log10(integrity risk).	
DTD Type:	Element
Format:	Negative decimal value, resolution 0,01
Defined values:	range: [-10; 0]
Default value:	
Example in XML:	`<h_conf_lev>-2</h_conf_lev>`
Note:	-

7.3.12 h_int_alert

Definition	
Indication that the location system detects location-related data mis-integrity.	
DTD Type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	-
Note:	Only applicable in case "*conf_class*" under "*h_conf_lev*" is set to "ALERT".

7.3.13 head_conf_lev

Definition	
Represents the preferred level of reliability of the heading error estimate. It is expressed as log10(Level of reliability).	
DTD Type:	Element
Format:	Negative decimal value, resolution 0,01
Defined values:	range: [-10; 0]
Default value:	
Example in XML:	`<head_conf_lev>-2</head_conf_lev>`
Note:	-

7.3.14 head_req

Definition	
Indicates that the heading information of the location target identified by MSID is required.	
DTD type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	`<head_req />`
Note:	-

7.3.15 head_unc

Definition	
Estimate of the heading uncertainty, in degrees.	
DTD type:	Element
Format:	Positive decimal value, resolution 0,1
Defined values:	range: [0; 10]
Default value:	-
Example in XML:	`<head_unc>1</head_unc>`
Note:	

7.3.16 LSEP-msids

Description	
Represents an identifier of a GBLS location target.	
Type:	Element
Format:	Char string
Defined values:	
Default value:	
Example:	`<LSEP_msids type="IMSI" enc="ASC">tbd</LSEP_msids>`
Note:	

7.3.17 v_acc

Definition	
Accuracy of requested vertical position in metres.	
DTD Type:	Element
Format:	Positive decimal value, resolution 0,001
Defined values:	range: [0; 10 000]
Default value:	-
Example in XML:	`<v_acc>0.1</v_acc>`
Note:	

7.3.18 v_acc_not_met

Definition	
Indication that the requested vertical position QoS was not met, if needed.	
DTD Type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	-
Note:	Only applicable if the request was for best effort class, i.e. a vertical position estimate is returned (rather than an error) although the requested QoS requirement (given in v_acc) could not be fulfilled.

7.3.19 v_conf_lev

Definition	
Depending on the value of attribute "conf_class", it represents either the required integrity risk which shall be used by the location system in its integrity determination process, or the preferred level of reliability of the vertical position error estimate. It is expressed as log10(Level of reliability) or log10(integrity risk).	
DTD Type:	Element
Format:	Negative decimal value, resolution 0,01
Defined values:	range: [-10; 0]
Default value:	-
Example in XML:	`<v_conf_lev>-2</v_conf_lev>`
Note:	-

7.3.20 v_unc

Definition	
Estimate of the altitude uncertainty, in metres.	
DTD type:	Element
Format:	Positive decimal value, resolution 0,01
Defined values:	range: [0; 100]
Default value:	-
Example in XML:	`<v_unc>0.5</v_unc>`
Note:	Usage of this element, in particular regarding the integrity concept, is defined in clause 7.2.2 (location elements).

7.3.21 v_req

Definition	
Indicates that the altitude information (or vertical position) of the location target identified by MSID is required.	
DTD type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	`<v_req />`
Note:	-

7.3.22 vel_acc

Definition	
Accuracy of requested velocity in m/s.	
DTD type:	Element
Format:	Positive decimal value, resolution 0,01
Defined values:	range: [0; 5]
Default value:	-
Example in XML:	<vel_acc>1</vel_acc>
Note:	-

7.3.23 vel_acc_not_met

Definition	
Indication that the requested velocity QoS was not met, if needed.	
DTD Type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	-
Note:	Only applicable if the request was for best effort class, i.e. a velocity estimate is provided (rather than an error) although the requested QoS requirement (given in vel_acc) could not be fulfilled.

7.3.24 vel_conf_lev

Definition	
Depending on the value of attribute "conf_class", it represents either the required integrity risk which shall be used by the location system in its integrity determination process, or the preferred level of reliability of the vertical position error estimate. It is expressed as log10(Level of reliability) or log10(integrity risk).	
DTD Type:	Element
Format:	Negative decimal value, resolution 0,01
Defined values:	range: [-10; 0]
Default value:	-
Example in XML:	<vel_conf_lev>-2</vel_conf_lev>
Note:	-

7.3.25 vel_unc

Definition	
Estimate of the velocity uncertainty, in m/s.	
DTD type:	Element
Format:	Positive decimal value, resolution 0,01
Defined values:	range: [0; 5]
Default value:	-
Example in XML:	<head_unc>1</head_unc>
Note:	

7.3.26 vel_req

Definition	
This element indicates that the velocity information of the location target identified by MSID is required.	
DTD type:	Element
Format:	Void
Defined values:	-
Default value:	-
Example in XML:	<vel_req />
Note:	-

8 LSIP Information Elements

8.1 LSIP Common Positioning IEs

8.1.1 General

Clauses 8.1.2 and 8.1.3 define IEs that carry common low-level IEs for the corresponding message extensions.

8.1.2 LSIP-CommonIEsRequestLocationInformation

```
-- ASN1START

LSIP-CommonIEsRequestLocationInformation ::= SEQUENCE {
    triggeredReporting          LSIP-TriggeredReportingCriteria     OPTIONAL,   -- Cond ECID
    qosReq                  LSIP-QoSReq                     OPTIONAL,   -- Need ON
    locationTargetIdReq         LSIP-LocationTargetIdReq            OPTIONAL,
    ...
}

LSIP-TriggeredReportingCriteria ::=     SEQUENCE {
    ChangeArea                  BOOLEAN,
    distanceEvent                   BOOLEAN,
    velocityEvent                   BOOLEAN,
    equidistanceEvent               BOOLEAN,
    logicalTriggerCombination       ENUMERATED {or, and, ...}           OPTIONAL,
    ...
}

LSIP-QoSReq ::= SEQUENCE {
    horizontalUncReq            LSIP-HorizontalUncReq               OPTIONAL,   -- Need ON
    verticalUncReq          LSIP-VerticalUncReq             OPTIONAL,   -- Need ON
    velocityUncReq          LSIP-VelocityUncReq             OPTIONAL,   -- Need ON
    headingUncReq               LSIP-HeadingUncReq                  OPTIONAL,   -- Need ON
    accelerationUncReq          LSIP-AccelerationUncReq         OPTIONAL,   -- Need ON
    authenticationReq           LSIP-AuthenticationReq              OPTIONAL,-- Need ON
    ...
}

LSIP-HorizontalUncReq ::= SEQUENCE {
    confidenceClass     ENUMERATED { INFO,ALERT, ...}           OPTIONAL,   Cond accEstReq
    QosClass                ENUMERATED { ASSURED,BEST_EFFORT, ...}  OPTIONAL,   Cond targetAcc
    ...
}

LSIP-VerticalUncReq ::= SEQUENCE {
    confidenceClass     ENUMERATED { INFO, ALERT, ...}          OPTIONAL,   Cond accEstReq
    Qos class               ENUMERATED { ASSURED, BEST_EFFORT, ...} OPTIONAL,   Cond targetAcc
    ...
}

LSIP-VelocityUncReq ::= SEQUENCE {
    confidenceClass     ENUMERATED { INFO, ALERT, ...}          OPTIONAL,   Cond accEstReq
    Qos class               ENUMERATED { ASSURED, BEST_EFFORT, ...} OPTIONAL,   Cond targetAcc
    ...
}

LSIP-HeadingUncReq ::= SEQUENCE {
    confidenceClass     ENUMERATED { INFO, ALERT, ...}          OPTIONAL,   Cond accEstReq
    Qos class               ENUMERATED { ASSURED, BEST_EFFORT, ...} OPTIONAL,   Cond targetAcc
    ...
}
LSIP-AccelerationUncReq ::= SEQUENCE {
    confidence      INTEGER(0..100),
    ...
}
LSIP-AuthenticationReq::=       SEQUENCE {
    PVTAuthenticationReq            BOOLEAN
    ...
}
```

```
LSIP-LocationTargetIdReq ::= SEQUENCE {
        Targetid            INTEGER(0..100)
    ...
}
LSIP-LocationSourceReq ::= SEQUENCE {
    odometer                NULL    OPTIONAL,
    bfn                NULL    OPTIONAL,
    ...
}
-- ASN1STOP
```

Conditional presence	Explanation
ECID	The field is optionally present, need ON, if ECID is requested. Otherwise it is not present.
targetAcc	The field shall be absent in case field "*confidence*" and "*confidenceClass*" are specified in the same "*QoS*" IE.
accEstReq	The field shall be absent in case field "*Error*" and "*qos_class*" are specified in the same "*QoS*" IE.

CommonIEsRequestLocationInformation field descriptions

triggeredReporting
This IE indicates that triggered reporting is requested to implement the reporting schemes required internally to the GBLS, and by the application (via LSEP) if at least one of the following fields is set to TRUE:

- ChangeArea set to TRUE if the location target either (1) enters (2) leaves the target area or (3) is outside the target area (target_area);
- distance_event: set to TRUE when the target's distance from a reference object either (1) decreases below the target_distance, or (2) increases above the target distance (target_distance);
- velocityEvent: set to TRUE when the target's speed either (1) increases above, (2) is above, (3) decreases below or (4) is below the target speed (target_speed);
- equidistanceEvent: set to TRUE when the target device has moved by a defined distance (target_equidistance);
- logicalTriggerCombination: if this field is set to TRUE, the target device provides requested location information for each event.

The triggeredReporting field should not be included by the location server and shall be ignored by the target device if the periodicalReporting IE or responseTime IE is included in LPP CommonIEsRequestLocationInformation.

horizontalUncReq : see table 8.1
verticalUncReq: see table 8.1
velocityUncReq: see table 8.1
headingAccuracy: see table 8.1
For each of these, only the combinations of IEs related to "xxUnc" indicated in table 8.1 shall be permitted.

confidenceClass:
INFO, ALERT (see table 8.1).

QosClass:
ASSURED, BEST_EFFORT (see table 8.1).

locationTargetIdReq:
This "request" message can relate to several targets.

PVTauthenticationReq:
Indicates need for PVT authentication.

Table 8.1

Case	*LPP Accuracy* field	*LPP Confidence* field	*confidence Class* field	*qosClass* field	Explanation
1	present	absent	absent	ASSURED	Targeted measurement error is specified, and only measurements complying with targeted error shall be provided.
2	present	absent	absent	BEST EFFORT	Targeted measurement error is specified, and measurement not complying with targeted error shall be flagged in the subsequent answer (using IE "*LSIP-QosIndicators*").
3	absent	present	INFO	absent	Estimation of the measurement error is required. Error estimate should comply with the required confidence level. In CL cannot be met, it shall be indicated in the subsequent answer (using IE "*LSIP-ConfidenceLevels*").
4	absent	present	ALERT	absent	Estimation of the measurement error is required. Error estimate shall comply with the required confidence level. In case estimated error cannot comply with the required CL it shall be reported in the subsequent answer to the "*server*" entity (using IE "*LSIP-IntegrityAlerts*").

8.1.3 LSIP-CommonIEsProvideLocationInformation

```
-- ASN1START

LSIP-CommonIEsProvideLocationInformation ::= SEQUENCE {
    QoS                     LSIP-QoS                    OPTIONAL,
    alerts                  LSIP-IntegrityAlerts        OPTIONAL,
    locatioTargetId         LSIP-LocationTargetId       OPTIONAL,
    locationSource          LSIP-LocationSource     OPTIONAL, --Cond LocationSource
    ...
}

LSIP-QoS::=     SEQUENCE {
    confidenceLevels                    LSIP-ConfidenceLevels               OPTIONAL, cond
clReporting
    ErrorMeasurements                   LSIP-ErrorMeasurements          OPTIONAL,    cond
errorMeasuresReq
    qosIndicators                       LSIP-QosIndicators                  OPTIONAL,    cond
targetErrorReq
    authenticationFlag                  LSIP-Authentication             OPTIONAL,    cond authReq
    ...
}

LSIP-Authentication::=  CHOICE {
    Yes     BOOLEAN,
    No      BOOLEAN,
    Unknown     BOOLEAN
}

LSIP-IntegrityAlerts ::= SEQUENCE {
    hplAlert                    HplALert            OPTIONAL,
    vplAlert                                OPTIONAL,
    velocityAlert               VelocityALert       OPTIONAL,
    headingAlert                        OPTIONAL,
    ...
}

HplALert ::= CHOICE {
    DoNotUse            BOOLEAN,
    NotMonitored        BOOLEAN,
    ...+
}

VplALert ::= CHOICE {
    DoNotUse            BOOLEAN,
```

```
    NotMonitored        BOOLEAN,
    ...
}

VelocityALert ::= CHOICE {
    DoNotUse            BOOLEAN,
    NotMonitored        BOOLEAN,
    ...
}

HeadingALert ::= CHOICE {
    DoNotUse            BOOLEAN,
    NotMonitored        BOOLEAN,
    ...
}

LSIP-LocationTargetId ::= SEQUENCE {
    Targetid        INTEGER(0..100),
    ...
}
LSIP-LocationSource ::= SEQUENCE {
    odometer                NULL    OPTIONAL,
    bfn                 NULL    OPTIONAL,
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
LocationSource	This parameter shall be present in each such message sent to a server when a location estimate is sent in either low accuracy format in LPP (as part of LPP CommonIEsProvideLocationInformation) or in high accuracy format in LPPe (as part of LPPe OMA-LPPe-CommonIEsProvideLocationInformation).
clReporting	This field is mandatory present if the associated location information request requires one or several measurement error estimates (among horizontal position, vertical position, velocity), with "confidence class" set to "INFO". It can be equal to the "confidence" set in the location information request, or lower in case the measurement error estimate computed cannot meet the required confidence level.
errorMeasuresReq	This field is mandatory present if the associated location information request requires for one or several measurement accuracy estimates among acceleration and heading, with "confidence class" set to "INFO" or "ALERT".
targetErrorReq	This field is mandatory present if the associated location information request requires a targeted error for one or several measurements (among horizontal position, vertical position, velocity), with "qosclass" set to "BEST EFFORT".
authReq	This field is mandatory present if PVT authentication is requested.

***CommonIEsProvideLocationInformation* field descriptions**
QoS: • confidenceLevels • errorMeasurements • qosIndicators • authenticationFlag
Integrity Alerts: • hplAlert • vplAlert • velocityAlert • headingAlert For each IE, the alert indicates the parameter is not valid (see LSIP-CommonIEsRequestLocationInformation).
locationTargetId: This refers to a single target id.
LSIP-locationSource: This parameter indicates the additional positioning technologies involved in calculating a position estimate sent by the target to the server. The parameter is encoded as a bitmap and lists the following positioning technologies: • odometer • BFN If more than one positioning technology is indicated, the target calculated a final position result reported to the server by appropriately combining individual position results (hybrid positioning).

8.2 LSIP Common Low-Level IEs

8.2.1 General

Clauses 8.2.2 to 8.2.4 define common IEs that are applicable to more than one LSIP positioning method.

8.2.2 LSIP-ConfidenceLevels

```
-- ASN1START

LSIP-ConfidenceLevels::=        SEQUENCE {
    velocityCL                      INTEGER(0..100)         OPTIONAL,
    headingCL                           INTEGER(0..100)         OPTIONAL,
    accelCL                         INTEGER(0..100)         OPTIONAL,

}

-- ASN1STOP
```

LSIP-ConfidenceLevels field descriptions
• velocityCL • accelCL • headingCL In each case the confidence level is defined in %.

8.2.3 LSIP-ErrorMeasurements

```
-- ASN1START

LSIP-ErrorMeasurements ::=      SEQUENCE {
    accelerationUnc         INTEGER(0..100)             OPTIONAL,
    headingUnc              INTEGER(0..100)             OPTIONAL,
    ...
}

-- ASN1STOP
```

LSIP-ErrorMeasurements field descriptions
accelerationUnc
• acceleration uncertainty in 0,1 ms^{-2}
headingUnc
• heading uncertainty in 0,1 degrees

8.2.4 LSIP-QosIndicators

```
-- ASN1START

LSIP-QosIndicators::=       SEQUENCE {
    horizontalUncNotMet         BOOLEAN,
    verticalUncNotMet               BOOLEAN,
    velocityUncNotMet               BOOLEAN,
    accelerationUncNotMet           BOOLEAN,
    headingUncNotMet                BOOLEAN,
    ...
}
-- ASN1STOP
```

LSIP-QosIndicators field descriptions
horizontalUncNotMet TRUE indicates error exceeds required uncertainty
verticalUncNotMet TRUE indicates error exceeds required uncertainty
velocityUncNotMet TRUE indicates error exceeds required uncertainty
accelerationUncNotMet TRUE indicates error exceeds required uncertainty
headingUncNotMet TRUE indicates error exceeds required uncertainty

8.3 Specific Positioning Method IEs

8.3.1 General

Clauses 8.3.2 to 8.3.4 define low-level IEs for specific LSIP messages.

8.3.2 GNSS Positioning

8.3.2.1 LSIP-GNSS-RequestLocationInformation

```
-- ASN1START

LSIP-GNSS-PositioningInstructions ::= SEQUENCE {
    gnssRfSamplesReq                LSIP-GNSS-RFSamplesReq              OPTIONAL,   -- Need ON
    gnssRfSamplesParameters     LSIP-GNSS-RFSamplesControlParameters    OPTIONAL, --Cond
RFsamplesReq
    gnssMeasurementsReq             LSIP-GNSS-MeasurementsReq           OPTIONAL,   -- Need ON
    gnssNavMessageReq               LSIP-GNSS-NavMessageReq             OPTIONAL,   -- Need ON
    gnssAuthenticationReq           LSIP-GNSS-AuthenticationReq         OPTIONAL,   -- Need ON

    ...
}

LSIP-GNSS-RFSamplesReq::= SEQUENCE {
    [tbd]
    ...
}

LSIP-GNSS-RFSamplesControlParameters::= SEQUENCE {
    [tbd]
    ...
}

LSIP-GNSS-MeasurementsReq::= SEQUENCE {
    [tbd]
    ...
}

LSIP-GNSS-NavMessageReq::= SEQUENCE {
    [tbd]
    ...
}

LSIP-GNSS-AuthenticationReq::= SEQUENCE {
    GNSSAuthenticationReq           BOOLEAN
    ...
}


-- ASN1STOP
```

Conditional presence	Explanation
RFsamplesReq	The field is optionally present, need ON, if *RFsamplesReq* is requested. Otherwise it is not present.

LSIP-GNSS-RequestLocationInformation field descriptions
LSIP-GNSS-RFSamplesReq FFS
LSIP-GNSS-RFSamplesControlParameters FFS
LSIP-GNSS-MeasurementsReq Ask for GNSS measurements
LSIP-GNSS-NavMessageReq Ask for Navigation Message
LSIP-GNSS-AuthenticationReq Ask for authentication

8.3.2.2 LSIP-GNSS-ProvideLocationInformation

```
-- ASN1START

LSIP-GNSS-ProvideLocationInformation ::= SEQUENCE {
    rfSamplingMeasurements      LSIP-GNSS-RfSamples     OPTIONAL,
    gnssObservablesMeasurements LSIP-GNSS-Measurements      OPTIONAL,
    gnssNavigationMessageData   LSIP-GNSS-NavMessage        OPTIONAL,
    gnssAuthentication          LSIP-GNSS-Authentication        OPTIONAL,

…
}

LSIP-GNSS-RfSamples ::= SEQUENCE {
    [tbd],
    ...
}

LSIP-GNSS-Measurements::= SEQUENCE {
    [tbd],
    ...
}

LSIP-GNSS-NavMessage::= SEQUENCE {
    [tbd],
    ...
}

LSIP-GNSS-Authentication::= CHOICE {
    Yes     BOOLEAN,
    No      BOOLEAN,
    Unknown     BOOLEAN
}


-- ASN1STOP
```

LSIP-GNSS-RequestLocationInformation field descriptions
LSIP-GNSS-RfSamples IQ samples grabbed by the GNSS sensor.
LSIP-GNSS-Measurements GNSS measurements (observables such as pseudorange and Doppler, CN0) calculated by the GNSS sensor.
LSIP-GNSS-NavMessage Decoded Navigation Message.
LSIP-GNSS-Authentication Authentication flag produced by the GNSS sensor (using internal algorithms).

8.3.3 Odometer positioning

8.3.3.1 LSIP-Odometer-RequestAssistanceData

```
-- ASN1START

LSIP-Odometer-RequestAssistanceData::= SEQUENCE {
    wheelSizereq            BOOLEAN,
    ...
```

```
}

-- ASN1STOP
```

LSIP-Odometer-RequestAssistanceData field descriptions
wheelSizereq
• request for diameter of wheel.

8.3.3.2 LSIP-Odometer-ProvideAssistanceData

```
-- ASN1START

LSIP-Odometer-ProvideAssistanceData::= SEQUENCE {
    wheelSize           INTEGER (0..1000),
    ...
}

-- ASN1STOP
```

LSIP-Odometer-ProvideAssistanceData field descriptions
wheelsize
• diameter of wheel in millimetres.

8.3.3.3 LSIP-Odometer-RequestLocationInformation

```
-- ASN1START

LSIP-Odometer-RequestLocationInformation::= SEQUENCE {
    odometerInformationType     SEQUENCE{
    travelledDistanceReq                                BOOLEAN,
    odomVelocityReq                                   BOOLEAN,
    ...
                                    }
    ...
}

-- ASN1STOP
```

LSIP-Odometer-RequestLocationInformation field descriptions
odometerInformationType
This field identifies the sensor.
travelledDistanceReq
• requests distance travelled.
odomVelocityReq
• requests speed from odometer.

8.3.3.4 LSIP-Odometer-ProvideLocationInformation

```
-- ASN1START

LSIP-Odometer-ProvideLocationInformation::= SEQUENCE {
    travelledDistance                   INTEGER (0..16383)          OPTIONAL,           Cond
odomDistReq
    odomVelocity                        INTEGER (0..1023)           OPTIONAL,           Cond
odomVelReq
    reverseFlag                     BOOLEAN
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
odomDistReq	The field is mandatory present if *travelledDistanceReq* has been issued; otherwise the field is not present.
odomVelReq	The field is mandatory present if *odomVelocityReq* has been issued; otherwise the field is not present.

LSIP-Odometer-ProvideLocationInformation field descriptions
travelledDistance
• represents the distance travelled in metres.
odomVelocity
• represents the velocity in 10E-2 m/s.
reverseFlag
NOTE: Mandatory present, since it accompanies the distance travelled and/or velocity information from the odometer.

8.3.4 Beam Forming Network Positioning

8.3.4.1 LSIP-BFN-RequestLocationInformation

```
-- ASN1START

LSIP-BFN-RequestLocationInformation::= SEQUENCE {
    MaxNbrofJammersreq                    INTEGER (1.. 8)         OPTIONAL,
    JammerPowerReq                    BOOLEAN,
    doAReq                            BOOLEAN,
    ...

}
-- ASN1STOP
```

LSIP-BFN-RequestLocationInformation field descriptions
MaxNbrofJammersreq
• request detected number of jammers by the BFN limited to a maximum.
JammerPowerReq
• request relative power of a jammer measured by the BFN.
doAReq
• request direction of arrival of a jammer by the BFN.

8.3.4.2 LSIP-BFN-ProvideLocationInformation

```
-- ASN1START

LSIP-BFN-ProvideLocationInformation::= SEQUENCE {
    detectedNbrofJammers    INTEGER (1.. maxNbrofJammers)           OPTIONAL,
    jammerID                SEQUENCE (SIZE (1..maxNbrJammers) OF LSIP-JammerSignal      OPTIONAL,
    ...
}

maxNbrJammers       INTEGER ::= 8

-- ASN1STOP
```

LSIP-BFN-ProvideLocationInformation field descriptions
detectedNbrofJammers
Number of jammers detected by the BFN.
JammerID
• detected jammer identifier.

8.3.4.3 LSIP-JammerSignal

```
-- ASN1START

LSIP-Jammer Signal::= SEQUENCE {
    JammerPower                LSIP-JammingPower              OPTIONAL,
    JammerDoA                      LSIP-DirectionOfArrival    OPTIONAL,
    ...

LSIP-JammingPower::= SEQUENCE {
    powerEstimate                  INTEGER (-10..30])                OPTIONAL,
    powerEstError                  INTEGER (0..50])                  OPTIONAL,
    ...
```

```
LSIP-DirectionOfArrival::= SEQUENCE {
    azimuth                         INTEGER (0..360),
    elevation                           INTEGER (0..90),
    azimuthEstUnc                       INTEGER (0..50),
    elevationEstUnc                 INTEGER (0..20),
    ...
}

-- ASN1STOP
```

LSIP- **JammerSignal** field descriptions
JammerPower   Relative power of jammer.
Jammer DoA   Direction of arrival of jammer.
powerEstimate   Power of jammer in dB relative to reference GNSS power.
powerEstError   Mean Error of jammer power estimate, resolution 0,2 dB.
azimuth   Azimuth of BFN DoA measurement: resolution 1 degree, range 0 to 360 degrees.
elevation   Azimuth of BFN DoA measurement: resolution 1 degree, range 0 to 90 degrees.
azimuthEstUnc   Mean Azimuth error of BFN DoA measurement: resolution 0,5 degrees.
elevationEstUnc   Mean Elevation error of BFN DoA measurement: resolution 0,5 degrees.

8.3.5 Mapping Positioning

For further study.

9 D-GNSS information elements

9.1 General

All of the following information is extracted from RTCM 10402.3 [7] or RTCM 10403.2 [8]. Presented here is only the list of messages required to process a particular D-GNSS method. More details about the detailed messages contents, data types and data fields will be found in the respective RTCM 10402.3 [7] and RTCM 10403.2 [8] reference documents.

9.2 Case of conventional D-GNSS

Conventional D-GNSS compatible with RTCM 104 version 3 -recommended (see RTCM 10403.2 [8] paragraph 3.2 for message type summary, paragraph 3.3 for data type and paragraph 3.4 for data fields definitions).

Table 9.1: RTCM messages to be used for conventional D-GNSS differential GNSS positioning method

Group name	Service	Minimum service operation	Full service operation
Observations	GNSS code differential operation including new signals and new constellations	MSM1 (compact GNSS pseudo ranges)	MSM1 (compact GNSS pseudo ranges)
Station coordinates		1005 or 1006	1005 or 1006
Antenna description			1007 or 1008 or 1033
Auxiliary operation information			1013

Conventional D-GPS compatible with RTCM 104 version 2 [7]

This standard [7] was developed when the GPS constellation was the only operational GNSS constellation. The evolution towards use for GLONASS or Galileo is still tentative.

Readers, interested to implement use of conventional D-GPS compatible with RTCM 104 version 2, are invited to read in depth RTCM 10402.3 [7] which provides details about the application of the protocol.

However, it is recommended that no new GBLS systems should be designed with such an aging protocol. Indeed, currently compatibility with new constellations like Galileo is only a tentative protocol.

Table 9.2: Recommended messages for conventional D-GPS compatible with RTCM

Group name	Service	Minimum service operation	Full service operation
Corrections (GPS only)		Type 1 messages	
Reference station parameters		Type 3 messages	
Antenna description		Type 23 messages	
GPS constellation health		Type 5 messages	

9.3 Case of RTK

Local RTK (see RTCM 10403.2 [8] paragraph 3.2 for message type summary, paragraph 3.3 for data type and paragraph 3.4 for data fields definitions).

Table 9.3: RTCM messages to be used for local RTK differential GNSS positioning method

Group name	Service	Minimum service operation	Full service operation
Observations	GPS L1 only	1001	1002
	GPS L1 and L2	1003	1004
	GLONASS L1 only	1009	1010
	GLONASS L1 and L2	1011	1012
	GPS+GLONASS L1 only	1001	1002
	GPS+GLONASS L1 and L2	1003	1004
	GNSS RTK standard precision including new signals and new constellations	MSM3 (compact GNSS pseudo ranges and phase ranges)	MSM5 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR)
	GNSS RTK high precision operation	MSM6 (full GNSS pseudo ranges, phase ranges, plus CNR high resolution)	MSM7 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR high resolution)
Station coordinates	all	1005 or 1006	1005 or 1006
Receiver and Antenna description	all	1033	1033
Auxiliary operation information	all GPS only		1013
	all GPS + GLONASS	1230	1013 and 1230

9.4 NRTK

NRTK/MAC (see RTCM 10403.2 [8] paragraph 3.2 for message type summary, paragraph 3.3 for data type and paragraph 3.4 for data fields definitions).

Table 9.4: RTCM messages to be used for network RTK/MAC differential GNSS positioning method

Group name	Service	Minimum service operation	Full service operation
Observations of the master station	GPS L1 and L2	1003	1004
	GLONASS L1 and L2	1011	1012
	GPS+GLONASS L1 and L2	1003	1004
	GNSS RTK standard precision including new signals and new constellations	MSM3 (compact GNSS pseudo ranges and phase ranges)	MSM5 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR)
	GNSS RTK high precision operation	MSM6 (full GNSS pseudo ranges, phase ranges, plus CNR high resolution)	MSM7 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR high resolution)
Station coordinates	all	1005 or 1006	1005 or 1006
receiver and Antenna description	all	1033	1033
Auxiliary operation information	all GPS only		1013
	with GLONASS	1230	1013 and 1230
Network RTK Corrections (MAC)	**GPS only** MAC network auxiliary station data message GPS ionospheric correction differences (1015) GPS geometric correction differences (1016) combined GPS geometric and ionospheric correction differences (1017) GPS Network RTK Residual message	 1014 1017	 1014 1015 and 1016 or 1017 1030
	GLONASS only MAC network auxiliary station data message GLONASS ionospheric correction differences (1037) GLONASS geometric correction differences (1038) combined GLONASS geometric and ionospheric correction differences (1039) GLONASS Network RTK Residual message GLONASS network RTK corrections	 1014 1039 1035	 1014 1037 and 1038 or 1039 1031 1035
	GPS+GLONASS MAC network auxiliary station data message GPS ionospheric correction differences (1015) GPS geometric correction differences (1016) combined GPS geometric and ionospheric correction differences (1017) GPS Network RTK Residual message GLONASS ionospheric correction differences (1037) GLONASS geometric correction differences (1038) combined GLONASS geometric and ionospheric correction differences (1039) GLONASS Network RTK Residual message GLONASS network RTK corrections	 1014 1017 1039 1035	 1014 1015 and 1016 or 1017 1030 1037 and 1038 or 1039 1031 1035

NRTK/FKP (see RTCM 10403.2 [8] paragraph 3.2 for message type summary, paragraph 3.3 for data type and paragraph 3.4 for data fields definitions).

Table 9.5: RTCM messages to be used for network RTK/FKP differential GNSS positioning method

Group name	Service	Minimum service operation	Full service operation
Observations of the reference station	GPS L1 and L2	1003	1004
	GLONASS L1 and L2	1011	1012
	GPS+GLONASS L1 and L2	1003	1004
	GNSS RTK standard precision including new signals and new constellations	MSM3 (compact GNSS pseudo ranges and phase ranges)	MSM5 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR)
	GNSS RTK high precision operation	MSM6 (full GNSS pseudo ranges, phase ranges, plus CNR high resolution)	MSM7 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR high resolution)
Station coordinates	all	1005 or 1006	1005 or 1006
Receiver and Antenna description	all	1033	1033
Auxiliary operation information	all GPS only		1013
	with GLONASS	1230	1013 and 1230
Network RTK Corrections (FKP)	**GPS only** GPS Network RTK corrections (FKP)	1034	1034 1030
	GLONASS only GLONASS network RTK corrections (FKP)	1035	1035 1031
	GPS+GLONASS GPS Network RTK corrections (FKP) GLONASS network RTK corrections(FKP)	1034 1035	1034 1030 1035 1031

NRTK/VRS (see RTCM 10403.2 [8] paragraph 3.2 for message type summary, paragraph 3.3 for data type and paragraph 3.4 for data fields definitions).

Table 9.6: RTCM messages to be used for network RTK/FKP differential GNSS positioning method

Group name	Service	Minimum service operation	Full service operation
Observations of the virtual station	GPS L1 and L2	1003	1004
	GLONASS L1 and L2	1011	1012
	GPS+GLONASS L1 and L2	1003	1004
	GNSS RTK standard precision including new signals and new constellations	MSM3 (compact GNSS pseudo ranges and phase ranges)	MSM5 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR)
	GNSS RTK high precision operation	MSM6 (full GNSS pseudo ranges, phase ranges, plus CNR high resolution)	MSM7 (full GNSS pseudo ranges, phase ranges, phase range rates and CNR high resolution)
Station coordinates	all	1005 or 1006	1005 or 1006
Receiver and Antenna description	all	1033	1033
Auxiliary operation information	all GPS only		1013
	with GLONASS	1230	1013 and 1230
Proprietary information	for requesting a virtual station at the approximate location of the rover	in the assigned range 4001 - 4095 4077 to 4095 are already assigned for existing organization, 4001 - 4076 are reserved	in the assigned range 4001 - 4095 4077 to 4095 are already assigned for existing organization, 4001 - 4076 are reserved

9.5 PPP

PPP (see RTCM 10403.2 [8] paragraph 3.2 for message type summary, paragraph 3.3 for data type and paragraph 3.4 for data fields definitions).

Table 9.7: RTCM messages to be used for PPP differential GNSS positioning method

Group name	Service	Minimum service operation	Full service operation
Orbit and clock corrections	GPS only	1060	1057 1058 1062
	GLONASS only	1066	1063 1064 1068
	GPS+GLONASS	1060 and 1066	1057 1058 1062 1063 1064 1068
Bias corrections	GPS only		1059
	GLONASS only		1065
	GPS+GLONASS		1059 and 1065
Auxiliary operation information	GPS only		1061
	GLONASS only		1067
	GPS+GLONASS		1061 and 1067

Annex A (informative): Rationale for LSEP/MLP and LSIP/LPPe

A.1 Basis for LSEP/MLP

In a practical GBLS implementation there are several candidates among standardized protocols for LSEP in next generation location systems including:

Protocol	Plane	Underlying Protocol
OMA MLP [4]	User	XML/HTML/WSP/SOAP
OSA/PARLAY API [i.4]	User	TCP/IP
OMA LOCSIP [i.3]	User	SIP
OMA ULP [i.2]	User	TCP/IP
OMA LPP/LPPe [5]	User or Control	TCP/IP

Several of these protocols combining their advantages could be used.

MLP has been designed with extensibility in mind, notably allowing the addition of new messages and of new parameters to existing messages. Therefore LSEP defines extensions to MLP including any modifications or exceptions.

A.2 Basis for LSIP/LPPe

In a practical GBLS implementation there are several candidates among standardized protocols for LSIP in next generation location systems including:

Protocol	Plane	Underlying Protocol
3GPP LPP [6], TIA-801 [i.5], RRC [i.6], RRLP [i.7]	Control	
OMA ULP [i.2]	User	TCP/IP
OMA LPP/LPPe [5]	User or Control	TCP/IP

The choice of LPPe/LPP is recommended for any GBLS implementation since it is comprehensive and flexible in terms of location data exchange, and is particularly suitable when the GBLS Positioning Module is realized as a mobile terminal connected to a telecommunications network for alternative positioning, etc. (e.g. 3GPP).

For LTE implementations of the GBLS, a Control Plane (and User Plane) solution is possible for Interface 10. For other implementations a User Plane solution is recommended for Interface 10, because of the restrictions of other protocols than LPPe.

LPPe is based on ETSI LPP [6], but in addition it allows convergence of both these positioning protocols over either User or Control Plane (and not only the Control Plane), thus removing potential bandwidth limitations and allowing messaging for new positioning technologies. LPPe is also suitable for transport over secure user-plane transport.

A.3 LSIP Implementation Cases

LPPe transactions follow a client-server model, and specifically between a SET and SLP ("target" and "server" in LPPe).

In the GBLS, LSIP is defined for interfaces between all internal functional blocks and to implement it two main solutions are possible:

1) either a single centralized server is implemented for communication with all blocks via relays through intermediate blocks, and the server provides all required GBLS data; or

2) each interface implements a separate client-server model and each interface transacts the relevant subset of the GBLS data.

In the latter case, an example of mapping of GBLS functional blocks to "server" and "target" roles defined by LPPe is shown in tables A.1 and A.2.

Table A.1: "Server" and "target" roles of GBLS components in A-GNSS data transfer

Standard	Interface no.	User/Control Plane Implementation	"Server" role	"Target" role
LPPe		C or U	SLP, E-SMLC	SET, UE
LSIP	1	U	Location Module	GNSS sensor
LSIP	2	U	Location Module	Telecommunication module
LSIP	3	U	Location Module	Inertial Navigation Sensor
LSIP	6	U	Location Module	Beam Forming Antenna
LSIP	7	U	Location Module	Map data base
LSIP	9	U	Central Management module	Location Module
LSIP	10	C or U	Central Facility	Positioning Module

Table A.2: "Server" and "target" roles of GBLS components in Location information transfer

Standard	Interface no.	User/Control Plane Implementation	"Server" role	"Target" role
LPPe		C or U	SLP, E-SMLC	SET, UE
LSIP	1	U	Location Module	GNSS sensor
LSIP	2	U	Location Module	Telecommunication module
LSIP	3	U	Location Module	Inertial Navigation Sensor
LSIP	4	U	Location Module	Magnetometer
LSIP	5	U	Location Module	Odometer
LSIP	6	U	Location Module	Beam Forming Antenna
LSIP	8	U	Application Interface	Location Module
LSIP	9	U	Central Management module	Location Module
LSIP	10	C or U	Central Facility	Positioning Module

A.4 LSIP Procedure examples for GBLS Interface 10

A.4.1 "Mobile-centric" Assistance data provisioning

Figure A.1 shows the transfer of Assistance Data on Interface 10 initiated by the On-Board Location Module acting as a client, triggering a request to the external network.

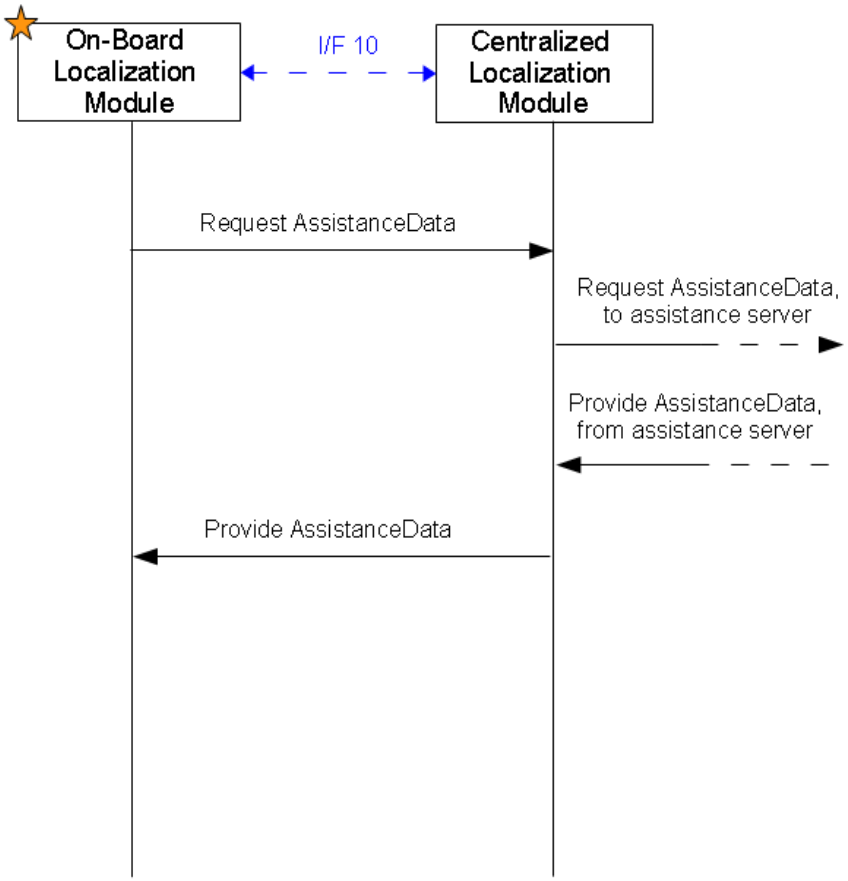

Figure A.1: Procedure for Assistance data provisioning between Location Module components

A.4.2 "Network-centric" Location Information provisioning

Figure A.2 shows the transfer of Location Data on Interface 10 initiated by an external application with the On-Board Location Module acting as a server, and the Centralized Location Module acting as a proxy client.

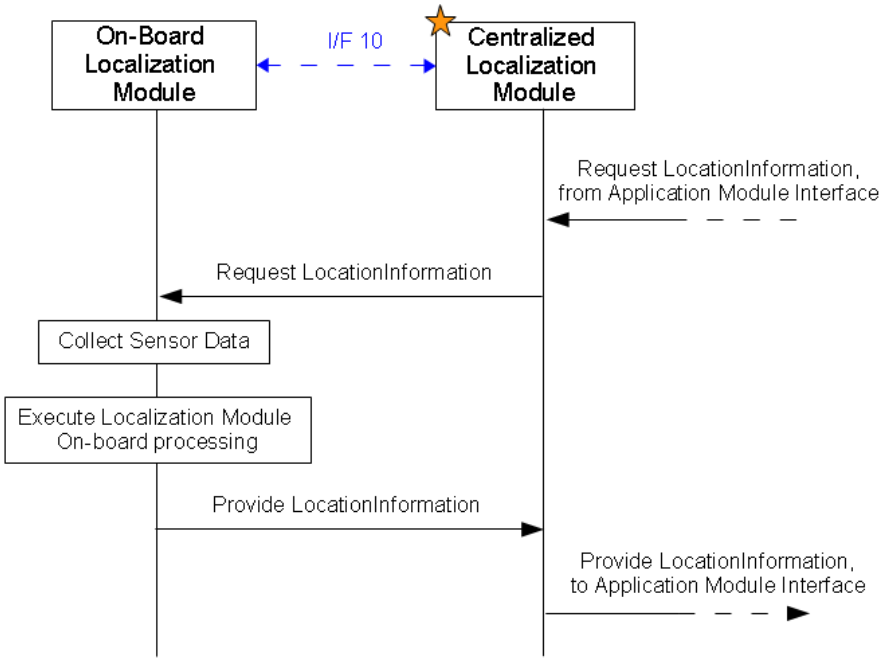

Figure A.2: Procedure for Location Information provisioning between Location Module components

Annex B (informative): Bibliography

- GPS-ICD-200K: "Navstar GPS Space Segment/Navigation User Segment Interfaces".
- ETSI TS 122 071: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Location Services (LCS); Service description; Stage 1 (3GPP TS 22.071)".

History

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