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Contents

Foreword

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1 Scope

The present document contains the definition of the LTE Positioning Protocol (LPP).

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 36.305: "Stage 2 functional specification of User Equipment (UE) positioning in E-UTRAN".

[3] 3GPP TS 23.271: "Functional stage 2 description of Location Services (LCS)".

[4] IS-GPS-200, Revision D, Navstar GPS Space Segment/Navigation User Interfaces, March 7th, 2006.

[5] IS-GPS-705, Navstar GPS Space Segment/User Segment L5 Interfaces, September 22, 2005.

[6] IS-GPS-800, Navstar GPS Space Segment/User Segment L1C Interfaces, September 4, 2008.

[7] IS-QZSS, Quasi Zenith Satellite System Navigation Service Interface Specifications for QZSS, Ver.1.1, July 31, 2009.

[8] Galileo OS Signal in Space ICD (OS SIS ICD), Issue 1.2, February 2014, European Union.

[9] Global Navigation Satellite System GLONASS Interface Control Document, Version 5.1, 2008.

[10] Specification for the Wide Area Augmentation System (WAAS), US Department of Transportation, Federal Aviation Administration, DTFA01-96-C-00025, 2001.

[11] RTCM-SC104, RTCM Recommended Standards for Differential GNSS Service (v.2.3), August 20, 2001.

[12] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); "Radio Resource Control (RRC); Protocol specification".

[13] 3GPP TS 25.331: "Radio Resource Control (RRC); Protocol Specification".

[14] 3GPP TS 44.031: "Location Services (LCS); Mobile Station (MS) - Serving Mobile Location Centre (SMLC) Radio Resource LCS Protocol (RRLP)".

[15] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

[16] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

[17] 3GPP TS 36.214: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer – Measurements".

[18] 3GPP TS 36.133: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management".

[19] 3GPP TS 23.003: "Numbering, addressing and identification".

[20] OMA-TS-LPPe-V1_0, LPP Extensions Specification, Open Mobile Alliance.

[21] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[22] ITU-T Recommendation X.691 (07/2002) "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)" (Same as the ISO/IEC International Standard 8825-2).

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

[24] ATIS-0500027: "Recommendations for Establishing Wide Scale Indoor Location Performance", May 2015.

[25] Bluetooth Special Interest Group: "Bluetooth Core Specification v4.2", December 2014.

[26] IEEE 802.11, Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[27] IETF RFC 6225, "Dynamic Host Configuration Protocol Options for Coordinate-Based Location Configuration Information", July 2011.

[28] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".

[29] "Earth Gravitational Model 96 (EGM96)", National Geospatial-Intelligence Agency, NASA.

[30] RTCM Standard 10403.3: "Differential GNSS (Global Navigation Satellite Systems) Services" – Version 3, October 7, 2016.

[31] IGS ANTEX: "The Antenna Exchanged Format" – version 1.4, September 15, 2010.

[32] Federal Information Processing Standards Publication 197, "Specification for the ADVANCED ENCRYPTION STANDARD (AES)", November 26, 2001.

[33] NIST Special Publication 800-38A, "Recommendation for Block Cipher Modes of Operation Methods and Techniques", 2001.

[34] 3GPP TS 38.101: "NR; User Equipment (UE) radio transmission and reception".

[35] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[36] 3GPP TS 38.215: "NR; Physical layer measurements".

3 Definitions and Abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], TS 36.305 [2] and TS 23.271 [3] apply. Other definitions are provided below.

Anchor carrier: In NB-IoT, a carrier where the UE assumes that NPSS/NSSS/NPBCH/SIB-NB for FDD or NPSS/NSSS/NPBCH for TDD are transmitted.

Location Server: a physical or logical entity (e.g., E-SMLC or SUPL SLP) that manages positioning for a target device by obtaining measurements and other location information from one or more positioning units and providing assistance data to positioning units to help determine this. A Location Server may also compute or verify the final location estimate.

NB-IoT: NB-IoT allows access to network services via E-UTRA with a channel bandwidth limited to 200 kHz.

Reference Source: a physical entity or part of a physical entity that provides signals (e.g., RF, acoustic, infra-red) that can be measured (e.g., by a Target Device) in order to obtain the location of a Target Device.

Target Device: the device that is being positioned (e.g., UE or SUPL SET).

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

Observed Time Difference Of Arrival (OTDOA): The time interval that is observed by a target device between the reception of downlink signals from two different TPs. If a signal from TP 1 is received at the moment t_1, and a signal from TP 2 is received at the moment t_2, the OTDOA is $t_2 - t_1$.

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

3.2 Abbreviations

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

ADR	Accumulated Delta-Range
A-GNSS	Assisted-GNSS
AP	Access Point
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
BDS	BeiDou Navigation Satellite System
BSSID	Basic Service Set Identifier
BTS	Base Transceiver Station (GERAN)
CID	Cell-ID (positioning method)
CNAV	Civil Navigation
CRS	Cell-specific Reference Signals
ECEF	Earth-Centered, Earth-Fixed
ECGI	Evolved Cell Global Identifier
ECI	Earth-Centered-Inertial
E-CID	Enhanced Cell-ID (positioning method)
EGNOS	European Geostationary Navigation Overlay Service
E-SMLC	Enhanced Serving Mobile Location Centre
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
EOP	Earth Orientation Parameters
EPDU	External Protocol Data Unit
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FKP	(German) Flächen-Korrektur-Parameter (area correction parameter)
FTA	Fine Time Assistance
GAGAN	GPS Aided Geo Augmented Navigation
GLONASS	GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (Engl.: Global Navigation Satellite System)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HA GNSS	High-Accuracy GNSS (RTK, PPP)
ICD	Interface Control Document
IGS	International GNSS Service
IOD	Issue of Data
IS	Interface Specification
LLA	Latitude Longitude Altitude
LPP	LTE Positioning Protocol
LPPa	LTE Positioning Protocol Annex
LSB	Least Significant Bit
MAC	Master Auxiliary Concept
MBS	Metropolitan Beacon System
MO-LR	Mobile Originated Location Request
MSAS	Multi-functional Satellite Augmentation System
MSB	Most Significant Bit

msd	mean solar day
MT-LR	Mobile Terminated Location Request
NAV	Navigation
NB-IoT	NarrowBand Internet of Things
NICT	National Institute of Information and Communications Technology
NI-LR	Network Induced Location Request
NPRS	Narrowband Positioning Reference Signals
NR	NR Radio Access
NRSRP	Narrowband Reference Signal Received Power
NRSRQ	Narrowband Reference Signal Received Quality
NTSC	National Time Service Center of Chinese Academy of Sciences
OSR	Observation Space Representation
OTDOA	Observed Time Difference Of Arrival
PDU	Protocol Data Unit
PPP	Precise Point Positioning
PRB	Physical Resource Block
PRC	Pseudo-Range Correction
PRS	Positioning Reference Signals
posSIB	Positioning System Information Block
PZ-90	Parametry Zemli 1990 Goda – Parameters of the Earth Year 1990
QZS	Quasi Zenith Satellite
QZSS	Quasi-Zenith Satellite System
QZST	Quasi-Zenith System Time
RF	Radio Frequency
RRC	Range-Rate Correction Radio Resource Control
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RSTD	Reference Signal Time Difference
RTK	Real-Time Kinematic
RTT	Round Trip Time
RU	Russia
SBAS	Space Based Augmentation System
SET	SUPL Enabled Terminal
SFN	System Frame Number
SLP	SUPL Location Platform
SSID	Service Set Identifier
SSR	State Space Representation
SUPL	Secure User Plane Location
SV	Space Vehicle
TB	Terrestrial Beacon
TBS	Terrestrial Beacon System
TLM	Telemetry
TOD	Time Of Day
TOW	Time Of Week
TP	Transmission Point
UDRE	User Differential Range Error
ULP	User Plane Location Protocol
USNO	US Naval Observatory
UT1	Universal Time No.1
UTC	Coordinated Universal Time
WAAS	Wide Area Augmentation System
WGS-84	World Geodetic System 1984
WLAN	Wireless Local Area Network

4 Functionality of Protocol

4.1 General

4.1.1 LPP Configuration

LPP is used point-to-point between a location server (E-SMLC or SLP) and a target device (UE or SET) in order to position the target device using position-related measurements obtained by one or more reference sources. Figure 4.1.1-1 shows the configuration as applied to the control- and user-plane location solutions for E-UTRAN (as defined in TS 36.305 [2] and TS 23.271 [3]).

NB-IoT is a non-backward compatible variant of E-UTRAN supporting a reduced set of functionalities. In this specification, procedures and messages specified for the UE equally apply to the UE in NB-IoT.

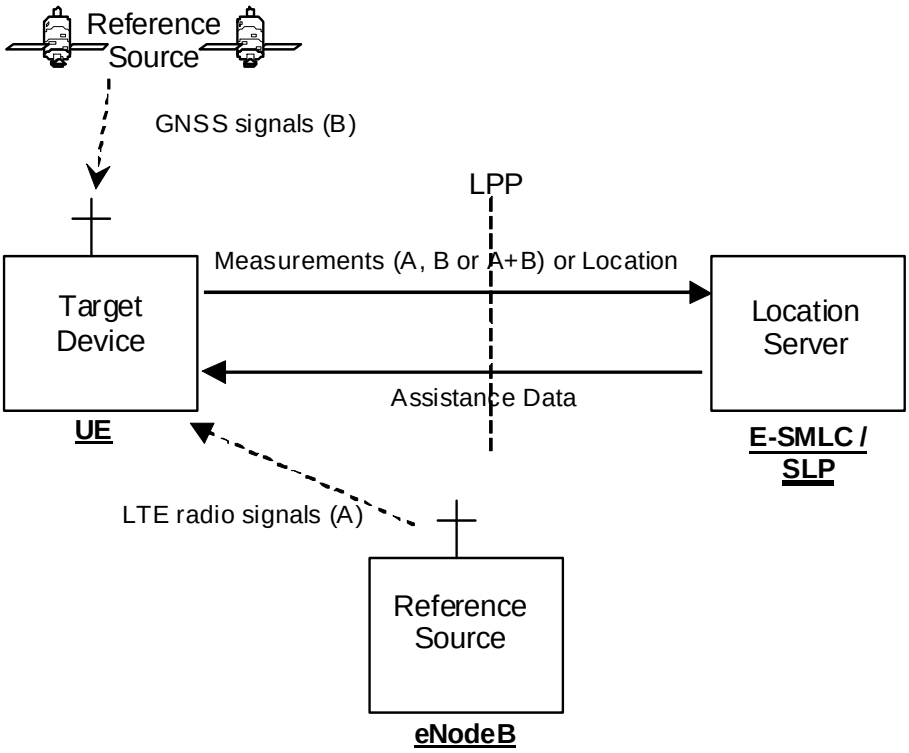

Figure 4.1.1-1: LPP Configuration for Control- and User-Plane Positioning in E-UTRAN

4.1.2 LPP Sessions and Transactions

An LPP session is used between a Location Server and the target device in order to obtain location related measurements or a location estimate or to transfer assistance data. A single LPP session is used to support a single location request (e.g., for a single MT-LR, MO-LR or NI-LR). Multiple LPP sessions can be used between the same endpoints to support multiple different location requests (as required by TS 23.271 [3]). Each LPP session comprises one or more LPP transactions, with each LPP transaction performing a single operation (capability exchange, assistance data transfer, or location information transfer). In E-UTRAN the LPP transactions are realized as LPP procedures. The instigator of an LPP session will always instigate the first LPP transaction, but subsequent transactions may be instigated by either end. LPP transactions within a session may occur serially or in parallel. LPP transactions are indicated at the LPP protocol level with a transaction ID in order to associate messages with one another (e.g., request and response).

Messages within a transaction are linked by a common transaction identifier.

4.1.3 LPP Position Methods

Internal LPP positioning methods and associated signalling content are defined in this specification.

This version of the specification defines OTDOA, A-GNSS, E-CID, Sensor, TBS, WLAN, and Bluetooth positioning methods.

4.1.4 LPP Messages

Each LPP transaction involves the exchange of one or more LPP messages between the location server and the target device. The general format of an LPP message consists of a set of common fields followed by a body. The body (which may be empty) contains information specific to a particular message type. Each message type contains information specific to one or more positioning methods and/or information common to all positioning methods.

The common fields are as follows:

Field	Role
Transaction ID	Identify messages belonging to the same transaction
Transaction End Flag	Indicate when a transaction (e.g. one with periodic responses) has ended
Sequence Number	Enable detection of a duplicate LPP message at a receiver
Acknowledgement	Enable an acknowledgement to be requested and/or returned for any LPP message

NOTE: Use of the Transaction ID and Transaction End fields conform to the procedures in clause 5 and are independent of the means used to transport LPP messages (e.g., whether using a NAS MO-LR Request, NAS Generic Transport or user-plane solution).

The following message types are defined:

- Request Capabilities;
- Provide Capabilities;
- Request Assistance Data;
- Provide Assistance Data;
- Request Location Information;
- Provide Location Information;
- Abort;
- Error.

4.2 Common LPP Session Procedure

The purpose of this procedure is to support an LPP session comprising a sequence of LPP transactions. The procedure is described in Figure 4.2-1.

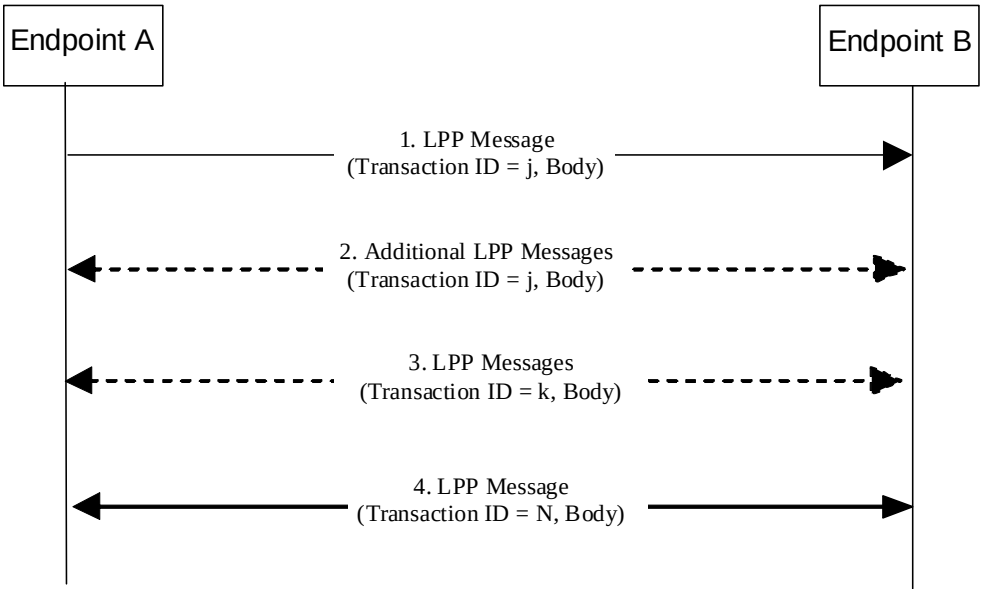

Figure 4.2-1 LPP Session Procedure

1. Endpoint A, which may be either the target or the server, initiates an LPP session by sending an LPP message for an initial LPP transaction *j* to the other endpoint B (which has an opposite role to A).
2. Endpoints A and B may exchange further messages to continue the transaction started in step 1.
3. Either endpoint may instigate further transactions by sending additional LPP messages.
4. A session is terminated by a final transaction *N* in which LPP messages will be exchanged between the two endpoints.

Within each transaction, all constituent messages shall contain the same transaction identifier. The last message sent in each transaction shall have the IE *endTransaction* set to TRUE. Transactions that occur in parallel shall use different transaction IDs; transaction IDs for completed transactions may be reused at any time after the final message of the previous transaction with the same ID is known to have been received.

4.3 LPP Transport

4.3.1 Transport Layer Requirements

LPP requires reliable, in-sequence delivery of LPP messages from the underlying transport layers. This section describes the transport capabilities that are available within LPP. A UE implementing LPP for the control-plane solution shall support LPP reliable transport (including all three of duplicate detection, acknowledgement, and retransmission).

LPP reliable transport functionality is not used in the user-plane solution.

The following requirements in subclauses 4.3.2, 4.3.3, and 4.3.4 for LPP reliable transport apply only when the capability is supported.

4.3.2 LPP Duplicate Detection

A sender shall include a sequence number in all LPP messages sent for a particular location session. The sequence number shall be distinct for different LPP messages sent in the same direction in the same location session (e.g., may start at zero in the first LPP message and increase monotonically in each succeeding LPP message). Sequence numbers used in the uplink and downlink are independent (e.g., can be the same).

A receiver shall record the most recent received sequence number for each location session. If a message is received carrying the same sequence number as that last received for the associated location session, it shall be discarded. Otherwise (i.e., if the sequence number is different or if no sequence number was previously received or if no sequence number is included), the message shall be processed.

Sending and receiving sequence numbers shall be deleted in a server when the associated location session is terminated and shall be deleted in a target device when there has been no activity for a particular location session for 10 minutes.

NOTE: For LPP control-plane use, a target device can be aware of a location session from information provided at the NAS level for downlink transport of an LPP message.

4.3.3 LPP Acknowledgement

4.3.3.1 General

Each LPP message may carry an acknowledgement request and/or an acknowledgement indicator. A LPP message including an acknowledgement request (i.e., that include the IE *ackRequested* set to TRUE) shall also include a sequence number. Upon reception of an LPP message which includes the IE *ackRequested* set to TRUE, a receiver returns an LPP message with an acknowledgement response (i.e., that includes the *ackIndicator* IE set to the same sequence number of the message being acknowledged). An acknowledgement response may contain no LPP message body (in which case only the sequence number being acknowledged is significant); alternatively, the acknowledgement may be sent in an LPP message along with an LPP message body. An acknowledgement is returned for each received LPP message that requested an acknowledgement including any duplicate(s). Once a sender receives an acknowledgement for an LPP message, and provided any included sequence number is matching, it is permitted to send the next LPP message. No message reordering is needed at the receiver since this stop-and-wait method of sending ensures that messages normally arrive in the correct order.

When an LPP message is transported via a NAS MO-LR request, the message does not request an acknowledgement.

4.3.3.2 Procedure related to Acknowledgement

Figure 4.3.3.2-1 shows the procedure related to acknowledgement.

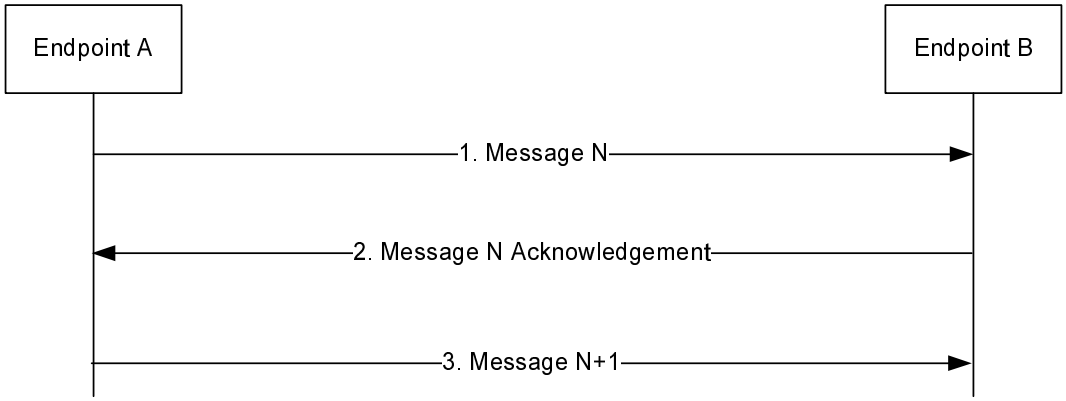

Figure 4.3.3.2-1: LPP Acknowledgement procedure

1. Endpoint A sends an LPP message *N* to Endpoint B which includes the IE *ackRequested* set to TRUE and a sequence number.

2. If LPP message *N* is received and Endpoint B is able to decode the *ackRequested* value and sequence number, Endpoint B shall return an acknowledgement for message *N*. The acknowledgement shall contain the IE *ackIndicator* set to the same sequence number as that in message *N*.

3. When the acknowledgement for LPP message *N* is received and provided the included *ackIndicator* IE matches the sequence number sent in message *N*, Endpoint A sends the next LPP message *N+1* to Endpoint B when this message is available.

4.3.4 LPP Retransmission

4.3.4.1 General

This capability builds on the acknowledgement and duplicate detection capabilities. When an LPP message which requires acknowledgement is sent and not acknowledged, it is resent by the sender following a timeout period up to three times. If still unacknowledged after that, the sender aborts all LPP activity for the associated session. The timeout period is determined by the sender implementation but shall not be less than a minimum value of 250ms.

In addition, for NB-IoT the timeout period may be determined by the sender implementation based on e.g., the coverage level of the UE.

4.3.4.2 Procedure related to Retransmission

Figure 4.3.4.2-1 shows the procedure related to retransmission when combined with acknowledgement and duplicate detection.

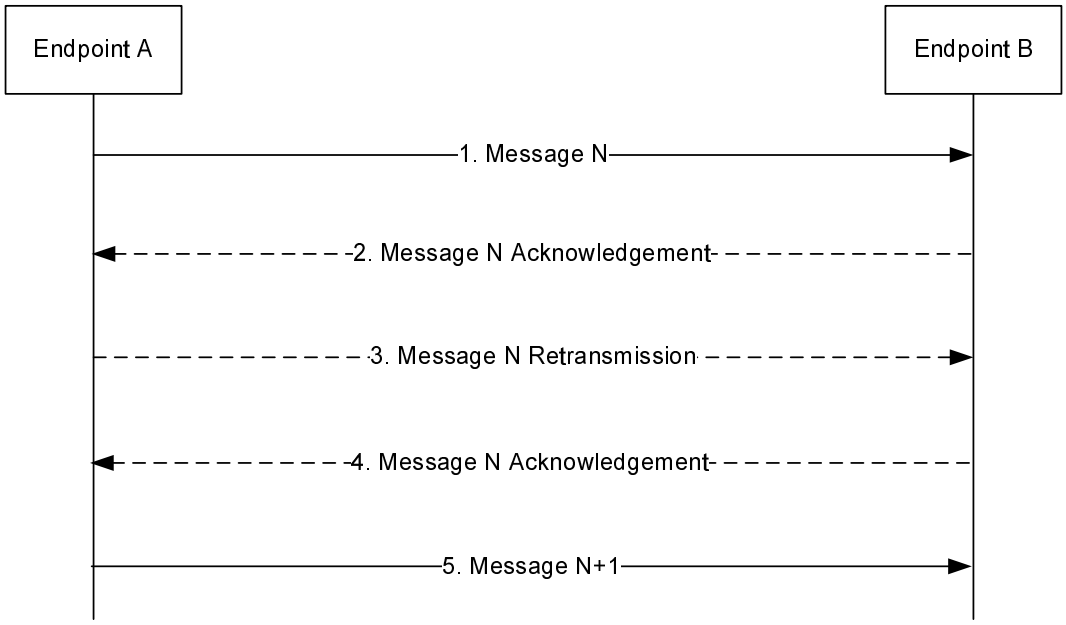

Figure 4.3.4.2-1: LPP Retransmission procedure

1. Endpoint A sends an LPP message *N* to Endpoint B for a particular location session and includes a request for acknowledgement along with a sequence number.

2. If LPP message *N* is received and Endpoint B is able to decode the *ackRequested* value and sequence number (regardless of whether the message body can be correctly decoded), Endpoint B shall return an acknowledgement for message *N*. If the acknowledgement is received by Endpoint A (such that the acknowledged message can be identified and sequence numbers are matching), Endpoint A skips steps 3 and 4.

3. If the acknowledgement in step 2 is not received after a timeout period, Endpoint A shall retransmit LPP message *N* and shall include the same sequence number as in step 1.

4. If LPP message *N* in step 3 is received and Endpoint B is able to decode the *ackRequested* value and sequence number (regardless of whether the message body can be correctly decoded and whether or not the message is considered a duplicate), Endpoint B shall return an acknowledgement. Steps 3 may be repeated one or more times if the acknowledgement in step 4 is not received after a timeout period by Endpoint A. If the acknowledgement in step 4 is still not received after sending three retransmissions, Endpoint A shall abort all procedures and activity associated with LPP support for the particular location session.

5. Once an acknowledgement in step 2 or step 4 is received, Endpoint A sends the next LPP message *N+1* for the location session to Endpoint B when this message is available.

4.3.5 LPP Message Segmentation

An LPP message body may be sent in several shorter LPP messages instead of one long LPP message to deliver a large amount of information (e.g., in case the LPP message size exceeds the maximum message size supported by lower layers). When a sender employs LPP message segmentation, the sender shall include the IE *SegmentationInfo* in each LPP message segment. The sender shall indicate in all but the final message segment that more messages are on the way.

When a receiver receives an LPP message indicating that more messages are on the way, the receiver may store the LPP message. If the receiver receives a subsequent LPP message for the same session and transaction ID, the receiver shall assume that the new LPP message continues the segmentation of the earlier message and may store the new message if the new message indicates that more messages are on the way. If the new message indicates that no more messages are on the way, the receiver shall assume that message segmentation is complete and shall process the new message and any stored message segments for the same session and transaction ID.

The reliable transport rules specified in sub-clause 4.3.2, 4.3.3, and 4.3.4 apply to each individual LPP message segment, independently of the value of the IE *SegmentationInfo*.

The rules for setting the common fields of the LPP message specified in sub-clause 4.1.4 (Transaction ID, Transaction End Flag, Sequence Number, Acknowledgment) apply to each individual LPP message segment, independently of the value of the IE *SegmentationInfo*.

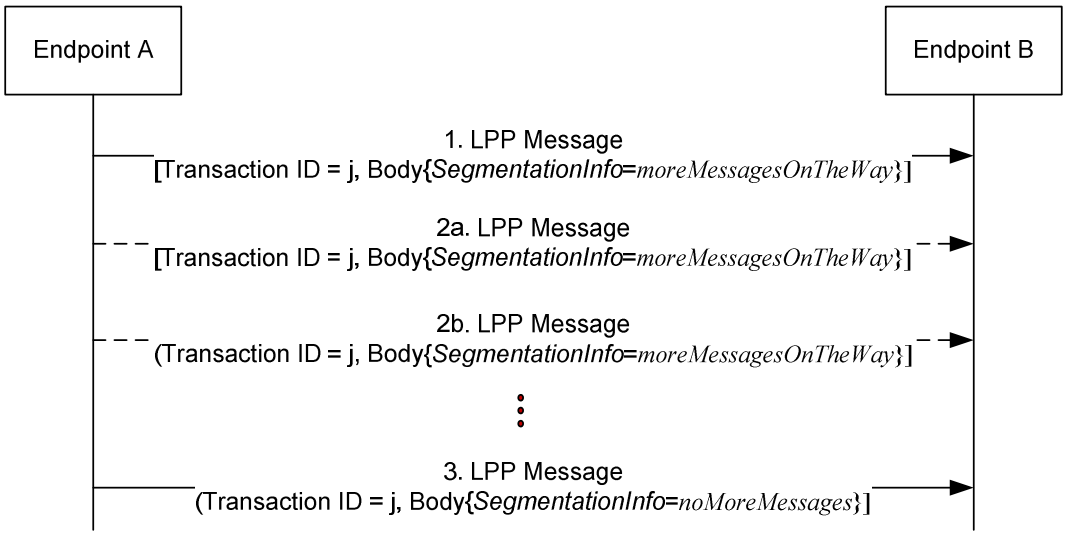

Figure 4.3.5-1: LPP Message Segmentation procedure

1. Endpoint A sends an LPP message to Endpoint B for a particular location session and includes the IE *SegmentationInfo* set to *moreMessagesOnTheWay* to indicate that this is one of many LPP message segments used to deliver the entire LPP message body.

2 Endpoint A may send one or more additional LPP messages to Endpoint B with the IE *SegmentationInfo* set to *moreMessagesOnTheWay* to continue delivering the segmented LPP message.

3. Endpoint A sends the final LPP message segment to Endpoint B and includes the IE *SegmentationInfo* set to *noMoreMessages* to indicate that this is the final LPP message segment. Endpoint B assumes that the complete LPP message body has been received.

5 LPP Procedures

5.1 Procedures related to capability transfer

The purpose of the procedures that are grouped together in this section is to enable the transfer of capabilities from the target device to the server. Capabilities in this context refer to positioning and protocol capabilities related to LPP and the positioning methods supported by LPP.

These procedures instantiate the Capability Transfer transaction from 3GPP TS 36.305 [2].

5.1.1 Capability Transfer procedure

The Capability Transfer procedure is shown in Figure 5.1.1-1.

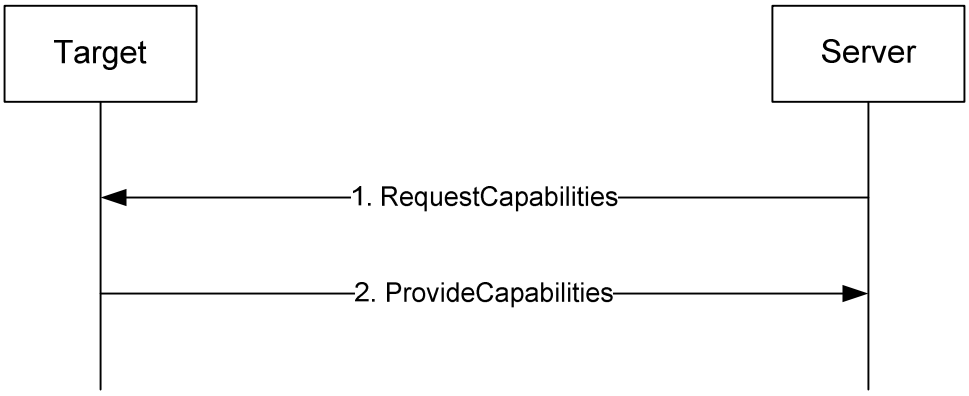

Figure 5.1.1-1: LPP Capability Transfer procedure

1. The server sends a *RequestCapabilities* message to the target. The server may indicate the types of capability needed.
2. The target responds with a *ProvideCapabilities* message to the server. The capabilities shall correspond to any capability types specified in step 1. This message shall include the *endTransaction* IE set to TRUE.

5.1.2 Capability Indication procedure

The Capability Indication procedure allows the target to provide unsolicited capabilities to the server and is shown in Figure 5.1.2-1.

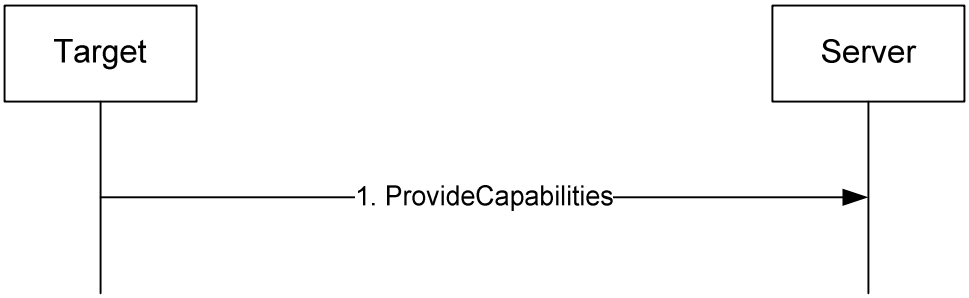

Figure 5.1.2-1: LPP Capability Indication procedure

1. The target sends a *ProvideCapabilities* message to the server. This message shall include the *endTransaction* IE set to TRUE.

5.1.3 Reception of LPP Request Capabilities

Upon receiving a *RequestCapabilities* message, the target device shall generate a *ProvideCapabilities* message as a response.

The target device shall:

1> for each positioning method for which a request for capabilities is included in the message:

2> if the target device supports this positioning method:

3> include the capabilities of the device for that supported positioning method in the response message;

1> set the IE *LPP-TransactionID* in the response message to the same value as the IE *LPP-TransactionID* in the received message;

1> deliver the response message to lower layers for transmission.

5.1.4 Transmission of LPP Provide Capabilities

When triggered to transmit a *ProvideCapabilities* message, the target device shall:

1> for each positioning method whose capabilities are to be indicated:

2> set the corresponding IE to include the device's capabilities;

2> if OTDOA capabilities are to be indicated:

3> include the IE *supportedBandListEUTRA*;

1> deliver the response to lower layers for transmission.

5.2 Procedures related to Assistance Data Transfer

The purpose of the procedures in this section is to enable the target to request assistance data from the server to assist in positioning, and to enable the server to transfer assistance data to the target in the absence of a request.

These procedures instantiate the Assistance Data Transfer transaction from 3GPP TS 36.305 [2].

5.2.1 Assistance Data Transfer procedure

The Assistance Data Transfer procedure is shown in Figure 5.2.1-1.

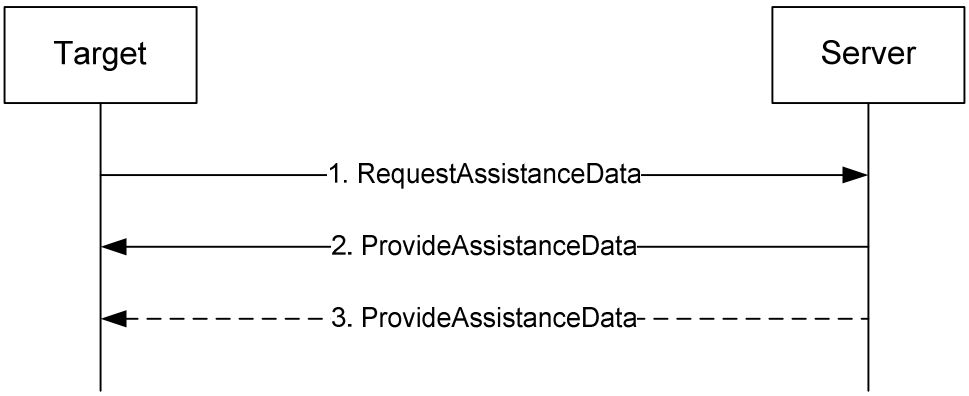

Figure 5.2.1-1: LPP Assistance data transfer procedure

1. The target sends a *RequestAssistanceData* message to the server.
2. The server responds with a *ProvideAssistanceData* message to the target containing assistance data. The transferred assistance data should match or be a subset of the assistance data requested in step 1. The server may

also provide any not requested information that it considers useful to the target. If step 3 does not occur, this message shall set the *endTransaction* IE to TRUE.

3. The server may transmit one or more additional *ProvideAssistanceData* messages to the target containing further assistance data. The transferred assistance data should match or be a subset of the assistance data requested in step 1. The server may also provide any not requested information that it considers useful to the target. The last message shall include the *endTransaction* IE set to TRUE.

5.2.1a Periodic Assistance Data Transfer procedure

The Periodic Assistance Data Transfer procedure is shown in Figure 5.2.1a-1. This procedure enables a target to request a server to send assistance data periodically.

NOTE 1: In this version of the specification, periodic assistance data transfer is supported for HA GNSS (e.g., RTK) positioning only.

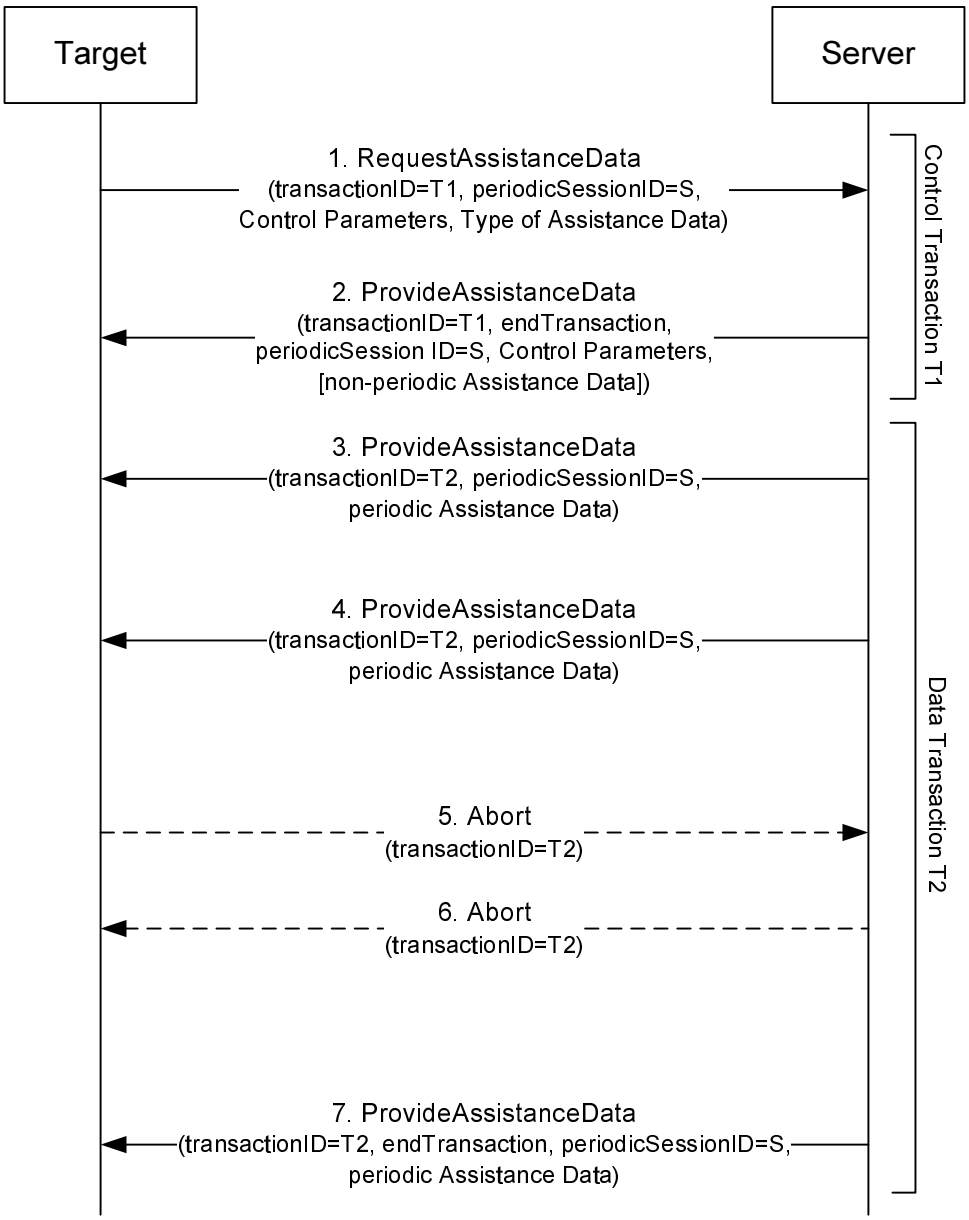

Figure 5.2.1a-1: LPP Periodic Assistance data transfer procedure

1. The target sends a *RequestAssistanceData* message to the server using some available *transactionID* T1. The message contains a *periodicSessionID* S (different to any other *periodicSessionID* currently in use between the target and server) in the IE *CommonIEsRequestAssistanceData.* The message also includes a positioning method specific assistance data request element (e.g., IE *A-GNSS-RequestAssistanceData*) identifying the type of assistance data being requested together with desired periodicity conditions for sending it and a duration for ending the assistance data transfer (e.g., in IE *GNSS-PeriodicAssistDataReq*).

2. The server responds with a *ProvideAssistanceData* message to the target. The message uses the *transactionID* T1 in step 1 and indicates the end of this transaction. The message contains the *periodicSessionID* S in IE *CommonIEsProvideAssistanceData.* If the request can be supported, the message contains the control parameters in the positioning method specific assistance data (e.g., IE *A-GNSS-ProvideAssistanceData)* which may confirm or redefine the type of assistance data or periodicity parameters requested at step 1 (e.g., in IE *GNSS-PeriodicAssistData*). If the target requested non-periodic assistance data in addition to the periodic assistance data in step 1, the *ProvideAssistanceData* message may also include the non-periodic assistance data in this step 2 (but not any periodic assistance data).
   If the request cannot be supported (fully or partly), an error reason is provided in the positioning method specific IE (e.g., IE *A-GNSS-Error*). If the request cannot even partly be supported remaining steps are then not performed.

   NOTE 2: The target device infers from an absence of the *periodicSessionID* that the location server does not support periodic assistance data delivery. In that case, the target device does not expect the Data Transaction (Steps 3-7).

3. When the first periodic message is available, the server sends an unsolicited *ProvideAssistanceData* message to the target containing the *periodicSessionID* S and the periodic assistance data confirmed in step 2. The message uses some available *transactionID* T2 that may be different to T1.

   NOTE 3: The positioning method specific control parameters (e.g., IE *GNSS-PeriodicAssistData*) are not included in the data transaction.

4. The server may continue to send further *ProvideAssistanceData* messages to the target containing the periodic assistance data confirmed or redefined in step 2 when each additional periodicity condition occurs.

   NOTE 4: The target device expects a *ProvideAssistanceData* messages at the in Step 2 confirmed interval(s). If some or all of the assistance data is not available at each periodic interval, an error indication is provided in the positioning method specific IE (e.g., IE *A-GNSS-Error*).

5. If the target requires the session to end, the target sends an *Abort* message to the server for transaction T2 that may optionally include an *abortCause*. Remaining steps are then omitted.

6. If the server requires the session to end, the server sends an *Abort* message to the target for transaction T2 that may optionally include an *abortCause*. Remaining steps are then omitted.

7. When the duration or other conditions for ending the periodic assistance data transfer occur, the last *ProvideAssistanceData* message transferred indicates the end of transaction T2.

5.2.2 Assistance Data Delivery procedure

The Assistance Data Delivery procedure allows the server to provide unsolicited assistance data to the target and is shown in Figure 5.2.2-1.

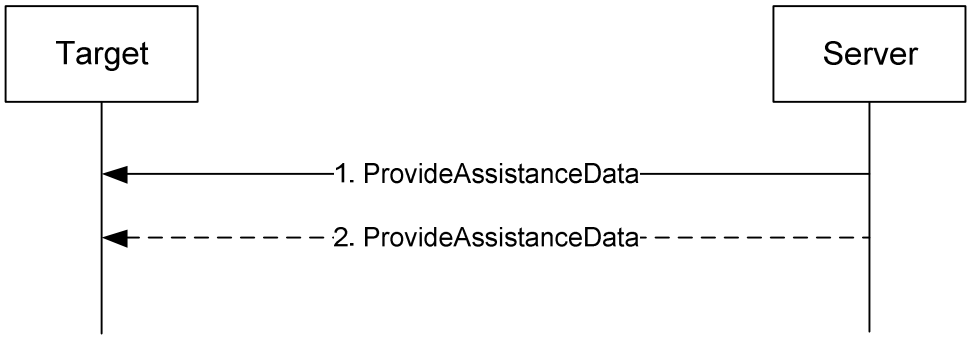

Figure 5.2.2-1: LPP Assistance data transfer procedure

1. The server sends a *ProvideAssistanceData* message to the target containing assistance data. If step 2 does not occur, this message shall set the *endTransaction* IE to TRUE.

2. The server may transmit one or more additional *ProvideAssistanceData* messages to the target containing additional assistance data. The last message shall include the *endTransaction* IE set to TRUE.

5.2.2a Periodic Assistance Data Delivery procedure

The Periodic Assistance Data Delivery procedure allows the server to provide unsolicited periodic assistance data to the target and is shown in Figure 5.2.2a-1.

NOTE 1: In this version of the specification, periodic assistance data delivery is supported for HA GNSS (e.g., RTK) positioning only.

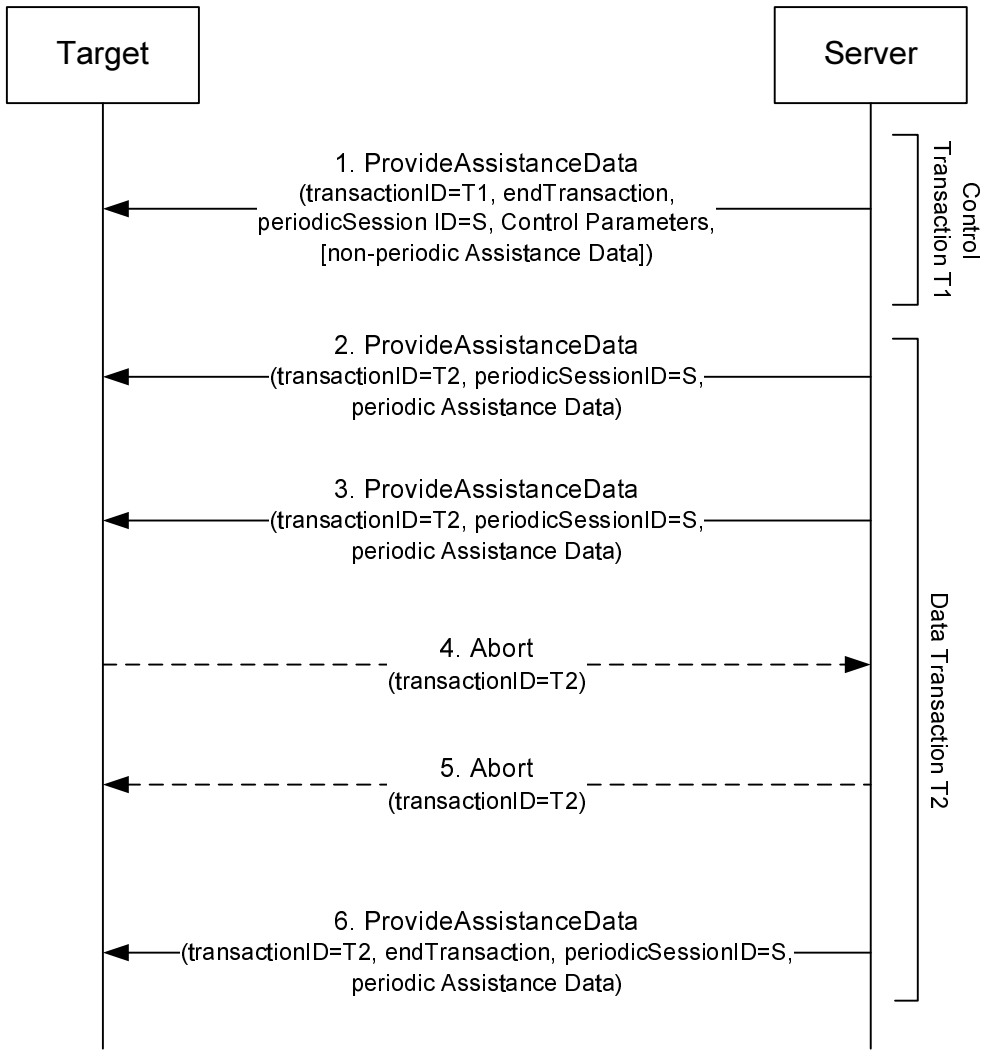

Figure 5.2.2a-1: LPP Periodic Assistance data delivery procedure

1. The server sends a *ProvideAssistanceData* message to the target using some available *transactionID* T1 and indicates the end of this transaction. The message contains a *periodicSessionID* S (different to any other *periodicSessionID* currently in use between the server and target) in the IE *CommonIEsProvideAssistanceData.* The message includes positioning method specific assistance data control parameters (e.g., in IE *A-GNSS-ProvideAssistanceData*) identifying the type of periodic assistance data being delivered together with periodicity conditions for sending it and a duration for ending the assistance data delivery (e.g., in IE *GNSS-PeriodicAssistData*). The *ProvideAssistanceData* message may also include non-periodic assistance data (but not any periodic assistance data).

2. When the first periodic message is available, the server sends an unsolicited *ProvideAssistanceData* message to the target containing the *periodicSessionID* S and the periodic assistance data announced in step 1. The message uses some available *transactionID* T2 that may be different to T1.

   NOTE 2: The positioning method specific control parameters (e.g., IE *GNSS-PeriodicAssistData*) are not included in the data transaction.

3. The server may continue to send further *ProvideAssistanceData* messages to the target containing the periodic assistance data announced in step 2 when each additional periodicity condition occurs.

   NOTE3: The target device expects a *ProvideAssistanceData* messages at the in Step 2 announced interval(s). If some or all of the assistance data is not available at each periodic interval, an error indication is provided in the positioning method specific IE (e.g., IE *A-GNSS-Error*).

4. If the target requires the session to end, the target sends an *Abort* message to the server for transaction T2 that may optionally include an *abortCause*. Remaining steps are then omitted.

5. If the server requires the session to end, the server sends an *Abort* message to the target for transaction T2 that may optionally include an *abortCause*. Remaining steps are then omitted.

6. When the duration or other conditions for ending the periodic assistance data transfer occur, the last *ProvideAssistanceData* message transferred indicates the end of transaction T2.

5.2.3 Transmission of LPP Request Assistance Data

When triggered to transmit a *RequestAssistanceData* message, the target device shall:

1> set the IEs for the positioning-method-specific request for assistance data to request the data indicated by upper layers.

5.2.4 Reception of LPP Provide Assistance Data

Upon receiving a *ProvideAssistanceData* message, the target device shall:

1> for each positioning method contained in the message:

2> deliver the related assistance data to upper layers.

5.3 Procedures related to Location Information Transfer

The purpose of the procedures in this section is to enable the server to request location measurement data and/or a location estimate from the target, and to enable the target to transfer location measurement data and/or a location estimate to a server in the absence of a request.

These procedures instantiate the Location Information Transfer transaction in 3GPP TS 36.305 [2].

NOTE: The service layer (e.g. NAS or OMA SUPL ULP) would be used to transfer information associated with a location request from a target to a server (MO-LR).

5.3.1 Location Information Transfer procedure

The Location Information Transfer procedure is shown in Figure 5.3.1-1.

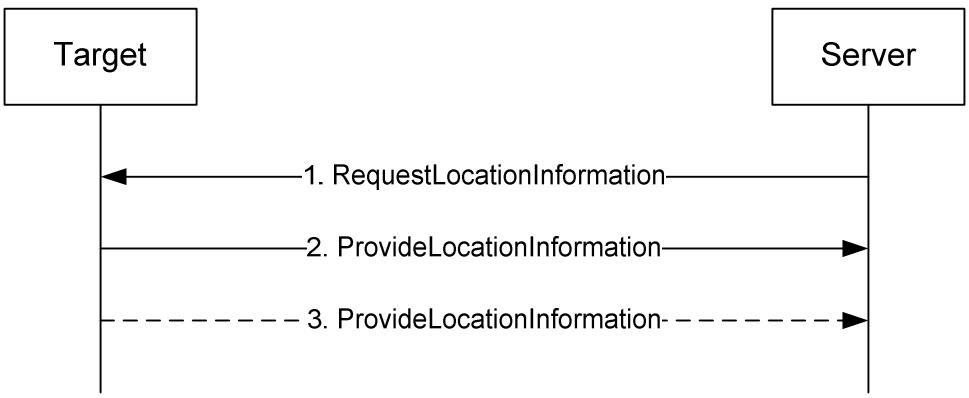

Figure 5.3.1-1: LPP Location Information transfer procedure

1. The server sends a *RequestLocationInformation* message to the target to request location information, indicating the type of location information needed and potentially the associated QoS.

2. The target sends a *ProvideLocationInformation* message to the server to transfer location information. The location information transferred should match or be a subset of the location information requested in step 1

unless the server explicitly allows additional location information. If step 3 does not occur, this message shall set the *endTransaction* IE to TRUE.

3. If requested in step 1, the target sends additional *ProvideLocationInformation* messages to the server to transfer location information. The location information transferred should match or be a subset of the location information requested in step 1 unless the server explicitly allows additional location information. The last message shall include the *endTransaction* IE set to TRUE.

5.3.2 Location Information Delivery procedure

The Location Information Delivery allows the target to provide unsolicited location information to the server. The procedure is shown in Figure 5.3.2-1.

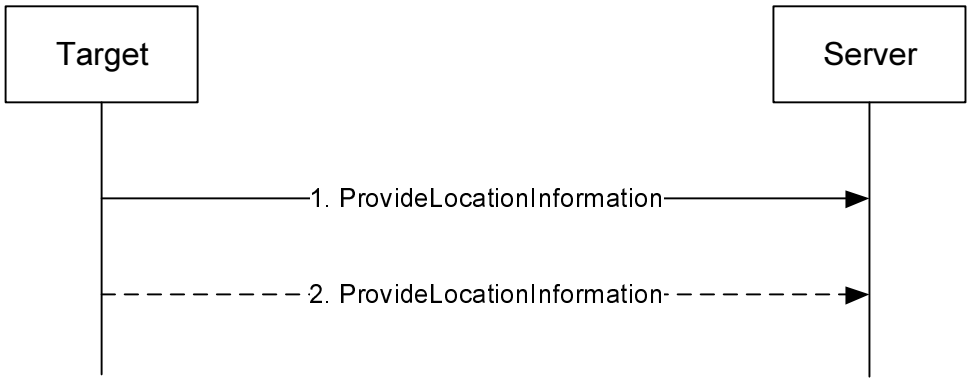

Figure 5.3.2-1: LPP Location Information Delivery procedure

1. The target sends a *ProvideLocationInformation* message to the server to transfer location information. If step 2 does not occur, this message shall set the *endTransaction* IE to TRUE.

2. The target may send one or more additional *ProvideLocationInformation* messages to the server containing additional location information data. The last message shall include the *endTransaction* IE set to TRUE.

5.3.3 Reception of Request Location Information

Upon receiving a *RequestLocationInformation* message, the target device shall:

1> if the requested information is compatible with the target device capabilities and configuration:

2> include the requested information in a *ProvideLocationInformation* message;

2> set the IE *LPP-TransactionID* in the response to the same value as the IE *LPP-TransactionID* in the received message;

2> deliver the *ProvideLocationInformation* message to lower layers for transmission.

1> otherwise:

2> if one or more positioning methods are included that the target device does not support:

3> continue to process the message as if it contained only information for the supported positioning methods;

3> handle the signaling content of the unsupported positioning methods by LPP error detection as in 5.4.3.

5.3.4 Transmission of Provide Location Information

When triggered to transmit *ProvideLocationInformation* message, the target device shall:

1> for each positioning method contained in the message:

2> set the corresponding IE to include the available location information;

1> deliver the response to lower layers for transmission.

5.4 Error Handling Procedures

5.4.1 General

This sub-clause describes how a receiving entity (target device or location server) behaves in cases when it receives erroneous or unexpected data or detects that certain data are missing.

5.4.2 Procedures related to Error Indication

Figure 5.4.2-1 shows the Error indication procedure.

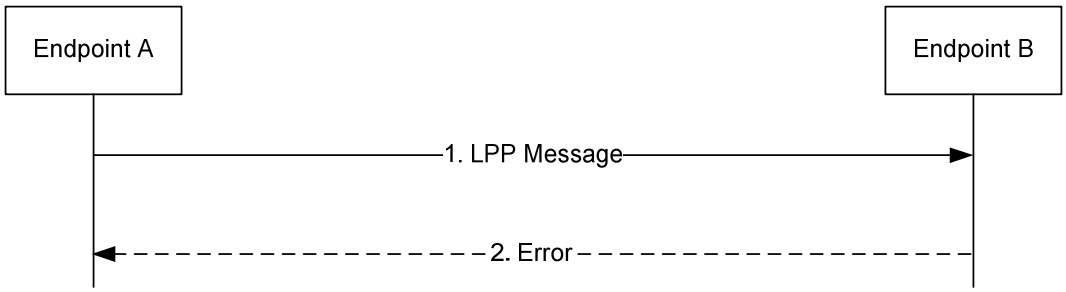

Figure 5.4.2-1: LPP Error Indication procedure

1. Endpoint A sends an LPP message to Endpoint B.
2. Endpoint B determines that the LPP message in step 1 contains an error. Endpoint B returns an *Error* message to Endpoint A indicating the error or errors and discards the message in step 1. If Endpoint B is able to determine that the erroneous LPP message in step 1 is an LPP Error or Abort Message, Endpoint B discards the message in step 1 without returning an *Error* message to Endpoint A.

5.4.3 LPP Error Detection

Upon receiving any LPP message, the receiving entity shall attempt to decode the message and verify the presence of any errors and:

1> if decoding errors are encountered:

2> if the receiver can not determine that the received message is an LPP *Error* or *Abort* message:

3> return an LPP *Error* message to the sender and include the received *LPP-TransactionID*, if this was decoded, and type of error;

3> if the receiver can determine the session and the *LPP-TransactionID* and the received message includes the IE *SegmentationInfo* and the receiver has previously stored message segments for this session and *LPP-TransactionID*:

4> discard all stored LPP message segments for this session and *LPP-TransactionID*;

3> discard the received message and stop the error detection procedure;

1> if the message is a duplicate of a previously received message:

2> discard the message and stop the error detection procedure;

1> if the *LPP-TransactionID* matches the *LPP-TransactionID* for a procedure that is still ongoing for the same session and the message type is invalid for the current state of the procedure:

2> abort the ongoing procedure;

2> return an LPP *Error* message to the sender and include the received transaction ID and type of error;

2> if the message includes the IE *SegmentationInfo* and the receiver has previously stored message segments for this session and *LPP-TransactionID*:

3> discard all stored LPP message segments for this session and *LPP-TransactionID;*

2> discard the message and stop the error detection procedure;

1> if the message includes the IE *SegmentationInfo*:

2> if the receiver has previously stored LPP message segments for this session and *LPP-TransactionID*:

3> if the received message type is different to the stored message type:

4> return an LPP *Error* message to the sender and include the received transaction ID and type of error;

4> discard the message and all stored LPP message segments for this session and *LPP-TransactionID* and stop the error detection procedure;

2> if the IE *SegmentationInfo* has the value *moreMessagesOnTheWay*:

3> store the received message;

NOTE: As an implementation option, the receiver of an LPP Provide Assistance Data or LPP Provide Location Information message may process the received message segment instead of storing the message.

2> if the IE *SegmentationInfo* has the value *noMoreMessages*:

3> continue error detection for the received message and any stored LPP message segments for this session and *LPP-TransactionID*;

1> if the message type is an LPP *RequestCapabilities* and some of the requested information is not supported:

2> return any information that can be provided in a normal response.

1> if the message type is an LPP *RequestAssistanceData* or *RequestLocationInformation* and some or all of the requested information is not supported:

2> return any information that can be provided in a normal response, which includes indications on other information that is not supported.

5.4.4 Reception of an LPP Error Message

Upon receiving an *Error* message, a device shall:

1> abort any ongoing procedure associated with the *LPP-TransactionID* if included in the received message.

The device may:

1> restart the aborted procedure taking into consideration the returned error information.

5.5 Abort Procedure

5.5.1 General

The purpose of the abort procedure is to allow the target device or location server to abort an ongoing procedure due to some unexpected event (e.g., cancellation of a location request by an LCS client). It can also be used to stop an ongoing procedure (e.g., periodic location reporting from the target device).

5.5.2 Procedures related to Abort

Figure 5.5.2-1 shows the Abort procedure.

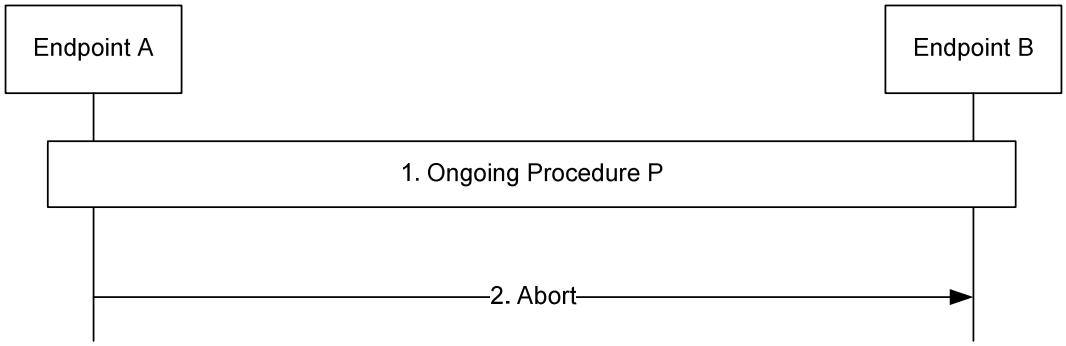

Figure 5.5.2-1: LPP Abort procedure

1. A procedure P is ongoing between endpoints A and B.
2. Endpoint A determines that the procedure must be aborted and sends an *Abort* message to Endpoint B carrying the transaction ID for procedure P. Endpoint B aborts procedure P.

5.5.3 Reception of an LPP Abort Message

Upon receiving an *Abort* message, a device shall:

1> abort any ongoing procedure associated with the transaction ID indicated in the message.

6 Information Element Abstract Syntax Definition

6.1 General

The contents of each LPP message is specified in sub-clause 6.2 using ASN.1 to specify the message syntax and using tables when needed to provide further detailed information about the fields specified in the message syntax.

The ASN.1 in this section uses the same format and coding conventions as described in Annex A of TS 36.331 [12].

Transfer syntax for LPP messages is derived from their ASN.1 definitions by use of Basic Packed Encoding Rules (BASIC-PER), Unaligned Variant, as specified in ITU-T Rec. X.691 [22]. The encoded LPP message always contains a multiple of 8 bits.

Transfer syntax for LPP IEs is derived from their ASN.1 definitions by use of Basic Packed Encoding Rules (BASIC-PER), Unaligned Variant, as specified in ITU-T Rec. X.691 [22]. The encoded LPP IE always contains a multiple of 8 bits. This applies when a single LPP IE is encoded as the basic production, i.e. for other purposes than encoding the LPP IE within an LPP message.

The need for fields to be present in a message or an abstract type, i.e., the ASN.1 fields that are specified as OPTIONAL in the abstract notation (ASN.1), is specified by means of comment text tags attached to the OPTIONAL

statement in the abstract syntax. The meaning of each tag is specified in table 6.1-1. These tags are used in the downlink (server to target) direction only.

Table 6.1-1: Meaning of abbreviations used to specify the need for fields to be present

Abbreviation	Meaning
Cond *conditionTag*	*Conditionally present* A field for which the need is specified by means of conditions. For each *conditionTag*, the need is specified in a tabular form following the ASN.1 segment. In case, according to the conditions, a field is not present, the target takes no action and where applicable shall continue to use the existing value (and/or the associated functionality) unless explicitly stated otherwise in the description of the field itself.
Need OP	*Optionally present* A field that is optional to signal. For downlink messages, the target is not required to take any special action on absence of the field beyond what is specified in the procedural text or the field description table following the ASN.1 segment. The target behaviour on absence should be captured either in the procedural text or in the field description.
Need ON	*Optionally present, No action* A field that is optional to signal. If the message is received by the target, and in case the field is absent, the target takes no action and where applicable shall continue to use the existing value (and/or the associated functionality).
Need OR	*Optionally present, Release* A field that is optional to signal. If the message is received by the target, and in case the field is absent, the target shall discontinue/ stop using/ delete any existing value (and/ or the associated functionality).

When specifying information elements which are to be represented by BIT STRINGs, if not otherwise specifically stated in the field description of the concerned IE or elsewhere, the following principle applies with regards to the ordering of bits:

- The first bit (leftmost bit) contains the most significant bit (MSB);
- the last bit (rightmost bit) contains the least significant bit (LSB).

6.2 LPP PDU Structure

– *LPP-PDU-Definitions*

This ASN.1 segment is the start of the LPP PDU definitions.

```
-- ASN1START

LPP-PDU-Definitions {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) lpp (7) version1 (1) lpp-PDU-Definitions (1) }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

-- ASN1STOP
```

– *LPP-Message*

The *LPP-Message* provides the complete set of information for an invocation or response pertaining to an LPP transaction.

```
-- ASN1START

LPP-Message ::= SEQUENCE {
    transactionID           LPP-TransactionID   OPTIONAL,   -- Need ON
    endTransaction          BOOLEAN,
    sequenceNumber          SequenceNumber      OPTIONAL,   -- Need ON
    acknowledgement         Acknowledgement     OPTIONAL,   -- Need ON
    lpp-MessageBody         LPP-MessageBody     OPTIONAL    -- Need ON
```

```
}

SequenceNumber ::= INTEGER (0..255)

Acknowledgement ::= SEQUENCE {
    ackRequested    BOOLEAN,
    ackIndicator    SequenceNumber      OPTIONAL
}

-- ASN1STOP
```

***LPP-Message* field descriptions**
transactionID This field is omitted if an *lpp-MessageBody* is not present (i.e. in an LPP message sent only to acknowledge a previously received message) or if it is not available to the transmitting entity (e.g., in an *LPP-Error* message triggered by a message that could not be parsed). If present, this field shall be ignored at a receiver in an LPP message for which the *lpp-MessageBody* is not present.
endTransaction This field indicates whether an LPP message is the last message carrying an *lpp-MessageBody* in a transaction (TRUE) or not last (FALSE). When LPP message segmentation is used, only the final LPP message segment may indicate the end of the transaction.
sequenceNumber This field may be included when LPP operates over the control plane and an *lpp-MessageBody* is included but shall be omitted otherwise.
acknowledgement This field is included in an LPP acknowledgement and in any LPP message requesting an acknowledgement when LPP operates over the control plane and is omitted otherwise.
ackRequested This field indicates whether an LPP acknowledgement is requested (TRUE) or not (FALSE). A value of TRUE may only be included when an *lpp-MessageBody* is included.
ackIndicator This field indicates the sequence number of the message being acknowledged.
lpp-MessageBody This field may be omitted in case the message is sent only to acknowledge a previously received message.

– *LPP-MessageBody*

The *LPP-MessageBody* identifies the type of an LPP message and contains all LPP information specifically associated with that type.

```
-- ASN1START

LPP-MessageBody ::= CHOICE {
    c1                      CHOICE {
        requestCapabilities         RequestCapabilities,
        provideCapabilities         ProvideCapabilities,
        requestAssistanceData       RequestAssistanceData,
        provideAssistanceData       ProvideAssistanceData,
        requestLocationInformation  RequestLocationInformation,
        provideLocationInformation  ProvideLocationInformation,
        abort                       Abort,
        error                       Error,
        spare7 NULL, spare6 NULL, spare5 NULL, spare4 NULL,
        spare3 NULL, spare2 NULL, spare1 NULL, spare0 NULL
    },
    messageClassExtension   SEQUENCE {}
}

-- ASN1STOP
```

– *LPP-TransactionID*

The *LPP-TransactionID* identifies a particular LPP transaction and the initiator of the transaction.

```
-- ASN1START

LPP-TransactionID ::= SEQUENCE {
    initiator               Initiator,
```

```
    transactionNumber       TransactionNumber,
    ...
}

Initiator ::= ENUMERATED {
    locationServer,
    targetDevice,
    ...
}

TransactionNumber ::= INTEGER (0..255)

-- ASN1STOP
```

6.3 Message Body IEs

– *RequestCapabilities*

The *RequestCapabilities* message body in a LPP message is used by the location server to request the target device capability information for LPP and the supported individual positioning methods.

```
-- ASN1START

RequestCapabilities ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            requestCapabilities-r9      RequestCapabilities-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}

RequestCapabilities-r9-IEs ::= SEQUENCE {
    commonIEsRequestCapabilities        CommonIEsRequestCapabilities        OPTIONAL,   -- Need ON
    a-gnss-RequestCapabilities          A-GNSS-RequestCapabilities          OPTIONAL,   -- Need ON
    otdoa-RequestCapabilities           OTDOA-RequestCapabilities           OPTIONAL,   -- Need ON
    ecid-RequestCapabilities            ECID-RequestCapabilities            OPTIONAL,   -- Need ON
    epdu-RequestCapabilities            EPDU-Sequence                       OPTIONAL,   -- Need ON
    ...,
    [[  sensor-RequestCapabilities-r13  Sensor-RequestCapabilities-r13      OPTIONAL,   -- Need ON
        tbs-RequestCapabilities-r13     TBS-RequestCapabilities-r13         OPTIONAL,   -- Need ON
        wlan-RequestCapabilities-r13    WLAN-RequestCapabilities-r13        OPTIONAL,   -- Need ON
        bt-RequestCapabilities-r13      BT-RequestCapabilities-r13          OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

– *ProvideCapabilities*

The *ProvideCapabilities* message body in a LPP message indicates the LPP capabilities of the target device to the location server.

```
-- ASN1START

ProvideCapabilities ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            provideCapabilities-r9      ProvideCapabilities-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}

ProvideCapabilities-r9-IEs ::= SEQUENCE {
    commonIEsProvideCapabilities        CommonIEsProvideCapabilities        OPTIONAL,
    a-gnss-ProvideCapabilities          A-GNSS-ProvideCapabilities          OPTIONAL,
    otdoa-ProvideCapabilities           OTDOA-ProvideCapabilities           OPTIONAL,
```

```
    ecid-ProvideCapabilities            ECID-ProvideCapabilities            OPTIONAL,
    epdu-ProvideCapabilities            EPDU-Sequence                       OPTIONAL,
    ...,
    [[  sensor-ProvideCapabilities-r13  Sensor-ProvideCapabilities-r13      OPTIONAL,
        tbs-ProvideCapabilities-r13     TBS-ProvideCapabilities-r13         OPTIONAL,
        wlan-ProvideCapabilities-r13    WLAN-ProvideCapabilities-r13        OPTIONAL,
        bt-ProvideCapabilities-r13      BT-ProvideCapabilities-r13          OPTIONAL
    ]]
}

-- ASN1STOP
```

– *RequestAssistanceData*

The *RequestAssistanceData* message body in a LPP message is used by the target device to request assistance data from the location server.

```
-- ASN1START

RequestAssistanceData ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            requestAssistanceData-r9    RequestAssistanceData-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}

RequestAssistanceData-r9-IEs ::= SEQUENCE {
    commonIEsRequestAssistanceData      CommonIEsRequestAssistanceData      OPTIONAL,
    a-gnss-RequestAssistanceData        A-GNSS-RequestAssistanceData        OPTIONAL,
    otdoa-RequestAssistanceData         OTDOA-RequestAssistanceData         OPTIONAL,
    epdu-RequestAssistanceData          EPDU-Sequence                       OPTIONAL,
    ...,
    [[  sensor-RequestAssistanceData-r14
                                        Sensor-RequestAssistanceData-r14    OPTIONAL,
        tbs-RequestAssistanceData-r14   TBS-RequestAssistanceData-r14       OPTIONAL,
        wlan-RequestAssistanceData-r14  WLAN-RequestAssistanceData-r14      OPTIONAL
    ]]
}

-- ASN1STOP
```

– *ProvideAssistanceData*

The *ProvideAssistanceData* message body in a LPP message is used by the location server to provide assistance data to the target device either in response to a request from the target device or in an unsolicited manner.

```
-- ASN1START

ProvideAssistanceData ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            provideAssistanceData-r9    ProvideAssistanceData-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}

ProvideAssistanceData-r9-IEs ::= SEQUENCE {
    commonIEsProvideAssistanceData      CommonIEsProvideAssistanceData      OPTIONAL,   -- Need ON
    a-gnss-ProvideAssistanceData        A-GNSS-ProvideAssistanceData        OPTIONAL,   -- Need ON
    otdoa-ProvideAssistanceData         OTDOA-ProvideAssistanceData         OPTIONAL,   -- Need ON
    epdu-Provide-Assistance-Data        EPDU-Sequence                       OPTIONAL,   -- Need ON
    ...,
    [[
    sensor-ProvideAssistanceData-r14    Sensor-ProvideAssistanceData-r14    OPTIONAL,   -- Need ON
    tbs-ProvideAssistanceData-r14       TBS-ProvideAssistanceData-r14       OPTIONAL,   -- Need ON
    wlan-ProvideAssistanceData-r14      WLAN-ProvideAssistanceData-r14      OPTIONAL    -- Need ON
    ]]
```

```
}

-- ASN1STOP
```

***ProvideAssistanceData* field descriptions**
commonIEsProvideAssistanceData
This IE is provided for future extensibility and should not be included in this version of the protocol.

– *RequestLocationInformation*

The *RequestLocationInformation* message body in a LPP message is used by the location server to request positioning measurements or a position estimate from the target device.

```
-- ASN1START

RequestLocationInformation ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            requestLocationInformation-r9   RequestLocationInformation-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}

RequestLocationInformation-r9-IEs ::= SEQUENCE {
    commonIEsRequestLocationInformation
                                    CommonIEsRequestLocationInformation OPTIONAL,   -- Need ON
    a-gnss-RequestLocationInformation   A-GNSS-RequestLocationInformation   OPTIONAL,   -- Need ON
    otdoa-RequestLocationInformation    OTDOA-RequestLocationInformation    OPTIONAL,   -- Need ON
    ecid-RequestLocationInformation     ECID-RequestLocationInformation     OPTIONAL,   -- Need ON
    epdu-RequestLocationInformation     EPDU-Sequence                       OPTIONAL,   -- Need ON
    ...,
    [[
    sensor-RequestLocationInformation-r13
                                    Sensor-RequestLocationInformation-r13
                                                                        OPTIONAL,   -- Need ON
    tbs-RequestLocationInformation-r13  TBS-RequestLocationInformation-r13  OPTIONAL,   -- Need ON
    wlan-RequestLocationInformation-r13 WLAN-RequestLocationInformation-r13 OPTIONAL,   -- Need ON
    bt-RequestLocationInformation-r13   BT-RequestLocationInformation-r13   OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

***RequestLocationInformation* field descriptions**
commonIEsRequestLocationInformation
This field specifies the location information type requested by the location server and optionally other configuration information associated with the requested location information. This field should always be included in this version of the protocol.

– *ProvideLocationInformation*

The *ProvideLocationInformation* message body in a LPP message is used by the target device to provide positioning measurements or position estimates to the location server.

```
-- ASN1START

ProvideLocationInformation ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            provideLocationInformation-r9   ProvideLocationInformation-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}
```

```
ProvideLocationInformation-r9-IEs ::= SEQUENCE {
    commonIEsProvideLocationInformation
                                        CommonIEsProvideLocationInformation OPTIONAL,
    a-gnss-ProvideLocationInformation   A-GNSS-ProvideLocationInformation   OPTIONAL,
    otdoa-ProvideLocationInformation    OTDOA-ProvideLocationInformation    OPTIONAL,
    ecid-ProvideLocationInformation     ECID-ProvideLocationInformation     OPTIONAL,
    epdu-ProvideLocationInformation     EPDU-Sequence                       OPTIONAL,
    ...,
    [[
    sensor-ProvideLocationInformation-r13
                                        Sensor-ProvideLocationInformation-r13
                                                                            OPTIONAL,
    tbs-ProvideLocationInformation-r13  TBS-ProvideLocationInformation-r13  OPTIONAL,
    wlan-ProvideLocationInformation-r13 WLAN-ProvideLocationInformation-r13 OPTIONAL,
    bt-ProvideLocationInformation-r13   BT-ProvideLocationInformation-r13   OPTIONAL
    ]]
}

-- ASN1STOP
```

– *Abort*

The *Abort* message body in a LPP message carries a request to abort an ongoing LPP procedure.

```
-- ASN1START

Abort ::= SEQUENCE {
    criticalExtensions      CHOICE {
        c1                      CHOICE {
            abort-r9        Abort-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        },
        criticalExtensionsFuture    SEQUENCE {}
    }
}

Abort-r9-IEs ::= SEQUENCE {
    commonIEsAbort      CommonIEsAbort          OPTIONAL,   -- Need ON
    ...,
    epdu-Abort          EPDU-Sequence           OPTIONAL    -- Need ON
}

-- ASN1STOP
```

– *Error*

The *Error* message body in a LPP message carries information concerning a LPP message that was received with errors.

```
-- ASN1START

Error ::= CHOICE {
    error-r9                    Error-r9-IEs,
    criticalExtensionsFuture    SEQUENCE {}
}

Error-r9-IEs ::= SEQUENCE {
    commonIEsError      CommonIEsError          OPTIONAL,   -- Need ON
    ...,
    epdu-Error          EPDU-Sequence           OPTIONAL    -- Need ON
}

-- ASN1STOP
```

6.4 Common IEs

Common IEs comprise IEs that are applicable to more than one LPP positioning method.

6.4.1 Common Lower-Level IEs

– *AccessTypes*

The IE *AccessTypes* is used to indicate several cellular access types using a bit map.

```
-- ASN1START

AccessTypes ::= SEQUENCE {
    accessTypes     BIT STRING {    eutra       (0),
                                    utra        (1),
                                    gsm         (2),
                                    nb-iot      (3),
                                    nr-v1510    (4) } (SIZE (1..8)),
    ...
}

-- ASN1STOP
```

***AccessTypes* field descriptions**
accessTypes
This field specifies the cellular access type(s). This is represented by a bit string, with a one-value at the bit position means the particular access type is addressed; a zero-value means not addressed.

– *ARFCN-ValueEUTRA*

The IEs *ARFCN-ValueEUTRA* and *ARFCN-ValueEUTRA-v9a0* are used to indicate the ARFCN of the E-UTRA carrier frequency, as defined in TS 36.331 [12].

```
-- ASN1START

ARFCN-ValueEUTRA ::= INTEGER (0..maxEARFCN)

ARFCN-ValueEUTRA-v9a0 ::=   INTEGER (maxEARFCN-Plus1..maxEARFCN2)

ARFCN-ValueEUTRA-r14 ::=    INTEGER (0..maxEARFCN2)

maxEARFCN                   INTEGER ::= 65535   -- Maximum value of EUTRA carrier frequency

maxEARFCN-Plus1             INTEGER ::= 65536   -- Lowest value extended EARFCN range

maxEARFCN2                  INTEGER ::= 262143  -- Highest value extended EARFCN range

-- ASN1STOP
```

NOTE: For fields using the original value range, as defined by IE *ARFCN-ValueEUTRA* i.e. without suffix, value *maxEARFCN* indicates that the E-UTRA carrier frequency is indicated by means of an extension.

– *ARFCN-ValueNR*

The IE *ARFCN-ValueNR* is used to indicate the ARFCN applicable for a downlink, uplink or bi-directional (TDD) NR global frequency raster, as defined in 3GPP TS 38.101-2 [34].

```
-- ASN1START

ARFCN-ValueNR-r15 ::= INTEGER (0..3279165)

-- ASN1STOP
```

– *ARFCN-ValueUTRA*

The IE *ARFCN-ValueUTRA* is used to indicate the ARFCN of the UTRA carrier frequency, as defined in TS 25.331 [13].

```
-- ASN1START
```

```
ARFCN-ValueUTRA ::= INTEGER (0..16383)

-- ASN1STOP
```

– CarrierFreq-NB

The IE *CarrierFreq-NB* is used to provide the NB-IoT carrier frequency, as defined in TS 36.101 [21].

```
-- ASN1START

CarrierFreq-NB-r14 ::=      SEQUENCE {
    carrierFreq-r14             ARFCN-ValueEUTRA-r14,
    carrierFreqOffset-r14       CarrierFreqOffsetNB-r14             OPTIONAL,
    ...
}

-- ASN1STOP
```

***CarrierFreq-NB* field descriptions**
carrierFreq
This field specifies the ARFCN applicable for the NB-IoT carrier frequency as defined in TS 36.101 [21, Table 5.7.3-1].
carrierFreqOffset
This field specifies the offset of the NB-IoT channel number to EARFCN as defined in TS 36.101 [21].

– CarrierFreqOffsetNB

The IE *CarrierFreqOffsetNB* is used to provide the offset of the NB-IoT channel number to EARFCN of a NB-IoT carrier.

```
-- ASN1START

CarrierFreqOffsetNB-r14 ::=     ENUMERATED {
                                    v-10, v-9, v-8, v-7, v-6, v-5, v-4, v-3, v-2, v-1, v-0dot5,
                                    v0, v1, v2, v3, v4, v5, v6, v7, v8, v9
                                    }

-- ASN1STOP
```

CarrierFreqOffsetNB field descriptions
CarrierFreqOffsetNB
This field specifies the offset of the NB-IoT channel number to EARFCN as defined in TS 36.101 [21]. Value v-10 means -10, v-9 means -9, and so on.

– CellGlobalIdEUTRA-AndUTRA

The IE *CellGlobalIdEUTRA-AndUTRA* specifies the global Cell Identifier for E-UTRA or UTRA, the globally unique identity of a cell in E-UTRA or UTRA.

```
-- ASN1START

CellGlobalIdEUTRA-AndUTRA ::= SEQUENCE {
    plmn-Identity       SEQUENCE {
                            mcc     SEQUENCE (SIZE (3)) OF INTEGER (0..9),
                            mnc     SEQUENCE (SIZE (2..3))  OF INTEGER (0..9)
                        },
    cellIdentity        CHOICE {
        eutra   BIT STRING (SIZE (28)),
        utra    BIT STRING (SIZE (32))
    },
    ...
}

-- ASN1STOP
```

***CellGlobalIdEUTRA-AndUTRA* field descriptions**
plmn-Identity This field identifies the PLMN of the cell as defined in TS 36.331 [12].
cellIdentity This field defines the identity of the cell within the context of the PLMN as defined in TS 36.331 [12] and TS 25.331 [13]. The size of the bit string allows for the 32-bit extended UTRAN cell ID; in case the cell ID is shorter, the first bits of the string are set to 0.

– *CellGlobalIdGERAN*

The IE *CellGlobalIdGERAN* specifies the global Cell Identifier for GERAN, the globally unique identity of a cell in GERAN.

```
-- ASN1START

CellGlobalIdGERAN ::= SEQUENCE {
    plmn-Identity       SEQUENCE {
                            mcc     SEQUENCE (SIZE (3)) OF INTEGER (0..9),
                            mnc     SEQUENCE (SIZE (2..3))  OF INTEGER (0..9)
                            },
    locationAreaCode        BIT STRING (SIZE (16)),
    cellIdentity            BIT STRING (SIZE (16)),
    ...
}

-- ASN1STOP
```

***CellGlobalIdGERAN* field descriptions**
plmn-Identity This field identifies the PLMN of the cell.
locationAreaCode This field is a fixed length code identifying the location area within a PLMN.
cellIdentity This field specifies the cell Identifier which is unique within the context of the GERAN location area.

– *ECGI*

The IE *ECGI* specifies the Evolved Cell Global Identifier (ECGI), the globally unique identity of a cell in E-UTRA (TS 36.331 [12]).

NOTE: The IE *ECGI* is also used for NB-IoT access.

```
-- ASN1START

ECGI ::= SEQUENCE {
    mcc             SEQUENCE (SIZE (3)) OF INTEGER (0..9),
    mnc             SEQUENCE (SIZE (2..3))  OF INTEGER (0..9),
    cellidentity    BIT STRING (SIZE (28))
}

-- ASN1STOP
```

– *Ellipsoid-Point*

The IE *Ellipsoid-Point* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

Ellipsoid-Point ::= SEQUENCE {
    latitudeSign                ENUMERATED {north, south},
    degreesLatitude             INTEGER (0..8388607),           -- 23 bit field
    degreesLongitude            INTEGER (-8388608..8388607)     -- 24 bit field
}

-- ASN1STOP
```

– *Ellipsoid-PointWithUncertaintyCircle*

The IE *Ellipsoid-PointWithUncertaintyCircle* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

Ellipsoid-PointWithUncertaintyCircle ::= SEQUENCE {
    latitudeSign               ENUMERATED {north, south},
    degreesLatitude            INTEGER (0..8388607),          -- 23 bit field
    degreesLongitude           INTEGER (-8388608..8388607),   -- 24 bit field
    uncertainty                INTEGER (0..127)
}

-- ASN1STOP
```

– *EllipsoidPointWithUncertaintyEllipse*

The IE *EllipsoidPointWithUncertaintyEllipse* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

EllipsoidPointWithUncertaintyEllipse ::= SEQUENCE {
    latitudeSign               ENUMERATED {north, south},
    degreesLatitude            INTEGER (0..8388607),          -- 23 bit field
    degreesLongitude           INTEGER (-8388608..8388607),   -- 24 bit field
    uncertaintySemiMajor       INTEGER (0..127),
    uncertaintySemiMinor       INTEGER (0..127),
    orientationMajorAxis       INTEGER (0..179),
    confidence                 INTEGER (0..100)
}

-- ASN1STOP
```

– *EllipsoidPointWithAltitude*

The IE *EllipsoidPointWithAltitude* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

EllipsoidPointWithAltitude ::= SEQUENCE {
    latitudeSign               ENUMERATED {north, south},
    degreesLatitude            INTEGER (0..8388607),          -- 23 bit field
    degreesLongitude           INTEGER (-8388608..8388607),   -- 24 bit field
    altitudeDirection          ENUMERATED {height, depth},
    altitude                   INTEGER (0..32767)             -- 15 bit field
}

-- ASN1STOP
```

– *EllipsoidPointWithAltitudeAndUncertaintyEllipsoid*

The IE *EllipsoidPointWithAltitudeAndUncertaintyEllipsoid* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

EllipsoidPointWithAltitudeAndUncertaintyEllipsoid ::= SEQUENCE {
    latitudeSign               ENUMERATED {north, south},
    degreesLatitude            INTEGER (0..8388607),          -- 23 bit field
    degreesLongitude           INTEGER (-8388608..8388607),   -- 24 bit field
    altitudeDirection          ENUMERATED {height, depth},
    altitude                   INTEGER (0..32767),            -- 15 bit field
    uncertaintySemiMajor       INTEGER (0..127),
    uncertaintySemiMinor       INTEGER (0..127),
```

```
    orientationMajorAxis        INTEGER (0..179),
    uncertaintyAltitude         INTEGER (0..127),
    confidence                  INTEGER (0..100)
}

-- ASN1STOP
```

– *EllipsoidArc*

The IE *EllipsoidArc* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

EllipsoidArc ::= SEQUENCE {
    latitudeSign                ENUMERATED {north, south},
    degreesLatitude             INTEGER (0..8388607),           -- 23 bit field
    degreesLongitude            INTEGER (-8388608..8388607),    -- 24 bit field
    innerRadius                 INTEGER (0..65535),             -- 16 bit field,
    uncertaintyRadius           INTEGER (0..127),
    offsetAngle                 INTEGER (0..179),
    includedAngle               INTEGER (0..179),
    confidence                  INTEGER (0..100)
}

-- ASN1STOP
```

– *EPDU-Sequence*

The *EPDU-Sequence* contains IEs that are defined externally to LPP by other organizations.

```
-- ASN1START

EPDU-Sequence ::= SEQUENCE (SIZE (1..maxEPDU)) OF EPDU

maxEPDU INTEGER ::= 16

EPDU ::= SEQUENCE {
    ePDU-Identifier         EPDU-Identifier,
    ePDU-Body               EPDU-Body
}

EPDU-Identifier ::= SEQUENCE {
    ePDU-ID                 EPDU-ID,
    ePDU-Name               EPDU-Name       OPTIONAL,
    ...
}

EPDU-ID ::= INTEGER (1..256)

EPDU-Name ::= VisibleString (SIZE (1..32))

EPDU-Body ::= OCTET STRING

-- ASN1STOP
```

***EPDU-Sequence* field descriptions**
EPDU-ID This field provides a unique integer ID for the externally defined positioning method. Its value is assigned to the external entity that defines the EPDU. See table External PDU Identifier Definition for a list of external PDU identifiers defined in this version of the specification.
EPDU-Name This field provides an optional character encoding which can be used to provide a quasi-unique name for an external PDU – e.g., by containing the name of the defining organization and/or the name of the associated public or proprietary standard for the EPDU.
EPDU-Body The content and encoding of this field are defined externally to LPP.

External PDU Identifier Definition

EPDU-ID	EPDU Defining entity	Method name	Reference
1	OMA LOC	OMA LPP extensions (LPPe)	OMA-TS-LPPe-V1_0 [20]

– *HighAccuracyEllipsoidPointWithUncertaintyEllipse*

The IE *HighAccuracyEllipsoidPointWithUncertaintyEllipse* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

HighAccuracyEllipsoidPointWithUncertaintyEllipse-r15 ::= SEQUENCE {
    degreesLatitude-r15             INTEGER(-2147483648..2147483647),
    degreesLongitude-r15            INTEGER(-2147483648..2147483647),
    uncertaintySemiMajor-r15        INTEGER (0..255),
    uncertaintySemiMinor-r15        INTEGER (0..255),
    orientationMajorAxis-r15        INTEGER (0..179),
    confidence-r15                  INTEGER (0..100)
}

-- ASN1STOP
```

– *HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid*

The IE *HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-r15 ::= SEQUENCE {
    degreesLatitude-r15             INTEGER(-2147483648..2147483647),
    degreesLongitude-r15            INTEGER(-2147483648..2147483647),
    altitude-r15                    INTEGER(-64000..1280000),
    uncertaintySemiMajor-r15        INTEGER (0..255),
    uncertaintySemiMinor-r15        INTEGER (0..255),
    orientationMajorAxis-r15        INTEGER (0..179),
    horizontalConfidence-r15        INTEGER (0..100),
    uncertaintyAltitude-r15         INTEGER (0..255),
    verticalConfidence-r15          INTEGER (0..100)
}

-- ASN1STOP
```

– *HorizontalVelocity*

The IE *HorizontalVelocity* is used to describe a velocity shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

HorizontalVelocity ::= SEQUENCE {
    bearing                     INTEGER(0..359),
    horizontalSpeed             INTEGER(0..2047)
}

-- ASN1STOP
```

– *HorizontalWithVerticalVelocity*

The IE *HorizontalWithVerticalVelocity* is used to describe a velocity shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

HorizontalWithVerticalVelocity ::= SEQUENCE {
    bearing                     INTEGER(0..359),
```

```
    horizontalSpeed             INTEGER(0..2047),
    verticalDirection           ENUMERATED{upward, downward},
    verticalSpeed               INTEGER(0..255)
}

-- ASN1STOP
```

– *HorizontalVelocityWithUncertainty*

The IE *HorizontalVelocityWithUncertainty* is used to describe a velocity shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

HorizontalVelocityWithUncertainty ::= SEQUENCE {
    bearing                     INTEGER(0..359),
    horizontalSpeed             INTEGER(0..2047),
    uncertaintySpeed            INTEGER(0..255)
}

-- ASN1STOP
```

– *HorizontalWithVerticalVelocityAndUncertainty*

The IE *HorizontalWithVerticalVelocityAndUncertainty* is used to describe a velocity shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

HorizontalWithVerticalVelocityAndUncertainty ::= SEQUENCE {
    bearing                     INTEGER(0..359),
    horizontalSpeed             INTEGER(0..2047),
    verticalDirection           ENUMERATED{upward, downward},
    verticalSpeed               INTEGER(0..255),
    horizontalUncertaintySpeed  INTEGER(0..255),
    verticalUncertaintySpeed    INTEGER(0..255)
}

-- ASN1STOP
```

– *LocationCoordinateTypes*

The IE *LocationCoordinateTypes* defines a list of possible geographic shapes as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

LocationCoordinateTypes ::= SEQUENCE {
    ellipsoidPoint                                          BOOLEAN,
    ellipsoidPointWithUncertaintyCircle                     BOOLEAN,
    ellipsoidPointWithUncertaintyEllipse                    BOOLEAN,
    polygon                                                 BOOLEAN,
    ellipsoidPointWithAltitude                              BOOLEAN,
    ellipsoidPointWithAltitudeAndUncertaintyEllipsoid       BOOLEAN,
    ellipsoidArc                                            BOOLEAN,
    ...,
    [[
        highAccuracyEllipsoidPointWithUncertaintyEllipse-r15                BOOLEAN     OPTIONAL,
        highAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-r15   BOOLEAN     OPTIONAL
    ]]
}

-- ASN1STOP
```

– *NCGI*

The IE *NCGI* specifies the NR Cell Global Identifier (NCGI) which is used to identify NR cells globally (3GPP TS 38.331 [35]).

```
-- ASN1START

NCGI-r15 ::= SEQUENCE {
    mcc-r15                 SEQUENCE (SIZE (3))     OF INTEGER (0..9),
    mnc-r15                 SEQUENCE (SIZE (2..3))  OF INTEGER (0..9),
    nr-cellidentity-r15     BIT STRING (SIZE (36))
}

-- ASN1STOP
```

– *PeriodicAssistanceDataControlParameters*

The IE *PeriodicAssistanceDataControlParameters* is used in a periodic assistance data delivery procedure as described in sub-clauses 5.2.1a and 5.2.2a.

```
-- ASN1START

PeriodicAssistanceDataControlParameters-r15 ::= SEQUENCE {
    periodicSessionID-r15           PeriodicSessionID-r15,
    ...
}

PeriodicSessionID-r15 ::= SEQUENCE {
    periodicSessionInitiator-r15    ENUMERATED { locationServer, targetDevice, ... },
    periodicSessionNumber-r15       INTEGER (0..255),
    ...
}

-- ASN1STOP
```

***PeriodicAssistanceDataControlParameters* field descriptions**
periodicSessionID
This field identifies a particular periodic assistance data delivery session and the initiator of the session.

– *Polygon*

The IE *Polygon* is used to describe a geographic shape as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

Polygon ::= SEQUENCE (SIZE (3..15)) OF PolygonPoints

PolygonPoints ::= SEQUENCE {
    latitudeSign                ENUMERATED {north, south},
    degreesLatitude             INTEGER (0..8388607),           -- 23 bit field
    degreesLongitude            INTEGER (-8388608..8388607)     -- 24 bit field
}

-- ASN1STOP
```

– *PositioningModes*

The IE *PositioningModes* is used to indicate several positioning modes using a bit map.

```
-- ASN1START

PositioningModes ::= SEQUENCE {
    posModes        BIT STRING {    standalone  (0),
                                    ue-based    (1),
                                    ue-assisted (2)
    } (SIZE (1..8)),
    ...
}

-- ASN1STOP
```

***PositioningModes* field descriptions**
posModes   This field specifies the positioning mode(s). This is represented by a bit string, with a one-value at the bit position means the particular positioning mode is addressed; a zero-value means not addressed.

– *SegmentationInfo*

The IE *SegmentationInfo* is used by a sender to indicate that LPP message segmentation is used, as specified in sub-clause 4.3.5.

```
-- ASN1START

SegmentationInfo-r14 ::= ENUMERATED { noMoreMessages, moreMessagesOnTheWay }

-- ASN1STOP
```

***SegmentationInfo* field descriptions**
SegmentationInfo   *noMoreMessages* indicates that this is the only or last LPP message segment used to deliver the entire message body.   *moreMessagesOnTheWay* indicates that this is one of multiple LPP message segments used to deliver the entire message body.

– *VelocityTypes*

The IE *VelocityTypes* defines a list of possible velocity shapes as defined in 3GPP TS 23.032 [15].

```
-- ASN1START

VelocityTypes ::= SEQUENCE {
    horizontalVelocity                                  BOOLEAN,
    horizontalWithVerticalVelocity                      BOOLEAN,
    horizontalVelocityWithUncertainty                   BOOLEAN,
    horizontalWithVerticalVelocityAndUncertainty        BOOLEAN,
    ...
}

-- ASN1STOP
```

6.4.2 Common Positioning

– *CommonIEsRequestCapabilities*

The *CommonIEsRequestCapabilities* carries common IEs for a Request Capabilities LPP message Type.

```
-- ASN1START

CommonIEsRequestCapabilities ::= SEQUENCE {
    ...,
    [[
    lpp-message-segmentation-req-r14    BIT STRING {    serverToTarget  (0),
                                                        targetToServer  (1) }   OPTIONAL -- Need ON
    ]]
}

-- ASN1STOP
```

***CommonIEsRequestCapabilities* field descriptions**
lpp-message-segmentation-req This field, if present, indicates that the target device is requested to provide its LPP message segmentation capabilities. If bit 0 is set to value 1, it indicates that the server is able to send segmented LPP messages to the target device; if bit 0 is set to value 0 it indicates that the server is not able to send segmented LPP messages to the target device. If bit 1 is set to value 1, it indicates that the server is able to receive segmented LPP messages from the target device; if bit 1 is set to value 0 it indicates that the server is not able to receive segmented LPP messages from the target device.

– *CommonIEsProvideCapabilities*

The *CommonIEsProvideCapabilities* carries common IEs for a Provide Capabilities LPP message Type.

```
-- ASN1START

CommonIEsProvideCapabilities ::= SEQUENCE {
    ...,
    [[
    segmentationInfo-r14            SegmentationInfo-r14            OPTIONAL,   -- Cond Segmentation
    lpp-message-segmentation-r14    BIT STRING { serverToTarget (0),
                                                 targetToServer  (1) }   OPTIONAL
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
Segmentation	This field is optionally present, need OP, if *lpp-message-segmentation-req* has been received from the location server with bit 1 (*targetToServer*) set to value 1. The field shall be omitted if *lpp-message-segmentation-req* has not been received in this location session, or has been received with bit 1 (*targetToServer*) set to value 0.

***CommonIEsProvideCapabilities* field descriptions**
segmentationInfo This field indicates whether this *ProvideCapabilities* message is one of many segments, as specified in sub-clause 4.3.5.
lpp-message-segmentation This field, if present, indicates the target device's LPP message segmentation capabilities. If bit 0 is set to value 1, it indicates that the target device supports receiving segmented LPP messages; if bit 0 is set to value 0 it indicates that the target device does not support receiving segmented LPP messages. If bit 1 is set to value 1, it indicates that the target device supports sending segmented LPP messages; if bit 1 is set to value 0 it indicates that the target device does not support sending segmented LPP messages.

– *CommonIEsRequestAssistanceData*

The *CommonIEsRequestAssistanceData* carries common IEs for a Request Assistance Data LPP message Type.

```
-- ASN1START

CommonIEsRequestAssistanceData ::= SEQUENCE {
    primaryCellID       ECGI        OPTIONAL,   -- Cond EUTRA
    ...,
    [[
        segmentationInfo-r14        SegmentationInfo-r14        OPTIONAL    -- Cond Segmentation
    ]],
    [[
        periodicAssistanceDataReq-r15
                                    PeriodicAssistanceDataControlParameters-r15
                                                                OPTIONAL,   -- Cond PerADreq
        primaryCellID-r15           NCGI-r15                    OPTIONAL    -- Cond NR
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
EUTRA	The field is mandatory present for E-UTRA or NB-IoT access. The field shall be omitted for non-EUTRA and non-NB-IoT user plane support.
Segmentation	This field is optionally present, need OP, if *lpp-message-segmentation-req* has been received from the location server with bit 1 (*targetToServer*) set to value 1. The field shall be omitted if *lpp-message-segmentation-req* has not been received in this location session, or has been received with bit 1 (*targetToServer*) set to value 0.
PerADreq	The field is mandatory present if the target device requests periodic assistance data delivery. Otherwise it is not present.
NR	The field is mandatory present for NR access. The field shall be omitted for non-NR user plane support.

***CommonIEsRequestAssistanceData* field descriptions**
primaryCellID This parameter identifies the current primary cell for the target device.
segmentationInfo This field indicates whether this *RequestAssistanceData* message is one of many segments, as specified in sub-clause 4.3.5.
periodicAssistanceDataReq This field indicates a request for periodic assistance data delivery, as specified in sub-clauses 5.2.1a.

– *CommonIEsProvideAssistanceData*

The *CommonIEsProvideAssistanceData* carries common IEs for a Provide Assistance Data LPP message Type.

```
-- ASN1START

CommonIEsProvideAssistanceData ::= SEQUENCE {
    ...,
    [[
        segmentationInfo-r14        SegmentationInfo-r14        OPTIONAL    -- Need ON
    ]],
    [[
        periodicAssistanceData-r15  PeriodicAssistanceDataControlParameters-r15
                                                                OPTIONAL    -- Cond PerAD
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
PerAD	The field is mandatory present in a periodic assistance data delivery session. Otherwise it is not present.

***CommonIEsRequestAssistanceData* field descriptions**
segmentationInfo This field indicates whether this *ProvideAssistanceData* message is one of many segments, as specified in sub-clause 4.3.5.
periodicAssistanceData This field indicates a periodic assistance data delivery, as specified in sub-clauses 5.2.1a and 5.2.2a.

– *CommonIEsRequestLocationInformation*

The *CommonIEsRequestLocationInformation* carries common IEs for a Request Location Information LPP message Type.

```
-- ASN1START

CommonIEsRequestLocationInformation ::= SEQUENCE {
    locationInformationType     LocationInformationType,
    triggeredReporting          TriggeredReportingCriteria  OPTIONAL,   -- Cond ECID
    periodicalReporting         PeriodicalReportingCriteria OPTIONAL,   -- Need ON
    additionalInformation       AdditionalInformation       OPTIONAL,   -- Need ON
    qos                         QoS                         OPTIONAL,   -- Need ON
```

```
    environment                 Environment                 OPTIONAL,   -- Need ON
    locationCoordinateTypes     LocationCoordinateTypes     OPTIONAL,   -- Need ON
    velocityTypes               VelocityTypes               OPTIONAL,   -- Need ON
    ...,
    [[
        messageSizeLimitNB-r14  MessageSizeLimitNB-r14      OPTIONAL    -- Need ON
    ]],
    [[
        segmentationInfo-r14    SegmentationInfo-r14        OPTIONAL    -- Need ON
    ]]
}

LocationInformationType ::= ENUMERATED {
    locationEstimateRequired,
    locationMeasurementsRequired,
    locationEstimatePreferred,
    locationMeasurementsPreferred,
    ...
}

PeriodicalReportingCriteria ::=     SEQUENCE {
    reportingAmount                     ENUMERATED {
                                            ra1, ra2, ra4, ra8, ra16, ra32,
                                            ra64, ra-Infinity
                                        } DEFAULT ra-Infinity,
    reportingInterval                   ENUMERATED {
                                            noPeriodicalReporting, ri0-25,
                                            ri0-5, ri1, ri2, ri4, ri8, ri16, ri32, ri64
                                        }
}

TriggeredReportingCriteria ::=      SEQUENCE {
    cellChange                          BOOLEAN,
    reportingDuration                   ReportingDuration,
    ...
}

ReportingDuration ::=               INTEGER (0..255)

AdditionalInformation ::= ENUMERATED {
    onlyReturnInformationRequested,
    mayReturnAditionalInformation,
    ...
}

QoS ::= SEQUENCE {
    horizontalAccuracy          HorizontalAccuracy      OPTIONAL,   -- Need ON
    verticalCoordinateRequest   BOOLEAN,
    verticalAccuracy            VerticalAccuracy        OPTIONAL,   -- Need ON
    responseTime                ResponseTime            OPTIONAL,   -- Need ON
    velocityRequest             BOOLEAN,
    ...,
    [[  responseTimeNB-r14      ResponseTimeNB-r14      OPTIONAL    -- Need ON
    ]],
    [[  horizontalAccuracyExt-r15   HorizontalAccuracyExt-r15       OPTIONAL,   -- Need ON
        verticalAccuracyExt-r15     VerticalAccuracyExt-r15         OPTIONAL    -- Need ON
    ]]
}

HorizontalAccuracy ::= SEQUENCE {
    accuracy        INTEGER(0..127),
    confidence      INTEGER(0..100),
    ...
}

VerticalAccuracy ::= SEQUENCE {
    accuracy        INTEGER(0..127),
    confidence      INTEGER(0..100),
    ...
}

HorizontalAccuracyExt-r15 ::= SEQUENCE {
    accuracyExt-r15     INTEGER(0..255),
    confidence-r15      INTEGER(0..100),
    ...
}

VerticalAccuracyExt-r15 ::= SEQUENCE {
```

```
    accuracyExt-r15     INTEGER(0..255),
    confidence-r15      INTEGER(0..100),
    ...
}

ResponseTime ::= SEQUENCE {
    time                                INTEGER (1..128),
    ...,
    [[  responseTimeEarlyFix-r12        INTEGER (1..128)        OPTIONAL        -- Need ON
    ]],
    [[  unit-r15                ENUMERATED { ten-seconds, ... } OPTIONAL        -- Need ON
    ]]
}

ResponseTimeNB-r14 ::= SEQUENCE {
    timeNB-r14                          INTEGER (1..512),
    responseTimeEarlyFixNB-r14          INTEGER (1..512)        OPTIONAL,       -- Need ON
    ...,
    [[  unitNB-r15              ENUMERATED { ten-seconds, ... } OPTIONAL        -- Need ON
    ]]
}

Environment ::= ENUMERATED {
    badArea,
    notBadArea,
    mixedArea,
    ...
}

MessageSizeLimitNB-r14 ::= SEQUENCE {
    measurementLimit-r14                INTEGER (1..512)        OPTIONAL,       -- Need ON
    ...
}

-- ASN1STOP
```

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

***CommonIEsRequestLocationInformation* field descriptions**
locationInformationType This IE indicates whether the server requires a location estimate or measurements. For '*locationEstimateRequired*', the target device shall return a location estimate if possible, or indicate a location error if not possible. For '*locationMeasurementsRequired*', the target device shall return measurements if possible, or indicate a location error if not possible. For '*locationEstimatePreferred*', the target device shall return a location estimate if possible, but may also or instead return measurements for any requested position methods for which a location estimate is not possible. For '*locationMeasurementsPreferred*', the target device shall return location measurements if possible, but may also or instead return a location estimate for any requested position methods for which return of location measurements is not possible.
triggeredReporting This IE indicates that triggered reporting is requested and comprises the following subfields: - ***cellChange***: If this field is set to TRUE, the target device provides requested location information each time the primary cell has changed. - ***reportingDuration***: Maximum duration of triggered reporting in seconds. A value of zero is interpreted to mean an unlimited (i.e. "infinite") duration. The target device should continue triggered reporting for the *reportingDuration* or until an LPP *Abort* or *LPP Error* message is received. 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 or *responseTimeNB* IE is included in *CommonIEsRequestLocationInformation.*

***CommonIEsRequestLocationInformation* field descriptions**

periodicalReporting

This IE indicates that periodic reporting is requested and comprises the following subfields:

- ***reportingAmount*** indicates the number of periodic location information reports requested. Enumerated values correspond to 1, 2, 4, 8, 16, 32, 64, or infinite/indefinite number of reports. If the *reportingAmount* is '*infinite/indefinite*', the target device shou-ld continue periodic reporting until an LPP *Abort* message is received. The value '*ra1*' shall not be used by a sender.
- ***reportingInterval*** indicates the interval between location information reports and the response time requirement for the first location information report. Enumerated values ri0-25, ri0-5, ri1, ri2, ri4, ri8, ri16, ri32, ri64 correspond to reporting intervals of 1, 2, 4, 8, 10, 16, 20, 32, and 64 seconds, respectively. Measurement reports containing no measurements or no location estimate are required when a *reportingInterval* expires before a target device is able to obtain new measurements or obtain a new location estimate. The value '*noPeriodicalReporting*' shall not be used by a sender.

additionalInformation

This IE indicates whether a target device is allowed to return additional information to that requested. If this IE indicates '*onlyReturnInformationRequested'* then the target device shall not return any additional information to that requested by the server. If this IE indicates '*mayReturnAdditionalInformation'* then the target device may return additional information to that requested by the server. If a location estimate is returned, any additional information is restricted to that associated with a location estimate (e.g. might include velocity if velocity was not requested but cannot include measurements). If measurements are returned, any additional information is restricted to additional measurements (e.g. might include E-CID measurements if A-GNSS measurements were requested but not E-CID measurements).

qos

This IE indicates the quality of service and comprises a number of sub-fields. In the case of measurements, some of the sub-fields apply to the location estimate that could be obtained by the server from the measurements provided by the target device assuming that the measurements are the only sources of error. Fields are as follows:

- ***horizontalAccuracy*** indicates the maximum horizontal error in the location estimate at an indicated confidence level. The '*accuracy*' corresponds to the encoded uncertainty as defined in 3GPP TS 23.032 [15] and '*confidence*' corresponds to confidence as defined in 3GPP TS 23.032 [15].
- ***verticalCoordinateRequest*** indicates whether a vertical coordinate is required (TRUE) or not (FALSE)
- ***verticalAccuracy*** indicates the maximum vertical error in the location estimate at an indicated confidence level and is only applicable when a vertical coordinate is requested. The '*accuracy*' corresponds to the encoded uncertainty altitude as defined in 3GPP TS 23.032 [15] and '*confidence*' corresponds to confidence as defined in 3GPP TS 23.032 [15].
- ***responseTime***
  - ***time*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation*. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 128. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 1280 seconds. If the *periodicalReporting* IE is included in *CommonIEsRequestLocationInformation*, this field should not be included by the location server and shall be ignored by the target device (if included).
  - ***responseTimeEarlyFix*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation* containing early location measurements or an early location estimate. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 128. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 1280 seconds. When this IE is included, a target should send a *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing early location information according to the *responseTimeEarlyFix* IE and a subsequent *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing final location information according to the *time* IE. A target shall omit sending a *ProvideLocationInformation* if the early location information is not available at the expiration of the time value in the *responseTimeEarlyFix* IE. A server should set the *responseTimeEarlyFix* IE to a value less than that for the *time* IE. A target shall ignore the *responseTimeEarlyFix* IE if its value is not less than that for the *time* IE.
  - ***unit*** indicates the unit of the *time* and *responseTimeEarlyFix* fields. Enumerated value '*ten-seconds*' corresponds to a resolution of 10 seconds. If this field is absent, the unit/resolution is 1 second.
- ***velocityRequest*** indicates whether velocity (or measurements related to velocity) is requested (TRUE) or not (FALSE).
- ***responseTimeNB***

  If the *periodicalReporting* IE or *responseTime* IE is included in *CommonIEsRequestLocationInformation*, this field should not be included by the location server and shall be ignored by the target device (if included).
  - ***timeNB*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation*. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 512. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 5120 seconds.
  - ***responseTimeEarlyFixNB*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation* containing early location

***CommonIEsRequestLocationInformation* field descriptions**
measurements or an early location estimate. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 512. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 5120 seconds. When this IE is included, a target should send a *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing early location information according to the *responseTimeEarlyFixNB* IE and a subsequent *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing final location information according to the *timeNB* IE. A target shall omit sending a *ProvideLocationInformation* if the early location information is not available at the expiration of the time value in the *responseTimeEarlyFixNB* IE. A server should set the *responseTimeEarlyFixNB* IE to a value less than that for the *timeNB* IE. A target shall ignore the *responseTimeEarlyFixNB* IE if its value is not less than that for the *timeNB* IE. - ***unitNB*** indicates the unit of the *timeNB* and *responseTimeEarlyFixNB* fields. Enumerated value '*ten-second*' corresponds to a resolution of 10 seconds. If this field is absent, the unit/resolution is 1 second. - ***horizontalAccuracyExt*** indicates the maximum horizontal error in the location estimate at an indicated confidence level. The '*accuracyExt*' corresponds to the encoded high accuracy uncertainty as defined in 3GPP TS 23.032 [15] and 'confidence' corresponds to confidence as defined in 3GPP TS 23.032 [15]. This field should not be included by the location server and shall be ignored by the target device if the *horizontalAccuracy* field is included in QoS. - ***verticalAccuracyExt*** indicates the maximum vertical error in the location estimate at an indicated confidence level and is only applicable when a vertical coordinate is requested. The '*accuracyExt*' corresponds to the encoded high accuracy uncertainty as defined in 3GPP TS 23.032 [15] and '*confidence*' corresponds to confidence as defined in 3GPP TS 23.032 [15]. This field should not be included by the location server and shall be ignored by the target device if the *verticalAccuracy* field is included in QoS. All QoS requirements shall be obtained by the target device to the degree possible but it is permitted to return a response that does not fulfill all QoS requirements if some were not attainable. The single exception is *time* and *timeNB* which shall always be fulfilled – even if that means not fulfilling other QoS requirements. A target device supporting NB-IoT access shall support the *responseTimeNB* IE. A target device supporting HA GNSS shall support the *HorizontalAccuracyExt*, *VerticalAccuracyEx*, and *unit* fields. A target device supporting NB-IoT access and HA GNSS shall support the *unitNB* field.
environment This field provides the target device with information about expected multipath and non line of sight (NLOS) in the current area. The following values are defined: - badArea: possibly heavy multipath and NLOS conditions (e.g. bad urban or urban). - notBadArea: no or light multipath and usually LOS conditions (e.g. suburban or rural). - mixedArea: environment that is mixed or not defined. If this field is absent, a default value of 'mixedArea' applies.
locationCoordinateTypes This field provides a list of the types of location estimate that the target device may return when a location estimate is obtained by the target.
velocityTypes This fields provides a list of the types of velocity estimate that the target device may return when a velocity estimate is obtained by the target.
messageSizeLimitNB This field provides an octet limit on the amount of location information a target device can return. - ***measurementLimit*** indicates the maximum amount of location information the target device should return in response to the *RequestLocationInformation* message received from the location server. The limit applies to the overall size of the LPP message at LPP level (LPP Provide Location Information), and is specified in steps of 100 octets. The message size limit is then given by the value provided in *measurementLimit* times 100 octets.
segmentationInfo This field indicates whether this *RequestLocationInformation* message is one of many segments, as specified in sub-clause 4.3.5

– *CommonIEsProvideLocationInformation*

The *CommonIEsProvideLocationInformation* carries common IEs for a Provide Location Information LPP message Type.

```
-- ASN1START

CommonIEsProvideLocationInformation ::= SEQUENCE {
    locationEstimate            LocationCoordinates     OPTIONAL,
    velocityEstimate            Velocity                OPTIONAL,
    locationError               LocationError           OPTIONAL,
    ...,
    [[  earlyFixReport-r12      EarlyFixReport-r12      OPTIONAL
```

```
    ]],
    [[  locationSource-r13      LocationSource-r13      OPTIONAL,
        locationTimestamp-r13   UTCTime                 OPTIONAL
    ]],
    [[
        segmentationInfo-r14    SegmentationInfo-r14    OPTIONAL        -- Cond Segmentation
    ]]
}

LocationCoordinates ::= CHOICE {
    ellipsoidPoint                              Ellipsoid-Point,
    ellipsoidPointWithUncertaintyCircle         Ellipsoid-PointWithUncertaintyCircle,
    ellipsoidPointWithUncertaintyEllipse        EllipsoidPointWithUncertaintyEllipse,
    polygon                                     Polygon,
    ellipsoidPointWithAltitude                  EllipsoidPointWithAltitude,
    ellipsoidPointWithAltitudeAndUncertaintyEllipsoid
                                                EllipsoidPointWithAltitudeAndUncertaintyEllipsoid,
    ellipsoidArc                                EllipsoidArc,
    ...,
    highAccuracyEllipsoidPointWithUncertaintyEllipse-v1510
                                HighAccuracyEllipsoidPointWithUncertaintyEllipse-r15,
    highAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-v1510
                                HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-r15
}

Velocity ::= CHOICE {
    horizontalVelocity                          HorizontalVelocity,
    horizontalWithVerticalVelocity              HorizontalWithVerticalVelocity,
    horizontalVelocityWithUncertainty           HorizontalVelocityWithUncertainty,
    horizontalWithVerticalVelocityAndUncertainty
                                                HorizontalWithVerticalVelocityAndUncertainty,
    ...
}

LocationError ::= SEQUENCE {
    locationfailurecause            LocationFailureCause,
    ...
}

LocationFailureCause ::= ENUMERATED {
    undefined,
    requestedMethodNotSupported,
    positionMethodFailure,
    periodicLocationMeasurementsNotAvailable,
    ...
}

EarlyFixReport-r12 ::= ENUMERATED {
    noMoreMessages,
    moreMessagesOnTheWay
}

LocationSource-r13 ::= BIT STRING { a-gnss              (0),
                                    wlan                (1),
                                    bt                  (2),
                                    tbs                 (3),
                                    sensor              (4),
                                    ha-gnss-v1510       (5) } (SIZE(1..16))

-- ASN1STOP
```

Conditional presence	Explanation
Segmentation	This field is optionally present, need OP, if *lpp-message-segmentation-req* has been received from the location server with bit 1 (*targetToServer*) set to value 1. The field shall be omitted if *lpp-message-segmentation-req* has not been received in this location session, or has been received with bit 1 (*targetToServer*) set to value 0.

***CommonIEsProvideLocationInformation* field descriptions**
locationEstimate This field provides a location estimate using one of the geographic shapes defined in 3GPP TS 23.032 [15]. Coding of the values of the various fields internal to each geographic shape follow the rules in TS 23.032 [15]. The conditions for including this field are defined for the *locationInformationType* field in a Request Location Information message.
velocityEstimate This field provides a velocity estimate using one of the velocity shapes defined in 3GPP TS 23.032 [15]. Coding of the values of the various fields internal to each velocity shape follow the rules in TS 23.032 [15].
locationError This field shall be included if and only if a location estimate and measurements are not included in the LPP PDU. The field includes information concerning the reason for the lack of location information. The *LocationFailureCause* '*periodicLocationMeasurementsNotAvailable*' shall be used by the target device if periodic location reporting was requested, but no measurements or location estimate are available when *the reportingInterval* expired.
earlyFixReport This field shall be included if and only if the *ProvideLocationInformation* message contains early location measurements or an early location estimate. The target device shall set the values of this field as follows: - noMoreMessages: This is the only or last *ProvideLocationInformation* message used to deliver the entire set of early location information. - moreMessagesOnTheWay: This is one of multiple *ProvideLocationInformation* messages used to deliver the entire set of early location information (if early location information will not fit into a single message). If this field is included, the IE *SegmentationInfo* shall not be included.
locationSource This field provides the source positioning technology for the location estimate. NOTE: In this version of the specification, the entry 'tbs' is used only for TBS positioning based on MBS signals.
locationTimestamp This field provides the UTC time when the location estimate is valid and should take the form of *YYMMDDhhmmssZ*.
segmentationInfo This field indicates whether this *ProvideLocationInformation* message is one of many segments, as specified in sub-clause 4.3.5

– *CommonIEsAbort*

The *CommonIEsAbort* carries common IEs for an Abort LPP message Type.

```
-- ASN1START

CommonIEsAbort ::= SEQUENCE {
    abortCause          ENUMERATED {
        undefined,
        stopPeriodicReporting,
        targetDeviceAbort,
        networkAbort,
        ...,
        stopPeriodicAssistanceDataDelivery-v1510
    }
}

-- ASN1STOP
```

***CommonIEsAbort* field descriptions**
abortCause This IE defines the request to abort an ongoing procedure. The abort cause '*stopPeriodicReporting*' should be used by the location server to stop any ongoing location reporting configured as *periodicalReporting* or *triggeredReporting* in the *CommonIEsRequestLocationInformation*. The abort cause '*stopPeriodicAssistanceDataDelivery*' should be used by the location server or target device to stop any ongoing periodic assistance data delivery, as specified in sub-clauses 5.2.1a and 5.2.2a.

– *CommonIEsError*

The *CommonIEsError* carries common IEs for an Error LPP message Type.

```
-- ASN1START

CommonIEsError ::= SEQUENCE {
    errorCause      ENUMERATED {
        undefined,
        lppMessageHeaderError,
        lppMessageBodyError,
        epduError,
        incorrectDataValue,
        ...,
        lppSegmentationError-v1450
    }
}

-- ASN1STOP
```

***CommonIEsError* field descriptions**
errorCause
This IE defines the cause for an error. '*lppMessageHeaderError*', '*lppMessageBodyError*' and '*epduError*' is used if a receiver is able to detect a coding error in the LPP header (i.e., in the common fields), LPP message body or in an EPDU, respectively. '*lppSegmentationError*' is used if a receiver detects an error in LPP message segmentation.

6.5 Positioning Method IEs

6.5.1 OTDOA Positioning

This subclause defines the information elements for downlink OTDOA positioning, which includes TBS positioning based on PRS signals (TS 36.305 [2]).

6.5.1.1 OTDOA Assistance Data

– *OTDOA-ProvideAssistanceData*

The IE *OTDOA-ProvideAssistanceData* is used by the location server to provide assistance data to enable UE-assisted downlink OTDOA. It may also be used to provide OTDOA positioning specific error reason.

Throughout clause 6.5.1, "assistance data reference cell" refers to the cell defined by the IE *OTDOA-ReferenceCellInfo* and "NB-IoT assistance data reference cell" refers to the cell defined by the IE *OTDOA-ReferenceCellInfoNB* (see clause 6.5.1.2). "RSTD reference cell" applies only in clause 6.5.1.5.

If both IEs, *OTDOA-ReferenceCellInfo* and *OTDOA-ReferenceCellInfoNB* are included in *OTDOA-ProvideAssistanceData*, the assistance data reference cell and NB-IoT assistance data reference cell correspond to the same cell, and the target device may assume that PRS and NPRS antenna ports are quasi co-located, as defined in TS 36.211 [16].

Throughout clause 6.5.1, the term "cell" refers to "transmission point (TP)", unless distinguished in the field description.

NOTE 1: The location server should include at least one cell for which the SFN can be obtained by the target device, e.g. the serving cell, in the assistance data, either as the assistance data reference cell or in the neighbour cell list. Otherwise the target device will be unable to perform the OTDOA measurement and the positioning operation will fail.

NOTE 2: Due to support of cells containing multiple TPs and PRS-only TPs not associated with cells, the term "cell" as used in clause 6.5.1 may not always correspond to a cell for the E-UTRAN.

NOTE 3: For NB-IoT access, due to support of NPRS on multiple carriers, the term "cell" as used in clause 6.5.1 refers to the anchor carrier, unless otherwise stated.

```
-- ASN1START

OTDOA-ProvideAssistanceData ::= SEQUENCE {
    otdoa-ReferenceCellInfo         OTDOA-ReferenceCellInfo             OPTIONAL,   -- Need ON
    otdoa-NeighbourCellInfo         OTDOA-NeighbourCellInfoList         OPTIONAL,   -- Need ON
    otdoa-Error                     OTDOA-Error                         OPTIONAL,   -- Need ON
    ...,
    [[
     otdoa-ReferenceCellInfoNB-r14  OTDOA-ReferenceCellInfoNB-r14       OPTIONAL,   -- Need ON
     otdoa-NeighbourCellInfoNB-r14  OTDOA-NeighbourCellInfoListNB-r14   OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

6.5.1.2 OTDOA Assistance Data Elements

– *OTDOA-ReferenceCellInfo*

The IE *OTDOA-ReferenceCellInfo* is used by the location server to provide assistance data reference cell information for OTDOA assistance data. The slot number offsets and expected RSTDs in *OTDOA-NeighbourCellInfoList* are provided relative to the cell defined by this IE. If *earfcnRef* of this assistance data reference cell is different from that of the serving cell, the LPP layer shall inform lower layers to start performing inter-frequency RSTD measurements with this cell and provide to lower layers the information about this assistance data reference cell, e.g. EARFCN and PRS positioning occasion information.

NOTE: The location server should always include the PRS configuration of the assistance data reference and neighbour cells. Otherwise the UE may not meet the accuracy requirements as defined in TS 36.133 [18].

```
-- ASN1START

OTDOA-ReferenceCellInfo ::= SEQUENCE {
    physCellId                  INTEGER (0..503),
    cellGlobalId                ECGI                            OPTIONAL,       -- Need ON
    earfcnRef                   ARFCN-ValueEUTRA                OPTIONAL,       -- Cond NotSameAsServ0
    antennaPortConfig           ENUMERATED {ports1-or-2, ports4, ... }
                                                                OPTIONAL,       -- Cond NotSameAsServ1
    cpLength                    ENUMERATED { normal, extended, ... },
    prsInfo                     PRS-Info                        OPTIONAL,       -- Cond PRS
    ...,
    [[ earfcnRef-v9a0           ARFCN-ValueEUTRA-v9a0           OPTIONAL        -- Cond NotSameAsServ2
    ]],
    [[  tpId-r14                INTEGER (0..4095)               OPTIONAL,       -- Need ON
        cpLengthCRS-r14         ENUMERATED { normal, extended, ... }
                                                                OPTIONAL,       -- Cond CRS
        sameMBSFNconfigRef-r14  BOOLEAN                         OPTIONAL,       -- Need ON
        dlBandwidth-r14         ENUMERATED {n6, n15, n25, n50, n75, n100}
                                                                OPTIONAL,       -- Cond NotSameAsServ3
        addPRSconfigRef-r14     SEQUENCE (SIZE (1..maxAddPRSconfig-r14)) OF PRS-Info
                                                                OPTIONAL        -- Need ON
    ]],
    [[
        nr-LTE-SFN-Offset-r15   INTEGER (0..1023)               OPTIONAL        -- Cond NR
    ]],
    [[
        tdd-config-v1520                    TDD-Config-v1520    OPTIONAL,       -- Need ON
        nr-LTE-fineTiming-Offset-r15        INTEGER (0..19)     OPTIONAL        -- Cond FineOffset
    ]]
}

maxAddPRSconfig-r14         INTEGER ::= 2

-- ASN1STOP
```

Conditional presence	Explanation
NotSameAsServ0	This field is absent if *earfcnRef-v9a0* is present. Otherwise, the field is mandatory present if the EARFCN of the OTDOA assistance data reference cell is not the same as the EARFCN of the target devices' current primary cell.
NotSameAsServ1	The field is mandatory present if the antenna port configuration of the OTDOA assistance data reference cell is not the same as the antenna port configuration of the target devices' current primary cell.
NotSameAsServ2	The field is absent if *earfcnRef* is present. Otherwise, the field is mandatory present if the EARFCN of the OTDOA assistance data reference cell is not the same as the EARFCN of the target devices' current primary cell.
PRS	The field is mandatory present if positioning reference signals are available in the assistance data reference cell (TS 36.211 [16]); otherwise it is not present.
CRS	The field is optionally present, need ON, if *prsInfo* is present. Otherwise it is not present.
NotSameAsServ3	The field is mandatory present if the downlink bandwidth configuration of the assistance data reference cell is not the same as the downlink bandwidth configuration of the target devices' current primary cell and if PRS frequency hopping is used in the assistance data reference cell (TS 36.211 [16]); otherwise it is not present.
NR	The field is optionally present, need ON, if the target device is served by an NR cell; otherwise it is not present.
FineOffset	The field is optionally present, need ON, if *nr-LTE-SFN-Offset* is present. Otherwise it is not present.

***OTDOA-ReferenceCellInfo* field descriptions**
physCellId This field specifies the physical cell identity of the assistance data reference cell, as defined in TS 36.331 [12].
cellGlobalId This field specifies the ECGI, the globally unique identity of a cell in E-UTRA, of the assistance data reference cell, as defined in TS 36.331 [12]. The server should include this field if it considers that it is needed to resolve ambiguity in the cell indicated by *physCellId*.
earfcnRef This field specifies the EARFCN of the assistance data reference cell.
antennaPortConfig This field specifies whether 1 (or 2) antenna port(s) or 4 antenna ports for cell specific reference signals (CRS) are used in the assistance data reference cell.
cpLength This field specifies the cyclic prefix length of the assistance data reference cell PRS if the *prsInfo* field is present, otherwise this field specifies the cyclic prefix length of the assistance data reference cell CRS.
prsInfo This field specifies the first PRS configuration of the assistance data reference cell.

***OTDOA-ReferenceCellInfo* field descriptions**
tpId
This field specifies an identity of the transmission point. This field together with the *physCellId* and/or *prsID* may be used to identify the transmission point in case the same physical cell ID is shared by multiple transmission points.
cpLengthCRS
This field specifies the cyclic prefix length of the assistance data reference cell CRS. If this field is present, the target device may assume the CRS and PRS antenna ports of the assistance data reference cell are quasi co-located (as defined in TS 36.211 [16]).
sameMBSFNconfigRef
This field indicates whether the MBSFN subframe configuration of the assistance data reference cell is the same as the current primary cell of the target device. TRUE means the same, and FALSE means not the same.
dlBandwidth
This field specifies the downlink bandwidth configuration of the assistance data reference cell, N_{RB} in downlink, see TS 36.101 [21, table 5.6-1]. Enumerated value n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on.
addPRSconfigRef
This field specifies the additional (second and possibly third) PRS configuration(s) of the assistance data reference cell.
nr-LTE-SFN-Offset
This field specifies the SFN offset between the serving NR cell and the assistance data reference cell. The offset corresponds to the number of full radio frames counted from the beginning of a radio frame #0 of the NR serving cell to the beginning of the closest subsequent radio frame #0 of the assistance data reference cell.
tdd-config
This field specifies the TDD specific physical channel configuration of the assistance data reference cell. The field should be present if the assistance data reference cell is a TDD cell and if the TDD UL/DL configuration of the assistance data reference cell is not the same as the target devices' current primary cell or if the target devices' current primary cell is a FDD cell.
nr-LTE-fineTiming-Offset
This field specifies the frame boundary offset between the NR serving cell and the LTE assistance data reference cell in units of 0.5 ms. The offset is counted from the beginning of a subframe #0 of the NR serving cell to the beginning of the closest subsequent subframe #0 of the LTE assistance data reference cell, rounded down to multiples of 0.5 ms. Value 0 corresponds to 0ms, value 1 corresponds to 0.5ms, 2 to 1ms and so on.

– *PRS-Info*

The IE *PRS-Info* provides the information related to the configuration of PRS in a cell.

```
-- ASN1START

PRS-Info ::= SEQUENCE {
    prs-Bandwidth           ENUMERATED { n6, n15, n25, n50, n75, n100, ... },
    prs-ConfigurationIndex  INTEGER (0..4095),
    numDL-Frames            ENUMERATED {sf-1, sf-2, sf-4, sf-6, ..., sf-add-v1420},
    ...,
    prs-MutingInfo-r9       CHOICE {
        po2-r9                  BIT STRING (SIZE(2)),
        po4-r9                  BIT STRING (SIZE(4)),
        po8-r9                  BIT STRING (SIZE(8)),
        po16-r9                 BIT STRING (SIZE(16)),
        ...,
        po32-v1420              BIT STRING (SIZE(32)),
        po64-v1420              BIT STRING (SIZE(64)),
        po128-v1420             BIT STRING (SIZE(128)),
        po256-v1420             BIT STRING (SIZE(256)),
        po512-v1420             BIT STRING (SIZE(512)),
        po1024-v1420            BIT STRING (SIZE(1024))
    }                                                   OPTIONAL,               -- Need OP
    [[  prsID-r14               INTEGER (0..4095)       OPTIONAL,               -- Need ON
        add-numDL-Frames-r14    INTEGER (1..160)        OPTIONAL,               -- Cond sf-add
        prsOccGroupLen-r14      ENUMERATED {g2, g4, g8, g16, g32, g64, g128,... }
                                                        OPTIONAL,               -- Cond Occ-Grp
        prsHoppingInfo-r14  CHOICE {
            nb2-r14             INTEGER (0.. maxAvailNarrowBands-Minus1-r14),
            nb4-r14             SEQUENCE (SIZE (3))
                                    OF INTEGER (0.. maxAvailNarrowBands-Minus1-r14)
    }                                                   OPTIONAL                -- Cond PRS-FH
    ]]
}

maxAvailNarrowBands-Minus1-r14      INTEGER ::= 15  -- Maximum number of narrowbands minus 1

-- ASN1STOP
```

Conditional presence	Explanation
sf-add	The field is mandatory present if the *numDL-Frames* field has the value '*sf-add*'; otherwise it is not present.
Occ-Grp	The field is mandatory present if a PRS occasion group is configured; otherwise it is not present.
PRS-FH	The field is mandatory present if frequency hopping is used for PRS; otherwise it is not present.

***PRS-Info* field descriptions**
prs-Bandwidth This field specifies the bandwidth that is used to configure the positioning reference signals on. Enumerated values are specified in number of resource blocks (n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on) and define 1.4, 3, 5, 10, 15 and 20 MHz bandwidth.
prs-ConfigurationIndex This field specfies the positioning reference signals configuration index I_{PRS} as defined in TS 36.211 [16].
numDL-Frames This field specifies the number of consecutive downlink subframes N_{PRS} with positioning reference signals, as defined in TS 36.211 [16]. Enumerated values define 1, 2, 4, or 6 consecutive downlink subframes. The value *sf-add* indicates that N_{PRS} is provided in the field *add-numDL-Frames.*
prs-MutingInfo This field specifies the PRS muting configuration of the cell. The PRS muting configuration is defined by a periodic PRS muting sequence with periodicity T_{REP} where T_{REP}, counted in the number of PRS occasion groups (TS 36.133 [18]), can be 2, 4, 8, 16, 32, 64, 128, 256, 512, or 1024 which is also the length of the selected bit string that represents this PRS muting sequence. If a bit in the PRS muting sequence is set to "0", then the PRS is muted in all the PRS occasions in the corresponding PRS occasion group. A PRS occasion group comprises one or more PRS occasions as indicated by *prsOccGroupLen*. Each PRS occasion comprises N_{PRS} downlink positioning subframes as defined in TS 36.211 [16]. The first bit of the PRS muting sequence corresponds to the first PRS occasion group that starts after the beginning of the assistance data reference cell SFN=0. The sequence is valid for all subframes after the target device has received the *prs-MutingInfo*. If this field is not present the target device may assume that the PRS muting is not in use for the cell. When the SFN of the assistance data reference cell is not known to the UE and *prs-MutingInfo* is provided for a cell in the *OTDOA-NeighbourCellInfoList* IE, the UE may assume no PRS is transmitted by that cell. When the UE receives a T_{REP}-bit muting pattern together with a PRS periodicity T_{PRS} for the same cell which exceeds 10240 subframes (i.e., $T_{REP} \times T_{PRS} > 10240$ subframes), the UE shall assume an n-bit muting pattern based on the first n-bits, where $n = 10240/T_{PRS}$.
prsID This field specifies the PRS-ID as defined in TS 36.211 [16].
add-numDL-Frames This field specifies the number of consecutive downlink subframes N_{PRS} with positioning reference signals, as defined in TS 36.211 [16]. Integer values define 1, 2, 3, …, 160 consecutive downlink subframes.
prsOccGroupLen This field specifies the PRS occasion group length, defined as the number of consecutive PRS occasions comprising a PRS occasion group. Each PRS occasion of the PRS occasion group consists of *numDL-Frames* or *add-numDL-Frames* consecutive downlink subframes with positioning reference signals. Enumerated values define 2, 4, 8, 16, 32, 64 or 128 consecutive PRS occasions. If omitted, the PRS occasion group length is 1. The product of the PRS periodicity T_PRS from the prs-ConfigurationIndex and the PRS occasion group length cannot exceed 1280.
prsHoppingInfo This field specifies the PRS frequency hopping configuration (TS 36.211 [16]). The choice nb2 indicates hopping between 2 narrowbands; the choice nb4 indicates hopping between 4 narrowbands. The first PRS positioning occasion of the first PRS occasion group that starts after the beginning of SFN=0 of the assistance data reference cell is located at the centre of the system bandwidth. The frequency band of each subsequent PRS occasion is indicated by nb2 or nb4, respectively, which defines the narrowband index n_{NB} as specified in TS 36.211 [16]. If this field is absent, no PRS frequency hopping is used.

– *TDD-Config*

The IE *TDD-Config* is used to specify the TDD specific physical channel configuration.

```
-- ASN1START
```

```
TDD-Config-v1520 ::= SEQUENCE {
    subframeAssignment-v1520            ENUMERATED { sa0, sa1, sa2, sa3, sa4, sa5, sa6 },
    ...
}

-- ASN1STOP
```

***TDD-Config* field descriptions**
subframeAssignment
This field specifies the TDD UL/DL subframe configuration where *sa0* points to Configuration 0, *sa1* to Configuration 1 etc. as specified in TS 36.211 [16], table 4.2-2. The target device assumes the same value for all assistance data cells residing on same frequency band.

– *OTDOA-NeighbourCellInfoList*

The IE *OTDOA-NeighbourCellInfoList* is used by the location server to provide neighbour cell information for OTDOA assistance data. If the target device is not capable of supporting additional neighbour cells (as indicated by the absence of the IE *additionalNeighbourCellInfoList* in *OTDOA-ProvideCapabilities*), the set of cells in the *OTDOA-NeighbourCellInfoList* is grouped per frequency layer and in the decreasing order of priority for measurement to be performed by the target device, with the first cell in the list being the highest priority for measurement and with the same *earfcn* not appearing in more than one instance of *OTDOA-NeighbourFreqInfo*.

If the target device is capable of supporting additional neighbour cells (as indicated by the presence of the IE *additionalNeighbourCellInfoList* in *OTDOA-ProvideCapabilities*), the list may contain all cells (up to 3x24 cells) belonging to the same frequency layer or cells from different frequency layers with the first cell in the list still being the highest priority for measurement.

The prioritization of the cells in the list is left to server implementation. The target device should provide the available measurements in the same order as provided by the server.

If inter-frequency neighbour cells are included in *OTDOA-NeighbourCellInfoList*, where an inter-frequency is a E-UTRA frequency which is different from the E-UTRA serving cell frequency, the LPP layer shall inform lower layers to start performing inter-frequency RSTD measurements for these neighbour cells and also provide to lower layers the information about these neighbour cells, e.g. EARFCN and PRS positioning occasion information.

```
-- ASN1START

OTDOA-NeighbourCellInfoList ::= SEQUENCE (SIZE (1..maxFreqLayers)) OF OTDOA-NeighbourFreqInfo
OTDOA-NeighbourFreqInfo ::= SEQUENCE (SIZE (1..24)) OF OTDOA-NeighbourCellInfoElement

OTDOA-NeighbourCellInfoElement ::= SEQUENCE {
    physCellId                          INTEGER (0..503),
    cellGlobalId                        ECGI                OPTIONAL,       -- Need ON
    earfcn                              ARFCN-ValueEUTRA    OPTIONAL,       -- Cond NotSameAsRef0
    cpLength                            ENUMERATED {normal, extended, ...}
                                                            OPTIONAL,       -- Cond NotSameAsRef1
    prsInfo                             PRS-Info            OPTIONAL,       -- Cond NotSameAsRef2
    antennaPortConfig                   ENUMERATED {ports-1-or-2, ports-4, ...}
                                                            OPTIONAL,       -- Cond NotsameAsRef3
    slotNumberOffset                    INTEGER (0..19)     OPTIONAL,       -- Cond NotSameAsRef4
    prs-SubframeOffset                  INTEGER (0..1279)   OPTIONAL,       -- Cond InterFreq
    expectedRSTD                        INTEGER (0..16383),
    expectedRSTD-Uncertainty            INTEGER (0..1023),
    ...,
    [[ earfcn-v9a0                  ARFCN-ValueEUTRA-v9a0   OPTIONAL        -- Cond NotSameAsRef5
    ]],
    [[  tpId-r14                    INTEGER (0..4095)       OPTIONAL,       -- Need ON
        prs-only-tp-r14             ENUMERATED { true }     OPTIONAL,       -- Cond TBS
        cpLengthCRS-r14             ENUMERATED { normal, extended, ... }
                                                            OPTIONAL,       -- Cond CRS
        sameMBSFNconfigNeighbour-r14    BOOLEAN             OPTIONAL,       -- Need ON
        dlBandwidth-r14             ENUMERATED {n6, n15, n25, n50, n75, n100}
                                                            OPTIONAL,       -- Cond NotSameAsRef6
        addPRSconfigNeighbour-r14   SEQUENCE (SIZE (1..maxAddPRSconfig-r14)) OF
                                        Add-PRSconfigNeighbourElement-r14
                                                            OPTIONAL        -- Need ON
    ]],
    [[
        tdd-config-v1520            TDD-Config-v1520        OPTIONAL        -- Need ON
```

```
    ]]
}

Add-PRSconfigNeighbourElement-r14 ::= SEQUENCE {
    add-prsInfo-r14                 PRS-Info                OPTIONAL,       -- Cond NotSameAsRef7
    ...
}

maxFreqLayers   INTEGER ::= 3

-- ASN1STOP
```

Conditional presence	Explanation
NotsameAsRef0	The field is absent if *earfcn-v9a0* is present. If earfcn-v9a0 is not present, the field is mandatory present if the EARFCN is not the same as for the assistance data reference cell; otherwise it is not present.
NotsameAsRef1	The field is mandatory present if the cyclic prefix length is not the same as for the assistance data reference cell; otherwise it is not present.
NotsameAsRef2	The field is mandatory present if the first PRS configuration is not the same as for the assistance data reference cell; otherwise it is not present.
NotsameAsRef3	The field is mandatory present if the antenna port configuration is not the same as for the assistance data reference cell; otherwise it is not present.
NotsameAsRef4	The field is mandatory present if the slot timing is not the same as for the assistance data reference cell; otherwise it is not present.
NotSameAsRef5	The field is absent if *earfcn* is present. If *earfcn* is not present, the field is mandatory present if the EARFCN is not the same as for the assistance data reference cell; otherwise it is not present.
InterFreq	The field is optionally present, need OP, if the EARFCN is not the same as for the assistance data reference cell; otherwise it is not present.
TBS	The field is mandatory present if the *OTDOA-NeighbourCellInfoElement* is provided for a PRS-only TP; otherwise it is not present.
CRS	The field is optionally present, need ON, if *prsInfo* is present. Otherwise it is not present.
NotSameAsRef6	The field is mandatory present if PRS frequency hopping is used on this neighbour cell (TS 36.211 [16]) and if the downlink bandwidth configuration is not the same as for the assistance data reference cell; otherwise it is not present.
NotSameAsRef7	The field is mandatory present if any instance of the additional PRS configurations of *addPRSconfigNeighbour* is not the same as the corresponding instance of the additional PRS configuration of the *addPRSconfigRef* for the assistance data reference cell; otherwise it is not present.

***OTDOA-NeighbourCellInfoList* field descriptions**
physCellId
This field specifies the physical cell identity of the neighbour cell, as defined in TS 36.331 [12].
cellGlobalId
This field specifies the ECGI, the globally unique identity of a cell in E-UTRA, of the neighbour cell, as defined in TS 36.331 [12]. The server should provide this field if it considers that it is needed to resolve any ambiguity in the cell identified by *physCellId*.
earfcn
This field specifies the EARFCN of the neighbour cell.
cpLength
This field specifies the cyclic prefix length of the neigbour cell PRS if PRS are present in this neighbour cell, otherwise this field specifies the cyclic prefix length of CRS in this neighbour cell.
prsInfo
This field specifies the first PRS configuration of the neighbour cell. When the EARFCN of the neighbour cell is the same as for the assistance data reference cell, the target device may assume that each PRS positioning occasion in the neighbour cell at least partially overlaps with a PRS positioning occasion in the assistance data reference cell where the maximum offset between the transmitted PRS positioning occasions may be assumed to not exceed half a subframe. When the EARFCN of the neighbour cell is the same as for the assistance data reference cell, the target may assume that this cell has the same PRS periodicity (T_{PRS}) as the assistance data reference cell.
antennaPortConfig
This field specifies whether 1 (or 2) antenna port(s) or 4 antenna ports for cell specific reference signals are used.

***OTDOA-NeighbourCellInfoList* field descriptions**
slotNumberOffset This field specifies the slot number offset at the transmitter between this cell and the assistance data reference cell. The *slotNumberOffset* together with the current slot number of the assistance data reference cell may be used to calculate the current slot number of this cell which may further be used to generate the CRS sequence by the target device. The offset corresponds to the number of full slots counted from the beginning of a radio frame of the assistance data reference cell to the beginning of the closest subsequent radio frame of this cell. If this field is absent, the slot timing is the same as for the assistance data reference cell.
prs-SubframeOffset This field specifies the offset between the first PRS subframe of the first PRS occasion group of the first PRS configuration in the assistance data reference cell on the reference carrier frequency layer and the first PRS subframe in the closest subsequent PRS occasion group of the PRS configuration with the longest PRS occasion group periodicity (NOTE 1) of this cell on the other carrier frequency layer. The value is given in number of full sub-frames. If the EARFCN is not the same as for the assistance data reference cell and the field is not present but PRS are available on this cell, the receiver shall consider the PRS subframe offset for this cell to be 0.
expectedRSTD If PRS is transmitted: This field indicates the RSTD value that the target device is expected to measure between this cell and the assistance data reference cell. The *expectedRSTD* field takes into account the expected propagation time difference as well as transmit time difference of PRS positioning occasions between the two cells. The RSTD value can be negative and is calculated as (*expectedRSTD*-8192). The resolution is $3\times T_s$, with T_s=1/(15000*2048) seconds. If PRS is not transmitted: This field indicates the RSTD value that the target device is expected to measure between this cell and the assistance data reference cell. The expectedRSTD field takes into account the expected propagation time difference as well as transmit time difference between the two cells. The RSTD value can be negative and is calculated as (expectedRSTD-8192). The resolution is $3´T_s$, with T_s=1/(15000*2048) seconds.
expectedRSTD-Uncertainty If PRS is transmitted: This field indicates the uncertainty in *expectedRSTD* value*.* The uncertainty is related to the location server's a-priori estimation of the target device location. The *expectedRSTD* and *expectedRSTD-Uncertainty* together define the search window for the target device. The scale factor of the *expectedRSTD-Uncertainty* field is $3\times T_s$, with T_s=1/(15000*2048) seconds. The target device may assume that the beginning of the PRS occasion group of the PRS configuration with the longest PRS occasion group periodicity (NOTE) of the neighbour cell is received within the search window of size [$-$ *expectedRSTD-Uncertainty*$\times 3\times T_s$*, expectedRSTD-Uncertainty*$\times 3\times T_s$] centered at T_{REF} + 1 millisecond$\times$N + (*expectedRSTD*$-$8192) $\times 3\times T_s$, where T_{REF} is the reception time of the beginning of the first PRS occasion group of the first PRS configuration of the assistance data reference cell at the target device antenna connector, N = 0 when the EARFCN of the neighbour cell is equal to that of the assistance data reference cell, and N = *prs-SubframeOffset* otherwise. If PRS is not transmitted: This field indicates the uncertainty in *expectedRSTD* value*.* The uncertainty is related to the location server's a-priori estimation of the target device location. The *expectedRSTD* and *expectedRSTD-Uncertainty* together define the search window for the target device. The scale factor of the *expectedRSTD-Uncertainty* field is $3\times T_s$, with T_s=1/(15000*2048) seconds. If T_x is the reception time of the beginning of the subframe X of the assistance data reference cell at the target device antenna connector, the target device may assume that the beginning of the closest subframe of this neighbour cell to subframe X is received within the search window of size [$-$ *expectedRSTD-Uncertainty*$\times 3\times T_s$*, expectedRSTD-Uncertainty*$\times 3\times T_s$] centered at T_x + (*expectedRSTD*$-$8192) $\times 3\times T_s$,
tpId This field specifies an identity of the transmission point. This field together with the *physCellId* and/or *prsID* may be used to identify the transmission point in case the same physical cell ID is shared by multiple transmission points.
prs-only-tp This field, if present, indicates that the *OTDOA-NeighbourCellInfoElement* is provided for a PRS-only TP. For the purpose of RSTD measurements from a PRS-only TP, the target device shall not assume any other signals or physical channels are present other than PRS (TS 36.213 [28]). For the purpose of RSTD measurements from a PRS-only TP, the target device shall use the *physCellId* only for PRS generation, and only if no PRS-ID is provided for this TP.

***OTDOA-NeighbourCellInfoList* field descriptions**
cpLengthCRS This field specifies the cyclic prefix length of this assistance data neighbour cell CRS. If this field is present, the target device may assume the CRS and PRS antenna ports of this assistance data neighbour cell are quasi co-located (as defined in TS 36.211 [16]).
sameMBSFNconfigNeighbour This field indicates whether the MBSFN subframe configuration of the neighbour cell is the same as the current primary cell of the target device. TRUE means the same, and FALSE means not the same.
dlBandwidth This field specifies the downlink bandwidth configuration of the neighbour cell, N_{RB} in downlink, see TS 36.101 [21, table 5.6-1]. Enumerated value n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on.
addPRSconfigNeighbour This field specifies the additional (second and possibly third) PRS configuration(s) of the neighbour cell. When the EARFCN of the neighbour cell is the same as for the assistance data reference cell, the target device may assume that each PRS positioning occasion in each instance of *addPRSconfigNeighbour* in the neighbour cell at least partially overlaps with a PRS positioning occasion of the same instance of *addPRSconfigRef* in the assistance data reference cell where the maximum offset between the transmitted PRS positioning occasions may be assumed to not exceed half a subframe. When the EARFCN of the neighbour cell is the same as for the assistance data reference cell, the target may assume that each instance of *addPRSconfigNeighbour* of this cell has the same PRS periodicity (T_{PRS}) as the corresponding instance of *addPRSconfigRef* of the assistance data reference cell.
tdd-config This field specifies the TDD specific physical channel configuration of the neighbour cell *earfcn*. The field should be present if this neighbour cell is a TDD cell and if the TDD UL/DL configuration for assistance data cells on this *earfcn* has not been provided in any other instance of *OTDOA-NeighbourCellInfoElement* or in IE *OTDOA-ReferenceCellInfo*, and is not the same as the target device's current primary cell when this is a TDD cell. NOTE 2.

NOTE 1: If this cell has more than one PRS configuration with equal longest PRS occasion group periodicity (i.e., PRS occasion group length times T_{PRS}), the first such configuration is referenced. In order to avoid ambiguity for frequency hopping, a PRS occasion group should contain at least 2 PRS occasions with hopping between 2 narrowbands and at least 4 PRS occasions with hopping between 4 narrowbands.

NOTE 2: The target device assumes the same TDD UL/DL configuration for all TDD cells residing on same frequency band specified by *earfcn*. Therefore, the location server should include the field *tdd-config* only once for assistance data cells with the same *earfcn* in IE *OTDOA-ProvideAssistanceData*. The location server does not need to include the field *tdd-config* for any assistance data cell in IE *OTDOA-ProvideAssistanceData* with the same *earfcn* or the same TDD UL/DL configuration as the target devices′ current primary cell if this is a TDD cell.

– *OTDOA-ReferenceCellInfoNB*

The IE *OTDOA-ReferenceCellInfoNB* is used by the location server to provide NB-IoT assistance data reference cell information for OTDOA assistance data.

```
-- ASN1START

OTDOA-ReferenceCellInfoNB-r14 ::= SEQUENCE {
    physCellIdNB-r14                INTEGER (0..503)            OPTIONAL,   -- Cond NoPRS-AD1
    cellGlobalIdNB-r14              ECGI                        OPTIONAL,   -- Cond NoPRS-AD2
    carrierFreqRef-r14              CarrierFreq-NB-r14          OPTIONAL,   -- Cond NotSameAsServ1
    earfcn-r14                      ARFCN-ValueEUTRA-r14        OPTIONAL,   -- Cond Inband
    eutra-NumCRS-Ports-r14          ENUMERATED {ports1-or-2, ports4}
                                                                OPTIONAL,   -- Cond NoPRS-AD3
    otdoa-SIB1-NB-repetitions-r14   ENUMERATED { r4, r8, r16 }  OPTIONAL,   -- Cond NotSameAsServ2
    nprsInfo-r14                    PRS-Info-NB-r14             OPTIONAL,   -- Cond NPRS-Type1
    ...,
    [[
    nprsInfo-Type2-v1470            PRS-Info-NB-r14             OPTIONAL    -- Cond NPRS-Type2
    ]],
    [[  tdd-config-r15              TDD-Config-v1520            OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
NoPRS-AD1	This field is mandatory present if the *OTDOA-ReferenceCellInfo* IE is not included in *OTDOA-ProvideAssistanceData,* or if the *OTDOA-ReferenceCellInfo* IE is included in *OTDOA-ProvideAssistanceData* and the narrowband physical layer cell identity is not the same as the physical cell identity provided in *OTDOA-ReferenceCellInfo* IE. Otherwise it is not present.
NoPRS-AD2	This field is optionally present, need ON, if the *OTDOA-ReferenceCellInfo* IE is not included in *OTDOA-ProvideAssistanceData,* or if the *OTDOA-ReferenceCellInfo* IE is included in *OTDOA-ProvideAssistanceData* and the global cell identity is not the same as provided in *OTDOA-ReferenceCellInfo* IE.
NotSameAsServ1	This field is mandatory present if the carrier frequency of the NB-IoT assistance data reference cell is not the same as the carrier frequency of the target devices' current serving NB-IoT cell. Otherwise it is not present.
Inband	This field is mandatory present, if the NPRS is configured within the LTE spectrum allocation (inband deployment). Otherwise it is not present.
NoPRS-AD3	This field is mandatory present if the *OTDOA-ReferenceCellInfo* IE is not included in *OTDOA-ProvideAssistanceData* and if the NB-IoT assistance data reference cell is deployed within the LTE spectrum allocation (inband deployment). Otherwise it is not present.
NotSameAsServ2	This field is mandatory present, if NPRS configuration Part B only is configured on the NB-IoT assistance data reference cell, and if the repetition number of SIB1-NB of the NB-IoT assistance data reference cell is not the same as the repetition number of SIB1-NB of the target devices' current serving NB-IoT cell. Otherwise it is not present.
NPRS-Type1	The field is mandatory present if Type 1 narrowband positioning reference signals are available in the assistance data reference cell (TS 36.211 [16]); otherwise it is not present.
NPRS-Type2	The field is mandatory present if Type 2 narrowband positioning reference signals are available in the assistance data reference cell (TS 36.211 [16]); otherwise it is not present.

***OTDOA-ReferenceCellInfoNB* field descriptions**
physCellIdNB
This field specifies the narrowband physical layer cell identity of the NB-IoT assistance data reference cell, as defined in TS 36.331 [12]. If this field is absent and if the *OTDOA-ReferenceCellInfo* IE is included in *OTDOA-ProvideAssistanceData* the narrowband physical layer cell identity is the same as the *physCellId* provided in *OTDOA-ReferenceCellInfo* IE.
cellGlobalIdNB
This field specifies the global cell identity of the NB-IoT assistance data reference cell, as defined in TS 36.331 [12]. If this field is absent and if the *OTDOA-ReferenceCellInfo* IE with *cellGlobalId* is included in *OTDOA-ProvideAssistanceData,* the global cell identity is the same as provided in *OTDOA-ReferenceCellInfo* IE.
carrierFreqRef
This field specifies the carrier frequency of the NB-IoT assistance data reference cell.
earfcn
This field specifies the EARFCN of the E-UTRAN frequency, in which the NB-IoT cell is deployed.
eutra-NumCRS-Ports
This field specifies whether 1 (or 2) antenna port(s) or 4 antenna ports for cell specific reference signals (CRS) are used in the NB-IoT assistance data reference cell. If this field is absent and if the *OTDOA-ReferenceCellInfo* IE is included in *OTDOA-ProvideAssistanceData*, the number of CRS antenna ports is the same as provided in *OTDOA-ReferenceCellInfo* IE.
otdoa-SIB1-NB-repetitions
This field specifies the repetition number of SIB1-NB of the NB-IoT assistance data reference cell. Enumerated values r4 correspond to 4 repetions, r8 to 8 repetitions, and r16 to 16 repetions. Note, when NPRS configuration Part B only is configured on the NB-IoT assistance data reference cell (i.e., anchor carrier), *nprs-NumSF* does also count/include subframes containing NPSS, NSSS, NPBCH, or SIB1-NB, but the UE can assume that no NPRS are transmitted in these subframes (TS 36.211 [16]).

***OTDOA-ReferenceCellInfoNB* field descriptions**
nprsInfo This field specifies the Type 1 NPRS (TS 36.211 [16]) configuration of the NB-IoT assistance data reference cell. When the target device receives this field with *operationModeInfoNPRS* set to value *'standalone'*, the target device shall assume no NPRS are transmitted on that NB-IoT carrier.
nprsInfo-Type2 This field specifies the Type 2 NPRS (TS 36.211 [16]) configuration of the NB-IoT assistance data reference cell.
tdd-config Indicates the TDD specific physical channel configuration of the NB-IoT assistance data reference cell operating in TDD mode. This field should be present if the DL/UL subframe configuration of the NB-IoT assistance data reference cell is not the same as the DL/UL subframe configuration of the current serving NB-IoT cell of the target device, or if the current serving NB-IoT cell of the target device operates in FDD mode.

– *PRS-Info-NB*

The IE *PRS-Info-NB* provides the information related to the configuration of NPRS in a cell. If *PRS-Info-NB* includes configurations for multiple NPRS carrier frequencies, the target device may assume the antenna ports for the NPRS carrier are quasi co-located, as defined in TS 36.211 [16].

```
-- ASN1START

PRS-Info-NB-r14 ::= SEQUENCE (SIZE (1..maxCarrier-r14)) OF NPRS-Info-r14

NPRS-Info-r14 ::= SEQUENCE {
    operationModeInfoNPRS-r14   ENUMERATED { inband, standalone },
    nprs-carrier-r14            CarrierFreq-NB-r14  OPTIONAL,   -- Cond Standalone/Guardband
    nprsSequenceInfo-r14        INTEGER (0..174)    OPTIONAL,   -- Cond Inband
    nprsID-r14                  INTEGER (0..4095)   OPTIONAL,   -- Cond NPRS-ID
    partA-r14                   SEQUENCE {
        nprsBitmap-r14          CHOICE {
            subframePattern10-r14   BIT STRING (SIZE (10)),
            subframePattern40-r14   BIT STRING (SIZE (40))
        },
        nprs-MutingInfoA-r14    CHOICE {
            po2-r14                 BIT STRING (SIZE(2)),
            po4-r14                 BIT STRING (SIZE(4)),
            po8-r14                 BIT STRING (SIZE(8)),
            po16-r14                BIT STRING (SIZE(16)),
            ...
        }                                                       OPTIONAL,       -- Cond MutingA
        ...
    }                                                           OPTIONAL,       -- Cond PartA
    partB-r14                   SEQUENCE {
        nprs-Period-r14         ENUMERATED { ms160, ms320, ms640, ms1280, ... , ms2560-v1510},
        nprs-startSF-r14        ENUMERATED { zero, one-eighth, two-eighths, three-eighths,
                                             four-eighths, five-eighths, six-eighths,
                                             seven-eighths, ...},
        nprs-NumSF-r14          ENUMERATED { sf10, sf20, sf40, sf80, sf160, sf320,
                                             sf640, sf1280, ... , sf2560-v1510},
        nprs-MutingInfoB-r14    CHOICE {
            po2-r14                 BIT STRING (SIZE(2)),
            po4-r14                 BIT STRING (SIZE(4)),
            po8-r14                 BIT STRING (SIZE(8)),
            po16-r14                BIT STRING (SIZE(16)),
            ...
        }                                                       OPTIONAL,       -- Cond MutingB
        ...,
    [[  sib1-SF-TDD-r15         ENUMERATED {sf0, sf4, sf0and5}      OPTIONAL        -- Cond SIB1-TDD
    ]]
    }                                                           OPTIONAL,       -- Cond PartB
    ...,
    [[
    partA-TDD-r15                   SEQUENCE {
        nprsBitmap-r15          CHOICE {
            subframePattern10-TDD-r15   BIT STRING (SIZE (8)),
            subframePattern40-TDD-r15   BIT STRING (SIZE (32)),
            ...
        },
        nprs-MutingInfoA-r15    CHOICE {
            po2-r15                 BIT STRING (SIZE(2)),
            po4-r15                 BIT STRING (SIZE(4)),
            po8-r15                 BIT STRING (SIZE(8)),
```

```
            po16-r15                BIT STRING (SIZE(16)),
            ...
        }                                                           OPTIONAL,   -- Cond MutingA
        ...
    }                                                               OPTIONAL    -- Cond PartA-TDD
    ]]
}

maxCarrier-r14  INTEGER ::= 5

-- ASN1STOP
```

Conditional presence	Explanation
Standalone/Guardband	This field is mandatory present, if the NPRS is configured in standalone or guardband operation mode. Otherwise it is not present.
Inband	This field is mandatory present, if the NPRS is configured within the LTE spectrum allocation (inband deployment) and the LTE carrier frequency is not provided in the assistance data. Otherwise it is not present.
NPRS-ID	The field is mandatory present, if the NPRS is generated based on the NPRS-ID (TS 36.211 [16]), different from the PCI. Otherwise the field is not present.
MutingA	The field is mandatory present, if muting is used for the NPRS Part A or Part A TDD configuration. Otherwise the field is not present.
PartA	The field is mandatory present, if NPRS is configured based on a bitmap of subframes which are not NB-IoT DL subframes (i.e., invalid DL subframes) (Part A configuration). Otherwise the field is not present. This field is not applicable for NB-IoT operating in TDD mode.
MutingB	The field is mandatory present, if muting is used for the NPRS Part B configuration. Otherwise the field is not present.
PartB	The field is mandatory present, if NPRS is configured based on a NPRS period, a NPRS subframe offset, and a number of consecutive NPRS downlink subframes per positioning occasion (Part B configuration). Otherwise the field is not present. If NPRS configuration Part A and Part B are both configured, then a subframe contains NPRS if both configurations indicate that it contains NPRS.
PartA-TDD	The field is mandatory present, if NPRS is configured for NB-IoT operating in TDD mode and if NPRS is configured based on a bitmap of subframes which are not NB-IoT DL subframes (i.e., invalid DL subframes) (Part A TDD configuration). Otherwise the field is not present.
SIB1-TDD	The field is mandatory present, if NPRS is configured for NB-IoT operating in TDD mode and if SIB1-NB is transmitted on this carrier frequency. Otherwise the field is not present.

***PRS-Info-NB* field descriptions**
operationModeInfoNPRS This field specifies the operation mode of the NPRS carrier. The value 'standalone' indicates standalone or guardband operation mode.
nprs-carrier This field specifies the NB-IoT carrier frequency for the NPRS.
nprsSequenceInfo This field specifies the index of the PRB containing the NPRS as defined in the table *nprsSequenceInfo* to E-UTRA PRB index relation below.
nprsID This field specifies the NPRS-ID as defined in TS 36.211 [16].
sib1-SF-TDD This field indicates the subframe(s) used to transmit SIB1-NB. Values *sf0* and *sf4* correspond with subframe #0 and #4 respectively. Value *sf0and5* corresponds with subframes #0 and #5.
subframePattern10, subframePattern40 This field specifies the NPRS subframe Part A configuration over 10ms or 40ms. Subframes not containing NPRS are indicated with value '0' in the bitmap; subframes containing NPRS are indicated with value '1' in the bitmap. The first/leftmost bit corresponds to the subframe #0 of the radio frame satisfying SFN mod x = 0, where x is the size of the bit string divided by 10.

***PRS-Info-NB* field descriptions**
nprs-MutingInfoA This field specifies the NPRS muting configuration of the NB-IoT carrier Part A configuration. The NPRS muting configuration is defined by a periodic NPRS muting sequence with periodicity T_{REP} where T_{REP}, counted in the number of NPRS positioning occasions, can be 2, 4, 8, or 16 which is also the length of the selected bit string that represents this NPRS muting sequence. If a bit in the NPRS muting sequence is set to '0', then the NPRS is muted in the corresponding NPRS positioning occasion. A NPRS positioning occasion for Part A comprises one radio frame (i.e., 10 subframes). The first/leftmost bit of the NPRS muting sequence corresponds to the first NPRS positioning occasion that starts after the beginning of the NB-IoT assistance data reference cell SFN=0. The sequence is valid for all subframes after the target device has received the *nprs-MutingInfoA*. When the SFN of the NB-IoT assistance data reference cell is not known to the target device and *nprs-MutingInfoA* is provided for a cell in the *OTDOA-NeighbourCellInfoListNB* IE, the target device may assume no NPRS is transmitted by that cell.
nprs-Period This field specifies the NPRS occasion period T_{NPRS} (TS 36.211 [16]). Enumerated values correspond to 160ms, 320ms, 640ms, 1280ms, and 2560ms. The value *ms2560* is only applicable to TDD mode.
nprs-startSF This field specifies the subframe offset α_{NPRS} (TS 36.211 [16]). Enumerated values correspond to α of 0, 1/8, 2/8, 3/8, 4/8, 5/8, 6/8, or 7/8.
nprs-NumSF This field specifies the number of consecutive downlink subframes N_{NPRS} in one NPRS positioning occasion (TS 36.211 [16]). Enumerated values correspond to 10, 20, 40, 80, 160, 320, 640, 1280, and 2560 subframes. The values *sf10* and *sf20* are only applicable to FDD mode. The value *sf2560* is only applicable to TDD mode. When the target device receives a *nprs-NumSF* which exceeds the *nprs-Period* (i.e., $N_{NPRS} > T_{NPRS}$), the target device may assume no NPRS is transmitted by that cell.
nprs-MutingInfoB This field specifies the NPRS muting configuration of the NB-IoT carrier Part B configuration. The NPRS muting configuration is defined by a periodic NPRS muting sequence with periodicity T_{REP} where T_{REP}, counted in the number of NPRS positioning occasions, can be 2, 4, 8, or 16 which is also the length of the selected bit string that represents this NPRS muting sequence. If a bit in the NPRS muting sequence is set to '0', then the NPRS is muted in the corresponding NPRS positioning occasion. A NPRS positioning occasion for Part B comprises N_{NPRS} consecutive downlink positioning subframes, where N_{NPRS} is given by the *nprs-NumSF* field. The first/leftmost bit of the NPRS muting sequence corresponds to the first NPRS positioning occasion that starts after the beginning of the NB-IoT assistance data reference cell SFN=0. The sequence is valid for all subframes after the target device has received the *nprs-MutingInfoB*. When the SFN of the NB-IoT assistance data reference cell is not known to the UE and *nprs-MutingInfoB* is provided for a cell in the *OTDOA-NeighbourCellInfoListNB* IE, the target device may assume no NPRS is transmitted by that cell. When the UE receives a T_{REP}-bit muting pattern together with a NPRS periodicity T_{NPRS} for the same carrier which exceeds 10240 subframes (i.e., $T_{REP} \times T_{NPRS} > 10240$ subframes), the target device shall assume an n-bit muting pattern based on the first n bits, where $n = 10240/T_{NPRS}$.
subframePattern10-TDD, subframePattern40-TDD This field specifies the NPRS subframe Part A configuration for TDD over 10ms or 40ms. The UE shall assume that subframe number 1 and 2 are not used for NPRS. The MSB of the NPRS bitmap corresponds to subframe 0, the second MSB corresponds to subframe 3, the third MSB corresponds to subframe 4 and so on, as also shown in Figure NPRS bitmap to subframe number mapping below.

***nprsSequenceInfo* to E-UTRA PRB index relation**

nprsSequenceInfo	**E-UTRA PRB index n'_{PRB} for odd number of $N_{\mathrm{RB}}^{\mathrm{DL}}$ [16]**	***nprsSequenceInfo***	**E-UTRA PRB index n'_{PRB} for even number of $N_{\mathrm{RB}}^{\mathrm{DL}}$ [16]**
0 - 74	-37, -36, …, 37	75 – 174	-50, -49, …, 49

NOTE: Based on the above relation, in inband deployment, the carrier frequency of the NPRS carrier ($f_{\text{NB-IoT}}$) can be calculated as follows:

$$f_{NB\text{-}IoT} = \begin{cases} f_{EUTRA} + 7.5 + 180 \cdot n'_{PRB} & \text{if } nprsSequenceInfo \le 74 \text{ and } n'_{PRB} > 0 \\ f_{EUTRA} - 7.5 + 180 \cdot n'_{PRB} & \text{if } nprsSequenceInfo \le 74 \text{ and } n'_{PRB} < 0 \\ f_{EUTRA} + 180 \cdot n'_{PRB} & \text{if } nprsSequenceInfo \le 74 \text{ and } n'_{PRB} = 0 \\ f_{EUTRA} + 97.5 + 180 \cdot n'_{PRB} & \text{if } nprsSequenceInfo \ge 75 \text{ and } n'_{PRB} \ge 0 \\ f_{EUTRA} - 97.5 + 180 \cdot (n'_{PRB} + 1) & \text{if } nprsSequenceInfo \ge 75 \text{ and } n'_{PRB} < 0 \end{cases}$$

where f_{EUTRA} is derived from *earfcn* according to TS 36.101 [21, 5.7.3].

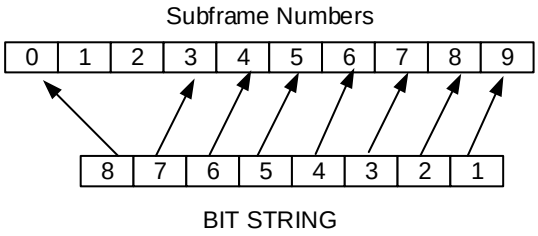

Figure 6.5.1.2-1: NPRS bitmap to subframe number mapping

– *OTDOA-NeighbourCellInfoListNB*

The IE *OTDOA-NeighbourCellInfoListNB* is used by the location server to provide NB-IoT neighbour cell information for OTDOA assistance data.

```
-- ASN1START

OTDOA-NeighbourCellInfoListNB-r14 ::= SEQUENCE (SIZE (1..maxCells-r14)) OF
                                                OTDOA-NeighbourCellInfoNB-r14

OTDOA-NeighbourCellInfoNB-r14 ::= SEQUENCE {
    physCellIdNB-r14                INTEGER (0..503)        OPTIONAL,       -- Cond NoPRS-AD1
    cellGlobalIdNB-r14              ECGI                    OPTIONAL,       -- Cond NoPRS-AD2
    carrierFreq-r14                 CarrierFreq-NB-r14      OPTIONAL,       -- Cond NotSameAsRef1
    earfcn-r14                      ARFCN-ValueEUTRA-r14    OPTIONAL,       -- Cond Inband
    eutra-NumCRS-Ports-r14          ENUMERATED {ports-1-or-2, ports-4, ...}
                                                            OPTIONAL,       -- Cond NotsameAsRef2
    otdoa-SIB1-NB-repetitions-r14   ENUMERATED { r4, r8, r16 }
                                                            OPTIONAL,       -- Cond NotSameAsRef3
    nprsInfo-r14                    PRS-Info-NB-r14         OPTIONAL,       -- Cond NotsameAsRef4
    nprs-slotNumberOffset-r14       INTEGER (0..19)         OPTIONAL,       -- Cond NotsameAsRef5
    nprs-SFN-Offset-r14             INTEGER (0..63)         OPTIONAL,       -- Cond NotsameAsRef6
    nprs-SubframeOffset-r14         INTEGER (0..1279)       OPTIONAL,       -- Need OP
    expectedRSTD-r14                INTEGER (0..16383)      OPTIONAL,       -- Cond NoPRS-AD3
    expectedRSTD-Uncertainty-r14    INTEGER (0..1023)       OPTIONAL,       -- Cond NoPRS-AD3
    prsNeighbourCellIndex-r14       INTEGER (1..72)         OPTIONAL,       -- Cond PRS-AD
    ...,
    [[
    nprsInfo-Type2-v1470            PRS-Info-NB-r14         OPTIONAL        -- Cond NotSameAsRef4
    ]],
    [[  tdd-config-r15              TDD-Config-v1520        OPTIONAL        -- Need ON
    ]]
}

maxCells-r14    INTEGER ::= 72

-- ASN1STOP
```

Conditional presence	Explanation
NoPRS-AD1	This field is mandatory present if the *OTDOA-NeighbourCellInfoList* IE is not included in *OTDOA-ProvideAssistanceData,* or if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData* and the narrowband physical layer cell identity of this cell is not the same as the physical cell identity of the corresponding cell (as indicated by *prsNeighbourCellIndex*) in *OTDOA-NeighbourCellInfoList* IE.
NoPRS-AD2	This field is optionally present, need ON, if the *OTDOA-NeighbourCellInfoList* IE is not included in *OTDOA-ProvideAssistanceData,* or if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData* and the global cell identity of this cell is not the same as for the corresponding cell (as indicated by *prsNeighbourCellIndex*) in *OTDOA-NeighbourCellInfoList* IE.
Inband	This field is mandatory present, if the NPRS is configured within the LTE spectrum allocation (inband deployment). Otherwise it is not present.
NotSameAsRef1	The field is mandatory present if the carrier frequency is not the same as for the NB-IoT assistance data reference cell; otherwise it is not present.
NotSameAsRef2	The field is mandatory present if this cell is deployed within the LTE spectrum allocation (inband deployment) and if the number of E-UTRA CRS antenna ports is not the same as for the NB-IoT assistance data reference cell; otherwise it is not present.
NotSameAsRef3	This field is mandatory present if NPRS configuration Part B only is configured on this neighbour cell, and if the repetition number of SIB1-NB of this neighbor cell is not the same as the repetition number of SIB1-NB of the NB-IoT assistance data reference cell. Otherwise it is not present.
NotSameAsRef4	The field is mandatory present, if the NPRS configuration is not the same as for the NB-IoT assistance data reference cell; otherwise it is not present.
NotSameAsRef5	The field is mandatory present if the slot timing is not the same as for the NB-IoT assistance data reference cell; otherwise it is not present.
NotSameAsRef6	The field is mandatory present if the frame timing is not the same as for the NB-IoT assistance data reference cell; otherwise it is not present.
NoPRS-AD3	This field is mandatory present if the *OTDOA-NeighbourCellInfoList* IE is not included in *OTDOA-ProvideAssistanceData,* or if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData* and *prsNeighbourCellIndex* is absent for this cell.
PRS-AD	This field is optionally present, need OP, if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData*; otherwise it is not present.

***OTDOA-NeighbourCellInfoListNB* field descriptions**
physCellIdNB
This field specifies the narrowband physical cell identity of the NB-IoT neighbour cell, as defined in TS 36.331 [12]. If this field is absent and if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData* the narrowband physical layer cell identity is the same as the *physCellId* provided for the corresponding cell (as indicated by *prsNeighbourCellIndex*) in *OTDOA-NeighbourCellInfoList* IE.
cellGlobalIdNB
This field specifies the global cell ID of the NB-IoT neighbour cell, as defined in TS 36.331 [12]. If this field is absent and if the *OTDOA-NeighbourCellInfoList* IE with *cellGlobalId* is included in *OTDOA-ProvideAssistanceData,* the global cell identity of the NB-IoT neighbour cell is the same as provided for the corresponding cell (as indicated by *prsNeighbourCellIndex*) in *OTDOA-NeighbourCellInfoList* IE.
carrierFreq
This field specifies the carrier frequency of the NB-IoT neighbour cell.
earfcn
This field specifies the EARFCN of the E-UTRAN frequency, in which the NB-IoT cell is deployed.
eutra-NumCRS-Ports
This field specifies whether 1 (or 2) antenna port(s) or 4 antenna ports for cell specific reference signals are used.
otdoa-SIB1-NB-repetitions
This field specifies the repetition number of SIB1-NB of the neighbour cell. Enumerated values r4 correspond to 4 repetions, r8 to 8 repetitions, and r16 to 16 repetions. Note, when NPRS configuration Part B only is configured on this NB-IoT neighbour cell (i.e., anchor carrier), *nprs-NumSF* does also count/include subframes containing NPSS, NSSS, NPBCH, or SIB1-NB, but the UE can assume that no NPRS are transmitted in these subframes (TS 36.211 [16]).

***OTDOA-NeighbourCellInfoListNB* field descriptions**
nprsInfo This field specifies the Type 1 NPRS (TS 36.211 [16]) configuration of the NB-IoT neighbour cell. When the carrier frequency of the NB-IoT neighbour cell is the same as for the NB-IoT assistance data reference cell, the target device may assume that each NPRS positioning occasion for each NPRS carrier frequency in the neighbour cell at least partially overlaps with a NPRS positioning occasion for each NPRS carrier frequency in the NB-IoT assistance data reference cell where the maximum offset between the transmitted NPRS positioning occasions may be assumed to not exceed half a subframe. When the carrier frequency of the neighbour cell is the same as for the NB-IoT assistance data reference cell, and NPRS configuration Part B is configured, the target may assume that this cell has the same NPRS periodicity (T_{NPRS}) as the assistance data reference cell for each NPRS carrier frequency. When the target device receives this field with *operationModeInfoNPRS* set to value *'standalone'*, the target device shall assume no NPRS are transmitted on that NB-IoT carrier.
nprs-slotNumberOffset This field specifies the slot number offset at the transmitter between this cell and the NB-IoT assistance data reference cell. The offset corresponds to the number of full slots counted from the beginning of a radio frame of the NB-IoT assistance data reference cell to the beginning of the closest subsequent radio frame of this cell. If this field is absent, the slot timing is the same as for the NB-IoT assistance data reference cell.
nprs-SFN-Offset This field specifies the SFN offset (modulo 64) at the transmitter between this cell and the NB-IoT assistance data reference cell. The offset corresponds to the number of full radio frames counted from the beginning of a radio frame #0 of the NB-IoT assistance data reference cell to the beginning of the closest subsequent radio frame #0 of this cell. The UE may use this field together with the *nprs-slotNumberOffset* and *otdoa-SIB1-NB-repetitions* to determine the SIB1-NB subframes of this neighbour cell.
nprs-SubframeOffset This field specifies the offset between the first NPRS subframe in the NB-IoT assistance data reference cell (NOTE 1) and the first NPRS subframe in the closest subsequent NPRS positioning occasion of the NPRS carrier with the longest NPRS periodicity of this cell (NOTE 2). The value is given in number of full sub-frames. If this field is not present, the receiver shall consider the NPRS subframe offset to be 0.
expectedRSTD This field indicates the RSTD value that the target device is expected to measure between this cell and the NB-IoT assistance data reference cell. The *expectedRSTD* field takes into account the expected propagation time difference as well as transmit time difference of NPRS positioning occasions between the two cells. The RSTD value can be negative and is calculated as (*expectedRSTD*-8192). The resolution is $3\times T_s$, with T_s=1/(15000*2048) seconds. If this field is absent and if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData*, the expected RSTD is the same as provided in *OTDOA-NeighbourCellInfoList* IE for the corresponding cell (as indicated by *prsNeighbourCellIndex*).
expectedRSTD-Uncertainty This field indicates the uncertainty in *expectedRSTD* value***.*** The uncertainty is related to the location server's a-priori estimation of the target device location. The *expectedRSTD* and *expectedRSTD-Uncertainty* together define the search window for the target device. The scale factor of the *expectedRSTD-Uncertainty* field is $3\times T_s$, with T_s=1/(15000*2048) seconds. If this field is absent and if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData*, the expected RSTD uncertainty is the same as provided in *OTDOA-NeighbourCellInfoList* IE for the corresponding cell (as indicated by *prsNeighbourCellIndex*). The target device may assume that the beginning of the NPRS positioning occasion of the NPRS carrier with the longest NPRS periodicity of the neighbour cell (NOTE 2) is received within the search window of size [–*expectedRSTD-Uncertainty*$\times 3\times T_s$, *expectedRSTD-Uncertainty*$\times 3\times T_s$] centered at T_{REF} + 1 millisecond$\times$N + (*expectedRSTD*–8192) $\times 3\times T_s$, where T_{REF} is the reception time of the beginning of the NPRS positioning occasion of the NB-IoT assistance data reference cell (NOTE 1) at the target device antenna connector, and N = *nprs-SubframeOffset*.

***OTDOA-NeighbourCellInfoListNB* field descriptions**
prsNeighbourCellIndex This field contains an index of the entry in IE *OTDOA-NeighbourCellInfoList*. Value 1 corresponds to the first cell in *OTDOA-NeighbourCellInfoList,* value 2 to the second, and so on. If this field is absent, and if the *OTDOA-NeighbourCellInfoList* IE is included in *OTDOA-ProvideAssistanceData,* it means there is no corresponding cell in *OTDOA-NeighbourCellInfoList* IE for this cell. The target device may assume the antenna ports of the PRS of the cell indicated by *prsNeighbourCellIndex* and the NPRS of this cell are quasi co-located, as defined in TS 36.211 [16].
nprsInfo-Type2 This field specifies the Type 2 NPRS (TS 36.211 [16]) configuration of the NB-IoT neighbour cell.
tdd-config Indicates the TDD specific physical channel configuration of the NB-IoT assistance data neighbour cell operating in TDD mode. This field should be present if the DL/UL subframe configuration of the NB-IoT assistance data neighbour cell is not the same as for the NB-IoT assistance data reference cell, or if the current serving NB-IoT cell of the target device operates in FDD mode.

NOTE 1: If the NB-IoT assistance data reference cell (i.e., anchor carrier) has no NPRS configured, the first NPRS carrier in *PRS-Info-NB* is referenced.

NOTE 2: "Cell" in this context may not necessarily be the anchor carrier. If this "cell" has more than one NPRS carrier with equal longest periodicity, the first such NPRS carrier in *PRS-Info-NB* is referenced. The length of a NPRS positioning occasion for Part A in this context is the length of the *nprsBitmap* bit string.

6.5.1.3 OTDOA Assistance Data Request

– *OTDOA-RequestAssistanceData*

The IE *OTDOA-RequestAssistanceData* is used by the target device to request assistance data from a location server.

```
-- ASN1START

OTDOA-RequestAssistanceData ::= SEQUENCE {
    physCellId          INTEGER (0..503),
    ...,
    [[
     adType-r14         BIT STRING { prs (0), nprs (1) } (SIZE (1..8))      OPTIONAL
    ]],
    [[
        nrPhysCellId-r15    INTEGER (0..1007)                                   OPTIONAL
    ]]
}

-- ASN1STOP
```

***OTDOA-RequestAssistanceData* field descriptions**
physCellId This field specifies the E-UTRA physical cell identity of the current primary cell of the target device.
adType This field specifies the assistance data requested. This is represented by a bit string, with a one-value at the bit position means the particular assistance data is requested; a zero-value means not requested. Bit 0 indicates that PRS assistance data are requested, bit 1 indicates that NPRS assistance data are requested.
nrPhysCellId This field specifies the NR physical cell identity of the current primary cell of the target device. If this field is present, the target device sets the *physCellId* to an arbitrary value which shall be ignored by the location server.

6.5.1.4 OTDOA Location Information

– *OTDOA-ProvideLocationInformation*

The IE *OTDOA-ProvideLocationInformation* is used by the target device to provide OTDOA location measurements to the location server. It may also be used to provide OTDOA positioning specific error reason.

```
-- ASN1START
```

```
OTDOA-ProvideLocationInformation ::= SEQUENCE {
    otdoaSignalMeasurementInformation   OTDOA-SignalMeasurementInformation  OPTIONAL,
    otdoa-Error                         OTDOA-Error                         OPTIONAL,
    ...,
    [[
        otdoaSignalMeasurementInformation-NB-r14    OTDOA-SignalMeasurementInformation-NB-r14
                                                                            OPTIONAL
    ]]
}

-- ASN1STOP
```

6.5.1.5 OTDOA Location Information Elements

– *OTDOA-SignalMeasurementInformation*

The IE *OTDOA-SignalMeasurementInformation* is used by the target device to provide RSTD measurements to the location server. The RSTD measurements are provided for a neighbour cell and the RSTD reference cell, both of which are provided in the IE *OTDOA-ProvideAssistanceData.* The RSTD reference cell may or may not be the same as the assistance data reference cell provided in *OTDOA-ReferenceCellInfo* or *OTDOA-ReferenceCellInfoNB*. If the target device stops reporting inter-frequency RSTD measurements, where the inter-frequency RSTD measurement is an OTDOA RSTD measurement with at least one cell on a frequency different from the serving cell frequency, the LPP layer shall inform lower layers that inter-frequency RSTD measurements are stopped.

NOTE 1: If there are more than 24 *NeighbourMeasurementElement* to be sent, the target device may send them in multiple *ProvideLocationInformation* messages, as described under sub-clause 5.3.

NOTE 2: If NPRS/PRS antenna ports are quasi co-located, the target device provides a single RSTD measurement for the quasi co-located antenna ports of NPRS/PRS.

```
-- ASN1START

OTDOA-SignalMeasurementInformation ::= SEQUENCE {
    systemFrameNumber       BIT STRING (SIZE (10)),
    physCellIdRef           INTEGER (0..503),
    cellGlobalIdRef         ECGI                    OPTIONAL,
    earfcnRef               ARFCN-ValueEUTRA        OPTIONAL,       -- Cond NotSameAsRef0
    referenceQuality        OTDOA-MeasQuality       OPTIONAL,
    neighbourMeasurementList    NeighbourMeasurementList,
    ...,
    [[ earfcnRef-v9a0       ARFCN-ValueEUTRA-v9a0   OPTIONAL        -- Cond NotSameAsRef1
    ]],
    [[ tpIdRef-r14          INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer0
        prsIdRef-r14        INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer1
        additionalPathsRef-r14
                            AdditionalPathList-r14  OPTIONAL,
        nprsIdRef-r14       INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer2
        carrierFreqOffsetNB-Ref-r14
                            CarrierFreqOffsetNB-r14 OPTIONAL,       -- Cond NB-IoT
        hyperSFN-r14        BIT STRING (SIZE (10))  OPTIONAL        -- Cond H-SFN
    ]],
    [[
        motionTimeSource-r15        MotionTimeSource-r15        OPTIONAL
    ]]
}

NeighbourMeasurementList ::= SEQUENCE (SIZE(1..24)) OF NeighbourMeasurementElement

NeighbourMeasurementElement ::= SEQUENCE {
    physCellIdNeighbour     INTEGER (0..503),
    cellGlobalIdNeighbour   ECGI                    OPTIONAL,
    earfcnNeighbour         ARFCN-ValueEUTRA        OPTIONAL,       -- Cond NotSameAsRef2
    rstd                    INTEGER (0..12711),
    rstd-Quality            OTDOA-MeasQuality,
    ...,
    [[ earfcnNeighbour-v9a0 ARFCN-ValueEUTRA-v9a0   OPTIONAL        -- Cond NotSameAsRef3
    ]],
    [[ tpIdNeighbour-r14    INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer0
        prsIdNeighbour-r14  INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer1
        delta-rstd-r14      INTEGER (0..5)          OPTIONAL,
        additionalPathsNeighbour-r14
                            AdditionalPathList-r14  OPTIONAL,
```

```
        nprsIdNeighbour-r14 INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer2
        carrierFreqOffsetNB-Neighbour-r14
                            CarrierFreqOffsetNB-r14 OPTIONAL        -- Cond NB-IoT
    ]],
    [[
        delta-SFN-r15           INTEGER (-8192..8191)   OPTIONAL
    ]]
}

AdditionalPathList-r14 ::= SEQUENCE (SIZE(1..maxPaths-r14)) OF AdditionalPath-r14

maxPaths-r14    INTEGER ::= 2

MotionTimeSource-r15 ::= SEQUENCE {
    timeSource-r15              ENUMERATED {servingCell, referenceCell, gnss, mixed,
                                            other, none, ...}
}

-- ASN1STOP
```

Conditional presence	Explanation
NotSameAsRef0	The field is absent if the corresponding *earfcnRef-v9a0* is present. Otherwise, the target device shall include this field if the EARFCN of the RSTD reference cell is not the same as the EARFCN of the assistance data reference cell provided in the OTDOA assistance data.
NotSameAsRef1	The field is absent if the corresponding *earfcnRef* is present. Otherwise, the target device shall include this field if the EARFCN of the RSTD reference cell is not the same as the EARFCN of the assistance data reference cell provided in the OTDOA assistance data.
NotSameAsRef2	The field is absent if the corresponding *earfcnNeighbour-v9a0* is present. Otherwise, the target device shall include this field if the EARFCN of this neighbour cell is not the same as the *earfcnRef* for the RSTD reference cell.
NotSameAsRef3	The field is absent if the corresponding *earfcnNeighbour* is present. Otherwise, the target device shall include this field if the EARFCN of this neighbour cell is not the same as the *earfcnRef* for the RSTD reference cell.
ProvidedByServer0	The target device shall include this field if a *tpId* for this transmission point is included in the *OTDOA-ProvideAssistanceData.* Otherwise the field is absent.
ProvidedByServer1	The target device shall include this field if a *prsID* for this transmission point is included in the *OTDOA-ProvideAssistanceData.* Otherwise the field is absent.
ProvidedByServer2	The target device shall include this field if an *nprsID* for this cell is included in the *OTDOA-ProvideAssistanceData* and if this cell is a NB-IoT only cell (without associated LTE PRS cell). Otherwise the field is absent.
NB-IoT	The target device shall include this field if the cell is a NB-IoT only cell (without associated LTE PRS cell). Otherwise the field is absent.
H-SFN	The target device shall include this field if it was able to determine a hyper SFN of the RSTD reference cell.

***OTDOA-SignalMeasurementInformation* field descriptions**
systemFrameNumber If the *deltaSFN* and *motionTimeSource* fields are not present, this field specifies the SFN of the RSTD reference cell containing the starting subframe of the PRS or NPRS positioning occasion if PRS or NPRS are available on the RSTD reference cell, or subframe of the CRS for RSTD measurements if PRS and NPRS are not available on the RSTD reference cell during which the most recent neighbour cell RSTD measurement was performed. In case of more than a single PRS configuration on the RSTD reference cell, the first PRS configuration is referenced. If the *deltaSFN* and *motionTimeSource* fields are present, this field specifies the SFN of the RSTD reference cell when the TOA measurement for the RSTD reference cell has been made.
physCellIdRef This field specifies the physical cell identity of the RSTD reference cell.
cellGlobalIdRef This field specifies the ECGI, the globally unique identity of a cell in E-UTRA, of the RSTD reference cell. The target shall provide this IE if it knows the ECGI of the RSTD reference cell.
earfcnRef This field specifies the EARFCN of the RSTD reference cell.
referenceQuality This field specifies the target device's best estimate of the quality of the TOA measurement from the RSTD reference cell, $T_{SubframeRxRef}$, where $T_{SubframeRxRef}$ is the time of arrival of the signal from the RSTD reference cell. When *deltaSFN* and *motionTimeSource* are both included, the target device shall not include measurement errors caused by motion of the target device in *referenceQuality* (e.g. the target device may assume the target device was stationary during OTDOA measurements).

OTDOA-SignalMeasurementInformation field descriptions
neighbourMeasurementList This list contains the measured RSTD values for neighbour cells together with the RSTD reference cell, along with quality for each measurement.
tpIdRef This field specifies the transmission point ID of the RSTD reference cell.
prsIdRef This field specifies the PRS-ID of the first PRS configuration of the RSTD reference cell.
additionalPathsRef This field specifies one or more additional detected path timing values for the RSTD reference cell, relative to the path timing used for determining the *rstd* value. If this field was requested but is not included, it means the UE did not detect any additional path timing values.
nprsIdRef This field specifies the NPRS-ID of the RSTD reference cell.
carrierFreqOffsetNB-Ref This field specifies the offset of the NB-IoT channel number to EARFCN given by *earfcnRef* as defined in TS 36.101 [21].
hyperSFN This field specifies the hyper SFN as defined in TS 36.331 [12] of the RSTD reference cell for the *systemFrameNumber*.
motionTimeSource This field provides reference information concerning the movement of the target device and comprises the following subfields: - ***timeSource*** specifies the external time source to which UE time was locked during the OTDOA measurements. Enumerated value "mixed" indicates that UE time was locked to more than one external time source during OTDOA measurements (e.g. is applicable to a change in serving cell when the serving cell was used as a time source). The value "other" indicates some other external time source. The value "none" indicates that UE time was not locked to an external time source. If this field is present, the target device shall also provide the IE *Sensor-MotionInformation* in IE *Sensor-ProvideLocationInformation*.
physCellIdNeighbour This field specifies the physical cell identity of the neighbour cell for which the RSTDs are provided.
cellGlobalIdNeighbour This field specifies the ECGI, the globally unique identity of a cell in E-UTRA, of the neighbour cell for which the RSTDs are provided. The target device shall provide this IE if it was able to determine the ECGI of the neighbour cell at the time of measurement.
earfcnNeighbour This field specifies the EARFCN of the neighbour cell used for the RSTD measurements.
rstd This field specifies the relative timing difference between this neighbour cell and the RSTD reference cell, as defined in TS 36.214 [17]. Mapping of the measured quantity is defined as in TS 36.133 [18] subclause 9.1.10.3.
rstd-Quality This field specifies the target device's best estimate of the quality of the measured *rstd*. When *deltaSFN* and *motionTimeSource* both included, the target device shall not include measurement errors caused by motion of the target device in *rstd-Quality* (e.g. the target device may assume the target device was stationary during OTDOA measurements).
tpIdNeighbour This field specifies the transmission point ID for the neighbour cell for which the RSTDs are provided.
prsIdNeighbour This field specifies the PRS-ID of the first PRS configuration of the neighbour cell for which the RSTDs are provided.
delta-rstd This field specifies the higher-resolution RSTD Δ_{RSTD} as defined in TS 36.133 [18] subclause 9.1.10.4. Mapping of the measured quantity is defined as in TS 36.133 [18] subclause 9.1.10.4.

***OTDOA-SignalMeasurementInformation* field descriptions**
additionalPathsNeighbour This field specifies one or more additional detected path timing values for the neighbour cell, relative to the path timing used for determining the *rstd* value. If this field was requested but is not included, it means the UE did not detect any additional path timing values.
nprsIdNeighbour This field specifies the NPRS-ID of the neighbour cell for which the RSTDs are provided.
carrierFreqOffsetNB-Neighbour This field specifies the offset of the NB-IoT channel number to EARFCN given by *earfcnNeighbour* as defined in TS 36.101 [21].
delta-SFN This field provides information concerning the movement of the target device: Together with *systemFrameNumber* specifies the *measurementSFN* of the RSTD reference cell when the TOA measurement for this neighbour cell has been made for determining the *rstd*. The *measurementSFN* is given by *systemFrameNumber* + *delta-SFN*. (The actual SFN is the *measurementSFN* modulo 1024.). The *measurementSFN* is used in IE *Sensor-MotionInformation* to provide movement information corresponding to the TOA measurement time. If this field is present, the target device shall also provide the IE *Sensor-MotionInformation* in IE *Sensor-ProvideLocationInformation*.

– *OTDOA-SignalMeasurementInformation-NB*

The IE *OTDOA-SignalMeasurementInformation-NB* is used by the target device to provide RSTD measurements to the location server. The RSTD measurements are provided for a neighbour cell and the RSTD reference cell, both of which are provided in the IE *OTDOA-ProvideAssistanceData*. The RSTD reference cell may or may not be the same as the assistance data reference cell provided in *OTDOA-ReferenceCellInfo* or *OTDOA-ReferenceCellInfoNB*. If the target device stops reporting inter-frequency RSTD measurements, where the inter-frequency RSTD measurement is an OTDOA RSTD measurement with at least one cell on a frequency different from the serving cell frequency, the LPP layer shall inform lower layers that inter-frequency RSTD measurements are stopped.

NOTE 1: If there are more than 24 *NeighbourMeasurementElement-NB* to be sent, the target device may send them in multiple *ProvideLocationInformation* messages, as described under sub-clause 5.3.

NOTE 2: If NPRS/PRS antenna ports are quasi co-located, the target device provides a single RSTD measurement for the quasi co-located antenna ports of NPRS/PRS.

```
-- ASN1START

OTDOA-SignalMeasurementInformation-NB-r14 ::= SEQUENCE {
    systemFrameNumber-r14           BIT STRING (SIZE (10)),
    physCellIdRef-r14               INTEGER (0..503),
    cellGlobalIdRef-r14             ECGI                    OPTIONAL,
    earfcnRef-r14                   ARFCN-ValueEUTRA-r14    OPTIONAL,   -- Cond NotSameAsRef0
    referenceQuality-r14            OTDOA-MeasQuality       OPTIONAL,
    neighbourMeasurementList-r14    NeighbourMeasurementList-NB-r14,
    tpIdRef-r14                     INTEGER (0..4095)       OPTIONAL,   -- Cond ProvidedByServer0
    prsIdRef-r14                    INTEGER (0..4095)       OPTIONAL,   -- Cond ProvidedByServer1
    additionalPathsRef-r14          AdditionalPathList-r14  OPTIONAL,
    nprsIdRef-r14                   INTEGER (0..4095)       OPTIONAL,   -- Cond ProvidedByServer2
    carrierFreqOffsetNB-Ref-r14     CarrierFreqOffsetNB-r14 OPTIONAL,   -- Cond NB-IoT
    hyperSFN-r14                    BIT STRING (SIZE (10))  OPTIONAL,   -- Cond H-SFN
    ...
}

NeighbourMeasurementList-NB-r14 ::= SEQUENCE (SIZE(1..24)) OF NeighbourMeasurementElement-NB-r14

NeighbourMeasurementElement-NB-r14 ::= SEQUENCE {
    physCellIdNeighbour-r14     INTEGER (0..503),
    cellGlobalIdNeighbour-r14   ECGI                    OPTIONAL,
    earfcnNeighbour-r14         ARFCN-ValueEUTRA-r14    OPTIONAL,       -- Cond NotSameAsRef2
    rstd-r14                    INTEGER (0..12711),
    rstd-Quality-r14            OTDOA-MeasQuality,
    tpIdNeighbour-r14           INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer0
    prsIdNeighbour-r14          INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer1
    delta-rstd-r14              INTEGER (0..5)          OPTIONAL,
    additionalPathsNeighbour-r14
                                AdditionalPathList-r14  OPTIONAL,
    nprsIdNeighbour-r14         INTEGER (0..4095)       OPTIONAL,       -- Cond ProvidedByServer2
    carrierFreqOffsetNB-Neighbour-r14
                                CarrierFreqOffsetNB-r14 OPTIONAL,       -- Cond NB-IoT
```

```
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
NotSameAsRef0	The target device shall include this field if the EARFCN of the RSTD reference cell is not the same as the EARFCN of the assistance data reference cell provided in the OTDOA assistance data.
NotSameAsRef2	The target device shall include this field if the EARFCN of this neighbour cell is not the same as the *earfcnRef* for the RSTD reference cell.
ProvidedByServer0	The target device shall include this field if a *tpId* for this transmission point is included in the *OTDOA-ProvideAssistanceData.* Otherwise the field is absent.
ProvidedByServer1	The target device shall include this field if a *prsID* for this transmission point is included in the *OTDOA-ProvideAssistanceData.* Otherwise the field is absent.
ProvidedByServer2	The target device shall include this field if an *nprsID* for this cell is included in the *OTDOA-ProvideAssistanceData* and if this cell is a NB-IoT only cell (without associated LTE PRS cell). Otherwise the field is absent.
NB-IoT	The target device shall include this field if the cell is a NB-IoT only cell (without associated LTE PRS cell). Otherwise the field is absent.
H-SFN	The target device shall include this field if it was able to determine a hyper SFN of the RSTD reference cell.

***OTDOA-SignalMeasurementInformation-NB* field descriptions**
systemFrameNumber This field specifies the SFN of the RSTD reference cell containing the starting subframe of the PRS or NPRS positioning occasion if PRS or NPRS are available on the RSTD reference cell, or subframe of the CRS for RSTD measurements if PRS and NPRS are not available on the RSTD reference cell during which the most recent neighbour cell RSTD measurement was performed. In case of more than a single PRS configuration on the RSTD reference cell, the first PRS configuration is referenced.
physCellIdRef This field specifies the physical cell identity of the RSTD reference cell.
cellGlobalIdRef This field specifies the ECGI, the globally unique identity of a cell in E-UTRA, of the RSTD reference cell. The target shall provide this IE if it knows the ECGI of the RSTD reference cell.
earfcnRef This field specifies the EARFCN of the RSTD reference cell.
referenceQuality This field specifies the target device's best estimate of the quality of the TOA measurement from the RSTD reference cell, $T_{SubframeRxRef}$, where $T_{SubframeRxRef}$ is the time of arrival of the signal from the RSTD reference cell.
neighbourMeasurementList This list contains the measured RSTD values for neighbour cells together with the RSTD reference cell, along with quality for each measurement.
tpIdRef This field specifies the transmission point ID of the RSTD reference cell.
prsIdRef This field specifies the PRS-ID of the first PRS configuration of the RSTD reference cell.
additionalPathsRef This field specifies one or more additional detected path timing values for the RSTD reference cell, relative to the path timing used for determining the *rstd* value. If this field was requested but is not included, it means the UE did not detect any additional path timing values.
nprsIdRef This field specifies the NPRS-ID of the RSTD reference cell.
carrierFreqOffsetNB-Ref This field specifies the offset of the NB-IoT channel number to EARFCN given by *earfcnRef* as defined in TS 36.101 [21].
hyperSFN This field specifies the hyper SFN as defined in TS 36.331 [12] of the RSTD reference cell for the *systemFrameNumber*.
physCellIdNeighbour This field specifies the physical cell identity of the neighbour cell for which the RSTDs are provided.
cellGlobalIdNeighbour This field specifies the ECGI, the globally unique identity of a cell in E-UTRA, of the neighbour cell for which the RSTDs are provided. The target device shall provide this IE if it was able to determine the ECGI of the neighbour cell at the time of measurement.

***OTDOA-SignalMeasurementInformation-NB* field descriptions**
earfcnNeighbour This field specifies the EARFCN of the neighbour cell used for the RSTD measurements.
rstd This field specifies the relative timing difference between this neighbour cell and the RSTD reference cell, as defined in TS 36.214 [17]. Mapping of the measured quantity is defined as in TS 36.133 [18] subclause 9.1.10.3.
rstd-Quality This field specifies the target device's best estimate of the quality of the measured *rstd*.
tpIdNeighbour This field specifies the transmission point ID for the neighbour cell for which the RSTDs are provided.
prsIdNeighbour This field specifies the PRS-ID of the first PRS configuration of the neighbour cell for which the RSTDs are provided.
delta-rstd This field specifies the higher-resolution RSTD Δ_{RSTD} as defined in TS 36.133 [18] subclause 9.1.10.4. Mapping of the measured quantity is defined as in TS 36.133 [18] subclause 9.1.10.4.
additionalPathsNeighbour This field specifies one or more additional detected path timing values for the neighbour cell, relative to the path timing used for determining the *rstd* value. If this field was requested but is not included, it means the UE did not detect any additional path timing values.
nprsIdNeighbour This field specifies the NPRS-ID of the neighbour cell for which the RSTDs are provided.
carrierFreqOffsetNB-Neighbour This field specifies the offset of the NB-IoT channel number to EARFCN given by *earfcnNeighbour* as defined in TS 36.101 [21].

– *OTDOA-MeasQuality*

```
-- ASN1START

OTDOA-MeasQuality ::= SEQUENCE {
    error-Resolution        BIT STRING (SIZE (2)),
    error-Value             BIT STRING (SIZE (5)),
    error-NumSamples        BIT STRING (SIZE (3))              OPTIONAL,
    ...
}

-- ASN1STOP
```

***OTDOA-MeasQuality* field descriptions**
error-Resolution This field specifies the resolution R used in *error-Value* field. The encoding on two bits is as follows: '00' 5 meters '01' 10 meters '10' 20 meters '11' 30 meters.
error-Value This field specifies the target device's best estimate of the uncertainty of the OTDOA (or TOA) measurement. The encoding on five bits is as follows: '00000' 0 to (R*1-1) meters '00001' R*1 to (R*2-1) meters '00010' R*2 to (R*3-1) meters … '11111' R*31 meters or more; where R is the resolution defined by *error-Resolution* field. E.g., R=20 m corresponds to 0-19 m, 20-39 m,…,620+ m.

***OTDOA-MeasQuality* field descriptions**
error-NumSamples If the *error-Value* field provides the sample uncertainty of the OTDOA (or TOA) measurement, this field specifies how many measurements have been used by the target device to determine this (i.e., sample size). Following 3 bit encoding is used: '000' Not the baseline metric '001' 5-9 '010' 10-14 '011' 15-24 '100' 25-34 '101' 35-44 '110' 45-54 '111' 55 or more. In case of the value '000', the *error-Value* field contains the target device's best estimate of the uncertainty of the OTDOA (or TOA) measurement not based on the baseline metric. E.g., other measurements such as signal-to-noise-ratio or signal strength can be utilized to estimate the *error-Value.* If this field is absent, the value of this field is '000'.

– *AdditionalPath*

The IE *AdditionalPath* is used by the target device to provide information about additional paths in association to the RSTD measurements in the form of a relative time difference and a quality value. The additional path *relativeTimeDifference* is the detected path timing relative to the detected path timing used for the *rstd* value (TS 36.214 [17]), and each additional path can be associated with a quality value *path-Quality*.

```
-- ASN1START

AdditionalPath-r14 ::= SEQUENCE {
    relativeTimeDifference-r14  INTEGER (-256..255),
    path-Quality-r14            OTDOA-MeasQuality               OPTIONAL,
    ...
}

-- ASN1STOP
```

***AdditionalPath* field descriptions**
relativeTimeDifference This field specifies the additional detected path timing relative to the detected path timing used for the *rstd* value in units of 0.5 Ts, with Ts=1/(15000*2048) seconds. A positive value indicates that the particular path is later in time than the detected path used for RSTD; a negative value indicates that the particular path is earlier in time than the detected path used for RSTD.
path-Quality This field specifies the target device's best estimate of the quality of the detected timing of the additional path.

6.5.1.6 OTDOA Location Information Request

– *OTDOA-RequestLocationInformation*

The IE *OTDOA-RequestLocationInformation* is used by the location server to request OTDOA location measurements from a target device. Details of the required measurements (e.g. details of assistance data reference cell and neighbour cells) are conveyed in the *OTDOA-ProvideAssistanceData* IE in a separate Provide Assistance Data message.

```
-- ASN1START

OTDOA-RequestLocationInformation ::= SEQUENCE {
    assistanceAvailability      BOOLEAN,
    ...,
    [[
        multipathRSTD-r14       ENUMERATED { requested }    OPTIONAL,       -- Need ON
        maxNoOfRSTDmeas-r14     INTEGER (1..32)             OPTIONAL        -- Need ON
    ]],
    [[
        motionMeasurements-r15  ENUMERATED { requested }    OPTIONAL        -- Need ON
    ]]
}
```

```
-- ASN1STOP
```

OTDOA-RequestLocationInformation field descriptions
assistanceAvailability This field indicates whether the target device may request additional OTDOA assistance data from the server. TRUE means allowed and FALSE means not allowed.
multipathRSTD This field, if present, indicates that the target device is requested to report additional detected path timing information per RSTD reference and neighbour cell.
maxNoOfRSTDmeas This field, if present, indicates the maximum number of *NeighbourMeasurementElement* fields (i.e., RSTD measurements) the target device can provide in *OTDOA-SignalMeasurementInformation*.
motionMeasurements This field, if present, indicates that the target device is requested to report the motion measurements (*deltaSFN* and *motionTimeSource*) in *OTDOA-SignalMeasurementInformation* as well as the IE *Sensor-MotionInformation* in IE *Sensor-ProvideLocationInformation*.

6.5.1.7 OTDOA Capability Information

– *OTDOA-ProvideCapabilities*

The IE *OTDOA-ProvideCapabilities* is used by the target device to indicate its capability to support OTDOA and to provide its OTDOA positioning capabilities to the location server.

```
-- ASN1START

OTDOA-ProvideCapabilities ::= SEQUENCE {
    otdoa-Mode      BIT STRING {    ue-assisted             (0),
                                    ue-assisted-NB-r14      (1),
                                    ue-assisted-NB-TDD-r15  (2) } (SIZE (1..8)),
    ...,
    supportedBandListEUTRA      SEQUENCE (SIZE (1..maxBands)) OF SupportedBandEUTRA     OPTIONAL,
    supportedBandListEUTRA-v9a0 SEQUENCE (SIZE (1..maxBands)) OF SupportedBandEUTRA-v9a0
                                                                                        OPTIONAL,
    interFreqRSTDmeasurement-r10        ENUMERATED { supported }                        OPTIONAL,
    additionalNeighbourCellInfoList-r10 ENUMERATED { supported }                        OPTIONAL,
    prs-id-r14                          ENUMERATED { supported }                        OPTIONAL,
    tp-separation-via-muting-r14        ENUMERATED { supported }                        OPTIONAL,
    additional-prs-config-r14           ENUMERATED { supported }                        OPTIONAL,
    prs-based-tbs-r14                   ENUMERATED { supported }                        OPTIONAL,
    additionalPathsReport-r14           ENUMERATED { supported }                        OPTIONAL,
    densePrsConfig-r14                  ENUMERATED { supported }                        OPTIONAL,
    maxSupportedPrsBandwidth-r14        ENUMERATED { n6, n15, n25, n50, n75, n100, ...} OPTIONAL,
    prsOccGroup-r14                     ENUMERATED { supported }                        OPTIONAL,
    prsFrequencyHopping-r14             ENUMERATED { supported }                        OPTIONAL,
    maxSupportedPrsConfigs-r14          ENUMERATED { c2, c3 }                           OPTIONAL,
    periodicalReporting-r14             ENUMERATED { supported }                        OPTIONAL,
    multiPrbNprs-r14                    ENUMERATED { supported }                        OPTIONAL,
    idleStateForMeasurements-r14        ENUMERATED { required }                         OPTIONAL,
    numberOfRXantennas-r14              ENUMERATED { rx1, ... }                         OPTIONAL,
    motionMeasurements-r15              ENUMERATED { supported }                        OPTIONAL,
    interRAT-RSTDmeasurement-r15        ENUMERATED { supported }                        OPTIONAL
}

maxBands INTEGER ::= 64

SupportedBandEUTRA ::= SEQUENCE {
    bandEUTRA                           INTEGER (1..maxFBI)
}

SupportedBandEUTRA-v9a0 ::=     SEQUENCE {
    bandEUTRA-v9a0                      INTEGER (maxFBI-Plus1..maxFBI2)     OPTIONAL
}

maxFBI                              INTEGER ::= 64  -- Maximum value of frequency band indicator
maxFBI-Plus1                        INTEGER ::= 65  -- lowest value extended FBI range
maxFBI2                             INTEGER ::= 256 -- highest value extended FBI range

-- ASN1STOP
```

***OTDOA-ProvideCapabilities* field descriptions**
otdoa-Mode This field specifies the OTDOA mode(s) supported by the target device. This is represented by a bit string, with a one value at the bit position means the particular OTDOA mode is supported; a zero value means not supported. A zero-value in all bit positions in the bit string means OTDOA positioning method is not supported by the target device. ue-assisted: Bit 0 indicates that the target device supports UE-assisted OTDOA and LTE PRS. ue-assisted-NB: Bit 1 indicates that the target device supports UE-assisted OTDOA and NB-IoT NPRS. ue-assisted-NB-TDD: Bit 2 indicates that the target device supports UE-assisted OTDOA and NB-IoT NPRS for TDD.
SupportedBandEUTRA This field specifies the frequency bands for which the target device supports RSTD measurements. One entry corresponding to each supported E-UTRA band as defined in TS 36.101 [21]. In case the target device includes *bandEUTRA-v9a0*, the target device shall set the corresponding entry of *bandEUTRA* (i.e. without suffix) to *maxFBI*.
interFreqRSTDmeasurement This field, if present, indicates that the target device supports inter-frequency RSTD measurements within and between the frequency bands indicated in *SupportedBandEUTRA*.
additionalNeighbourCellInfoList This field, if present, indicates that the target device supports up to 3×24 *OTDOA-NeighbourCellInfoElement* in *OTDOA-NeighbourCellInfoList* in *OTDOA-ProvideAssistanceData* without any restriction for the *earfcn* in each *OTDOA-NeighbourCellInfoElement* as specified in subclause 6.5.1.2.
prs-id This field, if present, indicates that the target device supports PRS generation based on the PRS-ID as specified in TS 36.211 [16] and support for TP-ID in *OTDOA-ReferenceCellInfo* and *OTDOA-NeighbourCellInfoList*.
tp-separation-via-muting This field, if present, indicates that the target device supports RSTD measurements for cells which have associated transmission points (e.g., Remote Radio Heads) within the cell coverage and where these associated transmission points have the same physical cell identity as the associated cell, and where these transmission points are identified via a different muting pattern. The field also indicates support for TP-ID in *OTDOA-ReferenceCellInfo* and *OTDOA-NeighbourCellInfoList*.
additional-prs-config This field, if present, indicates that the target device supports additional PRS configurations. The additional PRS configuration in *PRS-Info* IE comprise: - support for *prs-ConfigurationIndex* > 2399; - support for N_{PRS} values in addition to 1, 2, 4 and 6 (*add-numDL-Frames in PRS-Info);* - support for muting bit string lengths > 16 bits.
prs-based-tbs This field, if present, indicates that the target device supports RSTD measurements for PRS-only TPs.
additionalPathsReport This field, if present, indicates that the target device supports reporting of timing information for additional detected paths for RSTD reference and each neighbour cell.
densePrsConfig This field, if present, indicates that the target device supports a subset of the additional PRS configurations associated with capability *additional-prs-config* which comprises: - support for *prs-ConfigurationIndex* > 2404; - support for N_{PRS} values of 10, 20, 40, 80 and 160 (in addition to 1, 2, 4 and 6). In case *additional-prs-config* is present, this field is not present.
maxSupportedPrsBandwidth This field, if present, indicates the maximum PRS bandwidth supported by the target device. Enumerated value n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on. If this field is not present, the target device is assumed to support the PRS bandwidth associated with the target device type, which for LTE devices including Cat-M1/M2 is 100 resource blocks and for NB-IoT devices is 1 resource block.
prsOccGroup This field, if present, indicates that the target device supports PRS occasion groups, which implies that each bit of a configured muting pattern applies per PRS occasion group.
prsFrequencyHopping This field, if present, indicates that the target device supports PRS occasion frequency hopping, as specified in TS 36.211 [16].
maxSupportedPrsConfigs This field, if present, indicates that the target device supports multiple PRS configurations per cell. Enumerated value c2 indicates support for up to 2 configurations; c3 indicates support for up to 3 configurations.
periodicalReporting This field, if present, indicates that the target device supports *periodicalReporting* of RSTD measurements*.* If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonIEsRequestLocationInformation*.
multiPrbNprs This field, if present, indicates that the target device supports NPRS configuration in more than one resource block (i.e., *maxCarrier* in *PRS-Info-NB* greater 1).
idleStateForMeasurements This field, if present, indicates that the target device requires idle state to perform RSTD measurements.

***OTDOA-ProvideCapabilities* field descriptions**
numberOfRXantennas This field is not applicable to NB-IoT devices. This field, if present, indicates the number of UE downlink receive antennas for RSTD measurements (see 3GPP TS 36.133 [18]). Enumerated value rx1 indicates a single antenna receiver. If this field is absent, the target device is assumed to support two RX antennas for RSTD measurements.
motionMeasurements This field, if present, indicates that the target device supports reporting of motion measurements (*deltaSFN* and *motionTimeSource*) in *OTDOA-SignalMeasurementInformation*. The presence of this field implies presence of *sensor-MotionInformationSup* in IE *Sensor-ProvideCapabilities*.
interRAT-RSTDmeasurement This field, if present, indicates that the target device supports inter-RAT RSTD measurements (3GPP TS 38.215 [36]); i.e., E-UTRA RSTD measurements when the target device is served by an NR cell.

6.5.1.8 OTDOA Capability Information Request

– *OTDOA-RequestCapabilities*

The IE *OTDOA-RequestCapabilities* is used by the location server to request the capability of the target device to support OTDOA and to request OTDOA positioning capabilities from a target device.

```
-- ASN1START

OTDOA-RequestCapabilities ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.1.9 OTDOA Error Elements

– *OTDOA-Error*

The IE *OTDOA-Error* is used by the location server or target device to provide OTDOA error reasons to the target device or location server, respectively.

```
-- ASN1START

OTDOA-Error ::= CHOICE {
    locationServerErrorCauses       OTDOA-LocationServerErrorCauses,
    targetDeviceErrorCauses         OTDOA-TargetDeviceErrorCauses,
    ...
}

-- ASN1STOP
```

– *OTDOA-LocationServerErrorCauses*

The IE *OTDOA-LocationServerErrorCauses* is used by the location server to provide OTDOA error reasons to the target device.

```
-- ASN1START

OTDOA-LocationServerErrorCauses ::= SEQUENCE {
    cause       ENUMERATED  {   undefined,
                                assistanceDataNotSupportedByServer,
                                assistanceDataSupportedButCurrentlyNotAvailableByServer,
                                ...
                            },
    ...
}

-- ASN1STOP
```

– *OTDOA-TargetDeviceErrorCauses*

The IE *OTDOA-TargetDeviceErrorCauses* is used by the target device to provide OTDOA error reasons to the location server.

```
-- ASN1START

OTDOA-TargetDeviceErrorCauses ::= SEQUENCE {
    cause       ENUMERATED {    undefined,
                                assistance-data-missing,
                                unableToMeasureReferenceCell,
                                unableToMeasureAnyNeighbourCell,
                                attemptedButUnableToMeasureSomeNeighbourCells,
                                ...
                            },
    ...
}

-- ASN1STOP
```

6.5.2 A-GNSS Positioning

6.5.2.1 GNSS Assistance Data

– *A-GNSS-ProvideAssistanceData*

The IE *A-GNSS-ProvideAssistanceData* is used by the location server to provide assistance data to enable UE-based and UE-assisted A-GNSS. It may also be used to provide GNSS positioning specific error reasons.

```
-- ASN1START

A-GNSS-ProvideAssistanceData ::= SEQUENCE {
    gnss-CommonAssistData           GNSS-CommonAssistData               OPTIONAL,   -- Need ON
    gnss-GenericAssistData          GNSS-GenericAssistData              OPTIONAL,   -- Need ON
    gnss-Error                      A-GNSS-Error                        OPTIONAL,   -- Need ON
    ...,
    [[
        gnss-PeriodicAssistData-r15 GNSS-PeriodicAssistData-r15         OPTIONAL    -- Cond CtrTrans
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
CtrTrans	The field is mandatory present in the control transaction of a periodic assistance data delivery session as described in sub-clause 5.2.1a and 5.2.2a. Otherwise it is not present.

– *GNSS-CommonAssistData*

The IE *GNSS-CommonAssistData* is used by the location server to provide assistance data which can be used for any GNSS (e.g., GPS, Galileo, GLONASS, BDS, etc.).

```
-- ASN1START

GNSS-CommonAssistData ::= SEQUENCE {
    gnss-ReferenceTime              GNSS-ReferenceTime                  OPTIONAL,   -- Need ON
    gnss-ReferenceLocation          GNSS-ReferenceLocation              OPTIONAL,   -- Need ON
    gnss-IonosphericModel           GNSS-IonosphericModel               OPTIONAL,   -- Need ON
    gnss-EarthOrientationParameters GNSS-EarthOrientationParameters     OPTIONAL,   -- Need ON
    ...,
    [[
        gnss-RTK-ReferenceStationInfo-r15
                                    GNSS-RTK-ReferenceStationInfo-r15   OPTIONAL,   -- Need ON
        gnss-RTK-CommonObservationInfo-r15
                                    GNSS-RTK-CommonObservationInfo-r15  OPTIONAL,   -- Cond RTK
        gnss-RTK-AuxiliaryStationData-r15
                                    GNSS-RTK-AuxiliaryStationData-r15   OPTIONAL    -- Need ON
```

```
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
RTK	The field is mandatory present if the IE *GNSS-RTK-Observations* is included in IE *GNSS-GenericAssistData*; otherwise it is not present.

– *GNSS-GenericAssistData*

The IE *GNSS-GenericAssistData* is used by the location server to provide assistance data for a specific GNSS (e.g., GPS, Galileo, GLONASS, BDS, etc.). The specific GNSS for which the provided assistance data are applicable is indicated by the IE *GNSS-ID* and (if applicable) by the IE *SBAS-ID*. Assistance for up to 16 GNSSs can be provided.

```
-- ASN1START

GNSS-GenericAssistData ::= SEQUENCE (SIZE (1..16)) OF GNSS-GenericAssistDataElement

GNSS-GenericAssistDataElement ::= SEQUENCE {
    gnss-ID                         GNSS-ID,
    sbas-ID                         SBAS-ID                         OPTIONAL,   -- Cond GNSS-ID-SBAS
    gnss-TimeModels                 GNSS-TimeModelList              OPTIONAL,   -- Need ON
    gnss-DifferentialCorrections    GNSS-DifferentialCorrections    OPTIONAL,   -- Need ON
    gnss-NavigationModel            GNSS-NavigationModel            OPTIONAL,   -- Need ON
    gnss-RealTimeIntegrity          GNSS-RealTimeIntegrity          OPTIONAL,   -- Need ON
    gnss-DataBitAssistance          GNSS-DataBitAssistance          OPTIONAL,   -- Need ON
    gnss-AcquisitionAssistance      GNSS-AcquisitionAssistance      OPTIONAL,   -- Need ON
    gnss-Almanac                    GNSS-Almanac                    OPTIONAL,   -- Need ON
    gnss-UTC-Model                  GNSS-UTC-Model                  OPTIONAL,   -- Need ON
    gnss-AuxiliaryInformation       GNSS-AuxiliaryInformation       OPTIONAL,   -- Need ON
    ...,
    [[
        bds-DifferentialCorrections-r12
                                    BDS-DifferentialCorrections-r12 OPTIONAL,   -- Cond GNSS-ID-BDS
        bds-GridModel-r12           BDS-GridModelParameter-r12      OPTIONAL    -- Cond GNSS-ID-BDS
    ]],
    [[
        gnss-RTK-Observations-r15   GNSS-RTK-Observations-r15       OPTIONAL,   -- Need ON
        glo-RTK-BiasInformation-r15 GLO-RTK-BiasInformation-r15     OPTIONAL,   -- Cond GNSS-ID-GLO
        gnss-RTK-MAC-CorrectionDifferences-r15
                                    GNSS-RTK-MAC-CorrectionDifferences-r15
                                                                    OPTIONAL,   -- Need ON
        gnss-RTK-Residuals-r15      GNSS-RTK-Residuals-r15          OPTIONAL,   -- Need ON
        gnss-RTK-FKP-Gradients-r15  GNSS-RTK-FKP-Gradients-r15      OPTIONAL,   -- Need ON
        gnss-SSR-OrbitCorrections-r15
                                    GNSS-SSR-OrbitCorrections-r15   OPTIONAL,   -- Need ON
        gnss-SSR-ClockCorrections-r15
                                    GNSS-SSR-ClockCorrections-r15   OPTIONAL,   -- Need ON
        gnss-SSR-CodeBias-r15       GNSS-SSR-CodeBias-r15           OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
GNSS-ID-SBAS	The field is mandatory present if the *GNSS-ID* = *sbas*; otherwise it is not present.
GNSS-ID-BDS	The field may be present if the *GNSS-ID* = *bds*; otherwise it is not present.
GNSS-ID-GLO	The field may be present if the *GNSS ID* = *glonass*; otherwise it is not present.

– *GNSS-PeriodicAssistData*

The IE *GNSS-PeriodicAssistData* is used by the location server to provide control parameters for a periodic assistance data delivery session (e.g., interval and duration) to the target device.

NOTE: Omission of a particular assistance data type field in IE *GNSS-PeriodicAssistData* means that the location server does not provide this assistance data type in a data transaction of a periodic assistance data delivery session, as described in sub-clauses 5.2.1a and 5.2.2a. Inclusion of no assistance data type fields in IE *GNSS-PeriodicAssistData* means that a periodic assistance data delivery session is terminated.

```
-- ASN1START

GNSS-PeriodicAssistData-r15 ::= SEQUENCE {
    gnss-RTK-PeriodicObservations-r15       GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    glo-RTK-PeriodicBiasInformation-r15     GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    gnss-RTK-MAC-PeriodicCorrectionDifferences-r15
                                            GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    gnss-RTK-PeriodicResiduals-r15          GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    gnss-RTK-FKP-PeriodicGradients-r15      GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    gnss-SSR-PeriodicOrbitCorrections-r15
                                            GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    gnss-SSR-PeriodicClockCorrections-r15
                                            GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    gnss-SSR-PeriodicCodeBias-r15           GNSS-PeriodicControlParam-r15   OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

6.5.2.2 GNSS Assistance Data Elements

– *GNSS-ReferenceTime*

The IE *GNSS-ReferenceTime* is used by the location server to provide the GNSS specific system time with uncertainty and the relationship between GNSS system time and network air-interface timing of the eNodeB/NodeB/BTS transmission in the reference cell.

If the IE *networkTime* is present, the IEs *gnss-SystemTime* and *networkTime* provide a valid relationship between GNSS system time and air-interface network time, as seen at the approximate location of the target device, i.e. the propagation delay from the the eNodeB/NodeB/BTS to the target device shall be compensated for by the location server. Depending on implementation, the relation between GNSS system time and air-interface network time may have varying accuracy. The uncertainty of this timing relation is provided in the IE *referenceTimeUnc*. If the propagation delay from the eNodeB/NodeB/BTS to the target device is not accurately known, the location server shall use the best available approximation of the propagation delay and take the corresponding delay uncertainty into account in the calculation of the IE *referenceTimeUnc*.

If the IE *networkTime* is not present, the IE *gnssSystemTime* is an estimate of current GNSS system time at time of reception of the IE *GNSS-ReferenceTime* by the target device. The location server should achieve an accuracy of +/- 3 seconds for this estimate including allowing for the transmission delay between the location server and the target device. Note that the target device should further compensate *gnss-SystemTime* for the time between the reception of *GNSS-ReferenceTime* and the time when the *gnss-SystemTime* is used.

The location server shall provide a value for the *gnss-TimeID* only for GNSSs supported by the target device.

The IE *GNSS-ReferenceTimeForOneCell* can be provided multiple times (up to 16) to provide fine time assistance for several (neighbour) cells.

```
-- ASN1START

GNSS-ReferenceTime ::= SEQUENCE {
    gnss-SystemTime             GNSS-SystemTime,
    referenceTimeUnc            INTEGER (0..127)                    OPTIONAL,   -- Cond noFTA
    gnss-ReferenceTimeForCells  SEQUENCE (SIZE (1..16)) OF
                                    GNSS-ReferenceTimeForOneCell    OPTIONAL,   -- Need ON
    ...
}

GNSS-ReferenceTimeForOneCell ::= SEQUENCE {
    networkTime             NetworkTime,
    referenceTimeUnc            INTEGER (0..127),
    bsAlign                     ENUMERATED {true}   OPTIONAL,
    ...
}
```

```
-- ASN1STOP
```

Conditional presence	Explanation
noFTA	The field may be present if *gnss-ReferenceTimeForCells* is absent; otherwise it is not present.

***GNSS-ReferenceTime* field descriptions**
gnss-SystemTime This field provides the specific GNSS system time.
networkTime This field specifies the cellular network time at the epoch corresponding to *gnss-SystemTime.*
referenceTimeUnc This field provides the accuracy of the relation between *gnssSystemTime* and *networkTime* time if IE *networkTime* is provided. When IE *networkTime* is not provided, this field can be included to provide the accuracy of the provided *gnssSystemTime*. If GNSS TOD is the given GNSS time, then the true GNSS time, corresponding to the provided network time as observed at the target device location, lies in the interval [GNSS TOD - *referenceTimeUnc*, GNSS TOD + *referenceTimeUnc*]. The uncertainty *r*, expressed in microseconds, is mapped to a number *K*, with the following formula: $r = C*(((1+x)^K)-1)$ with C = 0.5 and x = 0.14. To encode any higher value of uncertainty than that corresponding in the above formula to K=127, the same value, K=127, shall also be used. The uncertainty is then coded on 7 bits, as the binary encoding of K. Example values for the *referenceTimeUnc* Format: see table K to uncertainty relation below.
bsAlign This flag, if present, indicates that the transmission timings of all cells sharing, depending on the RAT, the same carrier frequency and Tracking Area/Location Area/Routing Area as the cell indicated, are frame aligned. This information allows the target device to derive the GNSS - cellular time relation for any of these cells based on the timing relation information provided in *GNSS-ReferenceTime*. The flag should be set consistently in all these cells. This flag does not guarantee SFN alignment.

K to uncertainty relation

Value of K	Value of uncertainty
0	0 nanoseconds
1	70 nanoseconds
2	149.8 nanoseconds
-	-
50	349.62 microseconds
-	-
127	≥ 8.43 seconds

– *GNSS-SystemTime*

```
-- ASN1START

GNSS-SystemTime ::= SEQUENCE {
    gnss-TimeID                     GNSS-ID,
    gnss-DayNumber                  INTEGER (0..32767),
    gnss-TimeOfDay                  INTEGER (0..86399),
    gnss-TimeOfDayFrac-msec         INTEGER (0..999)        OPTIONAL,   -- Need ON
    notificationOfLeapSecond        BIT STRING (SIZE(2))    OPTIONAL,   -- Cond gnss-TimeID-glonass
    gps-TOW-Assist                  GPS-TOW-Assist          OPTIONAL,   -- Cond gnss-TimeID-gps
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
gnss-TimeID-glonass	The field may be present if *gnss-TimeID*=`glonass'; otherwise it is not present.
gnss-TimeID-gps	The field may be present if *gnss-TimeID*=`gps'; otherwise it is not present.

***GNSS-SystemTime* field descriptions**
gnss-TimeID This field specifies the GNSS for which the *GNSS-SystemTime* is provided.
gnss-DayNumber This field specifies the sequential number of days (with day count starting at 0) from the origin of the GNSS System Time as follows: GPS, QZSS, SBAS – Days from January 6th 1980 00:00:00 UTC (USNO); Galileo – Days from Galileo System Time (GST) start epoch, defined as 13 seconds before midnight between 21st August and 22nd August 1999; i.e., GST was equal to 13 seconds at August 22nd 1999 00:00:00 UTC; GLONASS – Days from December 31st 1995 21:00:00 UTC (SU), which is local UTC Moscow January 1st 1996 00:00:00, defined as UTC(SU) + 3 hours in [9]; BDS – Days from January 1st 2006 00:00:00 UTC (NTSC).
gnss-TimeOfDay This field specifies the integer number of seconds from the GNSS day change.
gnss-TimeOfDayFrac-msec This field specifies the fractional part of the *gnssTimeOfDay* field in 1-milli-seconds resolution. The total GNSS TOD is *gnss-TimeOfDay* + *gnssTimeOfDayFrac-msec.*
notificationOfLeapSecond This field specifies the notification of forthcoming leap second correction, as defined by parameter KP in [9, Table 4.7].
gps-TOW-Assist This field contains several fields in the Telemetry (TLM) Word and Handover Word (HOW) that are currently being broadcast by the respective GPS satellites. Combining this information with GPS TOW enables the target device to know the entire 1.2-second (60-bit) pattern of TLM and HOW that is transmitted at the start of each six-second NAV subframe by the particular GPS satellite.

– *GPS-TOW-Assist*

```
-- ASN1START

GPS-TOW-Assist ::= SEQUENCE (SIZE(1..64)) OF GPS-TOW-AssistElement

GPS-TOW-AssistElement ::= SEQUENCE {
    satelliteID     INTEGER (1..64),
    tlmWord         INTEGER (0..16383),
    antiSpoof       INTEGER (0..1),
    alert           INTEGER (0..1),
    tlmRsvdBits     INTEGER (0..3),
    ...
}

-- ASN1STOP
```

***GPS-TOW-Assist* field descriptions**
satelliteID This field identifies the satellite for which the *GPS-TOW-Assist* is applicable. This field is identical to the GPS PRN Signal No. defined in [4].
tlmWord This field contains a 14-bit value representing the Telemetry Message (TLM) being broadcast by the GPS satellite identified by the particular *satelliteID*, with the MSB occurring first in the satellite transmission, as defined in [4].
antiSpoof This field contains the Anti-Spoof flag that is being broadcast by the GPS satellite identified by *satelliteID*, as defined in [4].
alert This field contains the Alert flag that is being broadcast by the GPS satellite identified by *satelliteID*, as defined in [4].
tlmRsvdBits This field contains the two reserved bits in the TLM Word being broadcast by the GPS satellite identified by *satelliteID*, with the MSB occurring first in the satellite transmission, as defined in [4].

– *NetworkTime*

```
-- ASN1START

NetworkTime ::= SEQUENCE {
    secondsFromFrameStructureStart              INTEGER(0..12533),
    fractionalSecondsFromFrameStructureStart    INTEGER(0..3999999),
    frameDrift                                  INTEGER (-64..63)   OPTIONAL,   -- Cond GNSSsynch
```

```
    cellID      CHOICE {
                eUTRA       SEQUENCE {
                            physCellId          INTEGER (0..503),
                            cellGlobalIdEUTRA   CellGlobalIdEUTRA-AndUTRA   OPTIONAL,   -- Need ON
                            earfcn              ARFCN-ValueEUTRA,
                            ...,
                            [[ earfcn-v9a0      ARFCN-ValueEUTRA-v9a0 OPTIONAL  -- Cond EARFCN-max
                            ]]
                            },
                uTRA        SEQUENCE {
                            mode    CHOICE {
                                    fdd     SEQUENCE {
                                            primary-CPICH-Info  INTEGER (0..511),
                                            ...
                                            },
                                    tdd     SEQUENCE {
                                            cellParameters      INTEGER (0..127),
                                            ...
                                            }
                                    },
                            cellGlobalIdUTRA    CellGlobalIdEUTRA-AndUTRA   OPTIONAL,   -- Need ON
                            uarfcn              ARFCN-ValueUTRA,
                            ...
                            },
                gSM         SEQUENCE {
                            bcchCarrier         INTEGER (0..1023),
                            bsic                INTEGER (0..63),
                            cellGlobalIdGERAN   CellGlobalIdGERAN           OPTIONAL,   -- Need ON
                            ...
                            },
                ...,
                nBIoT-r14   SEQUENCE {
                            nbPhysCellId-r14    INTEGER (0..503),
                            nbCellGlobalId-r14  ECGI                        OPTIONAL,   -- Need ON
                            nbCarrierFreq-r14   CarrierFreq-NB-r14,
                            ...
                            },
                nr-r15      SEQUENCE {
                            nrPhysCellId-r15    INTEGER (0..1007),
                            nrCellGlobalID-r15  NCGI-r15                    OPTIONAL,   -- Need ON
                            nrARFCN-r15         ARFCN-ValueNR-r15,
                            ...
                            }
                },
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
EARFCN-max	The field is mandatory present if the corresponding *earfcn* (i.e. without suffix) is set to *maxEARFCN*. Otherwise the field is not present.
GNSSsynch	The field is present and set to 0 if *NetworkTime* is synchronized to *gnss-SystemTime*; otherwise the field is optionally present, need OR.

***NetworkTime* field descriptions**
secondsFromFrameStructureStart This field specifies the number of seconds from the beginning of the longest frame structure in the corresponding air interface. In case of E-UTRA, the SFN cycle length is 10.24 seconds. In case of UTRA, the SFN cycle length is 40.96 seconds. In case of GSM, the hyperfame length is 12533.76 seconds. In case of NB-IoT, the Hyper-SFN cycle lengths is 10485.76 seconds. In case of NR, the SFN cycle length is 10.24 seconds.
fractionalSecondsFromFrameStructureStart This field specifies the fractional part of the *secondsFromFrameStructureStart* in 250 ns resolution. The total time since the particular frame structure start is *secondsFromFrameStructureStart* + *fractionalSecondsFromFrameStructureStart*
frameDrift This field specifies the drift rate of the GNSS-network time relation with scale factor 2^{-30} seconds/second, in the range from -5.9605e-8 to +5.8673e-8 sec/sec.
cellID This field specifies the cell for which the GNSS–network time relation is provided.
physCellId This field specifies the physical cell identity of the reference cell (E-UTRA), as defined in TS 36.331 [12], for which the GNSS network time relation is provided.
cellGlobalIdEUTRA This field specifies the Evolved Cell Global Identifier (ECGI), the globally unique identity of a cell in E-UTRA, of the reference cell for the GNSS-network time relation, as defined in TS 36.331 [12].
earfcn This field specifies E-ARFCN of the reference cell for the GNSS-network time relation (E-UTRA). In case the server includes *earfcn-v9a0*, the server shall set the corresponding *earfcn* (i.e. without suffix) to *maxEARFCN*.
primary-CPICH-Info This field specifies the physical cell identity of the reference cell (UTRA) for the GNSS-network time relation, as defined in TS 25.331 [13].
cellParameters This field specifies the physical cell identity of the reference cell (UTRA) for the GNSS-network time relation, as defined in TS 25.331 [13].
cellGlobalIdUTRA The filed specifies the global UTRAN Cell Identifier, the globally unique identity of a cell in UTRA, of the reference cell for the GNSS-network time relation, as defined in TS 25.331 [13].
uarfcn This field specifies ARFCN of the reference cell for the GNSS-network time relation (UTRA).
bcchCarrier This field specifies the absolute GSM RF channel number of the BCCH of the reference base station (GERAN) for the GNSS-network time relation, as defined in TS 44.031 [14].
bsic This field specifies the Base Station Identity Code of the reference base station (GERAN) for the GNSS-network time relation, as defined in TS 44.031 [14].
cellGlobalIdGERAN This field specifies the Cell Global Identification (CGI), the globally unique identity of a cell in GERAN, of the reference base station for the GNSS-network time relation.
nbPhysCellId This field specifies the narrowband physical layer cell identity of the NB-IoT reference cell, as defined in TS 36.331 [12], for which the GNSS network time relation is provided.
nbCellGlobalId This field specifies the global cell identifier of the NB-IoT reference cell for which the GNSS-network time relation is provided, as defined in TS 36.331 [12].
nbCarrierFreq This field specifies the carrier frequency of the NB-IoT reference cell for which the GNSS-network time relation is provided.
nrPhysCellId This field specifies the physical cell identity of the reference cell (NR), as defined in 3GPP TS 38.331 [35], for which the GNSS network time relation is provided.
nrCellGlobalID This field specifies the NR Cell Global Identifier (NCGI) of the reference cell (NR) for the GNSS-network time relation, as defined in 3GPP TS 38.331 [35].
nrARFCN This field specifies NR-ARFCN of the reference cell (NR) for the GNSS-network time relation.

– *GNSS-ReferenceLocation*

The IE *GNSS-ReferenceLocation* is used by the location server to provide the target device with a-priori knowledge of its location in order to improve GNSS receiver performance. The IE *GNSS-ReferenceLocation* is provided in WGS-84 reference system.

```
-- ASN1START

GNSS-ReferenceLocation ::= SEQUENCE {
        threeDlocation          EllipsoidPointWithAltitudeAndUncertaintyEllipsoid,
        ...
}

-- ASN1STOP
```

– *GNSS-IonosphericModel*

The IE *GNSS-IonosphericModel* is used by the location server to provide parameters to model the propagation delay of the GNSS signals through the ionosphere. Proper use of these fields allows a single-frequency GNSS receiver to remove parts of the ionospheric delay from the pseudorange measurements. Two Ionospheric Models are supported: The Klobuchar model as defined in [4], and the NeQuick model as defined in [8].

```
-- ASN1START

GNSS-IonosphericModel ::= SEQUENCE {
    klobucharModel          KlobucharModelParameter     OPTIONAL,   -- Need ON
    neQuickModel            NeQuickModelParameter       OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

– *KlobucharModelParameter*

```
-- ASN1START

KlobucharModelParameter ::= SEQUENCE {
    dataID          BIT STRING (SIZE (2)),
    alfa0           INTEGER (-128..127),
    alfa1           INTEGER (-128..127),
    alfa2           INTEGER (-128..127),
    alfa3           INTEGER (-128..127),
    beta0           INTEGER (-128..127),
    beta1           INTEGER (-128..127),
    beta2           INTEGER (-128..127),
    beta3           INTEGER (-128..127),
    ...
}

-- ASN1STOP
```

***KlobucharModelParamater* field descriptions**
dataID When *dataID* has the value '11' it indicates that the parameters have been generated by QZSS, and the parameters have been specialized and are applicable within the area defined in [7]. When *dataID* has the value '01' it indicates that the parameters have been generated by BDS, and UE shall use these parameters according to the description given in 5.2.4.7 in [23]. When *dataID* has the value '00' it indicates the parameters are applicable worldwide [4], [7]. All other values for *dataID* are reserved.
alpha0 This field specifies the α_0 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{-30} seconds.
alpha1 This field specifies the α_1 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{-27} seconds/semi-circle.
alpha2 This field specifies the α_2 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{-24} seconds/semi-circle^2.

***KlobucharModelParamater* field descriptions**
alpha3
This field specifies the α_3 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{-24} seconds/semi-circle^3.
beta0
This field specifies the β_0 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{11} seconds.
beta1
This field specifies the β_1 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{14} seconds/semi-circle.
beta2
This field specifies the β_2 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{16} seconds/semi-circle^2.
beta3
This field specifies the β_3 parameter of the Klobuchar model, as specified in [4], [23]. Scale factor 2^{16} seconds/semi-circle^3.

– *NeQuickModelParameter*

```
-- ASN1START

NeQuickModelParameter ::= SEQUENCE {
    ai0         INTEGER (0..2047),
    ai1         INTEGER (-1024..1023),
    ai2         INTEGER (-8192..8191),
    ionoStormFlag1  INTEGER (0..1)      OPTIONAL,   -- Need OP
    ionoStormFlag2  INTEGER (0..1)      OPTIONAL,   -- Need OP
    ionoStormFlag3  INTEGER (0..1)      OPTIONAL,   -- Need OP
    ionoStormFlag4  INTEGER (0..1)      OPTIONAL,   -- Need OP
    ionoStormFlag5  INTEGER (0..1)      OPTIONAL,   -- Need OP
    ...
}

-- ASN1STOP
```

***NeQuickModelParameter* field descriptions**
ai0
Effective Ionisation Level 1st order parameter. Scale factor 2^{-2} Solar Flux Units (SFUs), [8] clause 5.1.6.
ai1
Effective Ionisation Level 2nd order parameter. Scale factor 2^{-8} Solar Flux Units/degree, [8] clause 5.1.6.
ai2
Effective Ionisation Level 3rd order parameter. Scale factor 2^{-15} Solar Flux Units/degree^2, [8] clause 5.1.6.
ionoStormFlag1, ionoStormFlag2, ionoStormFlag3, ionoStormFlag4, ionoStormFlag5
These fields specify the ionosphere disturbance flags (1,…,5) for five different regions as described in [8], clause 5.1.6. If the ionosphere disturbance flag for a region is not present the target device shall treat the ionosphere disturbance condition as unknown.

– *GNSS-EarthOrientationParameters*

The IE *GNSS-EarthOrientationParameters* is used by the location server to provide parameters to construct the ECEF and ECI coordinate transformation as defined in [4]. The IE *GNSS-EarthOrientationParameters* indicates the relationship between the Earth′s rotational axis and WGS-84 reference system.

```
-- ASN1START

GNSS-EarthOrientationParameters ::= SEQUENCE {
    teop                INTEGER (0..65535),
    pmX                 INTEGER (-1048576..1048575),
    pmXdot              INTEGER (-16384..16383),
    pmY                 INTEGER (-1048576..1048575),
    pmYdot              INTEGER (-16384..16383),
    deltaUT1            INTEGER (-1073741824..1073741823),
    deltaUT1dot         INTEGER (-262144..262143),
```

```
    ...
}

-- ASN1STOP
```

***GNSS-EarthOrientationParameters* field descriptions**
teop   This field specifies the EOP data reference time in seconds, as specified in [4].   Scale factor 2^4 seconds.
pmX   This field specifies the X-axis polar motion value at reference time in arc-seconds, as specified in [4].   Scale factor 2^{-20} arc-seconds.
pmXdot   This field specifies the X-axis polar motion drift at reference time in arc-seconds/day, as specified in [4].   Scale factor 2^{-21} arc-seconds/day.
pmY   This field specifies the Y-axis polar motion value at reference time in arc-seconds, as specified in [4].   Scale factor 2^{-20} arc-seconds.
pmYdot   This field specifies the Y-axis polar motion drift at reference time in arc-seconds/day, as specified in [4].   Scale factor 2^{-21} arc-seconds/day.
deltaUT1   This field specifies the UT1-UTC difference at reference time in seconds, as specified in [4].   Scale factor 2^{-24} seconds.
deltaUT1dot   This field specifies the Rate of UT1-UTC difference at reference time in seconds/day, as specified in [4].   Scale factor 2^{-25} seconds/day.

– *GNSS-RTK-ReferenceStationInfo*

The IE *GNSS-RTK-ReferenceStationInfo* is used by the location server to provide the Earth-centered, Earth-fixed (ECEF) coordinates of the antenna reference point (ARP) of the stationary reference station for which the *GNSS-RTK-Observations* assistance data are provided together with reference station antenna description.

The parameters provided in IE *GNSS-RTK-ReferenceStationInfo* are used as specified for message type 1006, 1033 and 1032 in [30].

```
-- ASN1START

GNSS-RTK-ReferenceStationInfo-r15 ::= SEQUENCE {
    referenceStationID-r15                  GNSS-ReferenceStationID-r15,
    referenceStationIndicator-r15           ENUMERATED {physical, non-physical},
    antenna-reference-point-ECEF-X-r15      INTEGER (-137438953472..137438953471),
    antenna-reference-point-ECEF-Y-r15      INTEGER (-137438953472..137438953471),
    antenna-reference-point-ECEF-Z-r15      INTEGER (-137438953472..137438953471),
    antennaHeight-r15                       INTEGER (0..65535)                  OPTIONAL, -- Need ON
    antennaDescription-r15                  AntennaDescription-r15              OPTIONAL, -- Need ON
    antenna-reference-point-unc-r15         AntennaReferencePointUnc-r15        OPTIONAL, -- Need ON
    physical-reference-station-info-r15     PhysicalReferenceStationInfo-r15    OPTIONAL, -- Cond NP
    ...
}

AntennaDescription-r15 ::= SEQUENCE {
    antennaDescriptor-r15                   VisibleString (SIZE (1..256)),
    antennaSetUpID-r15                      ENUMERATED { non-zero }             OPTIONAL, -- Need OP
    ...
}

AntennaReferencePointUnc-r15 ::= SEQUENCE {
    uncertainty-X-r15                       INTEGER (0..255),
    confidence-X-r15                        INTEGER (0..100),
    uncertainty-Y-r15                       INTEGER (0..255),
    confidence-Y-r15                        INTEGER (0..100),
    uncertainty-Z-r15                       INTEGER (0..255),
    confidence-Z-r15                        INTEGER (0..100),
    ...
}

PhysicalReferenceStationInfo-r15 ::= SEQUENCE {
    physicalReferenceStationID-r15          GNSS-ReferenceStationID-r15,
```

```
    physical-ARP-ECEF-X-r15                 INTEGER (-137438953472..137438953471),
    physical-ARP-ECEF-Y-r15                 INTEGER (-137438953472..137438953471),
    physical-ARP-ECEF-Z-r15                 INTEGER (-137438953472..137438953471),
    physical-ARP-unc-r15                    AntennaReferencePointUnc-r15        OPTIONAL, -- Need ON
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
NP	The field is optionally present, need ON, if the *referenceStationIndicator* has the value '*non-physical*'; otherwise it is not present.

***GNSS-RTK-ReferenceStationInfo* field descriptions**
referenceStationID The Reference Station ID is determined by the RTK service provider.
referenceStationIndicator This fields specifies type of reference station. Enumerated value *physical* indicates a real, physical reference station; value *non-physical* indicates a non-physical or computed reference station.
antenna-reference-point-ECEF-X This field specifies the antenna reference point X-coordinate in the World Geodetic System 1984 (WGS 84) datum. Scale factor 0.0001 m; range ±13,743,895.3471 m.
antenna-reference-point-ECEF-Y This field specifies the antenna reference point Y-coordinate in the World Geodetic System 1984 (WGS 84) datum. Scale factor 0.0001 m; range ±13,743,895.3471 m.
antenna-reference-point-ECEF-Z This field specifies the antenna reference point Z-coordinate in the World Geodetic System 1984 (WGS 84) datum. Scale factor 0.0001 m; range ±13,743,895.3471 m.
antennaHeight This field specifies the height of the Antenna Reference Point above the marker used in the survey campaign. Scale factor 0.0001 m; range 0–6.5535 m.
antennaDescriptor This field provides an ASCII descriptor of the reference station antenna using IGS naming convention [31]. The descriptor can be used to look up model specific phase center corrections of that antenna.
antennaSetUpID This field, if present, indicates that the standard IGS Model is not valid (≠ 0 [30]). If this field is absent the standard IGS Model is valid ('0 = Use standard IGS Model' [30]).
antenna-reference-point-unc This field specifies the uncertainty of the ARP coordinates. *uncertainty-X*, *uncertainty-Y*, and *uncertainty-Z* correspond to the encoded high accuracy uncertainty of the X, Y, and Z-coordinate, respectively, as defined in 3GPP TS 23.032 [15]. *confidence-X*, *confidence-Y*, and *confidence-Z* corresponds to confidence as defined in 3GPP TS 23.032 [15].
physical-reference-station-info This field provides the earth-centered, earth-fixed (ECEF) coordinates of the antenna reference point (ARP) for the real (or "physical") reference station used. This field may be used in case of the non-physical reference station approach to allow the target device to refer baseline vectors to a physical reference rather than to a non-physical reference without any connection to a physical point.
physicalReferenceStationID This field specifies the station ID of a real reference station, when the *referenceStationIndicator* has the value '*non-physical*'.
physical-ARP-ECEF-X This field specifies the antenna reference point X-coordinate in the World Geodetic System 1984 (WGS 84) datum. Scale factor 0.0001 m; range ±13,743,895.3471 m.
physical-ARP-ECEF-Y This field specifies the antenna reference point Y-coordinate in the World Geodetic System 1984 (WGS 84) datum. Scale factor 0.0001 m; range ±13,743,895.3471 m.
physical-ARP-ECEF-Z This field specifies the antenna reference point Z-coordinate in the World Geodetic System 1984 (WGS 84) datum. Scale factor 0.0001 m; range ±13,743,895.3471 m.
physical-ARP-unc This field specifies the uncertainty of the ARP coordinates.

– *GNSS-RTK-CommonObservationInfo*

The IE *GNSS-RTK-CommonObservationInfo* is used by the location server to provide common information applicable to the IE *GNSS-RTK-Observations.*

The parameters provided in IE *GNSS-RTK-CommonObservationInfo* are used as specified for message type 1071-1127 in [30].

```
-- ASN1START

GNSS-RTK-CommonObservationInfo-r15 ::= SEQUENCE {
    referenceStationID-r15              GNSS-ReferenceStationID-r15,
    clockSteeringIndicator-r15          INTEGER (0..3),
    externalClockIndicator-r15          INTEGER (0..3),
    smoothingIndicator-r15              BIT STRING (SIZE(1)),
    smoothingInterval-r15               BIT STRING (SIZE(3)),
    ...
}

-- ASN1STOP
```

***GNSS-RTK-CommonObservationInfo* field descriptions**
referenceStationID This field specifies the Station ID for which the *GNSS-RTK-Observations* are provided.
clockSteeringIndicator This field provides the clock steering indicator. The interpretation of the value is as follows: 0 clock steering is not applied In this case receiver clock must be kept in the range of ±1 ms (approximately ±300 km) 1 clock steering has been applied In this case receiver clock must be kept in the range of ±1 microsecond (approximately ±300 meters). 2 unknown clock steering status 3 reserved
externalClockIndicator This field provides the external clock indicator. The interpretation of the value is as follows: 0 internal clock is used 1 external clock is used, clock status is "locked" 2 external clock is used, clock status is "not locked", which may indicate external clock failure and that the transmitted data may not be reliable. 3 unknown clock is used
smoothingIndicator This field provides the GNSS Divergence-free Smoothing Indicator. The interpretation of the value is as follows: 1 Divergence-free smoothing is used 0 Other type of smoothing is used
smoothingInterval The GNSS Smoothing Interval is the integration period over which the pseudorange code phase measurements are averaged using carrier phase information. Divergence-free smoothing may be continuous over the entire period for which the satellite is visible. A value of zero indicates no smoothing is used. See table "smoothingInterval value to interpretation of Smoothing Interval relation" below.

***smoothingInterval* value to interpretation of Smoothing Interval relation**

Indicator	Smoothing Interval
000 (0)	No smoothing
001 (1)	< 30 s
010 (2)	30-60 s
011 (3)	1-2 min
100 (4)	2-4 min
101 (5)	4-8 min
110 (6)	>8 min
111 (7)	Unlimited smoothing interval

– *GNSS-RTK-AuxiliaryStationData*

The IE *GNSS-RTK-AuxiliaryStationData* is used by the location server to provide the coordinates of the antenna reference point (ARP) of Auxiliary Reference Stations, relative to the coordinates provided in IE *GNSS-RTK-ReferenceStationInfo*. The reference station provided in IE *GNSS-RTK-ReferenceStationInfo* is the Master Reference Station. Therefore, one Master Reference Station with its associated Auxiliary Stations is used in a single Provide Assistance Data message.

The parameters provided in IE *GNSS-RTK-AuxiliaryStationData* are used as specified for message type 1014 in [30].

```
-- ASN1START

GNSS-RTK-AuxiliaryStationData-r15 ::= SEQUENCE {
    networkID-r15                   GNSS-NetworkID-r15,
    subNetworkID-r15                GNSS-SubNetworkID-r15                   OPTIONAL,   -- Need ON
    master-referenceStationID-r15   GNSS-ReferenceStationID-r15,
    auxiliaryStationList-r15        AuxiliaryStationList-r15,
    ...
}

AuxiliaryStationList-r15 ::= SEQUENCE (SIZE (1..32)) OF AuxiliaryStationElement-r15

AuxiliaryStationElement-r15 ::= SEQUENCE {
    aux-referenceStationID-r15              GNSS-ReferenceStationID-r15,
    aux-master-delta-latitude-r15           INTEGER (-524288..524287),
    aux-master-delta-longitude-r15          INTEGER (-1048576..1048575),
    aux-master-delta-height-r15             INTEGER (-4194304..4194303),
    aux-ARP-unc-r15                         Aux-ARP-Unc-r15                 OPTIONAL,   -- Need ON
    ...
}

Aux-ARP-Unc-r15 ::= SEQUENCE {
    horizontalUncertainty-r15               INTEGER (0..255),
    horizontalConfidence-r15                INTEGER (0..100),
    verticalUncertainty-r15                 INTEGER (0..255)                OPTIONAL,   -- Need ON
    verticalConfidence-r15                  INTEGER (0..100)                OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***GNSS-RTK-AuxiliaryStationData* field descriptions**
networkID This field defines the network and the source of the particular set of reference stations and their observation information. The RTK service provider should ensure that the *networkID* is unique in the region serviced. The *networkID* indicates an area and its reference stations where the service providers will provide a homogenous solution with levelled integer ambiguities between its reference stations. In general, the area indicated by *networkID* will comprise one subnetwork with a unique *subNetworkID*.
subNetworkID This field identifies the subnetwork of a network identified by *networkID*. In general the area indicated by *networkID* will consist of one subnetwork. The *subNetworkID* indicates the actual solution number of integer ambiguity level. If one network has only one subnetwork, this indicates that an ambiguity level throughout the whole network is established.
master-referenceStationID This field identifies the Master Reference Station.
aux-referenceStationID This field identifies the Auxiliary Reference Station.
aux-master-delta-latitude This field provides the delta value in latitude of Antenna Reference Point of "Auxiliary Reference Station minus Master Reference Station" in geographical coordinates based on GRS80 ellipsoid parameters for the same ECEF system as used in IE *GNSS-RTK-ReferenceStationInfo*. Scale factor 25×10^{-6} degrees; range ±13.1071 degrees.
aux-master-delta-longitude This field provides the delta value in longitude of Antenna Reference Point of "Auxiliary Reference Station minus Master Reference Station" in geographical coordinates based on GRS80 ellipsoid parameters for the same ECEF system as used in IE *GNSS-RTK-ReferenceStationInfo*. Scale factor 25×10^{-6} degrees; range ±26.2142 degrees.
aux-master-delta-height This field provides the delta value in ellipsoidal height of Antenna Reference Point of "Auxiliary Reference Station minus Master Reference Station" in geographical coordinates based on GRS80 ellipsoid parameters for the same ECEF system as used in IE *GNSS-RTK-ReferenceStationInfo*. Scale factor 1 milli-meter; range ±4194.303 m.
aux-ARP-unc This field specifies the uncertainty of the auxiliary station ARP coordinates and comprise the following fields: - ***horizontalUncertainty*** indicates the horizontal uncertainty of the ARP latitude/longitude. The '*horizontalUncertainty*' corresponds to the encoded high accuracy uncertainty as defined in 3GPP TS 23.032 [15] and '*horizontalConfidence*' corresponds to confidence as defined in 3GPP TS 23.032 [15]. - ***verticalUncertainty*** indicates the vertical uncertainty of the ARP altitude. The '*verticalUncertainty*' corresponds to the encoded high accuracy uncertainty as defined in 3GPP TS 23.032 [15] and '*verticalConfidence*' corresponds to confidence as defined in 3GPP TS 23.032 [15].

– *GNSS-TimeModelList*

The IE *GNSS-TimeModelList* is used by the location server to provide the GNSS-GNSS system time offset between the GNSS system time indicated by IE *GNSS-ID* in IE *GNSS-GenericAssistDataElement* to the GNSS system time indicated by IE *gnss-TO-ID*. Several *GNSS-TimeModelElement* IEs can be included with different *gnss-TO-ID* fields. The location server should provide a *GNSS-TimeModelList* for the same *GNSS-ID* as the *gnss-TimeID* in IE *GNSS-SystemTime* in *GNSS-ReferenceTime* assistance. If the location server does not provide a *GNSS-TimeModelList* for the same *GNSS-ID* as the *gnss-TimeID* in IE *GNSS-SystemTime* in *GNSS-ReferenceTime* assistance the target device assumes *tA1* and *tA2* are equal to zero.

```
-- ASN1START

GNSS-TimeModelList ::= SEQUENCE (SIZE (1..15)) OF GNSS-TimeModelElement

GNSS-TimeModelElement ::= SEQUENCE {
    gnss-TimeModelRefTime       INTEGER (0..65535),
    tA0                         INTEGER (-67108864..67108863),
    tA1                         INTEGER (-4096..4095)                   OPTIONAL,   -- Need ON
    tA2                         INTEGER (-64..63)                       OPTIONAL,   -- Need ON
    gnss-TO-ID                  INTEGER (1..15),
    weekNumber                  INTEGER (0..8191)                       OPTIONAL,   -- Need ON
    deltaT                      INTEGER (-128..127)                     OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***GNSS-TimeModelElement* field descriptions**
gnss-TimeModelRefTime This field specifies the reference time of week for *GNSS-TimeModelElement* and it is given in GNSS specific system time. Scale factor 2^4 seconds.
tA0 This field specifies the bias coefficient of the *GNSS-TimeModelElement*. Scale factor 2^{-35} seconds.
tA1 This field specifies the drift coefficient of the *GNSS-TimeModelElement.* Scale factor of 2^{-51} seconds/second.
tA2 This field specifies the drift rate correction coefficient of the *GNSS-TimeModelElement.* Scale factor of 2^{-68} seconds/second^2.
gnss-TO-ID This field specifies the GNSS system time of the GNSS for which the *GNSS-TimeModelElement* is applicable. *GNSS-TimeModelElement* contains parameters to convert GNSS system time from the system indicated by *GNSS-ID* to GNSS system time indicated by *gnss-TO-ID*. The conversion is defined in [4,5,6]. See table of gnss-TO-ID to Indication relation below. NOTE.
weekNumber This field specifies the reference week of the *GNSS-TimeModelElement* given in GNSS specific system time. The location server should include this field, if *tA1* or *tA2* is included. Scale factor 1 week.
deltaT This field specifies the integer number of seconds of the GNSS-GNSS time offset provided in the *GNSS-TimeModelElement.* Scale factor 1 second.

gnss-TO-ID to Indication relation

Value of *gnss-TO-ID*	Indication
1	GPS
2	Galileo
3	QZSS
4	GLONASS
5	BDS
6-15	reserved

NOTE: The time relationship between the system time indicated by *GNSS-ID* and system time indicated by *gnss-TO-ID* is given by the following equation:

$$t_{GNSS} = t_E - (A_{0GGTO} + A_{1GGTO} (t_E - t_{GGTO} + 604800 (WN - WN_{GGTO})) + A_{2GGTO} (t_E - t_{GGTO} + 604800 (WN - WN_{GGTO}))^2)$$

where

t_{GNSS} is the system time of week for the GNSS indicated by *gnss-TO-ID*.
t_E is the system time of week for the GNSS indicated by *GNSS-ID*.
WN is the week number of the GNSS system time indicated by *GNSS-ID* corresponding to the t_E.
t_{GGTO} is the system time of week for the time model data in the GNSS time indicated by *GNSS-ID* and given by the *gnss-TimeModelRefTime* field.
WN_{GGTO} is the week number for the time model data in the GNSS time indicated by *GNSS-ID* corresponding to the t_{GGTO} and given by the *weekNumber* field.
A_{0GGTO} is given by the *tA0* field.
A_{1GGTO} is given by the *tA1* field.
A_{2GGTO} is given by the *tA2* field.

If the *tA1* and *tA2* are not included in the *GNSS-TimeModelElement*, the target device assumes A_{1GGTO} and A_{2GGTO} are equal to zero.

The GNSS system times in the IE *GNSS-TimeModelList* and used in the equation above are all given in Time of Week (TOW) and Week Number (WN) in the indicted GNSS specific system time. For conversion between TOW/WN and Day Number/Time of Day (*gnss-DayNumber*/*gnss-TimeOfDay*) a GNSS week consists of 7 days since the origin of the particular GNSS System time (with the week number count starting at 0), and a day consists of 86400 seconds.

– *GNSS-DifferentialCorrections*

The IE *GNSS-DifferentialCorrections* is used by the location server to provide differential GNSS corrections to the target device for a specific GNSS. Differential corrections can be provided for up to 3 signals per GNSS.

```
-- ASN1START

GNSS-DifferentialCorrections ::= SEQUENCE {
    dgnss-RefTime       INTEGER (0..3599),
    dgnss-SgnTypeList   DGNSS-SgnTypeList,
    ...
}

DGNSS-SgnTypeList ::= SEQUENCE (SIZE (1..3)) OF DGNSS-SgnTypeElement

DGNSS-SgnTypeElement ::= SEQUENCE {
    gnss-SignalID       GNSS-SignalID,
    gnss-StatusHealth   INTEGER (0..7),
    dgnss-SatList       DGNSS-SatList,
    ...
}

DGNSS-SatList ::= SEQUENCE (SIZE (1..64)) OF DGNSS-CorrectionsElement

DGNSS-CorrectionsElement ::= SEQUENCE {
    svID                SV-ID,
    iod             BIT STRING (SIZE(11)),
    udre                INTEGER (0..3),
    pseudoRangeCor      INTEGER (-2047..2047),
    rangeRateCor        INTEGER (-127..127),
    udreGrowthRate      INTEGER (0..7)          OPTIONAL,   -- Need ON
    udreValidityTime    INTEGER (0..7)          OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***GNSS-DifferentialCorrections* field descriptions**
dgnss-RefTime This field specifies the time for which the DGNSS corrections are valid, modulo 1 hour. *dgnss-RefTime* is given in GNSS specific system time. Scale factor 1-second.
dgnss-SgnTypeList This list includes differential correction data for different GNSS signal types, identified by *GNSS-SignalID*.
gnss-StatusHealth This field specifies the status of the differential corrections. The values of this field and their respective meanings are defined as in table *gnss-StatusHealth* Value to Indication relation below. The first six values in this field indicate valid differential corrections. When using the values described below, the "UDRE Scale Factor" value is applied to the UDRE values contained in the element. The purpose is to indicate an estimate in the amount of error in the corrections. The value "110" indicates that the source of the differential corrections (e.g., reference station or external DGNSS network) is currently not being monitored. The value "111" indicates that the corrections provided by the source are invalid, as judged by the source.
dgnss-SatList This list includes differential correction data for different GNSS satellites, identified by *SV-ID*.
iod This field specifies the Issue of Data field which contains the identity for the *GNSS-NavigationModel.*
udre This field provides an estimate of the uncertainty (1-σ) in the corrections for the particular satellite. The value in this field shall be multiplied by the UDRE Scale Factor in the *gnss-StatusHealth* field to determine the final UDRE estimate for the particular satellite. The meanings of the values for this field are shown in the table *udre Value* to Indication relation below.

***GNSS-DifferentialCorrections* field descriptions**
pseudoRangeCor This field specifies the correction to the pseudorange for the particular satellite at *dgnss-RefTime*, t_0. The value of this field is given in meters and the scale factor is 0.32 meters in the range of ±655.04 meters. The method of calculating this field is described in [11]. If the location server has received a request for GNSS assistance data from a target device which included a request for the GNSS Navigation Model and DGNSS, the location server shall determine, for each satellite, if the navigation model stored by the target device is still suitable for use with DGNSS corrections and if so and if DGNSS corrections are supported the location server should send DGNSS corrections without including the GNSS Navigation Model. The *iod* value sent for a satellite shall always be the IOD value that corresponds to the navigation model for which the pseudo-range corrections are applicable. The target device shall only use the *pseudoRangeCor* value when the IOD value received matches its available navigation model. Pseudo-range corrections are provided with respect to GNSS specific geodetic datum (e.g., PZ-90.02 if *GNSS-ID* indicates GLONASS). Scale factor 0.32 meters.
rangeRateCor This field specifies the rate-of-change of the pseudorange correction for the particular satellite, using the satellite ephemeris and clock corrections identified by the *iod* field. The value of this field is given in meters per second and the resolution is 0.032 meters/sec in the range of ±4.064 meters/sec. For some time $t_1 > t_0$, the corrections for *iod* are estimated by $PRC(t_1, IOD) = PRC(t_0, IOD) + RRC(t_0,IOD)\cdot(t_1 - t_0)$, and the target device uses this to correct the pseudorange it measures at t_1, $PR_m(t_1,IOD)$, by $PR(t_1, IOD) = PR_m(t_1, IOD) + PRC(t_1, IOD)$. The location server shall always send the RRC value that corresponds to the PRC value that it sends. The target device shall only use the RRC value when the *iod* value received matches its available navigation model. Scale factor 0.032 meters/second.
udreGrowthRate This field provides an estimate of the growth rate of uncertainty (1-σ) in the corrections for the particular satellite identified by *SV-ID*. The estimated UDRE at time value specified in the *udreValidityTime* t_1 is calculated as follows: $UDRE(t_0+t_1) = UDRE(t_0) \times udreGrowthRate$, where t_0 is the DGNSS Reference Time *dgnss-RefTime* for which the corrections are valid, t_1 is the *udreValidityTime* field, $UDRE(t_0)$ is the value of the *udre* field, and *udreGrowthRate* field is the factor as shown in the table Value of *udreGrowthRate* to Indication relation below.
udreValidityTime This field specifies the time when the *udreGrowthRate* field applies and is included if *udreGrowthRate* is included. The meaning of the values for this field is as shown in the table Value of *udreValidityTime* to Indication relation below.

gnss-StatusHealth Value to Indication relation

gnss-StatusHealth Value	**Indication**
000	UDRE Scale Factor = 1.0
001	UDRE Scale Factor = 0.75
010	UDRE Scale Factor = 0.5
011	UDRE Scale Factor = 0.3
100	UDRE Scale Factor = 0.2
101	UDRE Scale Factor = 0.1
110	Reference Station Transmission Not Monitored
111	Data is invalid - disregard

udre Value to Indication relation

***udre* Value**	**Indication**
00	UDRE ≤ 1.0 m
01	1.0 m < UDRE ≤ 4.0 m
10	4.0 m < UDRE ≤ 8.0 m
11	8.0 m < UDRE

Value of _udreGrowthRate_ to Indication relation

Value of *udreGrowthRate*	**Indication**
000	1.5

001	2
010	4
011	6
100	8
101	10
110	12
111	16

Value of *udreValidityTime* to Indication relation

Value of *udreValidityTime*	Indication [seconds]
000	20
001	40
010	80
011	160
100	320
101	640
110	1280
111	2560

– *GNSS-NavigationModel*

The IE *GNSS-NavigationModel* is used by the location server to provide precise navigation data to the GNSS capable target device. In response to a request from a target device for GNSS Assistance Data, the location server shall determine whether to send the navigation model for a particular satellite to a target device based upon factors like the T-Toe limit specified by the target device and any request from the target device for DGNSS (see also *GNSS-DifferentialCorrections*). GNSS Orbit Model can be given in Keplerian parameters or as state vector in Earth-Centered Earth-Fixed coordinates, dependent on the *GNSS-ID* and the target device capabilities. The meaning of these parameters is defined in relevant ICDs of the particular GNSS and GNSS specific interpretations apply. For example, GPS and QZSS use the same model parameters but some parameters have a different interpretation [7].

```
-- ASN1START

GNSS-NavigationModel ::= SEQUENCE {
    nonBroadcastIndFlag INTEGER (0..1),
    gnss-SatelliteList      GNSS-NavModelSatelliteList,
    ...
}

GNSS-NavModelSatelliteList ::= SEQUENCE (SIZE(1..64)) OF GNSS-NavModelSatelliteElement

GNSS-NavModelSatelliteElement ::= SEQUENCE {
    svID                SV-ID,
    svHealth            BIT STRING (SIZE(8)),
    iod             BIT STRING (SIZE(11)),
    gnss-ClockModel     GNSS-ClockModel,
    gnss-OrbitModel     GNSS-OrbitModel,
    ...,
    [[  svHealthExt-v1240 BIT STRING (SIZE(4))          OPTIONAL        -- Need ON
    ]]
}

GNSS-ClockModel ::= CHOICE {
    standardClockModelList  StandardClockModelList,         -- Model-1
    nav-ClockModel          NAV-ClockModel,                 -- Model-2
    cnav-ClockModel         CNAV-ClockModel,                -- Model-3
    glonass-ClockModel      GLONASS-ClockModel,             -- Model-4
    sbas-ClockModel         SBAS-ClockModel,                -- Model-5
    ...,
    bds-ClockModel-r12      BDS-ClockModel-r12              -- Model-6
}

GNSS-OrbitModel ::= CHOICE {
    keplerianSet            NavModelKeplerianSet,           -- Model-1
    nav-KeplerianSet        NavModelNAV-KeplerianSet,       -- Model-2
    cnav-KeplerianSet       NavModelCNAV-KeplerianSet,      -- Model-3
    glonass-ECEF            NavModel-GLONASS-ECEF,          -- Model-4
```

```
    sbas-ECEF               NavModel-SBAS-ECEF,             -- Model-5
    ...,
    bds-KeplerianSet-r12    NavModel-BDS-KeplerianSet-r12   -- Model-6
}

-- ASN1STOP
```

***GNSS-NavigationModel* field descriptions**
nonBroadcastIndFlag
This field indicates if the *GNSS-NavigationModel* elements are not derived from satellite broadcast data or are given in a format not native to the GNSS. A value of 0 means the *GNSS-NavigationModel* data elements correspond to GNSS satellite broadcasted data; a value of 1 means the *GNSS-NavigationModel* data elements are not derived from satellite broadcast.
gnss-SatelliteList
This list provides ephemeris and clock corrections for GNSS satellites indicated by *SV-ID*.
svHealth
This field specifies the satellite's current health. The health values are GNSS system specific. The interpretation of *svHealth* depends on the *GNSS-ID* and is as shown in table GNSS to svHealth Bit String(8) relation below.
iod
This field specifies the Issue of Data and contains the identity for GNSS Navigation Model. In case of broadcasted GPS NAV ephemeris, the *iod* contains the IODC as described in [4]. In case of broadcasted Modernized GPS ephemeris, the *iod* contains the 11-bit parameter t_{oe} as defined in [4, Table 30-I] [6, Table 3.5-1]. In case of broadcasted SBAS ephemeris, the *iod* contains the 8 bits Issue of Data as defined in [10] Message Type 9. In case of broadcasted QZSS QZS-L1 ephemeris, the *iod* contains the IODC as described in [7]. In case of broadcasted QZSS QZS-L1C/L2C/L5 ephemeris, the *iod* contains the 11-bit parameter t_{oe} as defined in [7]. In case of broadcasted GLONASS ephemeris, the *iod* contains the parameter t_b as defined in [9]. In the case of broadcasted Galileo ephemeris, the *iod* contains the IOD index as described in [8]. In the case of broadcasted BDS ephemeris, the *iod* contains 11 MSB bits of the t_{oe} as defined in [23]. The interpretation of *iod* depends on the *GNSS-ID* and is as shown in table GNSS to iod Bit String(11) relation below.
svHealthExt
This field specifies the satellite's additional current health. The health values are GNSS system specific. The interpretation of *svHealthExt* depends on the *GNSS-ID* and is as shown in table GNSS to svHealthExt Bit String(4) relation below.

GNSS to svHealth Bit String(8) relation

GNSS	***svHealth* Bit String(8)**							
	Bit 1 (MSB)	**Bit 2**	**Bit 3**	**Bit 4**	**Bit 5**	**Bit 6**	**Bit 7**	**Bit 8 (LSB)**
GPS L1/CA[1]	SV Health [4]						'0' (reserved)	'0' (reserved)
Modernized GPS[2]	L1C Health [6]	L1 Health [4,5]	L2 Health [4,5]	L5 Health [4,5]	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)
SBAS[3]	Ranging On (0),Off(1) [10]	Corrections On(0),Off(1) [10]	Integrity On(0),Off(1)[10]	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)
QZSS[4] QZS-L1	SV Health [7]						'0' (reserved)	'0' (reserved)
QZSS[5] QZS-L1C/L2C/L5	L1C Health [7]	L1 Health [7]	L2 Health [7]	L5 Health [7]	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)
GLONASS	B_n (MSB) [9, page 30]	F_T [9, Table 4.4]				'0' (reserved)	'0' (reserved)	'0' (reserved)
Galileo [8, clause 5.1.9.3]	E5a Data Validity Status	E5b Data Validity Status	E1-B Data Validity Status	E5a Signal Health Status		'0' (reserved)	'0' (reserved)	'0' (reserved)
BDS [23]	B1I Health (SatH1) [23]	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)	'0' (reserved)

Note 1: If *GNSS-ID* indicates 'gps', and GNSS Orbit Model-2 is included, this interpretation of *svHealth* applies.
Note 2: If *GNSS-ID* indicates 'gps', and GNSS Orbit Model-3 is included, this interpretation of *svHealth* applies.
If a certain signal is not supported on the satellite indicated by *SV-ID*, the corresponding health bit shall be set to '1' (i.e., signal can not be used).
Note 3: *svHealth* in case of *GNSS-ID* indicates 'sbas' includes the 5 LSBs of the Health included in GEO Almanac Message Parameters (Type 17) [10].
Note 4: If *GNSS-ID* indicates 'qzss', and GNSS Orbit Model-2 is included, this interpretation of *svHealth* applies.
Note 5: If *GNSS-ID* indicates 'qzss', and GNSS Orbit Model-3 is included, this interpretation of *svHealth* applies.

GNSS to iod Bit String(11) relation

GNSS	*iod* Bit String(11)										
	Bit 1 (MSB)	**Bit 2**	**Bit 3**	**Bit 4**	**Bit 5**	**Bit 6**	**Bit 7**	**Bit 8**	**Bit 9**	**Bit 10**	**Bit 11 (LSB)**
GPS L1/CA	'0'	Issue of Data, Clock [4]									
Modernized GPS	t_{oe} (seconds, scale factor 300, range 0 – 604500) [4,5,6]										
SBAS	'0'	'0'	'0'	Issue of Data ([10], Message Type 9)							
QZSS QZS-L1	'0'	Issue of Data, Clock [7]									
QZSS QZS-L1C/L2C/L5	t_{oe} (seconds, scale factor 300, range 0 – 604500) [7]										
GLONASS	'0'	'0'	'0'	'0'	t_b (minutes, scale factor 15) [9]						
Galileo	'0'	IODnav [8]									
BDS	11 MSB bits of t_{oe} (seconds, scale factor 512, range 0 – 604672) [23]										

GNSS to svHealthExt Bit String(4) relation

GNSS	*svHealthExt* Bit String(4)			
	Bit 1 (MSB)	**Bit 2**	**Bit 3**	**Bit 4 (LSB)**
Galileo [8, clause 5.1.9.3]	E5b Signal Health Status		E1-B Signal Health Status	

– *StandardClockModelList*

```
-- ASN1START

StandardClockModelList ::= SEQUENCE (SIZE(1..2)) OF StandardClockModelElement

StandardClockModelElement ::= SEQUENCE {
    stanClockToc            INTEGER (0..16383),
    stanClockAF2            INTEGER (-32..31),
    stanClockAF1            INTEGER (-1048576..1048575),
    stanClockAF0            INTEGER (-1073741824..1073741823),
    stanClockTgd            INTEGER (-512..511)             OPTIONAL,   -- Need ON
    sisa                    INTEGER (0..255),
    stanModelID             INTEGER (0..1)                  OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***StandardClockModelList* field descriptions**
standardClockModelList *gnss-ClockModel* Model-1 contains one or two clock model elements. If included, clock Model-1 shall be included once or twice depending on the target device capability. If the target device is supporting multiple Galileo signals, the location server shall include both F/Nav and I/Nav clock models in *gnss-ClockModel* if the location server assumes the target device to perform location information calculation using multiple signals.
stanClockToc Parameter t_{oc} defined in [8]. Scale factor 60 seconds.
stanClockAF2 Parameter af_2 defined in [8]. Scale factor 2^{-59} seconds/second^2.
stanClockAF1 Parameter af_1 defined in [8]. Scale factor 2^{-46} seconds/second.
stanClockAF0 Parameter af_0 defined in [8]. Scale factor 2^{-34} seconds.
stanClockTgd Parameter T_{GD}, Broadcast Group Delay (BGD), defined in [8]. Scale factor 2^{-32} seconds. This field is required if the target device supports only single frequency Galileo signal.

***StandardClockModelList* field descriptions**
sisa Signal-In-Space Accuracy (SISA), defined in [8] clause 5.1.11.
stanModelID This field specifies the identity of the clock model according to the table Value of stanModelID to Identity relation below. This field is required if the location server includes both F/Nav and I/Nav Galileo clock models in *gnss-ClockModel.*

Value of stanModelID to Identity relation

Value of *stanModelID*	Identity
0	I/Nav (E1,E5b)
1	F/Nav (E1,E5a)

– *NAV-ClockModel*

```
-- ASN1START

NAV-ClockModel ::= SEQUENCE {
    navToc          INTEGER (0..37799),
    navaf2          INTEGER (-128..127),
    navaf1          INTEGER (-32768..32767),
    navaf0          INTEGER (-2097152..2097151),
    navTgd          INTEGER (-128..127),
    ...
}

-- ASN1STOP
```

***NAV-ClockModel* field descriptions**
navToc Parameter t_{oc}, time of clock (seconds) [4,7] Scale factor 2^4 seconds.
navaf2 Parameter a_{f2}, clock correction polynomial coefficient (sec/sec^2) [4,7]. Scale factor 2^{-55} seconds/second^2.
navaf1 Parameter a_{f1}, clock correction polynomial coefficient (sec/sec) [4,7]. Scale factor 2^{-43} seconds/second.
navaf0 Parameter a_{f0}, clock correction polynomial coefficient (seconds) [4,7]. Scale factor 2^{-31} seconds.
navTgd Parameter T_{GD}, group delay (seconds) [4,7]. Scale factor 2^{-31} seconds.

– *CNAV-ClockModel*

```
-- ASN1START

CNAV-ClockModel ::= SEQUENCE {
    cnavToc         INTEGER (0..2015),
    cnavTop         INTEGER (0..2015),
    cnavURA0        INTEGER (-16..15),
    cnavURA1        INTEGER (0..7),
    cnavURA2        INTEGER (0..7),
    cnavAf2         INTEGER (-512..511),
    cnavAf1         INTEGER (-524288..524287),
    cnavAf0         INTEGER (-33554432..33554431),
    cnavTgd         INTEGER (-4096..4095),
    cnavISCl1cp     INTEGER (-4096..4095)           OPTIONAL,   -- Need ON
    cnavISCl1cd     INTEGER (-4096..4095)           OPTIONAL,   -- Need ON
    cnavISCl1ca     INTEGER (-4096..4095)           OPTIONAL,   -- Need ON
    cnavISCl2c      INTEGER (-4096..4095)           OPTIONAL,   -- Need ON
    cnavISCl5i5     INTEGER (-4096..4095)           OPTIONAL,   -- Need ON
```

```
    cnavISCl5q5     INTEGER (-4096..4095)           OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***CNAV-ClockModel* field descriptions**
cnavToc Parameter t_{oc}, clock data reference time of week (seconds) [4,5,6,7]. Scale factor 300 seconds.
cnavTop Parameter t_{op}, clock data predict time of week (seconds) [4,5,6,7]. Scale factor 300 seconds
cnavURA0 Parameter URA_{oc} Index, SV clock accuracy index (dimensionless) [4,5,6,7].
cnavURA1 Parameter URA_{oc1} Index, SV clock accuracy change index (dimensionless) [4,5,6,7].
cnavURA2 Parameter URA_{oc2} Index, SV clock accuracy change rate index (dimensionless) [4,5,6,7].
cnavAf2 Parameter $a_{f2\text{-}n}$, SV clock drift rate correction coefficient (sec/sec^2) [4,5,6,7]. Scale factor 2^{-60} seconds/second^2.
cnavAf1 Parameter $a_{f1\text{-}n}$, SV clock drift correction coefficient (sec/sec) [4,5,6,7]. Scale factor 2^{-48} seconds/second.
cnavAf0 Parameter $a_{f0\text{-}n}$, SV clock bias correction coefficient (seconds) [4,5,6,7]. Scale factor 2^{-35} seconds.
cnavTgd Parameter T_{GD}, Group delay correction (seconds) [4,5,6,7]. Scale factor 2^{-35} seconds.
cnavISCl1cp Parameter ISC_{L1CP}, inter signal group delay correction (seconds) [6,7]. Scale factor 2^{-35} seconds. The location server should include this field if the target device is GPS capable and supports the $L1_C$ signal.
cnavISCl1cd Parameter ISC_{L1CD}, inter signal group delay correction (seconds) [6,7]. Scale factor 2^{-35} seconds. The location server should include this field if the target device is GPS capable and supports the $L1_C$ signal.
cnavISCl1ca Parameter $ISC_{L1C/A}$, inter signal group delay correction (seconds) [4,5,7]. Scale factor 2^{-35} seconds. The location server should include this field if the target device is GPS capable and supports the $L1_{CA}$ signal.
cnavISCl2c Parameter ISC_{L2C}, inter signal group delay correction (seconds) [4,5,7]. Scale factor 2^{-35} seconds. The location server should include this field if the target device is GPS capable and supports the $L2_C$ signal.
cnavISCl5i5 Parameter ISC_{L5I5}, inter signal group delay correction (seconds) [5,7]. Scale factor 2^{-35} seconds. The location server should include this field if the target device is GPS capable and supports the L5 signal.
cnavISCl5q5 Parameter ISC_{L5Q5}, inter signal group delay correction (seconds) [5,7]. Scale factor 2^{-35} seconds. The location server should include this field if the target device is GPS capable and supports the L5 signal.

– *GLONASS-ClockModel*

```
-- ASN1START

GLONASS-ClockModel ::= SEQUENCE {
    gloTau          INTEGER (-2097152..2097151),
    gloGamma        INTEGER (-1024..1023),
    gloDeltaTau     INTEGER (-16..15)               OPTIONAL,   -- Need ON
    ...
}
```

```
-- ASN1STOP
```

***GLONASS-ClockModel* field descriptions**
gloTau
Parameter $\tau_n(t_b)$, satellite clock offset (seconds) [9].
Scale factor 2^{-30} seconds.
gloGamma
Parameter $\gamma_n(t_b)$, relative frequency offset from nominal value (dimensionless) [9].
Scale factor 2^{-40}.
gloDeltaTau
Parameter $\Delta\tau_n$, time difference between transmission in G2 and G1 (seconds) [9].
Scale factor 2^{-30} seconds.
The location server should include this parameter if the target device is dual frequency GLONASS receiver capable.

– *SBAS-ClockModel*

```
-- ASN1START

SBAS-ClockModel ::= SEQUENCE {
    sbasTo          INTEGER (0..5399),
    sbasAgfo        INTEGER (-2048..2047),
    sbasAgf1        INTEGER (-128..127),
    ...
}

-- ASN1STOP
```

***SBAS-ClockModel* field descriptions**
sbasTo
Parameter t_0 [10].
Scale factor 16 seconds.
sbasAgfo
Parameter a_{Gf0} [10].
Scale factor 2^{-31} seconds.
sbasAgf1
Parameter a_{Gf1} [10].
Scale factor 2^{-40} seconds/second.

– *BDS-ClockModel*

```
-- ASN1START

BDS-ClockModel-r12 ::= SEQUENCE {
    bdsAODC-r12         INTEGER (0..31),
    bdsToc-r12          INTEGER (0..131071),
    bdsA0-r12           INTEGER (-8388608..8388607),
    bdsA1-r12           INTEGER (-2097152..2097151),
    bdsA2-r12           INTEGER (-1024..1023),
    bdsTgd1-r12         INTEGER (-512..511),
    ...
}

-- ASN1STOP
```

***BDS-ClockModel* field descriptions**
bdsAODC Parameter Age of Data, Clock (AODC), see [23], Table 5-6.
bdsToc Parameter T_{oc}, Time of clock (seconds) [23]. Scale factor 2^3 seconds.
bdsA0 Parameter a_0, Clock correction polynomial coefficient (seconds) [23]. Scale factor 2^{-33} seconds.
bdsA1 Parameter a_1, Clock correction polynomial coefficient (sec/sec) [23]. Scale factor 2^{-50} sec/sec.
bdsA2 Parameter a_2, Clock correction polynomial coefficient (sec/sec^2) [23]. Scale factor 2^{-66} sec/sec^2.
bdsTgd1 Parameter Equipment group delay differential T_{GD1} [23]. Scale factor is 0.1 nanosecond.

– *NavModelKeplerianSet*

```
-- ASN1START

NavModelKeplerianSet ::= SEQUENCE {
    keplerToe       INTEGER (0 .. 16383),
    keplerW         INTEGER (-2147483648..2147483647),
    keplerDeltaN    INTEGER (-32768..32767),
    keplerM0        INTEGER (-2147483648..2147483647),
    keplerOmegaDot  INTEGER (-8388608.. 8388607),
    keplerE     INTEGER (0..4294967295),
    keplerIDot      INTEGER (-8192..8191),
    keplerAPowerHalf INTEGER (0.. 4294967295),
    keplerI0        INTEGER (-2147483648..2147483647),
    keplerOmega0    INTEGER (-2147483648..2147483647),
    keplerCrs       INTEGER (-32768..32767),
    keplerCis       INTEGER (-32768..32767),
    keplerCus       INTEGER (-32768..32767),
    keplerCrc       INTEGER (-32768..32767),
    keplerCic       INTEGER (-32768..32767),
    keplerCuc       INTEGER (-32768..32767),
    ...
}

-- ASN1STOP
```

***NavModelKeplerianSet* field descriptions**
keplerToe Parameter t_{oe}, time-of-ephemeris in seconds [8]. Scale factor 60 seconds.
keplerW Parameter ω, argument of perigee (semi-circles) [8]. Scale factor 2^{-31} semi-circles.
keplerDeltaN Parameter Δn, mean motion difference from computed value (semi-circles/sec) [8]. Scale factor 2^{-43} semi-circles/second.
keplerM0 Parameter M_0, mean anomaly at reference time (semi-circles) [8]. Scale factor 2^{-31} semi-circles.
keplerOmegaDot Parameter OMEGAdot, rate of change of right ascension (semi-circles/sec) [8]. Scale factor 2^{-43} semi-circles/second.
keplerE Parameter e, eccentricity [8]. Scale factor 2^{-33}.
KeplerIDot Parameter Idot, rate of change of inclination angle (semi-circles/sec) [8]. Scale factor 2^{-43} semi-circles/second.

NavModelKeplerianSet field descriptions
keplerAPowerHalf Parameter sqrtA, square root of semi-major Axis in (meters)^{½} [8]. Scale factor 2^{-19} meters ^{½}.
keplerI0 Parameter i_0, inclination angle at reference time (semi-circles) [8]. Scale factor 2^{-31} semi-circles.
keplerOmega0 Parameter $OMEGA_0$, longitude of ascending node of orbit plane at weekly epoch (semi-circles) [8]. Scale factor 2^{-31} semi-circles.
keplerCrs Parameter C_{rs}, amplitude of the sine harmonic correction term to the orbit radius (meters) [8]. Scale factor 2^{-5} meters.
keplerCis Parameter C_{is}, amplitude of the sine harmonic correction term to the angle of inclination (radians) [8]. Scale factor 2^{-29} radians.
keplerCus Parameter C_{us}, amplitude of the sine harmonic correction term to the argument of latitude (radians) [8]. Scale factor 2^{-29} radians.
keplerCrc Parameter C_{rc}, amplitude of the cosine harmonic correction term to the orbit radius (meters) [8]. Scale factor 2^{-5} meters.
keplerCic Parameter C_{ic}, amplitude of the cosine harmonic correction term to the angle of inclination (radians) [8]. Scale factor 2^{-29} radians.
keplerCuc Parameter C_{uc}, amplitude of the cosine harmonic correction term to the argument of latitude (radians) [8]. Scale factor 2^{-29} radians.

– *NavModelNAV-KeplerianSet*

```
-- ASN1START

NavModelNAV-KeplerianSet ::= SEQUENCE {
    navURA          INTEGER (0..15),
    navFitFlag      INTEGER (0..1),
    navToe          INTEGER (0..37799),
    navOmega        INTEGER (-2147483648..2147483647),
    navDeltaN       INTEGER (-32768..32767),
    navM0           INTEGER (-2147483648..2147483647),
    navOmegaADot    INTEGER (-8388608..8388607),
    navE            INTEGER (0..4294967295),
    navIDot         INTEGER (-8192..8191),
    navAPowerHalf   INTEGER (0..4294967295),
    navI0           INTEGER (-2147483648..2147483647),
    navOmegaA0      INTEGER (-2147483648..2147483647),
    navCrs          INTEGER (-32768..32767),
    navCis          INTEGER (-32768..32767),
    navCus          INTEGER (-32768..32767),
    navCrc          INTEGER (-32768..32767),
    navCic          INTEGER (-32768..32767),
    navCuc          INTEGER (-32768..32767),
    addNAVparam     SEQUENCE {
        ephemCodeOnL2   INTEGER (0..3),
        ephemL2Pflag    INTEGER (0..1),
        ephemSF1Rsvd    SEQUENCE {
            reserved1       INTEGER (0..8388607),   -- 23-bit field
            reserved2       INTEGER (0..16777215),  -- 24-bit field
            reserved3       INTEGER (0..16777215),  -- 24-bit field
            reserved4       INTEGER (0..65535)      -- 16-bit field
        },
        ephemAODA       INTEGER (0..31)
    }   OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***NavModelNAV-KeplerianSet* field descriptions**
navURA Parameter URA Index, SV accuracy (dimensionless) [4,7].
navFitFlag Parameter Fit Interval Flag, fit interval indication (dimensionless) [4,7]
navToe Parameter t_{oe}, time of ephemeris (seconds) [4,7]. Scale factor 2^4 seconds.
navOmega Parameter ω, argument of perigee (semi-circles) [4,7]. Scale factor 2^{-31} semi-circles.
navDeltaN Parameter Δn, mean motion difference from computed value (semi-circles/sec) [4,7]. Scale factor 2^{-43} semi-circles/second.
navM0 Parameter M_0, mean anomaly at reference time (semi-circles) [4,7]. Scale factor 2^{-31} semi-circles.
navOmegaADot Parameter $\dot{\Omega}$, rate of right ascension (semi-circles/sec) [4,7]. Scale factor 2^{-43} semi-circles/second.
navE Parameter e, eccentricity (dimensionless) [4,7]. Scale factor 2^{-33}.
navIDot Parameter IDOT, rate of inclination angle (semi-circles/sec) [4,7]. Scale factor 2^{-43} semi-circles/second.
navAPowerHalf Parameter $\sqrt{A}$, square root of semi-major axis (meters$^{1/2}$) [4,7]. Scale factor 2^{-19} meters $^{1/2}$.
navI0 Parameter i_0, inclination angle at reference time (semi-circles) [4,7]. Scale factor 2^{-31} semi-circles.
navOmegaA0 Parameter Ω_0, longitude of ascending node of orbit plane at weekly epoch (semi-circles) [4,7]. Scale factor 2^{-31} semi-circles.
navCrs Parameter C_{rs}, amplitude of sine harmonic correction term to the orbit radius (meters) [4,7]. Scale factor 2^{-5} meters.
navCis Parameter C_{is}, amplitude of sine harmonic correction term to the angle of inclination (radians) [4,7]. Scale factor 2^{-29} radians.
navCus Parameter C_{us}, amplitude of sine harmonic correction term to the argument of latitude (radians) [4,7]. Scale factor 2^{-29} radians.
navCrc Parameter C_{rc}, amplitude of cosine harmonic correction term to the orbit radius (meters) [4,7]. Scale factor 2^{-5} meters.
navCic Parameter C_{ic}, amplitude of cosine harmonic correction term to the angle of inclination (radians) [4,7]. Scale factor 2^{-29} radians.
navCuc Parameter C_{uc}, amplitude of cosine harmonic correction term to the argument of latitude (radians) [4,7]. Scale factor 2^{-29} radians.
addNAVparam These fields include data and reserved bits in the GPS NAV message [4,14]. These additional navigation parameters, if provided by the location server, allow the target device to perform data wipe-off similar to what is done by the target device with the *GNSS-DataBitAssistance.*

– *NavModelCNAV-KeplerianSet*

```
-- ASN1START

NavModelCNAV-KeplerianSet ::= SEQUENCE {
    cnavTop             INTEGER (0..2015),
    cnavURAindex        INTEGER (-16..15),
```

```
    cnavDeltaA          INTEGER (-33554432..33554431),
    cnavAdot            INTEGER (-16777216..16777215),
    cnavDeltaNo         INTEGER (-65536..65535),
    cnavDeltaNoDot      INTEGER (-4194304..4194303),
    cnavMo              INTEGER (-4294967296..4294967295),
    cnavE               INTEGER (0..8589934591),
    cnavOmega           INTEGER (-4294967296..4294967295),
    cnavOMEGA0          INTEGER (-4294967296..4294967295),
    cnavDeltaOmegaDot   INTEGER (-65536..65535),
    cnavIo              INTEGER (-4294967296..4294967295),
    cnavIoDot           INTEGER (-16384..16383),
    cnavCis             INTEGER (-32768..32767),
    cnavCic             INTEGER (-32768..32767),
    cnavCrs             INTEGER (-8388608..8388607),
    cnavCrc             INTEGER (-8388608..8388607),
    cnavCus             INTEGER (-1048576..1048575),
    cnavCuc             INTEGER (-1048576..1048575),
    ...
}

-- ASN1STOP
```

***NavModelCNAV-KeplerianSet* field descriptions**
cnavTop Parameter t_{op}, data predict time of week (seconds) [4,5,6,7]. Scale factor 300 seconds.
cnavURAindex Parameter URA_{oe} Index, SV accuracy (dimensionless) [4,5,6,7].
cnavDeltaA Parameter ΔA, semi-major axis difference at reference time (meters) [4,5,6,7]. Scale factor 2^{-9} meters.
cnavAdot Parameter $\dot{A}$, change rate in semi-major axis (meters/sec) [4,5,6,7]. Scale factor 2^{-21} meters/sec.
cnavDeltaNo Parameter Δn_0, mean motion difference from computed value at reference time (semi-circles/sec) [4,5,6,7]. Scale factor 2^{-44} semi-circles/second.
cnavDeltaNoDot Parameter $\Delta \dot{n}_0$, rate of mean motion difference from computed value (semi-circles/sec^2) [4,5,6,7]. Scale factor 2^{-57} semi-circles/second^2.
cnavMo Parameter $M_{0\text{-}n}$, mean anomaly at reference time (semi-circles) [4,5,6,7]. Scale factor 2^{-32} semi-circles.
cnavE Parameter e_n, eccentricity (dimensionless) [4,5,6,7]. Scale factor 2^{-34}.
cnavOmega Parameter ω_n, argument of perigee (semi-circles) [4,5,6,7]. Scale factor 2^{-32} semi-circles.
cnavOMEGA0 Parameter $\Omega_{0\text{-}n}$, reference right ascension angle (semi-circles) [4,5,6,7]. Scale factor 2^{-32} semi-circles.
cnavDeltaOmegaDot Parameter $\Delta\dot{\Omega}$, rate of right ascension difference (semi-circles/sec) [4,5,6,7]. Scale factor 2^{-44} semi-circles/second.
cnavIo Parameter $i_{o\text{-}n}$, inclination angle at reference time (semi-circles) [4,5,6,7]. Scale factor 2^{-32} semi-circles.
cnavIoDot Parameter $I_{0\text{-}n}$-DOT, rate of inclination angle (semi-circles/sec) [4,5,6,7]. Scale factor 2^{-44} semi-circles/second.
cnavCis Parameter $C_{is\text{-}n}$, amplitude of sine harmonic correction term to the angle of inclination (radians) [4,5,6,7]. Scale factor 2^{-30} radians.
cnavCic Parameter $C_{ic\text{-}n}$, amplitude of cosine harmonic correction term to the angle of inclination (radians) [4,5,6,7]. Scale factor 2^{-30} radians.

***NavModelCNAV-KeplerianSet* field descriptions**
cnavCrs Parameter C_{rs-n}, amplitude of sine harmonic correction term to the orbit radius (meters) [4,5,6,7]. Scale factor 2^{-8} meters.
cnavCrc Parameter C_{rc-n}, amplitude of cosine harmonic correction term to the orbit radius (meters) [4,5,6,7]. Scale factor 2^{-8} meters.
cnavCus Parameter C_{us-n}, amplitude of the sine harmonic correction term to the argument of latitude (radians) [4,5,6,7]. Scale factor 2^{-30} radians.
cnavCuc Parameter C_{uc-n}, amplitude of cosine harmonic correction term to the argument of latitude (radians) [4,5,6,7]. Scale factor 2^{-30} radians.

– *NavModel-GLONASS-ECEF*

```
-- ASN1START

NavModel-GLONASS-ECEF ::= SEQUENCE {
    gloEn               INTEGER (0..31),
    gloP1               BIT STRING (SIZE(2)),
    gloP2               BOOLEAN,
    gloM                INTEGER (0..3),
    gloX                INTEGER (-67108864..67108863),
    gloXdot             INTEGER (-8388608..8388607),
    gloXdotdot          INTEGER (-16..15),
    gloY                INTEGER (-67108864..67108863),
    gloYdot             INTEGER (-8388608..8388607),
    gloYdotdot          INTEGER (-16..15),
    gloZ                INTEGER (-67108864..67108863),
    gloZdot             INTEGER (-8388608..8388607),
    gloZdotdot          INTEGER (-16..15),
    ...
}

-- ASN1STOP
```

***NavModel-GLONASS-ECEF* field descriptions**
gloEn Parameter E_n, age of data (days) [9]. Scale factor 1 days.
gloP1 Parameter P1, time interval between two adjacent values of t_b (minutes) [9].
gloP2 Parameter P2, change of t_b flag (dimensionless) [9].
gloM Parameter M, type of satellite (dimensionless) [9].
gloX Parameter $x_n(t_b)$, x-coordinate of satellite at time t_b (kilometers) [9]. Scale factor 2^{-11} kilometers.
gloXdot Parameter $\dot{x}_n(t_b)$, x-coordinate of satellite velocity at time t_b (kilometers/sec) [9]. Scale factor 2^{-20} kilometers/second.
gloXdotdot Parameter $\ddot{x}_n(t_b)$, x-coordinate of satellite acceleration at time t_b (kilometers/sec^2) [9]. Scale factor 2^{-30} kilometers/second^2.
gloY Parameter $y_n(t_b)$, y-coordinate of satellite at time t_b (kilometers) [9]. Scale factor 2^{-11} kilometers.
gloYdot Parameter $\dot{y}_n(t_b)$, y-coordinate of satellite velocity at time t_b (kilometers/sec) [9]. Scale factor 2^{-20} kilometers/second.

***NavModel-GLONASS-ECEF* field descriptions**
gloYdotdot
Parameter $\ddot{y}_n(t_b)$, y-coordinate of satellite acceleration at time t_b (kilometers/sec^2) [9].
Scale factor 2^{-30} kilometers/second^2.
gloZ
Parameter $z_n(t_b)$, z-coordinate of satellite at time t_b (kilometers) [9].
Scale factor 2^{-11} kilometers.
gloZdot
Parameter $\dot{z}_n(t_b)$, z-coordinate of satellite velocity at time t_b (kilometers/sec) [9].
Scale factor 2^{-20} kilometers/second.
gloZdotdot
Parameter $\ddot{z}_n(t_b)$, z-coordinate of satellite acceleration at time t_b (kilometers/sec^2) [9].
Scale factor 2^{-30} kilometers/second^2.

– *NavModel-SBAS-ECEF*

```
-- ASN1START

NavModel-SBAS-ECEF ::= SEQUENCE {
    sbasTo              INTEGER (0..5399)                   OPTIONAL,   -- Cond ClockModel
    sbasAccuracy        BIT STRING (SIZE(4)),
    sbasXg              INTEGER (-536870912..536870911),
    sbasYg              INTEGER (-536870912..536870911),
    sbasZg              INTEGER (-16777216..16777215),
    sbasXgDot           INTEGER (-65536..65535),
    sbasYgDot           INTEGER (-65536..65535),
    sbasZgDot           INTEGER (-131072..131071),
    sbasXgDotDot        INTEGER (-512..511),
    sbagYgDotDot        INTEGER (-512..511),
    sbasZgDotDot        INTEGER (-512..511),
    ...
}

-- ASN1STOP
```

Conditional presence	**Explanation**
ClockModel	This field is mandatory present if *gnss-ClockModel* Model-5 is not included; otherwise it is not present.

***NavModel-SBAS-ECEF* field descriptions**
sbasTo
Parameter t_0, time of applicability (seconds) [10].
Scale factor 16 seconds.
sbasAccuracy
Parameter Accuracy, (dimensionless) [10].
sbasXg
Parameter X_G, (meters) [10].
Scale factor 0.08 meters.
sbasYg
Parameter Y_G, (meters) [10].
Scale factor 0.08 meters.
sbasZg
Parameter Z_G, (meters) [10].
Scale factor 0.4 meters.
sbasXgDot
Parameter X_G, Rate-of-Change, (meters/sec) [10].
Scale factor 0.000625 meters/second.
sbasYgDot
Parameter Y_G, Rate-of-Change, (meters/sec) [10]
Scale factor 0.000625 meters/second.
sbasZgDot
Parameter Z_G, Rate-of-Change, (meters/sec) [10].
Scale factor 0.004 meters/second.

NavModel-SBAS-ECEF field descriptions
sbasXgDotDot Parameter X_G, Acceleration, (meters/sec^2) [10]. Scale factor 0.0000125 meters/second^2.
sbagYgDotDot Parameter Y_G, Acceleration, (meters/sec^2) [10]. Scale factor 0.0000125 meters/second^2.
sbasZgDotDot Parameter Z_G Acceleration, (meters/sec^2) [10]. Scale factor 0.0000625 meters/second^2.

– *NavModel-BDS-KeplerianSet*

```
-- ASN1START

NavModel-BDS-KeplerianSet-r12 ::= SEQUENCE {
    bdsAODE-r12             INTEGER (0..31),
    bdsURAI-r12             INTEGER (0..15),
    bdsToe-r12              INTEGER (0..131071),
    bdsAPowerHalf-r12       INTEGER (0..4294967295),
    bdsE-r12                INTEGER (0..4294967295),
    bdsW-r12                INTEGER (-2147483648..2147483647),
    bdsDeltaN-r12           INTEGER (-32768..32767),
    bdsM0-r12               INTEGER (-2147483648..2147483647),
    bdsOmega0-r12           INTEGER (-2147483648..2147483647),
    bdsOmegaDot-r12         INTEGER (-8388608..8388607),
    bdsI0-r12               INTEGER (-2147483648..2147483647),
    bdsIDot-r12             INTEGER (-8192..8191),
    bdsCuc-r12              INTEGER (-131072..131071),
    bdsCus-r12              INTEGER (-131072..131071),
    bdsCrc-r12              INTEGER (-131072..131071),
    bdsCrs-r12              INTEGER (-131072..131071),
    bdsCic-r12              INTEGER (-131072..131071),
    bdsCis-r12              INTEGER (-131072..131071),
    ...
}

-- ASN1STOP
```

***NavModel-BDS-KeplerianSet* field descriptions**
bdsAODE Parameter Age of Data, Ephemeris (AODE), see [23], Table 5-8.
bdsURAI Parameter URA Index, URA is used to describe the signal-in-space accuracy in meters as defined in [23].
bdsToe Parameter t_{oe}, Ephemeris reference time (seconds) [23]. Scale factor 2^3 seconds.
bdsAPowerHalf Parameter $A^{1/2}$, Square root of semi-major axis (meters$^{1/2}$) [23]. Scale factor 2^{-19} meters$^{1/2}$.
bdsE Parameter e, Eccentricity, dimensionless [23]. Scale factor 2^{-33}.
bdsW Parameter ω, Argument of perigee (semi-circles) [23]. Scale factor 2^{-31} semi-circles.
bdsDeltaN Parameter Δn, Mean motion difference from computed value (semi-circles/sec) [23]. Scale factor 2^{-43} semi-circles/sec.
bdsM0 Parameter M_0, Mean anomaly at reference time (semi-circles) [23]. Scale factor 2^{-31} semi-circles.
bdsOmega0 Parameter Ω_0, Longitude of ascending node of orbital of plane computed according to reference time (semi-circles) [23]. Scale factor 2^{-31} semi-circles.
bdsOmegaDot Parameter $\dot{\Omega}$, Rate of right ascension (semi-circles/sec) [23]. Scale factor 2^{-43} semi-circles/sec.
bdsI0 Parameter i_0, Inclination angle at reference time (semi-circles) [23] Scale factor 2^{-31} semi-circles.
bdsIDot Parameter Idot, Rate of inclination angle (semi-circles/sec) [23]. Scale factor 2^{-43} semi-circles/sec.
bdsCuc Parameter C_{uc}, Amplitude of cosine harmonic correction term to the argument of latitude (radians) [23]. Scale factor 2^{-31} radians.
bdsCus Parameter C_{us}, Amplitude of sine harmonic correction term to the argument of latitude (radians) [23]. Scale factor 2^{-31} radians.
bdsCrc Parameter C_{rc}, Amplitude of cosine harmonic correction term to the orbit radius (meters) [23]. Scale factor 2^{-6} meters.
bdsCrs Parameter C_{rs}, Amplitude of sine harmonic correction term to the orbit radius (meters) [23]. Scale factor 2^{-6} meters.
bdsCic Parameter C_{ic}, Amplitude of cosine harmonic correction term to the angle of inclination (radians) [23]. Scale factor 2^{-31} radians.
bdsCis Parameter C_{is}, Amplitude of sine harmonic correction term to the angle of inclination (radians) [23]. Scale factor 2^{-31} radians.

– *GNSS-RealTimeIntegrity*

The IE *GNSS-RealTimeIntegrity* is used by the location server to provide parameters that describe the real-time status of the GNSS constellations. *GNSS-RealTimeIntegrity* data communicates the health of the GNSS signals to the mobile in real-time.

The location server shall always transmit the *GNSS-RealTimeIntegrity* with the current list of unhealthy signals (i.e., not only for signals/SVs currently visible at the reference location), for any GNSS positioning attempt and whenever GNSS assistance data are sent. If the number of bad signals is zero, then the *GNSS-RealTimeIntegrity* IE shall be omitted.

```
-- ASN1START

GNSS-RealTimeIntegrity ::= SEQUENCE {
    gnss-BadSignalList  GNSS-BadSignalList,
    ...
}

GNSS-BadSignalList ::= SEQUENCE (SIZE(1..64)) OF BadSignalElement

BadSignalElement ::= SEQUENCE {
    badSVID         SV-ID,
    badSignalID     GNSS-SignalIDs  OPTIONAL,   -- Need OP
    ...
}

-- ASN1STOP
```

***GNSS-RealTimeIntegrity* field descriptions**
gnss-BadSignalList This field specifies a list of satellites with bad signal or signals.
badSVID This field specifies the GNSS *SV-ID* of the satellite with bad signal or signals.
badSignalID This field identifies the bad signal or signals of a satellite. This is represented by a bit string in *GNSS-SignalIDs*, with a one-value at a bit position means the particular GNSS signal type of the SV is unhealthy; a zero-value means healthy. Absence of this field means that all signals on the specific SV are bad.

– *GNSS-DataBitAssistance*

The IE *GNSS-DataBitAssistance* is used by the location server to provide data bit assistance data for specific satellite signals for data wipe-off. The data bits included in the assistance data depends on the GNSS and its signal.

```
-- ASN1START

GNSS-DataBitAssistance ::= SEQUENCE {
    gnss-TOD                INTEGER (0..3599),
    gnss-TODfrac            INTEGER (0..999)        OPTIONAL,   -- Need ON
    gnss-DataBitsSatList    GNSS-DataBitsSatList,
    ...
}

GNSS-DataBitsSatList ::= SEQUENCE (SIZE(1..64))OF GNSS-DataBitsSatElement

GNSS-DataBitsSatElement ::= SEQUENCE {
    svID                    SV-ID,
    gnss-DataBitsSgnList    GNSS-DataBitsSgnList,
    ...
}

GNSS-DataBitsSgnList ::= SEQUENCE (SIZE(1..8)) OF GNSS-DataBitsSgnElement

GNSS-DataBitsSgnElement ::= SEQUENCE {
    gnss-SignalType         GNSS-SignalID,
    gnss-DataBits           BIT STRING (SIZE (1..1024)),
    ...
}

-- ASN1STOP
```

***GNSS-DataBitAssistance* field descriptions**
gnss-TOD This field specifies the reference time of the first bit of the data in *GNSS-DataBitAssistance* in integer seconds in GNSS specific system time, modulo 1 hour. Scale factor 1 second.
gnss-TODfrac This field specifies the fractional part of the *gnss-TOD* in 1-milli-second resolution. Scale factor 1 millisecond. The total GNSS TOD is *gnss-TOD* + *gnss-TODfrac.*
gnss-DataBitsSatList This list specifies the data bits for a particular GNSS satellite *SV-ID* and signal *GNSS-SignalID*.

***GNSS-DataBitAssistance* field descriptions**
svID This field specifies the GNSS *SV-ID* of the satellite for which the *GNSS-DataBitAssistance* is given.
gnss-SignalType This field identifies the GNSS signal type of the *GNSS-DataBitAssistance.*
gnss-DataBits Data bits are contained in GNSS system and data type specific format. In case of GPS L1 C/A, it contains the NAV data modulation bits as defined in [4] . In case of Modernized GPS L1C, it contains the encoded and interleaved modulation symbols as defined in [6] clause 3.2.3.1. In case of Modernized GPS L2C, it contains either the NAV data modulation bits, the FEC encoded NAV data modulation symbols, or the FEC encoded CNAV data modulation symbols, dependent on the current signal configuration of this satellite as defined in [4, Table 3-III]. In case of Modernized GPS L5, it contains the FEC encoded CNAV data modulation symbols as defined in [5]. In case of SBAS, it contains the FEC encoded data modulation symbols as defined in [10]. In case of QZSS QZS-L1, it contains the NAV data modulation bits as defined in [7] clause 5.2. In case of QZSS QZS-L1C, it contains the encoded and interleaved modulation symbols as defined in [7] clause 5.3. In case of QZSS QZS-L2C, it contains the encoded modulation symbols as defined in [7] clause 5.5. In case of QZSS QZS-L5, it contains the encoded modulation symbols as defined in [7] clause 5.6. In case of GLONASS, it contains the 100 sps differentially Manchester encoded modulation symbols as defined in [9] clause 3.3.2.2. In case of Galileo, it contains the FEC encoded and interleaved modulation symbols. The logical levels 1 and 0 correspond to signal levels -1 and +1, respectively. In case of BDS, it contains the encoded and interleaved modulation symbols as defined in [23, clause 5.1.3].

– *GNSS-AcquisitionAssistance*

The IE *GNSS-AcquisitionAssistance* is used by the location server to provide parameters that enable fast acquisition of the GNSS signals. Essentially, these parameters describe the range and derivatives from respective satellites to the reference location at the reference time *GNSS-SystemTime* provided in IE *GNSS-ReferenceTime*.

Whenever *GNSS-AcquisitionAssistance* is provided by the location server, the IE *GNSS-ReferenceTime* shall be provided as well. E.g., even if the target device request for assistance data includes only a request for *GNSS-AcquisitionAssistance,* the location server shall also provide the corresponding IE *GNSS-ReferenceTime.*

Figure 6.5.2.2-1 illustrates the relation between some of the fields, using GPS TOW as exemplary reference.

```
-- ASN1START

GNSS-AcquisitionAssistance ::= SEQUENCE {
    gnss-SignalID               GNSS-SignalID,
    gnss-AcquisitionAssistList  GNSS-AcquisitionAssistList,
    ...,
    confidence-r10              INTEGER (0..100)    OPTIONAL    -- Need ON
}

GNSS-AcquisitionAssistList ::= SEQUENCE (SIZE(1..64)) OF GNSS-AcquisitionAssistElement

GNSS-AcquisitionAssistElement ::= SEQUENCE {
    svID                        SV-ID,
    doppler0                    INTEGER (-2048..2047),
    doppler1                    INTEGER (0..63),
    dopplerUncertainty          INTEGER (0..4),
    codePhase                   INTEGER (0..1022),
    intCodePhase                INTEGER (0..127),
    codePhaseSearchWindow       INTEGER (0..31),
    azimuth                     INTEGER (0..511),
    elevation                   INTEGER (0..127),
    ...,
    codePhase1023               BOOLEAN             OPTIONAL,   -- Need OP
    dopplerUncertaintyExt-r10   ENUMERATED {    d60,
                                                d80,
                                                d100,
                                                d120,
                                                noInformation, ... }    OPTIONAL    -- Need ON
```

```
}

-- ASN1STOP
```

***GNSS-AcquisitionAssistance* field descriptions**
gnss-SignalID This field specifies the GNSS signal for which the acquisition assistance are provided.
gnss-AcquisitionAssistList These fields provide a list of acquisition assistance data for each GNSS satellite.
confidence This field specifies the confidence level of the reference location area or volume used to calculate the acquisition assistance parameters (search windows). A high percentage value (e.g., 98% or more) indicates to the target device that the provided search windows are reliable. The location server should include this field to indicate the confidence level of the provided information.
svID This field specifies the GNSS *SV-ID* of the satellite for which the *GNSS-AcquisitionAssistance* is given.
doppler0 This field specifies the Doppler (0^{th} order term) value. A positive value in Doppler defines the increase in satellite signal frequency due to velocity towards the target device. A negative value in Doppler defines the decrease in satellite signal frequency due to velocity away from the target device. Doppler is given in unit of m/s by multiplying the Doppler value in Hz by the nominal wavelength of the assisted signal. Scale factor 0.5 m/s in the range from -1024 m/s to +1023.5 m/s.
doppler1 This field specifies the Doppler (1^{st} order term) value. A positive value defines the rate of increase in satellite signal frequency due to acceleration towards the target device. A negative value defines the rate of decrease in satellite signal frequency due to acceleration away from the target device. Scale factor 1/210 m/s^2 in the range from -0.2 m/s^2 to +0.1 m/s^2. Actual value of Doppler (1^{st} order term) is calculated as (-42 + *doppler1*) * 1/210 m/s^2, with *doppler1* in the range of 0…63.
dopplerUncertainty This field specifies the Doppler uncertainty value. It is defined such that the Doppler experienced by a stationary target device is in the range [Doppler–Doppler Uncertainty] to [Doppler+Doppler Uncertainty]. Doppler Uncertainty is given in unit of m/s by multiplying the Doppler Uncertainty value in Hz by the nominal wavelength of the assisted signal. Defined values: 2.5 m/s, 5 m/s, 10 m/s, 20 m/s, 40 m/s as encoded by an integer *n* in the range 0-4 according to: $2^{-n}(40)$ m/s; n = 0 – 4. If the *dopplerUncertaintyExt* field is present, the target device that supports the *dopplerUncertaintyExt* shall ignore this field.
codePhase This field together with the *codePhase1023* field specifies the code phase, in units of milli-seconds, in the range from 0 to 1 millisecond scaled by the nominal chipping rate of the GNSS signal, where increasing values of the field signify increasing predicted signal code phases, as seen by a receiver at the reference location at the reference time. The reference location would typically be an *a priori* estimate of the target device location. Scale factor 2^{-10} ms in the range from 0 to $(1-2^{-10})$ ms. Note: The value $(1-2^{-10})$ ms is encoded using the *codePhase1023* IE.
intCodePhase This field contains integer code phase (expressed modulo 128 ms). The satellite integer milli-seconds code phase currently being transmitted at the reference time, as seen by a receiver at the reference location is calculated as reference time (expressed in milli-seconds) minus (*intCodePhase* + (n×128 ms)), as shown in Figure 6.5.2.2-1, with n = …-2,-1,0,1,2…. Scale factor 1 ms in the range from 0 to 127 ms.
codePhaseSearchWindow This field contains the code phase search window. The code phase search window accounts for the uncertainty in the estimated target device location but not any uncertainty in reference time. It is defined such that the expected code phase is in the range [Code Phase–Code Phase Search Window] to [Code Phase+Code Phase Search Window] given in units of milli-seconds. Range 0-31, mapping according to the table codePhaseSearchWindow Value to Interpretation Code Phase Search Window [ms] relation shown below.
azimuth This field specifies the azimuth angle. An angle of x degrees means the satellite azimuth a is in the range ($x \le a < x+0.703125$) degrees. Scale factor 0.703125 degrees.
elevation This field specifies the elevation angle. An angle of y degrees means the satellite elevation e is in the range ($y \le e < y+0.703125$) degrees. Scale factor 0.703125 degrees.

***GNSS-AcquisitionAssistance* field descriptions**
codePhase1023
This field if set to TRUE indicates that the code phase has the value $1023 \times 2^{-10} = (1-2^{-10})$ ms. This field may only be set to TRUE if the value provided in the *codePhase* IE is 1022. If this field is set to FALSE, the code phase is the value provided in the *codePhase* IE in the range from 0 to $(1 - 2\times2^{-10})$ ms. If this field is not present and the *codePhase* IE has the value 1022, the target device may assume that the code phase is between $(1 - 2\times2^{-10})$ and $(1 - 2^{-10})$ ms.
dopplerUncertaintyExt
If this field is present, the target device that supports this field shall ignore the *dopplerUncertainty* field. The location server should include this field only if supported by the target device. This field specifies the Doppler uncertainty value. It is defined such that the Doppler experienced by a stationary target device is in the range [Doppler–Doppler Uncertainty] to [Doppler+Doppler Uncertainty]. Doppler Uncertainty is given in unit of m/s by multiplying the Doppler Uncertainty value in Hz by the nominal wavelength of the assisted signal. Enumerated values define 60 m/s, 80 m/s, 100 m/s, 120 ms, and ''No Information''.

codePhaseSearchWindow Value to Interpretation Code Phase Search Window [ms] relation

***codePhaseSearchWindow* Value**	**Interpretation Code Phase Search Window [ms]**
'00000'	No information
'00001'	0,002
'00010'	0,004
'00011'	0,008
'00100'	0,012
'00101'	0,016
'00110'	0,024
'00111'	0,032
'01000'	0,048
'01001'	0,064
'01010'	0,096
'01011'	0,128
'01100'	0,164
'01101'	0,200
'01110'	0,250
'01111'	0,300
'10000'	0,360
'10001'	0,420
'10010'	0,480
'10011'	0,540
'10100'	0,600
'10101'	0,660
'10110'	0,720
'10111'	0,780
'11000'	0,850
'11001'	1,000
'11010'	1,150
'11011'	1,300
'11100'	1,450
'11101'	1,600
'11110'	1,800
'11111'	2,000

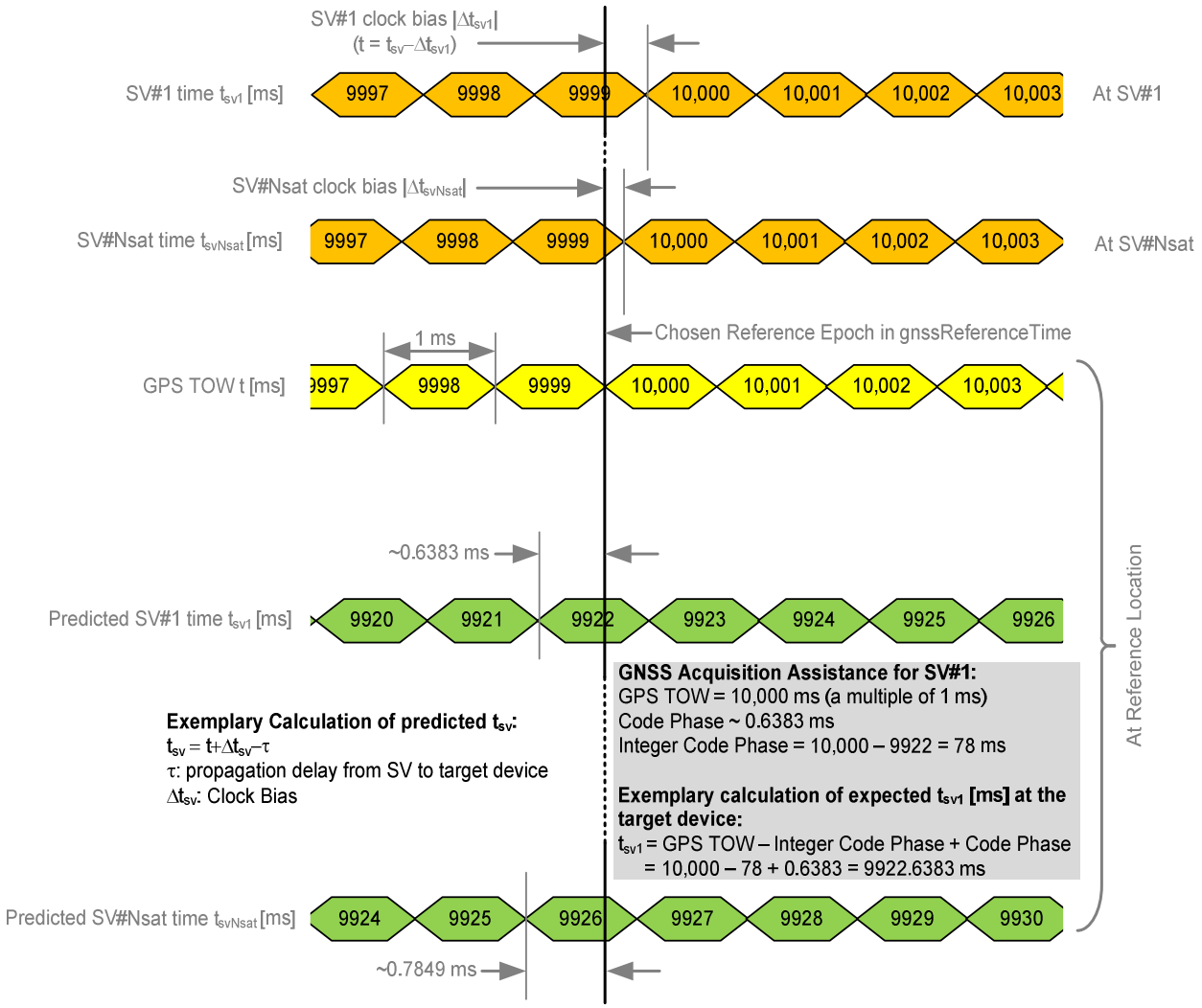

Figure 6.5.2.2-1: Exemplary calculation of some GNSS Acquisition Assistance fields.

– *GNSS-Almanac*

The IE *GNSS-Almanac* is used by the location server to provide the coarse, long-term model of the satellite positions and clocks. The meaning of these parameters is defined in relevant ICDs of the particular GNSS and GNSS specific interpretations apply. For example, GPS and QZSS use the same model parameters but some parameters have a different interpretation [7]. *GNSS-Almanac* is useful for receiver tasks that require coarse accuracy, such as determining satellite visibility. The model is valid for up to a few weeks, typically. Since it is a long-term model, the field should be provided for all satellites available in the GNSS constellation (i.e., not only for SVs visible at the reference location and including SVs flagged as unhealthy in almanac). The *completeAlmanacProvided* field indicates whether or not the location server provided almanacs for the complete GNSS constellation.

```
-- ASN1START

GNSS-Almanac ::= SEQUENCE {
    weekNumber                  INTEGER (0..255)    OPTIONAL,   -- Need ON
    toa                       INTEGER (0..255)    OPTIONAL,   -- Need ON
    ioda                        INTEGER (0..3)      OPTIONAL,   -- Need ON
    completeAlmanacProvided     BOOLEAN,
    gnss-AlmanacList            GNSS-AlmanacList,
    ...,
    [[  toa-ext-v1240           INTEGER (256..1023) OPTIONAL,   -- Need ON
        ioda-ext-v1240          INTEGER (4..15)     OPTIONAL    -- Need ON
    ]]
}

GNSS-AlmanacList ::= SEQUENCE (SIZE(1..64)) OF GNSS-AlmanacElement

GNSS-AlmanacElement ::= CHOICE {
```

```
    keplerianAlmanacSet             AlmanacKeplerianSet,        -- Model-1
    keplerianNAV-Almanac            AlmanacNAV-KeplerianSet,    -- Model-2
    keplerianReducedAlmanac         AlmanacReducedKeplerianSet, -- Model-3
    keplerianMidiAlmanac            AlmanacMidiAlmanacSet,      -- Model-4
    keplerianGLONASS                AlmanacGLONASS-AlmanacSet,  -- Model-5
    ecef-SBAS-Almanac               AlmanacECEF-SBAS-AlmanacSet,-- Model-6
    ...,
    keplerianBDS-Almanac-r12        AlmanacBDS-AlmanacSet-r12   -- Model-7
}

-- ASN1STOP
```

***GNSS-Almanac* field descriptions**
weekNumber
This field specifies the almanac reference week number in GNSS specific system time to which the almanac reference time *toa* is referenced, modulo 256 weeks. This field is required for non-GLONASS GNSS.
Note, in case of Galileo, the almanac reference week number WN_a natively contains only the 2 LSB's [8], clause 5.1.10].
toa, toa-ext
In case of *GNSS-ID* does not indicate Galileo, this field specifies the almanac reference time given in GNSS specific system time, in units of seconds with a scale factor of 2^{12}. *toa* is required for non-GLONASS GNSS.
In case of *GNSS-ID* does indicate Galileo, this field specifies the almanac reference time given in GNSS specific system time, in units of seconds with a scale factor of 600 seconds. Either *toa* or *toa-ext* is required for Galileo GNSS.
ioda, ioda-ext
This field specifies the issue of data. Either *ioda* or *ioda-ext* is required for Galileo GNSS.
completeAlmanacProvided
If set to TRUE, the *gnss-AlmanacList* contains almanacs for the complete GNSS constellation indicated by *GNSS-ID*.
gnss-AlmanacList
This list contains the almanac model for each GNSS satellite in the GNSS constellation.

– *AlmanacKeplerianSet*

```
-- ASN1START

AlmanacKeplerianSet ::= SEQUENCE {
    svID                    SV-ID,
    kepAlmanacE             INTEGER (0..2047),
    kepAlmanacDeltaI        INTEGER (-1024..1023),
    kepAlmanacOmegaDot      INTEGER (-1024..1023),
    kepSV-StatusINAV        BIT STRING (SIZE (4)),
    kepSV-StatusFNAV        BIT STRING (SIZE (2))           OPTIONAL,   -- Need ON
    kepAlmanacAPowerHalf    INTEGER (-4096..4095),
    kepAlmanacOmega0        INTEGER (-32768..32767),
    kepAlmanacW             INTEGER (-32768..32767),
    kepAlmanacM0            INTEGER (-32768..32767),
    kepAlmanacAF0           INTEGER (-32768..32767),
    kepAlmanacAF1           INTEGER (-4096..4095),
    ...
}

-- ASN1STOP
```

***AlmanacKeplerianSet* field descriptions**
svID
This field identifies the satellite for which the GNSS Almanac Model is given.
kepAlmanacE
Parameter e, eccentricity, dimensionless [8].
Scale factor 2^{-16}.
kepAlmanacDeltaI
Parameter δi, inclination at reference time relative to i_0=56°; semi-circles [8].
Scale factor 2^{-14} semi-circles.
kepAlmanacOmegaDot
Parameter $\dot{\Omega}$, rate of change of right ascension (semi-circles/sec) [8].
Scale factor 2^{-33} semi-circles/seconds.
kepSV-StatusINAV
This field contains the I/NAV signal health status [8], clause 5.1.10 , $E5b_{HS}$ and $E1\text{-}B_{HS}$, where $E5b_{HS}$ occupies the 2 MSBs in *kepSV-StatusINAV*, and $E1\text{-}B_{HS}$ the two LSBs.

***AlmanacKeplerianSet* field descriptions**
kepSV-StatusFNAV This field contains the F/NAV signal health status [8], clause 5.1.10 ,$E5a_{HS}$. If the target device is supporting multiple Galileo signals, the location server shall include this field.
kepAlmanacAPowerHalf Parameter $\Delta(a^{1/2})$, difference with respect to the square root of the nominal semi-major axis, $(meters)^{1/2}$ [8]. Scale factor 2^{-9} meters ^{½} .
kepAlmanacOmega0 Parameter $OMEGA_0$, longitude of ascending node of orbital plane at weekly epoch (semi-circles) [8]. Scale factor 2^{-15} semi-circles.
kepAlmanacW Parameter ω, argument of perigee (semi-circles) [8]. Scale factor 2^{-15} semi-circles.
kepAlmanacM0 Parameter M_0, mean anomaly at reference time (semi-circles) [8]. Scale factor 2^{-15} semi-circles.
kepAlmanacAF0 Parameter af_0, satellite clock correction bias, seconds [8]. Scale factor 2^{-19} seconds.
kepAlmanacAF1 Parameter af_1, satellite clock correction linear, sec/sec [8]. Scale factor 2^{-38} seconds/second.

– *AlmanacNAV-KeplerianSet*

```
-- ASN1START

AlmanacNAV-KeplerianSet ::= SEQUENCE {
    svID                    SV-ID,
    navAlmE                 INTEGER (0..65535),
    navAlmDeltaI            INTEGER (-32768..32767),
    navAlmOMEGADOT          INTEGER (-32768..32767),
    navAlmSVHealth          INTEGER (0..255),
    navAlmSqrtA             INTEGER (0..16777215),
    navAlmOMEGAo            INTEGER (-8388608..8388607),
    navAlmOmega             INTEGER (-8388608..8388607),
    navAlmMo                INTEGER (-8388608..8388607),
    navAlmaf0               INTEGER (-1024..1023),
    navAlmaf1               INTEGER (-1024..1023),
    ...
}

-- ASN1STOP
```

***AlmanacNAV-KeplerianSet* field descriptions**
svID This field identifies the satellite for which the GNSS Almanac Model is given.
navAlmE Parameter e, eccentricity, dimensionless [4,7]. Scale factor 2^{-21}.
navAlmDeltaI Parameter δi, correction to inclination, semi-circles [4,7]. Scale factor 2^{-19} semi-circles.
navAlmOMEGADOT Parameter $\dot{\Omega}$, rate of right ascension, semi-circles/sec [4,7]. Scale factor 2^{-38} semi-circles/second.
navAlmSVHealth Parameter SV Health, satellite health [4,7].
navAlmSqrtA Parameter $\sqrt{A}$, square root of the semi-major axis, meters$^{1/2}$ [4,7] Scale factor 2^{-11} meters$^{1/2}$.
navAlmOMEGAo Parameter Ω_0, longitude of ascending node of orbit plane at weekly epoch, semi-circles [4,7]. Scale factor 2^{-23} semi-circles.
navAlmOmega Parameter ω, argument of perigee semi-circles [4,7]. Scale factor 2^{-23} semi-circles.
navAlmMo Parameter M_0, mean anomaly at reference time semi-circles [4,7]. Scale factor 2^{-23} semi-circles.
navAlmaf0 Parameter a_{f0}, apparent satellite clock correction seconds [4,7]. Scale factor 2^{-20} seconds.
navAlmaf1 Parameter a_{f1}, apparent satellite clock correction sec/sec [4,7]. Scale factor 2^{-38} semi-circles seconds/second.

– *AlmanacReducedKeplerianSet*

```
-- ASN1START

AlmanacReducedKeplerianSet ::= SEQUENCE {
    svID                    SV-ID,
    redAlmDeltaA            INTEGER (-128..127),
    redAlmOmega0            INTEGER (-64..63),
    redAlmPhi0              INTEGER (-64..63),
    redAlmL1Health          BOOLEAN,
    redAlmL2Health          BOOLEAN,
    redAlmL5Health          BOOLEAN,
    ...
}

-- ASN1STOP
```

***AlmanacReducedKeplerianSet* field descriptions**
svID This field identifies the satellite for which the GNSS Almanac Model is given.
redAlmDeltaA Parameter δ_A, meters [4,5,6,7]. Scale factor 2^{+9} meters.
redAlmOmega0 Parameter Ω_0, semi-circles [4,5,6,7]. Scale factor 2^{-6} semi-circles.
redAlmPhi0 Parameter Φ_0, semi-circles [4,5,6,7]. Scale factor 2^{-6} semi-circles.
redAlmL1Health Parameter L1 Health, dimensionless [4,5,6,7].
redAlmL2Health Parameter L2 Health, dimensionless [4,5,6,7].
redAlmL5Health Parameter L5 Health, dimensionless [4,5,6,7].

– *AlmanacMidiAlmanacSet*

```
-- ASN1START

AlmanacMidiAlmanacSet ::= SEQUENCE {
    svID                    SV-ID,
    midiAlmE                INTEGER (0..2047),
    midiAlmDeltaI           INTEGER (-1024..1023),
    midiAlmOmegaDot         INTEGER (-1024..1023),
    midiAlmSqrtA            INTEGER (0..131071),
    midiAlmOmega0           INTEGER (-32768..32767),
    midiAlmOmega            INTEGER (-32768..32767),
    midiAlmMo               INTEGER (-32768..32767),
    midiAlmaf0              INTEGER (-1024..1023),
    midiAlmaf1              INTEGER (-512..511),
    midiAlmL1Health         BOOLEAN,
    midiAlmL2Health         BOOLEAN,
    midiAlmL5Health         BOOLEAN,
    ...
}

-- ASN1STOP
```

***AlmanacMidiAlmanacSet* field descriptions**
svID This field identifies the satellite for which the GNSS Almanac Model is given.
midiAlmE Parameter e, dimensionless [4,5,6,7]. Scale factor 2^{-16}.
midiAlmDeltaI Parameter δ_i, semi-circles [4,5,6,7]. Scale factor 2^{-14} semi-circles.
midiAlmOmegaDot Parameter $\dot{\Omega}$, semi-circles/sec [4,5,6,7]. Scale factor 2^{-33} semi-circles/second.
midiAlmSqrtA Parameter $\sqrt{A}$, meters$^{1/2}$ [4,5,6,7]. Scale factor 2^{-4} meters$^{1/2}$.
midiAlmOmega0 Parameter Ω_0, semi-circles [4,5,6,7]. Scale factor 2^{-15} semi-circles.
midiAlmOmega Parameter ω, semi-circles [4,5,6,7]. Scale factor 2^{-15} semi-circles.
midiAlmMo Parameter M_0, semi-circles [4,5,6,7]. Scale factor 2^{-15} semi-circles.
midiAlmaf0 Parameter a_{f0}, seconds [4,5,6,7]. Scale factor 2^{-20} seconds.
midiAlmaf1 Parameter a_{f1}, sec/sec [4,5,6,7]. Scale factor 2^{-37} seconds/second.
midiAlmL1Health Parameter L1 Health, dimensionless [4,5,6,7].
midiAlmL2Health Parameter L2 Health, dimensionless [4,5,6,7].
midiAlmL5Health Parameter L5 Health, dimensionless [4,5,6,7].

– *AlmanacGLONASS-AlmanacSet*

```
-- ASN1START

AlmanacGLONASS-AlmanacSet ::= SEQUENCE {
    gloAlm-NA               INTEGER (1..1461),
    gloAlmnA                INTEGER (1..24),
    gloAlmHA                INTEGER (0..31),
    gloAlmLambdaA           INTEGER (-1048576..1048575),
    gloAlmtlambdaA          INTEGER (0..2097151),
    gloAlmDeltaIa           INTEGER (-131072..131071),
    gloAlmDeltaTA           INTEGER (-2097152..2097151),
    gloAlmDeltaTdotA        INTEGER (-64..63),
    gloAlmEpsilonA          INTEGER (0..32767),
    gloAlmOmegaA            INTEGER (-32768..32767),
    gloAlmTauA              INTEGER (-512..511),
    gloAlmCA                INTEGER (0..1),
    gloAlmMA                BIT STRING (SIZE(2))           OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***AlmanacGLONASS-AlmanacSet* field descriptions**
gloAlm-NA Parameter N^A, days [9]. Scale factor 1 days.
gloAlmnA Parameter n^A, dimensionless [9].
gloAlmHA Parameter H_n^A, dimensionless [9].
gloAlmLambdaA Parameter λ_n^A, semi-circles [9]. Scale factor 2^{-20} semi-circles.
gloAlmtlambdaA Parameter $t_{\lambda n}^A$, seconds [9]. Scale factor 2^{-5} seconds.
gloAlmDeltaIa Parameter Δi_n^A, semi-circles [9]. Scale factor 2^{-20} semi-circles.
gloAlmDeltaTA Parameter ΔT_n^A, sec/orbit period [9]. Scale factor 2^{-9} seconds/orbit period.
gloAlmDeltaTdotA Parameter $\Delta T\_DOT_n^A$, sec/orbit period^2 [9]. Scale factor 2^{-14} seconds/orbit period^2.
gloAlmEpsilonA Parameter ε_n^A, dimensionless [9]. Scale factor 2^{-20}.
gloAlmOmegaA Parameter ω_n^A, semi-circles [9]. Scale factor 2^{-15} semi-circles.
gloAlmTauA Parameter τ_n^A, seconds [9]. Scale factor 2^{-18} seconds.
gloAlmCA Parameter C_n^A, dimensionless [9].
gloAlmMA Parameter M_n^A, dimensionless [9]. This parameter is present if its value is nonzero; otherwise it is not present.

– *AlmanacECEF-SBAS-AlmanacSet*

```
-- ASN1START

AlmanacECEF-SBAS-AlmanacSet ::= SEQUENCE {
    sbasAlmDataID           INTEGER (0..3),
    svID                    SV-ID,
    sbasAlmHealth           BIT STRING (SIZE(8)),
    sbasAlmXg               INTEGER (-16384..16383),
    sbasAlmYg               INTEGER (-16384..16383),
    sbasAlmZg               INTEGER (-256..255),
    sbasAlmXgdot            INTEGER (-4..3),
    sbasAlmYgDot            INTEGER (-4..3),
    sbasAlmZgDot            INTEGER (-8..7),
    sbasAlmTo               INTEGER (0..2047),
    ...
}

-- ASN1STOP
```

***AlmanacECEF-SBAS-AlmanacSet* field descriptions**
sbasAlmDataID Parameter Data ID, dimensionless [10].
svID This field identifies the satellite for which the GNSS Almanac Model is given.
sbasAlmHealth Parameter Health, dimensionless [10].
sbasAlmXg Parameter X_G, meters [10]. Scale factor 2600 meters.
sbasAlmYg Parameter Y_G, meters [10]. Scale factor 2600 meters.
sbasAlmZg Parameter Z_G, meters [10]. Scale factor 26000 meters.
sbasAlmXgdot Parameter X_G Rat-of-Change, meters/sec [10]. Scale factor 10 meters/second.
sbasAlmYgDot Parameter Y_G Rate-of-Change, meters/sec [10]. Scale factor 10 meters/second.
sbasAlmZgDot Parameter Z_G Rate-of-Change, meters/sec [10]. Scale factor 40.96 meters/second.
sbasAlmTo Parameter t_0, seconds [10]. Scale factor 64 meters/seconds.

– *AlmanacBDS-AlmanacSet*

```
-- ASN1START

AlmanacBDS-AlmanacSet-r12 ::= SEQUENCE {
    svID                    SV-ID,
    bdsAlmToa-r12           INTEGER (0..255)                    OPTIONAL,   -- Cond NotSameForAllSV
    bdsAlmSqrtA-r12         INTEGER (0..16777215),
    bdsAlmE-r12             INTEGER (0..131071),
    bdsAlmW-r12             INTEGER (-8388608..8388607),
    bdsAlmM0-r12            INTEGER (-8388608..8388607),
    bdsAlmOmega0-r12        INTEGER (-8388608..8388607),
    bdsAlmOmegaDot-r12      INTEGER (-65536..65535),
    bdsAlmDeltaI-r12        INTEGER (-32768..32767),
    bdsAlmA0-r12            INTEGER (-1024..1023),
    bdsAlmA1-r12            INTEGER (-1024..1023),
    bdsSvHealth-r12         BIT STRING (SIZE(9))                OPTIONAL,   -- Cond SV-ID
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
NotSameForAllSV	This field may be present if the t_{oa} is not the same for all SVs; otherwise it is not present and the t_{oa} is provided in *GNSS-Almanac*.
SV-ID	This field is mandatory present if *SV-ID* is between 0 and 29; otherwise it is not present.

***AlmanacBDS-AlmanacSet* field descriptions**
svID This field identifies the satellite for which the GNSS Almanac Model is given.
bdsAlmToa Parameter t_{oa}, Almanac reference time(seconds) [23] Scale factor 2^{12} seconds.
bdsAlmSqrtA Parameter $A^{1/2}$, Square root of semi-major axis (meters$^{1/2}$) [23] Scale factor 2^{-11} meters$^{1/2}$.
bdsAlmE Parameter e, Eccentricity, dimensionless [23] Scale factor 2^{-21}.
bdsAlmW Parameter ω, Argument of Perigee (semi-circles) [23] Scale factor 2^{-23} semi-circles.
bdsAlmM0 Parameter $M_{0,}$ Mean anomaly at reference time (semi-circles) [23] Scale factor 2^{-23} semi-circles.
bdsAlmOmega0 Parameter $\Omega_{0,}$ Longitude of ascending node of orbital plane computed according to reference time (semi-circles) [23] Scale factor 2^{-23} semi-circles.
bdsAlmOmegaDot Parameter $\dot{\Omega}$, Rate of right ascension (semi-circles/sec) [23] Scale factor 2^{-38} semi-circles/sec.
bdsAlmDeltaI Parameter δ_i, Correction of orbit reference inclination at reference time (semi-circles) [23] Scale factor 2^{-19} semi-circles.
bdsAlmA0 Parameter a_0, Satellite clock bias (seconds) [23] Scale factor 2^{-20} seconds.
bdsAlmA1 Parameter a_1, Satellite clock rate (sec/sec) [23] Scale factor 2^{-38} sec/sec.
bdsSvHealth This field indicates satellites health information as defined in [23] Table 5-15. The left most bit is the MSB.

– *GNSS-UTC-Model*

The IE *GNSS-UTC-Model* is used by the location server to provide several sets of parameters needed to relate GNSS system time to Universal Time Coordinate (UTC), as defined in [4], [5], [6], [7], [8], [9], [10], [23].

The UTC time standard, UTC(k), is GNSS specific. E.g., if *GNSS-ID* indicates GPS, *GNSS-UTC-Model* contains a set of parameters needed to relate GPS system time to UTC(USNO); if *GNSS-ID* indicates QZSS, *GNSS-UTC-Model* contains a set of parameters needed to relate QZST to UTC(NICT); if *GNSS-ID* indicates GLONASS, *GNSS-UTC-Model* contains a set of parameters needed to relate GLONASS system time to UTC(RU); if *GNSS-ID* indicates SBAS, *GNSS-UTC-Model* contains a set of parameters needed to relate SBAS network time for the SBAS indicated by *SBAS-ID* to the UTC standard defined by the UTC Standard ID; if *GNSS-ID* indicates BDS, *GNSS-UTC-Model* contains a set of parameters needed to relate BDS system time to UTC (NTSC).

```
-- ASN1START

GNSS-UTC-Model ::= CHOICE {
    utcModel1           UTC-ModelSet1,          -- Model-1
    utcModel2           UTC-ModelSet2,          -- Model-2
    utcModel3           UTC-ModelSet3,          -- Model-3
    utcModel4           UTC-ModelSet4,          -- Model-4
    ...,
    utcModel5-r12       UTC-ModelSet5-r12       -- Model-5
}

-- ASN1STOP
```

– *UTC-ModelSet1*

```
-- ASN1START
```

```
UTC-ModelSet1 ::= SEQUENCE {
    gnss-Utc-A1         INTEGER (-8388608..8388607),
    gnss-Utc-A0         INTEGER (-2147483648..2147483647),
    gnss-Utc-Tot        INTEGER (0..255),
    gnss-Utc-WNt        INTEGER (0..255),
    gnss-Utc-DeltaTls   INTEGER (-128..127),
    gnss-Utc-WNlsf      INTEGER (0..255),
    gnss-Utc-DN         INTEGER (-128..127),
    gnss-Utc-DeltaTlsf  INTEGER (-128..127),
    ...
}

-- ASN1STOP
```

***UTC-ModelSet1* field descriptions**
gnss-Utc-A1 Parameter A_1, scale factor 2^{-50} seconds/second [4,7,8].
gnss-Utc-A0 Parameter A_0, scale factor 2^{-30} seconds [4,7,8].
gnss-Utc-Tot Parameter t_{ot}, scale factor 2^{12} seconds [4,7,8].
gnss-Utc-WNt Parameter WN_t, scale factor 1 week [4,7,8].
gnss-Utc-DeltaTls Parameter Δt_{LS}, scale factor 1 second [4,7,8].
gnss-Utc-WNlsf Parameter WN_{LSF}, scale factor 1 week [4,7,8].
gnss-Utc-DN Parameter DN, scale factor 1 day [4,7,8].
gnss-Utc-DeltaTlsf Parameter Δt_{LSF}, scale factor 1 second [4,7,8].

– *UTC-ModelSet2*

```
-- ASN1START

UTC-ModelSet2 ::= SEQUENCE {
    utcA0               INTEGER (-32768..32767),
    utcA1               INTEGER (-4096..4095),
    utcA2               INTEGER (-64..63),
    utcDeltaTls         INTEGER (-128..127),
    utcTot              INTEGER (0..65535),
    utcWNot             INTEGER (0..8191),
    utcWNlsf            INTEGER (0..255),
    utcDN               BIT STRING (SIZE(4)),
    utcDeltaTlsf        INTEGER (-128..127),
    ...
}

-- ASN1STOP
```

***UTC-ModelSet2* field descriptions**
utcA0 Parameter $A_{0\text{-}n}$, bias coefficient of GNSS time scale relative to UTC time scale (seconds) [4,5,6,7]. Scale factor 2^{-35} seconds.
utcA1 Parameter $A_{1\text{-}n}$, drift coefficient of GNSS time scale relative to UTC time scale (sec/sec) [4,5,6,7]. Scale factor 2^{-51} seconds/second.
utcA2 Parameter $A_{2\text{-}n}$, drift rate correction coefficient of GNSS time scale relative to UTC time scale (sec/sec^2) [4,5,6,7]. Scale factor 2^{-68} seconds/second^2.
utcDeltaTls Parameter Δt_{LS}, current or past leap second count (seconds) [4,5,6,7]. Scale factor 1 second.
utcTot Parameter t_{ot}, time data reference time of week (seconds) [4,5,6,7]. Scale factor 2^4 seconds.

***UTC-ModelSet2* field descriptions**
utcWNot Parameter WN_{ot}, time data reference week number (weeks) [4,5,6,7]. Scale factor 1 week.
utcWNlsf Parameter WN_{LSF}, leap second reference week number (weeks) [4,5,6,7]. Scale factor 1 week.
utcDN Parameter DN, leap second reference day number (days) [4,5,6,7]. Scale factor 1 day.
utcDeltaTlsf Parameter Δt_{LSF}, current or future leap second count (seconds) [4,5,6,7]. Scale factor 1 second.

– *UTC-ModelSet3*

```
-- ASN1START

UTC-ModelSet3 ::= SEQUENCE {
    nA                  INTEGER (1..1461),
    tauC                INTEGER (-2147483648..2147483647),
    b1                  INTEGER (-1024..1023)                   OPTIONAL,   -- Cond GLONASS-M
    b2                  INTEGER (-512..511)                 OPTIONAL,   -- Cond GLONASS-M
    kp                  BIT STRING (SIZE(2))                    OPTIONAL,   -- Cond GLONASS-M
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
GLONASS-M	The field is mandatory present if GLONASS-M satellites are present in the current GLONASS constellation; otherwise it is not present.

***UTC-ModelSet3* field descriptions**
nA Parameter N^A, calendar day number within four-year period beginning since the leap year (days) [9]. Scale factor 1 day.
tauC Parameter τ_c, GLONASS time scale correction to UTC(SU) (seconds) [9]. Scale factor 2^{-31} seconds.
b1 Parameter B1, coefficient to determine ΔUT1 (seconds) [9]. Scale factor 2^{-10} seconds.
b2 Parameter B2, coefficient to determine ΔUT1 (seconds/msd) [9]. Scale factor 2^{-16} seconds/msd.
kp Parameter KP, notification of expected leap second correction (dimensionless) [9].

– *UTC-ModelSet4*

```
-- ASN1START

UTC-ModelSet4 ::= SEQUENCE {
    utcA1wnt            INTEGER (-8388608..8388607),
    utcA0wnt            INTEGER (-2147483648..2147483647),
    utcTot              INTEGER (0..255),
    utcWNt              INTEGER (0..255),
    utcDeltaTls         INTEGER (-128..127),
    utcWNlsf            INTEGER (0..255),
    utcDN               INTEGER (-128..127),
    utcDeltaTlsf        INTEGER (-128..127),
    utcStandardID       INTEGER (0..7),
    ...
}
```

```
-- ASN1STOP
```

***UTC-ModelSet4* field descriptions**
utcA1wnt Parameter A_{1WNT}, sec/sec ([10], Message Type 12). Scale factor 2^{-50} seconds/second.
utcA0wnt Parameter A_{0WNT}, seconds ([10], Message Type 12). Scale factor 2^{-30} seconds.
utcTot Parameter t_{ot}, seconds ([10], Message Type 12). Scale factor 2^{12} seconds.
utcWNt Parameter WN_t, weeks ([10], Message Type 12). Scale factor 1 week.
utcDeltaTls Parameter Δt_{LS}, seconds ([10], Message Type 12). Scale factor 1 second.
utcWNlsf Parameter WN_{LSF}, weeks ([10], Message Type 12). Scale factor 1 week.
utcDN Parameter DN, days ([10], Message Type 12). Scale factor 1 day.
utcDeltaTlsf Parameter Δt_{LSF}, seconds ([10], Message Type 12). Scale factor 1 second.
utcStandardID If *GNSS-ID* indicates 'sbas', this field indicates the UTC standard used for the SBAS network time indicated by *SBAS-ID* to UTC relation as defined in the table Value of UTC Standard ID to UTC Standard relation shown below ([10], Message Type 12).

Value of UTC Standard ID to UTC Standard relation

Value of UTC Standard ID	UTC Standard
0	UTC as operated by the Communications Research Laboratory (CRL), Tokyo, Japan
1	UTC as operated by the National Institute of Standards and Technology (NIST)
2	UTC as operated by the U. S. Naval Observatory (USNO)
3	UTC as operated by the International Bureau of Weights and Measures (BIPM)
4-7	Reserved for future definition

– *UTC-ModelSet5*

```
-- ASN1START

UTC-ModelSet5-r12 ::= SEQUENCE {
    utcA0-r12           INTEGER (-2147483648..2147483647),
    utcA1-r12           INTEGER (-8388608..8388607),
    utcDeltaTls-r12     INTEGER (-128..127),
    utcWNlsf-r12        INTEGER (0..255),
    utcDN-r12           INTEGER (0..255),
    utcDeltaTlsf-r12    INTEGER (-128..127),
    ...
}

-- ASN1STOP
```

***UTC-ModelSet5* field descriptions**
utcA0 Parameter A_{0UTC}, BDS clock bias relative to UTC, seconds [23]. Scale factor 2^{-30} seconds.

***UTC-ModelSet5* field descriptions**
utcA1 Parameter A_{1UTC}, BDS clock rate relative to UTC, sec/sec [23]. Scale factor 2^{-50} sec/sec.
utcDeltaTls Parameter Δt_{LS}, delta time due to leap seconds before the new leap second effective, seconds [23]. Scale factor 1 second.
utcWNlsf Parameter WN_{LSF}, week number of the new leap second, weeks [23]. Scale factor 1 week.
utcDN Parameter DN, day number of week of the new leap second, days [23]. Scale factor 1 day.
utcDeltaTlsf Parameter Δt_{LSF}, delta time due to leap seconds after the new leap second effective, seconds [23]. Scale factor 1 second.

– *GNSS-AuxiliaryInformation*

The IE *GNSS-AuxiliaryInformation* is used by the location server to provide additional information dependent on the *GNSS-ID*. If *GNSS-AuxiliaryInformation* is provided together with other satellite dependent GNSS assistance data (i.e., any of *GNSS-DifferentialCorrections*, *GNSS-NavigationModel*, *GNSS-DataBitAssistance*, or *GNSS-AcquisitionAssistance* IEs), the *GNSS-AuxiliaryInformation* should be provided for the same satellites and in the same LPP message as the other satellite dependent GNSS assistance data.

```
-- ASN1START

GNSS-AuxiliaryInformation ::= CHOICE {
    gnss-ID-GPS     GNSS-ID-GPS,
    gnss-ID-GLONASS GNSS-ID-GLONASS,
    ...
}

GNSS-ID-GPS ::= SEQUENCE    (SIZE(1..64)) OF GNSS-ID-GPS-SatElement

GNSS-ID-GPS-SatElement ::= SEQUENCE {
    svID                SV-ID,
    signalsAvailable    GNSS-SignalIDs,
    ...
}

GNSS-ID-GLONASS ::= SEQUENCE (SIZE(1..64)) OF GNSS-ID-GLONASS-SatElement

GNSS-ID-GLONASS-SatElement ::= SEQUENCE {
    svID                SV-ID,
    signalsAvailable    GNSS-SignalIDs,
    channelNumber       INTEGER (-7..13)        OPTIONAL,       -- Cond FDMA
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
FDMA	The field is mandatory present if the GLONASS SV indicated by *svID* broadcasts FDMA signals; otherwise it is not present.

***GNSS-AuxiliaryInformation* field descriptions**
gnss-ID-GPS This choice may only be present if *GNSS-ID* indicates GPS.
gnss-ID-GLONASS This choice may only be present if *GNSS-ID* indicates GLONASS.
svID This field specifies the GNSS SV for which the *GNSS-AuxiliaryInformation* is given.
signalsAvailable This field indicates the ranging signals supported by the satellite indicated by *svID*. This field is given as a bit string as defined in *GNSS-SignalIDs* for a particular GNSS. If a bit is set to '1' it indicates that the satellite identified by *svID* transmits ranging signals according to the signal correspondence in *GNSS-SignalIDs*. If a bit is set to '0' it indicates that the corresponding signal is not supported on the satellite identified by *svID*.
channelNumber This field indicates the GLONASS carrier frequency number of the satellite identified by *svID*, as defined in [9].

– *BDS-DifferentialCorrections*

The IE *BDS-DifferentialCorrections* is used by the location server to provide differential corrections to the target device.

```
-- ASN1START

BDS-DifferentialCorrections-r12 ::= SEQUENCE {
    dbds-RefTime-r12            INTEGER (0..3599),
    bds-SgnTypeList-r12         BDS-SgnTypeList-r12,
    ...
}

BDS-SgnTypeList-r12 ::= SEQUENCE (SIZE (1..3)) OF BDS-SgnTypeElement-r12

BDS-SgnTypeElement-r12 ::= SEQUENCE {
    gnss-SignalID               GNSS-SignalID               OPTIONAL,   -- Need ON
    dbds-CorrectionList-r12     DBDS-CorrectionList-r12,
    ...
}

DBDS-CorrectionList-r12 ::= SEQUENCE (SIZE (1..64)) OF DBDS-CorrectionElement-r12

DBDS-CorrectionElement-r12 ::= SEQUENCE {
    svID                        SV-ID,
    bds-UDREI-r12               INTEGER (0..15),
    bds-RURAI-r12               INTEGER (0..15),
    bds-ECC-DeltaT-r12          INTEGER (-4096..4095),
    ...
}

-- ASN1STOP
```

***BDS-DifferentialCorrections* field descriptions**
dbds-RefTime This field *specifies* the time for which the differential corrections are valid, modulo 1 hour. d*bds-RefTime* is given in BDS system time. Scale factor 1-second.
bds-UDREI This field indicates user differential range error information by user differential range error index (UDREI) as defined in [23], clause 5.3.3.7.2.
bds-RURAI This field indicates Regional User Range Accuracy (RURA) information by Regional User Range Accuracy Index (UDREI) as defined in [23], clause 5.3.3.6.
bds-ECC-DeltaT This field indicates the BDS differential correction information which is expressed in equivalent clock correction (Δt). Add the value of Δt to the observed pseudo-range to correct the effect caused by the satellite clock offset and ephemeris error. Value -4096 means the Δt is not available. The scale factor is 0.1 meter.

– *BDS-GridModelParameter*

```
-- ASN1START

BDS-GridModelParameter-r12 ::= SEQUENCE {
    bds-RefTime-r12         INTEGER (0..3599),
    gridIonList-r12         GridIonList-r12,
    ...
}

GridIonList-r12 ::= SEQUENCE (SIZE (1..320)) OF GridIonElement-r12

GridIonElement-r12 ::= SEQUENCE {
    igp-ID-r12              INTEGER (1..320),
    dt-r12                  INTEGER (0..511),
    givei-r12               INTEGER (0..15) ,
    ...
}

-- ASN1STOP
```

***BDS-GridModelParamater* field descriptions**
bds-RefTime This field specifies the time for which the grid model parameters are valid, modulo 1 hour. *bds-RefTime* is given in BDS system time. Scale factor 1-second.
gridIonList This list provides ionospheric grid point information for each grid point. Up to 16 instances are used in this version of the specification. The values 17 to 320 are reserved for future use.
igp-ID This field indicates the ionospheric grid point (IGP) number as defined in [23], clause 5.3.3.8.
dt This field indicates d_T as defined in [23], clause 5.3.3.8.1, i.e. the vertical delay at the corresponding IGP indicated by *igp-ID*. The scale factor is 0.125 meter.
givei This field indicates the Grid Ionospheric Vertical Error Index (GIVEI) which is used to describe the delay correction accuracy at ionospheric grid point indicated by *igp-ID*, the mapping between GIVEI and GIVE is defined in [23], clause 5.3.3.8.2.

– *GNSS-RTK-Observations*

The IE *GNSS-RTK-Observations* is used by the location server to provide GNSS reference station observables (pseudorange, phaserange, phaserange-rate (Doppler), and carrier-to-noise ratio) of the GNSS signals. Essentially, these parameters describe the range and derivatives from respective satellites to the reference station location provided in IE *GNSS-RTK-ReferenceStationInfo*.

The parameters provided in IE *GNSS-RTK-Observations* are used as specified for message type 1071-1127 in [30].

```
-- ASN1START

GNSS-RTK-Observations-r15 ::= SEQUENCE {
    epochTime-r15                           GNSS-SystemTime,
    gnss-ObservationList-r15                GNSS-ObservationList-r15,
    ...
}

GNSS-ObservationList-r15 ::= SEQUENCE (SIZE(1..64)) OF GNSS-RTK-SatelliteDataElement-r15

GNSS-RTK-SatelliteDataElement-r15 ::= SEQUENCE{
    svID-r15                                SV-ID,
    integer-ms-r15                          INTEGER (0..254)                OPTIONAL,   -- Need ON
    rough-range-r15                         INTEGER (0..1023),
    rough-phase-range-rate-r15              INTEGER (-8192..8191)           OPTIONAL,   -- Need ON
    gnss-rtk-SatelliteSignalDataList-r15    GNSS-RTK-SatelliteSignalDataList-r15,
    ...
}

GNSS-RTK-SatelliteSignalDataList-r15 ::= SEQUENCE (SIZE(1..24)) OF
                                                    GNSS-RTK-SatelliteSignalDataElement-r15
```

```
GNSS-RTK-SatelliteSignalDataElement-r15 ::= SEQUENCE {
    gnss-SignalID-r15                   GNSS-SignalID,
    fine-PseudoRange-r15                INTEGER (-524288..524287),
    fine-PhaseRange-r15                 INTEGER (-8388608..8388607),
    lockTimeIndicator-r15               INTEGER (0..1023),
    halfCycleAmbiguityIndicator-r15     BIT STRING (SIZE (1)),
    carrier-to-noise-ratio-r15          INTEGER (0..1023)                   OPTIONAL,   -- Need ON
    fine-PhaseRangeRate-r15             INTEGER (-16384..16383)             OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***GNSS-RTK-Observations* field descriptions**
epochTime This field specifies the epoch time of the observations. The *gnss-TimeID* in *GNSS SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement.*
svID This field specifies the GNSS *SV-ID* of the satellite for which the GNSS Observations are provided.
integer-ms This field contains the integer number of milliseconds in the satellite rough range. Rough range can be used to restore complete observables for a given satellite. Scale factor 1 milli-second in the range from 0 to 254 milli-seconds.
rough-range This field contains the sub-milliseconds in the satellite rough range (modulo 1 millisecond). Scale factor 2^{-10} milli-seconds in the range from 0 to $(1-2^{-10})$ milli-seconds.
rough-phase-range-rate This field contains the GNSS satellite rough phaserange rate. Scale factor 1 m/s. Range ±8191 m/s.
gnss-SignalID This field specifies the GNSS signal for which the GNSS observations are provided.
fine-PseudoRange This field contains the GNSS signal fine pseudorange. Being added to fields *integer-ms* and *rough-range* allows getting the full pseudorange observable corresponding to given signal. NOTE 1. Scale factor 2^{-29} milli-seconds. Range $\pm(2^{-10}–2^{-29})$ milli-seconds.
fine-PhaseRange This field contains the GNSS signal fine phaserange. Being added to fields *integer-ms* and *rough-range* allows getting the full phaserange observable corresponding to given signal. NOTE 2. Scale factor 2^{-31} milli-seconds. Range $\pm(2^{-8}–2^{-31})$ milli-seconds.
lockTimeIndicator This field provides a measure of the amount of time during which the receiver has maintained continuous lock on that satellite signal. If a cycle slip occurs during the previous measurement cycle, the lock time indicator shall be reset to zero. Mapping according to the table *lockTimeIndicator* value to interpretation lock-time relation shown below.
halfCycleAmbiguityIndicator Value 0 indicates no half-cycle ambiguity. Value 1 indicates half-cycle ambiguity. When providing phaserange with unresolved polarity encoding this bit shall be set to 1. A target device that is not capable of handling half-cycle ambiguities shall skip such phaserange observables. If polarity resolution forced phaserange to be corrected by half-a-cycle, then the *lockTimeIndicator* must be reset to zero, indicating that despite continuous tracking the final phaserange experienced non-continuity.
carrier-to-noise-ratio This field provides the GNSS signal carrier-to-noise-ratio in dB-Hz. Scale factor 2^{-4} dB-Hz in the range from 0.0625 to 63.9375 dB-Hz.
fine-PhaseRangeRate This field contains the GNSS signal fine Phase Range Rate. Full phaserange rate is the sum of this field and the *rough-phase-range-rate* field. NOTE 3. Scale factor 0.0001 m/s. Range ±1.6383 m/s.

NOTE 1: Complete Pseudorange for each signal (i) of given satellite can be restored as follows:
Pseudorange(i) = c/1000 × (*integer-ms* + *rough_range*/1024 + 2^{-29} × *fine_Pseudorange*(i)), meter.

NOTE 2: Complete Phaserange for each signal (i) of given satellite can be restored as follows:
Phaserange(i) = c/1000 × (*integer-ms* + *rough_range*/1024 + 2^{-31} × *fine_Phaserange*(i)), meter.

NOTE 3: Complete PhaseRangeRate for each signal (i) of given satellite can be restored as follows: PhaseRangeRate(i) = *rough-phase-range-rate* + 0.0001**fine-PhaseRangeRate* (i), meter/sec.

NOTE 4: The speed of light c is 299,792,458 meters per second.

***lockTimeIndicator* value to interpretation lock-time relation**

Indicator (i)	Supplementary coefficient (k)	Minimum Lock Time (ms)	Range of Indicated Lock Times (t) (ms)
0 – 63	1	i	0 ≤ t < 64
64 – 95	2	2 × i – 64	64 ≤ t < 128
96 – 127	4	4 × i – 256	128 ≤ t < 256
128 – 159	8	8 × i – 768	256 ≤ t < 512
160 – 191	16	16 × i – 2048	512 ≤ t < 1024
192 – 223	32	32 × i – 5120	1024 ≤ t < 2048
224 – 255	64	64 × i – 12288	2048 ≤ t < 4096
256 – 287	128	128 × i – 28672	4096 ≤ t < 8192
288 – 319	256	256 × i – 65536	8192 ≤ t < 16384
320 – 351	512	512 × i – 147456	16384 ≤ t < 32768
352 – 383	1024	1024 × i – 327680	32768 ≤ t < 65536
384 – 415	2048	2048 × i – 720896	65536 ≤ t < 131072
416 – 447	4096	4096 × i – 1572864	131072 ≤ t < 262144
448 – 479	8192	8192 × i – 3407872	262144 ≤ t < 524288
480 – 511	16384	16384 × i – 7340032	524288 ≤ t < 1048576
512 – 543	32768	32768 × i – 15728640	1048576 ≤ t < 2097152
544 – 575	65536	65536 × i – 33554432	2097152 ≤ t < 4194304
576 – 607	131072	131072 × i – 71303168	4194304 ≤ t < 8388608
608 – 639	262144	262144 × i – 150994944	8388608 ≤ t < 16777216
640 – 671	524288	524288 × i – 318767104	16777216 ≤ t < 33554432
672 – 703	1048576	1048576 × i – 671088640	33554432 ≤ t < 67108864
704	2097152	2097152 × i – 1409286144	67108864 ≤ t
705 – 1023	Reserved		

– *GLO-RTK-BiasInformation*

The IE *GLO-RTK-BiasInformation* is used by the location server to provide the so-called "GLONASS Code-Phase bias values" (CPB) for up to all FDMA GLONASS observations.

If IE *GNSS-RTK-Observations* for *gnss-ID = glonass* are provided, but IE *GLO-RTK-BiasInformation* is not provided, the target device assumes that the CPB information has been applied to the GLONASS observation data a priori.

The parameters provided in IE *GLO-RTK-BiasInformation* are used as specified for message type 1230 in [30].

```
-- ASN1START

GLO-RTK-BiasInformation-r15 ::= SEQUENCE{
    referenceStationID-r15      GNSS-ReferenceStationID-r15,
    cpbIndicator-r15            BIT STRING (SIZE(1)),
    l1-ca-cpBias-r15            INTEGER (-32768..32767)         OPTIONAL,       -- Need ON
    l1-p-cpBias-r15             INTEGER (-32768..32767)         OPTIONAL,       -- Need ON
    l2-ca-cpBias-r15            INTEGER (-32768..32767)         OPTIONAL,       -- Need ON
    l2-p-cpBias-r15             INTEGER (-32768..32767)         OPTIONAL,       -- Need ON
    ...
}

-- ASN1STOP
```

***GLO-RTK-BiasInformation* field descriptions**
referenceStationID
This field specifies the Station ID for which the *GLO-RTK-BiasInformation* is provided.

***GLO-RTK-BiasInformation* field descriptions**
cpbIndicator This field specifies the GLONASS Code-Phase Bias Indicator. The interpretation of the value is as follows: 0 – The GLONASS Pseudorange and Phaserange observations in IE *GNSS-RTK-Observations* are not aligned to the same measurement epoch. 1 – The GLONASS Pseudorange and Phaserange observations in IE *GNSS-RTK-Observations* are aligned to the same measurement epoch.
l1-ca-cpBias This field specifies the GLONASS L1 C/A Code-Phase Bias, which represents the offset between the L1 C/A Pseudorange and L1 Phaserange measurement epochs in meters. If *cpbIndicator* is set to 0, the measurement epoch of the GLONASS L1 Phaserange measurements may be aligned using: Aligned GLONASS L1 Phaserange = Full GLONASS L1 Phaserange + GLONASS L1 C/A Code-Phase Bias. If *cpbIndicator* is set to 1, the measurement epoch of the GLONASS L1 Phaserange measurements may be unaligned using: Unaligned GLONASS L1 Phaserange = Full GLONASS L1 Phaserange – GLONASS L1 C/A Code-Phase Bias. Scale factor 0.02 m. Range ±655.34 m.
l1-p-cpBias This field specifies the GLONASS L1 P Code-Phase Bias, which represents the offset between the L1 P Pseudorange and L1 Phaserange measurement epochs in meters. If *cpbIndicator* is set to 0, the measurement epoch of the GLONASS L1 Phaserange measurements may be aligned using: Aligned GLONASS L1 Phaserange = Full GLONASS L1 Phaserange + GLONASS L1 P Code-Phase Bias. If *cpbIndicator* is set to 1, the measurement epoch of the GLONASS L1 Phaserange measurements may be unaligned using: Unaligned GLONASS L1 Phaserange = Full GLONASS L1 Phaserange – GLONASS L1 P Code-Phase Bias. Scale factor 0.02 m. Range ±655.34 m.
l2-ca-cpBias This field specifies the GLONASS L2 C/A Code-Phase Bias, which represents the offset between the L2 C/A Pseudorange and L2 Phaserange measurement epochs in meters. If *cpbIndicator* is set to 0, the measurement epoch of the GLONASS L2 Phaserange measurements may be aligned using: Aligned GLONASS L2 Phaserange = Full GLONASS L2 Phaserange + GLONASS L2 C/A Code-Phase Bias. If *cpbIndicator* is set to 1, the measurement epoch of the GLONASS L2 Phaserange measurements may be unaligned using: Unaligned GLONASS L2 Phaserange = Full GLONASS L2 Phaserange – GLONASS L2 C/A Code-Phase Bias. Scale factor 0.02 m. Range ±655.34 m.
l2-p-cpBias This field specifies the GLONASS L2 P Code-Phase Bias, which represents the offset between the L2 P Pseudorange and L2 Phaserange measurement epochs in meters. If *cpbIndicator* is set to 0, the measurement epoch of the GLONASS L2 Phaserange measurements may be aligned using: Aligned GLONASS L2 Phaserange = Full GLONASS L2 Phaserange + GLONASS L2 P Code-Phase Bias. If *cpbIndicator* is set to 1, the measurement epoch of the GLONASS L2 Phaserange measurements may be unaligned using: Unaligned GLONASS L2 Phaserange = Full GLONASS L2 Phaserange – GLONASS L2 P Code-Phase Bias. Scale factor 0.02 m. Range ±655.34 m.

– *GNSS-RTK-MAC-CorrectionDifferences*

The IE *GNSS-RTK-MAC-CorrectionDifferences* is used by the location server to provide dispersive (ionospheric) and non-dispersive (geometric) correction difference components for up to 32 pairs of Auxiliary and Master Reference Stations. The Master Reference Station coordinates are provided in IE *GNSS-RTK-ReferenceStationInfo* and the Auxiliary Station coordinates are provided in IE *GNSS-RTK-AuxiliaryStationData*.

The parameters provided in IE *GNSS-RTK-MAC-CorrectionDifferences* are used as specified for message type 1017 and 1039 in [30] and apply to all GNSS.

```
-- ASN1START

GNSS-RTK-MAC-CorrectionDifferences-r15 ::= SEQUENCE {
    networkID-r15                       GNSS-NetworkID-r15,
    subNetworkID-r15                    GNSS-SubNetworkID-r15               OPTIONAL,   -- Need ON
    master-ReferenceStationID-r15       GNSS-ReferenceStationID-r15,
    l1-r15                              GNSS-FrequencyID-r15                OPTIONAL,   -- Need OP
    l2-r15                              GNSS-FrequencyID-r15                OPTIONAL,   -- Need OP
    rtkCorrectionDifferencesList-r15    RTK-CorrectionDifferencesList-r15,
```

```
    ...
}

RTK-CorrectionDifferencesList-r15 ::= SEQUENCE (SIZE (1..32)) OF
                                        RTK-CorrectionDifferencesElement-r15

RTK-CorrectionDifferencesElement-r15 ::= SEQUENCE {
    epochTime-r15                           GNSS-SystemTime,
    auxiliary-referenceStationID-r15        GNSS-ReferenceStationID-r15,
    geometric-ionospheric-corrections-differences-r15
                                            Geometric-Ionospheric-Corrections-Differences-r15,
    ...
}

Geometric-Ionospheric-Corrections-Differences-r15 ::= SEQUENCE (SIZE(1..64)) OF
                                    Geometric-Ionospheric-Corrections-Differences-Element-r15

Geometric-Ionospheric-Corrections-Differences-Element-r15 ::= SEQUENCE {
    svID-r15                                        SV-ID,
    ambiguityStatusFlag-r15                         INTEGER (0..3),
    non-synch-count-r15                             INTEGER (0..7),
    geometricCarrierPhaseCorrectionDifference-r15   INTEGER (-65536..65535),
    iod-r15                                         BIT STRING (SIZE(11)),
    ionosphericCarrierPhaseCorrectionDifference-r15 INTEGER (-65536..65535),
    ...
}

-- ASN1STOP
```

***GNSS-RTK-MAC-CorrectionDifferences* field descriptions**
networkID This field provides the network ID.
subNetworkID This field identifies the subnetwork of a network identified by *networkID*.
master-ReferenceStationID This field specifies the station ID of the Master Reference Station.
l1, l2 These fields specify the dual-frequency combination of L1 and L2 link/frequencies for which the *rtkCorrectionDifferencesList* is provided. If the fields are absent, the default interpretation in table 'L1/L2 default interpretation' applies.
rtkCorrectionDifferencesList This field provides the correction differences for Auxiliary-Master Reference Station pairs.
epochTime This field specifies the epoch time of observations used to derive the correction differences. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*.
auxiliary-referenceStationID This field specifies the station ID of the Auxiliary Reference Station.
svID This field specifies the satellite for which the data is provided.
ambiguityStatusFlag This field provides the ambiguity status. 'L1' below corresponds to the link indicated by the *l1* field; 'L2' below corresponds to the link indicated by the *l2* field. 0 - Reserved for future use (artificial observations) 1 - Correct Integer Ambiguity Level for L1 and L2 2 - Correct Integer Ambiguity Level for L1-L2 widelane 3 - Uncertain Integer Ambiguity Level. Only a likely guess is used.
non-synch-count This field provides the count of unrecoverable cycle slips. Whenever an unrecoverable cycle slip occurs this count shall be increased. The counter shall not be increased more than once per minute. Data for satellites with cycle slips more frequent than once per minute should not be provided.
geometricCarrierPhaseCorrectionDifference This field provides the Geometric Carrier Phase Correction Difference (GCPCD), which is the Correction Difference for the geometric part (troposphere and orbits) calculated based on integer leveled L1 and L2 correction differences (L1CD and L2CD). $GCPCD = \frac{f_1^2}{f_1^2 - f_2^2} L1CD - \frac{f_2^2}{f_1^2 - f_2^2} L2CD$ L1CD, L2CD, and ICPCD are presented in meters. 'L1' below corresponds to the link indicated by the *l1* field; 'L2' below corresponds to the link indicated by the *l2* field. Scale factor 0.5 milli-meter; range ±32.767 meters.

***GNSS-RTK-MAC-CorrectionDifferences* field descriptions**
iod
This field specifies the IOD value of the broadcast ephemeris used for calculation of Correction Differences (see IE *GNSS-NavigationModel*).
ionosphericCarrierPhaseCorrectionDifference
This field provides the Ionospheric Carrier Phase Correction Difference (ICPCD), which is the Correction Difference for the ionospheric part calculated based on integer leveled L1 and L2 correction differences (L1CD and L2CD). $ICPCD = \frac{f_2^2}{f_2^2 - f_1^2} L1CD - \frac{f_2^2}{f_2^2 - f_1^2} L2CD$ L1CD, L2CD, and ICPCD are presented in meters. 'L1' below corresponds to the link indicated by the *l1* field; 'L2' below corresponds to the link indicated by the *l2* field. Scale factor 0.5 milli-meter; range ±32.767 meters.

L1/L2 default interpretation

GNSS	*l1*	*l2*
GPS	L1	L2
SBAS	L1	L5
QZSS	L1	L2
Galileo	E1	E5a
GLONASS	G1	G2
BDS	B1	B2

– *GNSS-RTK-Residuals*

The IE *GNSS-RTK-Residuals* is used by the location server to provide Network RTK correction residual error information.

If the interpolation of the corrections for the target device location is performed at the location server, resulting in a non-physical reference station, the *GNSS-RTK-Residuals* are referenced to the non-physical reference station.

If the interpolation of the corrections is performed by the target device (e.g., using *GNSS-RTK-MAC-CorrectionDifferences)*, the *GNSS-RTK-Residuals* are referenced to the closest master or auxiliary station to the target device.

The parameters provided in IE *GNSS-RTK-Residuals* are used as specified for message type 1030 and 1031 in [30] and apply to all GNSS.

```
-- ASN1START

GNSS-RTK-Residuals-r15 ::= SEQUENCE {
    epochTime-r15                       GNSS-SystemTime,
    referenceStationID-r15              GNSS-ReferenceStationID-r15,
    n-Refs-r15                          INTEGER (0..127),
    l1-r15                              GNSS-FrequencyID-r15                OPTIONAL,   -- Need OP
    l2-r15                              GNSS-FrequencyID-r15                OPTIONAL,   -- Need OP
    rtk-residuals-list-r15              RTK-Residuals-List-r15,
    ...
}

RTK-Residuals-List-r15 ::= SEQUENCE (SIZE(1..64)) OF RTK-Residuals-Element-r15

RTK-Residuals-Element-r15 ::= SEQUENCE {
    svID-r15            SV-ID,
    s-oc-r15            INTEGER (0..255),
    s-od-r15            INTEGER (0..511),
    s-oh-r15            INTEGER (0..63),
    s-lc-r15            INTEGER (0..1023),
    s-ld-r15            INTEGER (0..1023),
    ...
}

-- ASN1STOP
```

***GNSS-RTK-Residuals* field descriptions**
epochTime This field specifies the epoch time of the Network RTK Residual Error data. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*.
referenceStationID This field specifies the Reference Station ID. The Reference Station may be a physical or non-physical station.
n-Refs This field specifies the number of reference stations used to derive the residual statistics (1 to 127; 127 indicates 127 or more stations). The number of reference stations should never be zero. If zero is encountered the target device should ignore the message.
l1, l2 These fields specify the dual-frequency combination of L1 and L2 link/frequencies for which the *rtk residuals-list* is provided. If the fields are absent, the default interpretation in table 'L1/L2 default interpretation' in IE *GNSS-RTK-MAC-CorrectionDifferences* applies.
svID This field specifies the satellite for which the data is provided.
s-oc This field specifies the constant term of standard deviation (1 sigma) for non-dispersive interpolation residuals, s_{0c}. Scale factor 0.5 milli-meter; range 0–127 milli-meter. NOTE 1.
s-od This field specifies the distance dependent term of standard deviation (1 sigma) for nondispersive interpolation residuals, s_{0d}. Scale factor 0.01 ppm; range 0–5.11 ppm. NOTE 1.
s-oh This field specifies the height dependent term of standard deviation (1 sigma) for nondispersive interpolation residuals, s_{0h}. Scale factor 0.1 ppm; range 0–5.1 ppm. NOTE 1.
s-lc This field specifies the constant term of standard deviation (1 sigma) for dispersive interpolation residuals (as affecting L1 frequency), s_{lc}. 'L1' corresponds to the link indicated by the *l1* field. Scale factor 0.5 milli-meter; range 0–511 milli-meter
s-ld This field specifies the distance dependent term of standard deviation (1 sigma) for dispersive interpolation residuals (as affecting L1 frequency), s_{ld}. 'L1' corresponds to the link indicated by the *l1* field. NOTE 2.

NOTE 1: The complete standard deviation for the expected non-dispersive interpolation residual is computed from *s-oc*, *s-od* and *s-oh* using the formula:

$$s_o = \sqrt{s_{0c}^2 + s_{0d}^2 \cdot d_{\mathrm{Re}\,f}^2 + s_{0h}^2 \cdot dh_{\mathrm{Re}\,f}^2} \quad [\mathrm{mm}]$$

where d_{Ref} is the distance of the target device from the nearest physical reference station in [km] and $|dh_{Ref}|$ is the absolute value of the height difference between the nearest physical reference station and the target device in [km].

NOTE 2: The complete standard deviation for the expected dispersive interpolation residual is computed from *s-lc* and *s-ld* using the formula:

$$s_l(L1) = \sqrt{s_{lc}^2 + s_{ld}^2 \cdot d_{\mathrm{Re}\,f}^2} \quad [\mathrm{mm}]$$

where d_{Ref} is the distance of the target device from the nearest physical reference station in [km].
The standard deviation for the L2 frequency is calculated using the formula:

$$s_l(L2) = s_l(L1) \cdot \frac{\lambda_2^2}{\lambda_1^2} \ [\mathrm{mm}]$$

. 'L2' corresponds to the link indicated by the *l2* field; $\lambda_1 = c/f_1$, $\lambda_2 = c/f_2$ are the nominal wavelengths of the links indicated by the *l1*, *l2* fields, respectively.

– *GNSS-RTK-FKP-Gradients*

The IE *GNSS-RTK-FKP-Gradients* is used by the location server to provide the FKP Network RTK gradients of distance-dependent errors like ionosphere, troposphere and orbits. The target device may use the gradients to compute the influence of the distance dependent errors for its own position.

The parameters provided in IE *GNSS-RTK-FKP-Gradients* are used as specified for message type 1034 and 1035 in [30] and apply to all GNSS.

```
-- ASN1START

GNSS-RTK-FKP-Gradients-r15 ::= SEQUENCE {
```

```
    referenceStationID-r15              GNSS-ReferenceStationID-r15,
    epochTime-r15                       GNSS-SystemTime,
    l1-r15                              GNSS-FrequencyID-r15                OPTIONAL,   -- Need OP
    l2-r15                              GNSS-FrequencyID-r15                OPTIONAL,   -- Need OP
    fkp-gradients-list-r15              FKP-Gradients-List-r15,
    ...
}

FKP-Gradients-List-r15 ::= SEQUENCE (SIZE(1..64)) OF FKP-Gradients-Element-r15

FKP-Gradients-Element-r15 ::= SEQUENCE {
    svID-r15                            SV-ID,
    iod-r15                             BIT STRING (SIZE(11)),
    north-geometric-gradient-r15        INTEGER (-2048..2047),
    east-geometric-gradient-r15         INTEGER (-2048..2047),
    north-ionospheric-gradient-r15      INTEGER (-8192..8191),
    east-ionospheric-gradient-r15       INTEGER (-8192..8191),
    ...
}

-- ASN1STOP
```

***GNSS-RTK-FKP-Gradients* field descriptions**
referenceStationID This field specifies the Reference Station ID. The Reference Station may be a physical or non-physical station.
epochTime This field specifies the epoch time of the FKP data. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*.
l1, l2 These fields specify the dual-frequency combination of L1 and L2 link/frequencies for which the *fkp-gradients-list* is provided. If the fields are absent, the default interpretation in table 'L1/L2 default interpretation' in IE *GNSS-RTK-MAC-CorrectionDifferences* applies. NOTE.
svID This field specifies the satellite for which the data is provided.
iod This field specifies the IOD value of the broadcast ephemeris used for calculation of FKP data (see IE *GNSS-NavigationModel*).
north-geometric-gradient This field specifies the gradient (FKP) of the geometric (non-dispersive) error components in South-North direction in parts per million of the south-north distance to the reference station. Scale factor 0.01 ppm; range ±20.47 ppm.
east-geometric-gradient This field specifies the gradient (FKP) of the geometric (non-dispersive) error components in West-East direction in parts per million of the west-east distance to the reference station. Scale factor 0.01 ppm; range ±20.47 ppm.
north-ionospheric-gradient This field specifies the gradient (FKP) of the ionospheric (dispersive) error component in South-North direction. Scale factor 0.01 ppm; range ±81.91 ppm.
east-ionospheric-gradient This field specifies the gradient (FKP) of the ionospheric (dispersive) error component in West-East direction. Scale factor 0.01 ppm; range ±81.91 ppm.

NOTE: As described in [30], the distance dependent error for the geometric part $\delta\rho_0$ and ionospheric part $\delta\rho_I$ is computed from the gradients provided in *FKP-Gradients-Element*. The distance dependent error for a carrier phase measurements Φ on a signal with frequency f can be computed by:

$$\delta\rho_{\phi,f} = \delta\rho_0 + \left(\frac{f_1}{f}\right)^2 \delta\rho_I$$

where f_1, f is the link/frequency indicated by the *l1*, *l2* fields, respectively.

– *GNSS-SSR-OrbitCorrections*

The IE *GNSS-SSR-OrbitCorrections* is used by the location server to provide radial, along-track and cross-track orbit corrections. The target device may use the parameters to compute a satellite position correction to be combined with the satellite position calculated from broadcast ephemeris.

The parameters provided in IE *GNSS-SSR-OrbitCorrections* are used as specified for SSR Clock Messages (e.g., message type 1057 and 1063) in [30] and apply to all GNSS.

```
-- ASN1START

GNSS-SSR-OrbitCorrections-r15 ::= SEQUENCE {
    epochTime-r15                       GNSS-SystemTime,
    ssrUpdateInterval-r15               INTEGER (0..15),
    satelliteReferenceDatum-r15         ENUMERATED { itrf, regional, ... },
    iod-ssr-r15                         INTEGER (0..15),
    ssr-OrbitCorrectionList-r15         SSR-OrbitCorrectionList-r15,
    ...
}

SSR-OrbitCorrectionList-r15 ::= SEQUENCE (SIZE(1..64)) OF SSR-OrbitCorrectionSatelliteElement-r15

SSR-OrbitCorrectionSatelliteElement-r15 ::= SEQUENCE {
    svID-r15                            SV-ID,
    iod-r15                             BIT STRING (SIZE(11)),
    delta-radial-r15                    INTEGER (-2097152..2097151),
    delta-AlongTrack-r15                INTEGER (-524288..524287),
    delta-CrossTrack-r15                INTEGER (-524288..524287),
    dot-delta-radial-r15                INTEGER (-1048576..1048575)             OPTIONAL,
    dot-delta-AlongTrack-r15            INTEGER (-262144..262143)               OPTIONAL,
    dot-delta-CrossTrack-r15            INTEGER (-262144..262143)               OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-SSR-OrbitCorrections* field descriptions**
epochTime
This field specifies the epoch time of the orbit corrections. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*.
ssrUpdateInterval
This field specifies the SSR Update Interval. The SSR Update Intervals for all SSR parameters start at time 00:00:00 of the GPS time scale. A change of the SSR Update Interval during the transmission of SSR data should ensure consistent data for a target device. See table Value to SSR Update Interval Relation below. NOTE 1.
satelliteReferenceDatum
This field specifies the satellite refence datum for the orbit corrections.
iod-ssr
This field specifies the Issue of Data number for the SSR data. A change of *iod-ssr* is used to indicate a change in the SSR generating configuration.
svID
This field specifies the satellite for which the orbit corrections are provided.
iod
This field specifies the IOD value of the broadcast ephemeris for which the orbit corrections are valid (see IE *GNSS-NavigationModel*). NOTE 2.
delta-radial
This field specifies the radial orbit correction for broadcast ephemeris. NOTE 3. Scale factor 0.1 mm; range ±209.7151 m.
delta-AlongTrack
This field specifies the along-track orbit correction for broadcast ephemeris. NOTE 3. Scale factor 0.4 mm; range ±209.7148 m.
delta-CrossTrack
This field specifies the cross-track orbit correction for broadcast ephemeris. NOTE 3. Scale factor 0.4 mm; range ±209.7148 m.
dot-delta-radial
This field specifies the velocity of radial orbit correction for broadcast ephemeris. NOTE 3. Scale factor 0.001 mm/s; range ±1.048575 m/s.
dot-delta-AlongTrack
This field specifies the velocity of along-track orbit correction for broadcast ephemeris. NOTE 3. Scale factor 0.004 mm/s; range ±1.048572 m/s.
dot-delta-CrossTrack
This field specifies the velocity of cross-track orbit correction for broadcast ephemeris. NOTE 3. Scale factor 0.004 mm/s; range ±1.048572 m/s.

NOTE 1: The update intervals are aligned to the GPS time scale for all GNSS in order to allow synchronous operation for multiple GNSS services. This means that the update intervals may not be aligned to the beginning of the day for another GNSS. Due to the leap seconds, this is generally the case for GLONASS.

NOTE 2: In case the *gnss-ID* indicates 'gps' or 'qzss', the *iod* refers to the NAV broadcast ephemeris (GPS L1 C/A or QZSS QZS-L1, respectively, in table GNSS to iod Bit String(11) relation in IE *GNSS-NavigationModel).*

NOTE 3: The reference time t_0 is *epochTime* + ½ × *ssrUpdateInterval*. The reference time t_0 for *ssrUpdateInterval* '0' is *epochTime*.

Value to SSR Update Interval Relation

Value of ssrUpdateInterval	SSR Update Interval
0	1 second
1	2 seconds
2	5 seconds
3	10 seconds
4	15 seconds
5	30 seconds
6	60 seconds
7	120 seconds
8	240 seconds
9	300 seconds
10	600 seconds
11	900 seconds
12	1800 seconds
13	3600 seconds
14	7200 seconds
15	10800 seconds

– *GNSS-SSR-ClockCorrections*

The IE *GNSS-SSR-ClockCorrections* is used by the location server to provide clock correction parameters. The target device may use the parameters to compute a clock correction to be applied to the broadcast satellite clock parameters, identified by *iod* of corresponding *GNSS-SSR-OrbitCorrections*.

The parameters provided in IE *GNSS-SSR-ClockCorrections* are used as specified for SSR Clock Messages (e.g., message type 1058 and 1064) in [30] and apply to all GNSS.

```
-- ASN1START

GNSS-SSR-ClockCorrections-r15 ::= SEQUENCE {
    epochTime-r15                       GNSS-SystemTime,
    ssrUpdateInterval-r15               INTEGER (0..15),
    iod-ssr-r15                         INTEGER (0..15),
    ssr-ClockCorrectionList-r15         SSR-ClockCorrectionList-r15,
    ...
}

SSR-ClockCorrectionList-r15 ::= SEQUENCE (SIZE(1..64)) OF SSR-ClockCorrectionSatelliteElement-r15

SSR-ClockCorrectionSatelliteElement-r15 ::= SEQUENCE {
    svID-r15                            SV-ID,
    delta-Clock-C0-r15                  INTEGER (-2097152..2097151),
    delta-Clock-C1-r15                  INTEGER (-1048576..1048575)         OPTIONAL,
    delta-Clock-C2-r15                  INTEGER (-67108864..67108863)       OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-SSR-ClockCorrections* field descriptions**
epochTime This field specifies the epoch time of the clock corrections. The gnss-TimeID in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement.*
ssrUpdateInterval This field specifies the SSR Update Interval. The SSR Update Intervals for all SSR parameters start at time 00:00:00 of the GPS time scale. A change of the SSR Update Interval during the transmission of SSR data should ensure consistent data for a target device. See table Value to SSR Update Interval Relation in IE *GNSS-SSR-OrbitCorrections*.
iod-ssr This field specifies the Issue of Data number for the SSR data. A change of iod-ssr is used to indicate a change in the SSR generating configuration.
svID This field specifies the satellite for which the clock corrections are provided.
delta-Clock-C0 This field specifies the C_0 polynomial coefficient for correction of broadcast satellite clock. NOTE 1. Scale factor 0.1 mm; range ±209.7151 m.
delta-Clock-C1 This field specifies the C_1 polynomial coefficient for correction of broadcast satellite clock. NOTE 1. Scale factor 0.001 mm/s; range ±1.048575 m/s.
delta-Clock-C2 This field specifies the C_2 polynomial coefficient for correction of broadcast satellite clock. NOTE 1. Scale factor 0.00002 mm/s^2; range ±1.34217726 m/s^2.

NOTE 1: The reference time t_0 is *epochTime* + ½ × *ssrUpdateInterval*. The reference time t_0 for *ssrUpdateInterval* '0' is *epochTime*.

– *GNSS-SSR-CodeBias*

The IE *GNSS-SSR-CodeBias* is used by the location server to provide GNSS signal code bias. The target device may add the code bias to the pseudo-range measurement of the corresponding code signal to get corrected pseudo-ranges.

NOTE: Any code biases transmitted in the broadcast messages (e.g., the GPS group delay differential T_{GD} [4] (*NAV-ClockModel*)) are not applied at all by the target device.

The parameters provided in IE *GNSS-SSR-CodeBias* are used as specified for SSR Code Bias Messages (e.g., message type 1059 and 1065) in [30] and apply to all GNSS.

```
-- ASN1START

GNSS-SSR-CodeBias-r15 ::= SEQUENCE {
    epochTime-r15                       GNSS-SystemTime,
    ssrUpdateInterval-r15               INTEGER (0..15),
    iod-ssr-r15                         INTEGER (0..15),
    ssr-CodeBiasSatList-r15             SSR-CodeBiasSatList-r15,
    ...
}

SSR-CodeBiasSatList-r15 ::= SEQUENCE (SIZE(1..64)) OF SSR-CodeBiasSatElement-r15

SSR-CodeBiasSatElement-r15 ::= SEQUENCE {
    svID-r15                            SV-ID,
    ssr-CodeBiasSignalList-r15          SSR-CodeBiasSignalList-r15,
    ...
}

SSR-CodeBiasSignalList-r15 ::= SEQUENCE (SIZE(1..16)) OF SSR-CodeBiasSignalElement-r15

SSR-CodeBiasSignalElement-r15 ::= SEQUENCE {
    signal-and-tracking-mode-ID-r15     GNSS-SignalID,
    codeBias-r15                        INTEGER (-8192..8191),
    ...
}

-- ASN1STOP
```

***GNSS-SSR-CodeBias* field descriptions**
epochTime This field specifies the epoch time of the code bias data. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*.
ssrUpdateInterval This field specifies the SSR Update Interval. The SSR Update Intervals for all SSR parameters start at time 00:00:00 of the GPS time scale. A change of the SSR Update Interval during the transmission of SSR data should ensure consistent data for a target device. See table Value to SSR Update Interval Relation in IE *GNSS-SSR-OrbitCorrections*.
iod-ssr This field specifies the Issue of Data number for the SSR data. A change of *iod-ssr* is used to indicate a change in the SSR generating configuration.
svID This field specifies the GNSS satellite for which the code biases are provided.
signal-and-tracking-mode-ID This field specifies the GNSS signal for which the code biases are provided.
codeBias This field provides the code bias for the GNSS signal indicated by *signal-and-tracking-mode-ID*. Scale factor 0.01 m; range ±81.91 m.

6.5.2.3 GNSS Assistance Data Request

– *A-GNSS-RequestAssistanceData*

The IE *A-GNSS-RequestAssistanceData* is used by the target device to request GNSS assistance data from a location server.

```
-- ASN1START

A-GNSS-RequestAssistanceData ::= SEQUENCE {
    gnss-CommonAssistDataReq        GNSS-CommonAssistDataReq        OPTIONAL, -- Cond CommonADReq
    gnss-GenericAssistDataReq       GNSS-GenericAssistDataReq       OPTIONAL, -- Cond GenADReq
    ...,
    [[
        gnss-PeriodicAssistDataReq-r15
                                    GNSS-PeriodicAssistDataReq-r15  OPTIONAL -- Cond PerADReq
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
CommonADReq	The field is mandatory present if the target device requests *GNSS-CommonAssistData*; otherwise it is not present.
GenADReq	This field is mandatory present if the target device requests *GNSS-GenericAssistData* for one or more specific GNSS; otherwise it is not present.
PerADReq	This field is mandatory present if the target device requests periodic GNSS assistance data delivery. This field may only be included if any of the fields are included in IE *GNSS-GenericAssistDataReq:* - *GNSS-RTK-ObservationsReq*, - *GLO-RTK-BiasInformationReq*, - *GNSS-RTK-MAC-CorrectionDifferencesReq*, - *GNSS-RTK-ResidualsReq,* - *GNSS-RTK-FKP-GradientsReq*, - *GNSS-SSR-OrbitCorrectionsReq*, - *GNSS-SSR-ClockCorrectionsReq*, or - *GNSS-SSR-CodeBiasReq.*

– *GNSS-CommonAssistDataReq*

The IE *GNSS-CommonAssistDataReq* is used by the target device to request assistance data that are applicable to any GNSS from a location server.

```
-- ASN1START
```

```
GNSS-CommonAssistDataReq ::= SEQUENCE {
    gnss-ReferenceTimeReq               GNSS-ReferenceTimeReq
                                                                OPTIONAL, -- Cond RefTimeReq
    gnss-ReferenceLocationReq           GNSS-ReferenceLocationReq
                                                                OPTIONAL, -- Cond RefLocReq
    gnss-IonosphericModelReq            GNSS-IonosphericModelReq
                                                                OPTIONAL, -- Cond IonoModReq
    gnss-EarthOrientationParametersReq  GNSS-EarthOrientationParametersReq
                                                                OPTIONAL, -- Cond EOPReq
    ...,
    [[
        gnss-RTK-ReferenceStationInfoReq-r15
                                        GNSS-RTK-ReferenceStationInfoReq-r15
                                                                OPTIONAL, -- Cond ARPReq
        gnss-RTK-AuxiliaryStationDataReq-r15
                                        GNSS-RTK-AuxiliaryStationDataReq-r15
                                                                OPTIONAL -- Cond AuxARPReq
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
RefTimeReq	The field is mandatory present if the target device requests *GNSS-ReferenceTime*; otherwise it is not present.
RefLocReq	This field is mandatory present if the target device requests *GNSS-ReferenceLocation*; otherwise it is not present.
IonoModReq	This field is mandatory present if the target device requests *GNSS-IonosphericModel*; otherwise it is not present.
EOPReq	This field is mandatory present if the target device requests *GNSS-EarthOrientationParameters*; otherwise it is not present.
ARPReq	This field is mandatory present if the target device requests *GNSS-RTK-ReferenceStationInfo*; otherwise it is not present.
AuxARPReq	This field is mandatory present if the target device requests *GNSS-RTK-AuxiliaryStationData*; otherwise it is not present.

– *GNSS-GenericAssistDataReq*

The IE *GNSS-GenericAssistDataReq* is used by the target device to request assistance data from a location server for one or more specific GNSS (e.g., GPS, Galileo, GLONASS, BDS, etc.). The specific GNSS for which the assistance data are requested is indicated by the IE *GNSS-ID* and (if applicable) by the IE *SBAS-ID*. Assistance for up to 16 GNSSs can be requested.

```
-- ASN1START

GNSS-GenericAssistDataReq ::= SEQUENCE (SIZE (1..16)) OF GNSS-GenericAssistDataReqElement

GNSS-GenericAssistDataReqElement ::= SEQUENCE {
    gnss-ID                         GNSS-ID,
    sbas-ID                         SBAS-ID                         OPTIONAL, -- Cond GNSS-ID-SBAS
    gnss-TimeModelsReq              GNSS-TimeModelListReq           OPTIONAL, -- Cond TimeModReq
    gnss-DifferentialCorrectionsReq GNSS-DifferentialCorrectionsReq OPTIONAL, -- Cond DGNSS-Req
    gnss-NavigationModelReq         GNSS-NavigationModelReq         OPTIONAL, -- Cond NavModReq
    gnss-RealTimeIntegrityReq       GNSS-RealTimeIntegrityReq       OPTIONAL, -- Cond RTIReq
    gnss-DataBitAssistanceReq       GNSS-DataBitAssistanceReq       OPTIONAL, -- Cond DataBitsReq
    gnss-AcquisitionAssistanceReq   GNSS-AcquisitionAssistanceReq   OPTIONAL, -- Cond AcquAssistReq
    gnss-AlmanacReq                 GNSS-AlmanacReq                 OPTIONAL, -- Cond AlmanacReq
    gnss-UTCModelReq                GNSS-UTC-ModelReq               OPTIONAL, -- Cond UTCModReq
    gnss-AuxiliaryInformationReq    GNSS-AuxiliaryInformationReq    OPTIONAL, -- Cond AuxInfoReq
    ...,
    [[
        bds-DifferentialCorrectionsReq-r12
                                    BDS-DifferentialCorrectionsReq-r12
                                                                    OPTIONAL, -- Cond DBDS-Req
        bds-GridModelReq-r12        BDS-GridModelReq-r12            OPTIONAL  -- Cond BDS-GridModReq
    ]],
    [[
        gnss-RTK-ObservationsReq-r15
                                    GNSS-RTK-ObservationsReq-r15    OPTIONAL,   -- Cond RTK-OSR-Req
        glo-RTK-BiasInformationReq-r15
```

```
                                    GLO-RTK-BiasInformationReq-r15  OPTIONAL,   -- Cond GLO-CPB-Req
        gnss-RTK-MAC-CorrectionDifferencesReq-r15
                                    GNSS-RTK-MAC-CorrectionDifferencesReq-r15
                                                                    OPTIONAL,   -- Cond MAC-Req
        gnss-RTK-ResidualsReq-r15   GNSS-RTK-ResidualsReq-r15       OPTIONAL,   -- Cond Res-Req
        gnss-RTK-FKP-GradientsReq-r15
                                    GNSS-RTK-FKP-GradientsReq-r15   OPTIONAL,   -- Cond FKP-Req
        gnss-SSR-OrbitCorrectionsReq-r15
                                    GNSS-SSR-OrbitCorrectionsReq-r15
                                                                    OPTIONAL, -- Cond OC-Req
        gnss-SSR-ClockCorrectionsReq-r15
                                    GNSS-SSR-ClockCorrectionsReq-r15
                                                                    OPTIONAL, -- Cond CC-Req
        gnss-SSR-CodeBiasReq-r15    GNSS-SSR-CodeBiasReq-r15        OPTIONAL -- Cond CB-Req
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
GNSS-ID-SBAS	The field is mandatory present if the *GNSS-ID = sbas*; otherwise it is not present.
TimeModReq	The field is mandatory present if the target device requests *GNSS-TimeModelList*; otherwise it is not present.
DGNSS-Req	The field is mandatory present if the target device requests *GNSS-DifferentialCorrections*; otherwise it is not present.
NavModReq	The field is mandatory present if the target device requests *GNSS-NavigationModel*; otherwise it is not present.
RTIReq	The field is mandatory present if the target device requests *GNSS-RealTimeIntegrity*; otherwise it is not present.
DataBitsReq	The field is mandatory present if the target device requests *GNSS-DataBitAssistance*; otherwise it is not present.
AcquAssistReq	The field is mandatory present if the target device requests *GNSS-AcquisitionAssistance*; otherwise it is not present.
AlmanacReq	The field is mandatory present if the target device requests *GNSS-Almanac*; otherwise it is not present.
UTCModReq	The field is mandatory present if the target device requests *GNSS-UTCModel*; otherwise it is not present.
AuxInfoReq	The field is mandatory present if the target device requests *GNSS-AuxiliaryInformation*; otherwise it is not present.
DBDS-Req	The field is mandatory present if the target device requests *BDS-DifferentialCorrections*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'.
BDS-GridModReq	The field is mandatory present if the target device requests *BDS-GridModel*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'.
RTK-OSR-Req	The field is mandatory present if the target device requests *GNSS-RTK-Observations*; otherwise it is not present.
GLO-CPB-Req	The field is mandatory present if the target device requests *GLO-RTK-BiasInformation*; otherwise it is not present.
MAC-Req	The field is mandatory present if the target device requests *GNSS-RTK-MAC-CorrectionDifferences*; otherwise it is not present.
Res-Req	The field is mandatory present if the target device requests *GNSS-RTK-Residuals*; otherwise it is not present.
FKP-Req	The field is mandatory present if the target device requests *GNSS-RTK-FKP-Gradients*; otherwise it is not present.
OC-Req	The field is mandatory present if the target device requests *GNSS-SSR-OrbitCorrections*; otherwise it is not present.
CC-Req	The field is mandatory present if the target device requests *GNSS-SSR-ClockCorrections*; otherwise it is not present.
CB-Req	The field is mandatory present if the target device requests *GNSS-SSR-CodeBias*; otherwise it is not present.

– *GNSS-PeriodicAssistDataReq*

The IE *GNSS-PeriodicAssistDataReq* is used by the target device to request periodic assistance data delivery from a location server.

```
-- ASN1START
```

```
GNSS-PeriodicAssistDataReq-r15 ::= SEQUENCE {
    gnss-RTK-PeriodicObservationsReq-r15    GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pOSR
    glo-RTK-PeriodicBiasInformationReq-r15  GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pCPB
    gnss-RTK-MAC-PeriodicCorrectionDifferencesReq-r15
                                            GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pMAC
    gnss-RTK-PeriodicResidualsReq-r15       GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pRes
    gnss-RTK-FKP-PeriodicGradientsReq-r15   GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pFKP
    gnss-SSR-PeriodicOrbitCorrectionsReq-r15
                                            GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pOC
    gnss-SSR-PeriodicClockCorrectionsReq-r15
                                            GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pCC
    gnss-SSR-PeriodicCodeBiasReq-r15        GNSS-PeriodicControlParam-r15   OPTIONAL, -- Cond pCB
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
pOSR	The field is mandatory present if the target device requests periodic *GNSS-RTK-Observations*; otherwise it is not present.
pCPB	The field is mandatory present if the target device requests periodic *GLO-RTK-BiasInformation*; otherwise it is not present.
pMAC	The field is mandatory present if the target device requests periodic *GNSS-RTK-MAC-CorrectionDifferences*; otherwise it is not present.
pRes	The field is mandatory present if the target device requests periodic *GNSS-RTK-Residuals*; otherwise it is not present.
pFKP	The field is mandatory present if the target device requests periodic *GNSS-RTK-FKP-Gradients*; otherwise it is not present.
pOC	The field is mandatory present if the target device requests periodic *GNSS-SSR-OrbitCorrections*; otherwise it is not present.
pCC	The field is mandatory present if the target device requests periodic *GNSS-SSR-ClockCorrections*; otherwise it is not present.
pCB	The field is mandatory present if the target device requests periodic *GNSS-SSR-CodeBias*; otherwise it is not present.

6.5.2.4 GNSS Assistance Data Request Elements

– *GNSS-ReferenceTimeReq*

The IE *GNSS-ReferenceTimeReq* is used by the target device to request the *GNSS-ReferenceTime* assistance from the location server.

```
-- ASN1START

GNSS-ReferenceTimeReq ::= SEQUENCE {
    gnss-TimeReqPrefList    SEQUENCE (SIZE (1..8)) OF GNSS-ID,
    gps-TOW-assistReq       BOOLEAN                             OPTIONAL, -- Cond gps
    notOfLeapSecReq         BOOLEAN                             OPTIONAL, -- Cond glonass
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
gps	The field is mandatory present if *gnss-TimeReqPrefList* includes a *GNSS-ID*= 'gps'; otherwise it is not present.
glonass	The field is mandatory present if *gnss-TimeReqPrefList* includes a *GNSS-ID*= 'glonass'; otherwise it is not present.

***GNSS-ReferenceTimeReq* field descriptions**
gnss-TimeReqPrefList This field is used by the target device to request the system time for a specific GNSS, specified by GNSS-ID in the order of preference. The first *GNSS-ID* in the list is the most preferred GNSS for reference time, the second *GNSS-ID* is the second most preferred, etc.
gps-TOW-assistReq This field is used by the target device to request the *gps-TOW-Assist* field in *GNSS-SystemTime*. TRUE means requested.
notOfLeapSecReq This field is used by the target device to request the *notificationOfLeapSecond* field in *GNSS-SystemTime*. TRUE means requested.

– *GNSS-ReferenceLocationReq*

The IE *GNSS-ReferenceLocationReq* is used by the target device to request the *GNSS-ReferenceLocation* assistance from the location server.

```
-- ASN1START

GNSS-ReferenceLocationReq ::=   SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-IonosphericModelReq*

The IE *GNSS-IonosphericModelReq* is used by the target device to request the *GNSS-IonosphericModel* assistance from the location server.

```
-- ASN1START

GNSS-IonosphericModelReq ::=    SEQUENCE {
    klobucharModelReq       BIT STRING (SIZE(2))    OPTIONAL,   -- Cond klobuchar
    neQuickModelReq         NULL                    OPTIONAL,   -- Cond nequick
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
klobuchar	The field is mandatory present if the target device requests *klobucharModel*; otherwise it is not present. The BIT STRING defines the *dataID* requested, defined in IE *KlobucharModelParameter*.
nequick	The field is mandatory present if the target device requests *neQuickModel*; otherwise it is not present.

– *GNSS-EarthOrientationParametersReq*

The IE *GNSS-EarthOrientationParametersReq* is used by the target device to request the *GNSS-EarthOrientationParameters* assistance from the location server.

```
-- ASN1START

GNSS-EarthOrientationParametersReq ::=  SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-RTK-ReferenceStationInfoReq*

The IE *GNSS-RTK-ReferenceStationInfoReq* is used by the target device to request the *GNSS-RTK-ReferenceStationInfo* assistance from the location server.

```
-- ASN1START

GNSS-RTK-ReferenceStationInfoReq-r15 ::= SEQUENCE {
    antennaDescriptionReq-r15           BOOLEAN,
    antennaHeightReq-r15                BOOLEAN,
    physicalReferenceStationReq-r15     BOOLEAN,
    stationID-r15                       GNSS-ReferenceStationID-r15     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-ReferenceStationInfoReq* field descriptions**
antennaDescriptionReq This field specifies whether or not the location server is requested to include the field *AntennaDescription* in the *GNSS-RTK-ReferenceStationInfo* IE. TRUE means requested.
antennaHeightReq This field specifies whether or not the location server is requested to include the field *antennaHeight* in the *GNSS-RTK-ReferenceStationInfo* IE. TRUE means requested.
physicalReferenceStationReq This field specifies whether or not the location server is requested to include the field *physical-reference-station-info* in the *GNSS-RTK-ReferenceStationInfo* IE. TRUE means requested.
stationID This field specifies the Station ID for which the *GNSS-RTK-ReferenceStationInfo* is requested.

– *GNSS-RTK-AuxiliaryStationDataReq*

The IE *GNSS-RTK-AuxiliaryStationDataReq* is used by the target device to request the *GNSS-RTK-AuxiliaryStationData* assistance from the location server.

```
-- ASN1START

GNSS-RTK-AuxiliaryStationDataReq-r15 ::= SEQUENCE {
    master-referenceStationID-r15       GNSS-ReferenceStationID-r15     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-AuxiliaryStationDataReq* field descriptions**
master-referenceStationID This field specifies the Master Reference Station ID for which the Auxiliary Stations are requested.

– *GNSS-TimeModelListReq*

The IE *GNSS-TimeModelListReq* is used by the target device to request the *GNSS-TimeModelElement* assistance from the location server.

```
-- ASN1START

GNSS-TimeModelListReq ::= SEQUENCE (SIZE(1..15)) OF GNSS-TimeModelElementReq

GNSS-TimeModelElementReq ::= SEQUENCE {
    gnss-TO-IDsReq  INTEGER (1..15),
    deltaTreq       BOOLEAN,
    ...
}

-- ASN1STOP
```

***GNSS-TimeModelElementReq* field descriptions**
gnss-TO-IDsReq This field specifies the requested *gnss-TO-ID*. The meaning and encoding is the same as the *gnss-TO-ID* field in the *GNSS-TimeModelElement* IE.
deltaTreq This field specifies whether or not the location server is requested to include the *deltaT* field in the *GNSS-TimeModelElement* IE. TRUE means requested.

– *GNSS-DifferentialCorrectionsReq*

The IE *GNSS-DifferentialCorrectionsReq* is used by the target device to request the *GNSS-DifferentialCorrections* assistance from the location server.

```
-- ASN1START

GNSS-DifferentialCorrectionsReq ::= SEQUENCE {
    dgnss-SignalsReq            GNSS-SignalIDs,
    dgnss-ValidityTimeReq       BOOLEAN,
    ...
}

-- ASN1STOP
```

***GNSS-DifferentialCorrectionsReq* field descriptions**
dgnss-SignalsReq This field specifies the GNSS Signal(s) for which the *GNSS-DifferentialCorrections* are requested. A one-value at a bit position means DGNSS corrections for the specific signal are requested; a zero-value means not requested. The target device shall set a maximum of three bits to value 'one'.
dgnss-ValidityTimeReq This field specifies whether the *udreGrowthRate* and *udreValidityTime* in *GNSS-DifferentialCorrections* are requested or not. TRUE means requested.

– *GNSS-NavigationModelReq*

The IE *GNSS-NavigationModelReq* is used by the target device to request the *GNSS-NavigationModel* assistance from the location server.

```
-- ASN1START

GNSS-NavigationModelReq ::= CHOICE {
    storedNavList       StoredNavListInfo,
    reqNavList          ReqNavListInfo,
    ...
}


StoredNavListInfo ::= SEQUENCE {
    gnss-WeekOrDay          INTEGER (0..4095),
    gnss-Toe                INTEGER (0..255),
    t-toeLimit              INTEGER (0..15),
    satListRelatedDataList  SatListRelatedDataList  OPTIONAL,
    ...
}

SatListRelatedDataList ::= SEQUENCE (SIZE (1..64)) OF SatListRelatedDataElement

SatListRelatedDataElement ::= SEQUENCE {
    svID                SV-ID,
    iod             BIT STRING (SIZE(11)),
    clockModelID        INTEGER (1..8)          OPTIONAL,
    orbitModelID        INTEGER (1..8)          OPTIONAL,
    ...
}

ReqNavListInfo ::=  SEQUENCE {
    svReqList               BIT STRING (SIZE (64)),
    clockModelID-PrefList   SEQUENCE (SIZE (1..8)) OF   INTEGER (1..8)      OPTIONAL,
    orbitModelID-PrefList   SEQUENCE (SIZE (1..8)) OF   INTEGER (1..8)      OPTIONAL,
    addNavparamReq          BOOLEAN             OPTIONAL,   -- Cond orbitModelID-2
```

```
    ...
}


-- ASN1STOP
```

Conditional presence	Explanation
orbitModelID-2	The field is mandatory present if *orbitModelID-PrefList* is absent or includes a Model-ID = '2'; otherwise it is not present.

***GNSS-NavigationModelReq* field descriptions**
storedNavList This list provides information to the location server about which *GNSS-NavigationModel* data the target device has currently stored for the particular GNSS indicated by *GNSS-ID*.
reqNavList This list provides information to the location server which *GNSS-NavigationModel* data are requested by the target device.
gnss-WeekOrDay If *GNSS-ID* does not indicate 'glonass', this field defines the GNSS Week number of the assistance currently held by the target device. If *GNSS-ID* is set to 'glonass', this field defines the calendar number of day within the four-year interval starting from 1st of January in a leap year, as defined by the parameter N_T in [9] of the assistance currently held by the target device.
gnss-Toe If *GNSS-ID* does not indicate 'glonass', this field defines the GNSS time of ephemeris in hours of the latest ephemeris set contained by the target device. If *GNSS-ID* is set to 'glonass', this field defines the time of ephemeris in units of 15 minutes of the latest ephemeris set contained by the target device (range 0 to 95 representing time values between 0 and 1425 minutes). In this case, values 96 to 255 shall not be used by the sender.
t-toeLimit If *GNSS-ID* does not indicate 'glonass', this IE defines the ephemeris age tolerance of the target device in units of hours. If *GNSS-ID* is set to 'glonass', this IE defines the ephemeris age tolerance of the target device in units of 30 minutes.
satListRelatedDataList This list defines the clock and orbit models currently held by the target device for each SV. This field is not included if the target device does not have any stored clock and orbit models for any SV.
svID This field identifies the particular GNSS satellite.
iod This field identifies the issue of data currently held by the target device.
clockModelID, orbitModelID These fields define the clock and orbit model number currently held by the target device. If these fields are absent, the default interpretation of the table GNSS-ID to clockModelID & orbitModelID relation below applies.
svReqList This field defines the SV for which the navigation model assistance is requested. Each bit position in this BIT STRING represents a *SV-ID*. Bit 0 represents *SV-ID*=0 and bit 63 represents *SV-ID*=63. A one-value at a bit position means the navigation model data for the corresponding *SV-ID* is requested, a zero-value means not requested.
clockModelIDPrefList, orbitModelID-PrefList These fields define the Model-IDs of the clock and orbit models that the target device wishes to obtain in the order of preference. The first Model-ID in the list is the most preferred model, the second Model-ID the second most preferred, etc. If these fields are absent, the default interpretation of the table GNSS-ID to clockModelID-PrefList & orbitModelIDPrefList relation below applies.
addNavparamReq This field specifies whether the location server is requested to include the *addNAVparam* fields in *GNSS-NavigationModel* IE (*NavModel-NAVKeplerianSet* field) or not. TRUE means requested.

GNSS-ID to clockModelID & orbitModelID relation

GNSS-ID	*clockModelID*	*orbitModelID*
gps	2	2
sbas	5	5
qzss	2	2
galileo	1	1
glonass	4	4
bds	6	6

GNSS-ID to clockModelID-PrefList & orbitModelID-PrefList relation

GNSS-ID	*clockModelID-PrefList*	*orbitModelID-PrefList*
gps	Model-2	Model-2
sbas	Model-5	Model-5
qzss	Model-2	Model-2
galileo	Model-1	Model-1
glonass	Model-4	Model-4
bds	Model-6	Model-6

– *GNSS-RealTimeIntegrityReq*

The IE *GNSS-RealTimeIntegrityReq* is used by the target device to request the *GNSS-RealTimeIntegrity* assistance from the location server.

```
-- ASN1START

GNSS-RealTimeIntegrityReq ::=   SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-DataBitAssistanceReq*

The IE *GNSS-DataBitAssistanceReq* is used by the target device to request the *GNSS-DataBitAssistance* assistance from the location server.

```
-- ASN1START

GNSS-DataBitAssistanceReq ::=   SEQUENCE {
    gnss-TOD-Req        INTEGER (0..3599),
    gnss-TOD-FracReq    INTEGER (0..999)        OPTIONAL,
    dataBitInterval     INTEGER (0..15),
    gnss-SignalType     GNSS-SignalIDs,
    gnss-DataBitsReq    GNSS-DataBitsReqSatList OPTIONAL,
    ...
}

GNSS-DataBitsReqSatList ::= SEQUENCE (SIZE(1..64)) OF GNSS-DataBitsReqSatElement

GNSS-DataBitsReqSatElement ::= SEQUENCE {
    svID                SV-ID,
    ...
}

-- ASN1STOP
```

***GNSS-DataBitAssistanceReq* field descriptions**
gnss-TOD-Req This field specifies the reference time for the first data bit requested in GNSS specific system time, modulo 1 hour. Scale factor 1 second.
gnss-TOD-FracReq This field specifies the fractional part of *gnss-TOD-Req* in 1-milli-second resolution. Scale factor 1 millisecond.

***GNSS-DataBitAssistanceReq* field descriptions**
dataBitInterval This field specifies the time length for which the Data Bit Assistance is requested. The *GNSS-DataBitAssistance* shall be relative to the time interval (*gnss-TOD-Req*, *gnss-TOD-Req* + *dataBitInterval*). The *dataBitInterval r*, expressed in seconds, is mapped to a binary number K with the following formula: $r = 0.1 \times 2^K$ Value K=15 means that the time interval is not specified.
gnss-SignalType This field specifies the GNSS Signal(s) for which the *GNSS-DataBitAssistance* are requested. A one-value at a bit position means *GNSS-DataBitAssistance* for the specific signal is requested; a zero-value means not requested.
gnss-DataBitsReq This list contains the SV-IDs for which the *GNSS-DataBitAssistance* is requested.

– *GNSS-AcquisitionAssistanceReq*

The IE *GNSS-AcquisitionAssistanceReq* is used by the target device to request the *GNSS-AcquisitionAssistance* assistance from the location server.

```
-- ASN1START

GNSS-AcquisitionAssistanceReq ::=   SEQUENCE {
    gnss-SignalID-Req       GNSS-SignalID,
    ...
}

-- ASN1STOP
```

***GNSS-AcquisitionAssistanceReq* field descriptions**
gnss-SignalID-Req This field specifies the GNSS signal type for which *GNSSAcquisitionAssistance* is requested.

– *GNSS-AlmanacReq*

The IE *GNSS-AlmanacReq* is used by the target device to request the *GNSS-Almanac* assistance from the location server.

```
-- ASN1START

GNSS-AlmanacReq ::= SEQUENCE {
    modelID             INTEGER(1..8)   OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-AlmanacReq* field descriptions**
modelID This field specifies the Almanac Model ID requested. If this field is absent, the default interpretation as in the table GNSS-ID to modelID relation below applies.

GNSS-ID to modelID relation

GNSS-ID	***modelID***
gps	2
sbas	6
qzss	2
galileo	1
glonass	5
bds	7

– GNSS-UTC-ModelReq

The IE *GNSS-UTC-ModelReq* is used by the target device to request the *GNSS-UTC-Model* assistance from the location server.

```
-- ASN1START

GNSS-UTC-ModelReq ::=   SEQUENCE {
    modelID             INTEGER(1..8)   OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-UTC-ModelReq* field descriptions**
modelID
This field specifies the *GNSS-UTCModel* set requested. If this field is absent, the default interpretation as in the table GNSS-ID to modelID relation below applies.

GNSS-ID to modelID relation

GNSS-ID	***modelID***
gps	1
sbas	4
qzss	1
galileo	1
glonass	3
bds	5

– GNSS-AuxiliaryInformationReq

The IE *GNSS-AuxiliaryInformationReq* is used by the target device to request the *GNSS-AuxiliaryInformation* assistance from the location server.

```
-- ASN1START

GNSS-AuxiliaryInformationReq ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– BDS-DifferentialCorrectionsReq

The IE *BDS-DifferentialCorrectionsReq* is used by the target device to request the *BDS-DifferentialCorrections* assistance from the location server.

```
-- ASN1START

BDS-DifferentialCorrectionsReq-r12 ::=  SEQUENCE {
    dgnss-SignalsReq            GNSS-SignalIDs,
    ...
}

-- ASN1STOP
```

***BDS-DifferentialCorrectionsReq* field descriptions**
dgnss-SignalsReq
This field specifies the BDS Signal(s) for which the *BDS-DifferentialCorrections* are requested. A one-value at a bit position means BDS differential corrections for the specific signal are requested; a zero-value means not requested. The target device shall set a maximum of three bits to value 'one'.

– *BDS-GridModelReq*

The IE *BDS-GridModelReq* is used by the target device to request the *BDS-GridModel* assistance from the location server.

```
-- ASN1START

BDS-GridModelReq-r12 ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-RTK-ObservationsReq*

The IE *GNSS-RTK-ObservationsReq* is used by the target device to request the *GNSS-RTK-Observations* assistance from the location server.

```
-- ASN1START

GNSS-RTK-ObservationsReq-r15::=     SEQUENCE {
    gnss-RTK-SignalsReq-r15             GNSS-SignalIDs,
    gnss-RTK-Integer-ms-Req-r15         BOOLEAN,
    gnss-RTK-PhaseRangeRateReq-r15      BOOLEAN,
    gnss-RTK-CNR-Req-r15                BOOLEAN,
    stationID-r15                       GNSS-ReferenceStationID-r15     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-ObservationsReq* field descriptions**
gnss-RTK-SignalsReq This field specifies the GNSS Signal(s) for which the *GNSS-RTK-Observations* are requested. A one-value at a bit position means RTK observations for the specific signal are requested; a zero-value means not requested.
gnss-RTK-Integer-ms-Req This field specifies whether the integer-ms is requested or not. TRUE means requested.
gnss-RTK-PhaseRangeRateReq This field specifies whether the *rough-phase-range-rate* and *fine-PhaseRangeRate* are requested or not. TRUE means requested.
gnss-RTK-CNR-Req This field specifies whether the *carrier-to-noise-ratio* is requested or not. TRUE means requested.
stationID This field specifies the Station ID for which the GNSS-RTK-Observations are requested.

– *GLO-RTK-BiasInformationReq*

The IE *GLO-RTK-BiasInformationReq* is used by the target device to request the *GLO-RTK-BiasInformation* assistance from the location server.

```
-- ASN1START

GLO-RTK-BiasInformationReq-r15 ::=  SEQUENCE {
    stationID-r15                       GNSS-ReferenceStationID-r15     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GLO-RTK-BiasInformationReq* field descriptions**
stationID This field specifies the Station ID for which the *GLO-RTK-BiasInformation* is requested.

– *GNSS-RTK-MAC-CorrectionDifferencesReq*

The IE *GNSS-RTK-MAC-CorrectionDifferencesReq* is used by the target device to request the *GNSS-RTK-MAC-CorrectionDifferences* assistance from the location server.

```
-- ASN1START

GNSS-RTK-MAC-CorrectionDifferencesReq-r15 ::=   SEQUENCE {
    master-ReferenceStationID-r15       GNSS-ReferenceStationID-r15             OPTIONAL,
    aux-ReferenceStationList-r15        AUX-ReferenceStationList-r15            OPTIONAL,
    linkCombinations-PrefList-r15       GNSS-Link-CombinationsList-r15          OPTIONAL,
    ...
}

AUX-ReferenceStationList-r15 ::= SEQUENCE (SIZE (1..32)) OF AUX-ReferenceStationID-Element-r15

AUX-ReferenceStationID-Element-r15 ::= SEQUENCE {
    aux-stationID-r15       GNSS-ReferenceStationID-r15,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-MAC-CorrectionDifferencesReq* field descriptions**
master-ReferenceStationID, aux-ReferenceStationList These fields specify the Master and Auxiliary Reference Station IDs for which the *GNSS-RTK-MAC-CorrectionDifferences* are requested.
linkCombinations-PrefList This field specifies the dual-frequency combination of L1 and L2 link/frequencies for which the target device wishes to obtain the *GNSS-RTK-MAC-CorrectionDifferences* in the order of preference. The first *GNSS-Link-Combinations* in *GNSS-Link-CombinationsList* is the most preferred combination, the second *GNSS-Link-Combinations* in *GNSS-Link-CombinationsList* is the second most preferred, etc.

– *GNSS-RTK-ResidualsReq*

The IE *GNSS-RTK-ResidualsReq* is used by the target device to request the *GNSS-RTK-Residuals* assistance from the location server.

```
-- ASN1START

GNSS-RTK-ResidualsReq-r15 ::=   SEQUENCE {
    stationID-r15                       GNSS-ReferenceStationID-r15     OPTIONAL,
    linkCombinations-PrefList-r15       GNSS-Link-CombinationsList-r15  OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-ResidualsReq* field descriptions**
stationID This field specifies the Station ID for which the *GNSS-RTK-Residuals* are requested.
linkCombinations-PrefList This field specifies the dual-frequency combination of L1 and L2 link/frequencies for which the target device wishes to obtain the *GNSS-RTK-Residuals* in the order of preference. The first *GNSS-Link-Combinations* in *GNSS-Link-CombinationsList* is the most preferred combination, the second *GNSS-Link-Combinations* in *GNSS-Link-CombinationsList* is the second most preferred, etc.

– *GNSS-RTK-FKP-GradientsReq*

The IE *GNSS-RTK-FKP-GradientsReq* is used by the target device to request the *GNSS-RTK-FKP-Gradients* assistance from the location server.

```
-- ASN1START

GNSS-RTK-FKP-GradientsReq-r15 ::=   SEQUENCE {
    stationID-r15                       GNSS-ReferenceStationID-r15     OPTIONAL,
```

```
    linkCombinations-PrefList-r15       GNSS-Link-CombinationsList-r15  OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-FKP-GradientsReq* field descriptions**
stationID This field specifies the Station ID for which the *GNSS-RTK-FKP-Gradients* are requested.
linkCombinations-PrefList This field specifies the dual-frequency combination of L1 and L2 link/frequencies for which the target device wishes to obtain the *GNSS-RTK-FKP-Gradients* in the order of preference. The first *GNSS-Link-Combinations* in *GNSS-Link-CombinationsList* is the most preferred combination, the second *GNSS-Link-Combinations* in *GNSS-Link-CombinationsList* is the second most preferred, etc.

– *GNSS-SSR-OrbitCorrectionsReq*

The IE *GNSS-SSR-OrbitCorrectionsReq* is used by the target device to request the *GNSS-SSR-OrbitCorrections* assistance from the location server.

```
-- ASN1START

GNSS-SSR-OrbitCorrectionsReq-r15 ::= SEQUENCE {
    storedNavList-r15               GNSS-NavListInfo-r15               OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-SSR-OrbitCorrectionsReq* field descriptions**
storedNavList This list provides information to the location server about which NAV data the target device has currently stored for the particular GNSS indicated by *GNSS-ID*.

– *GNSS-SSR-ClockCorrectionsReq*

The IE *GNSS-SSR-ClockCorrectionsReq* is used by the target device to request the *GNSS-SSR-ClockCorrections* assistance from the location server.

```
-- ASN1START

GNSS-SSR-ClockCorrectionsReq-r15 ::= SEQUENCE {
    storedNavList-r15               GNSS-NavListInfo-r15               OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-SSR-ClockCorrectionsReq* field descriptions**
storedNavList This list provides information to the location server about which NAV data the target device has currently stored for the particular GNSS indicated by *GNSS-ID*.

– *GNSS-SSR-CodeBiasReq*

The IE *GNSS-SSR-CodeBiasReq* is used by the target device to request the *GNSS-SSR-CodeBias* assistance from the location server.

```
-- ASN1START

GNSS-SSR-CodeBiasReq-r15 ::= SEQUENCE {
    signal-and-tracking-mode-ID-Map-r15     GNSS-SignalIDs,
    storedNavList-r15                       GNSS-NavListInfo-r15               OPTIONAL,
```

```
    ...
}

-- ASN1STOP
```

***GNSS-SSR-CodeBiasReq* field descriptions**
signal-and-tracking-mode-ID-Map This field specifies the GNSS signal(s) for which the *GNSS-SSR-CodeBias* is requested.
storedNavList This list provides information to the location server about which NAV data the target device has currently stored for the particular GNSS indicated by *GNSS-ID*.

6.5.2.5 GNSS Location Information

– *A-GNSS-ProvideLocationInformation*

The IE *A-GNSS-ProvideLocationInformation* is used by the target device to provide location measurements (e.g., pseudo-ranges, location estimate, velocity) to the location server, together with time information. It may also be used to provide GNSS positioning specific error reason.

```
-- ASN1START

A-GNSS-ProvideLocationInformation ::= SEQUENCE {
    gnss-SignalMeasurementInformation   GNSS-SignalMeasurementInformation       OPTIONAL,
    gnss-LocationInformation            GNSS-LocationInformation                OPTIONAL,
    gnss-Error                          A-GNSS-Error                            OPTIONAL,
    ...
}

-- ASN1STOP
```

6.5.2.6 GNSS Location Information Elements

– *GNSS-SignalMeasurementInformation*

The IE *GNSS-SignalMeasurementInformation* is used by the target device to provide GNSS signal measurement information to the location server and GNSS-network time association if requested by the location server. This information includes the measurements of code phase, Doppler, C/N_o and optionally accumulated carrier phase, also called accumulated deltarange (ADR), which enable the UE-assisted GNSS method where position is computed in the location server. Figure 6.5.2.6-1 illustrates the relation between some of the fields.

```
-- ASN1START

GNSS-SignalMeasurementInformation ::= SEQUENCE {
    measurementReferenceTime        MeasurementReferenceTime,
    gnss-MeasurementList            GNSS-MeasurementList,
    ...
}

-- ASN1STOP
```

***GNSS-SignalMeasurementInformation* field descriptions**
measurementReferenceTime This field specifies the GNSS system time for which the information provided in *gnss-MeasurementList* is valid. It may also include network time, if requested by the location server and supported by the target device.
gnss-MeasurementList This field provides GNSS signal measurement information for up to 16 GNSSs.

– *MeasurementReferenceTime*

The IE *MeasurementReferenceTime* is used to specify the time when the measurements provided in *A-GNSS-ProvideLocationInformation* are valid. It may also include GNSS-network time association, in which case reported measurements shall be valid for the cellular frame boundary defined in the network time association.

```
-- ASN1START

MeasurementReferenceTime ::= SEQUENCE {
    gnss-TOD-msec       INTEGER (0..3599999),
    gnss-TOD-frac       INTEGER (0..3999)           OPTIONAL,
    gnss-TOD-unc        INTEGER (0..127)            OPTIONAL,
    gnss-TimeID         GNSS-ID,
    networkTime         CHOICE {
        eUTRA   SEQUENCE {
                physCellId          INTEGER (0..503),
                cellGlobalId        CellGlobalIdEUTRA-AndUTRA       OPTIONAL,
                systemFrameNumber   BIT STRING (SIZE (10)),
                ...
                },
        uTRA    SEQUENCE {
                mode                    CHOICE {
                                        fdd         SEQUENCE {
                                                    primary-CPICH-Info  INTEGER (0..511),
                                                    ...
                                                    },
                                        tdd         SEQUENCE {
                                                    cellParameters      INTEGER (0..127),
                                                    ...
                                                    }
                                        },
                cellGlobalId            CellGlobalIdEUTRA-AndUTRA       OPTIONAL,
                referenceSystemFrameNumber
                                        INTEGER (0..4095),
                ...
                },
        gSM     SEQUENCE {
                bcchCarrier         INTEGER (0..1023),
                bsic                INTEGER (0..63),
                cellGlobalId        CellGlobalIdGERAN                   OPTIONAL,
                referenceFrame      SEQUENCE {
                                    referenceFN     INTEGER (0..65535),
                                    referenceFNMSB      INTEGER (0..63)     OPTIONAL,
                                    ...
                                    },
                deltaGNSS-TOD       INTEGER (0 .. 127)      OPTIONAL,
                ...
                },
        ...,
        nbIoT-r14
                SEQUENCE {
                nbPhysCellId-r14    INTEGER (0..503),
                nbCellGlobalId-r14  ECGI                        OPTIONAL,
                sfn-r14             BIT STRING (SIZE (10)),
                hyperSFN-r14        BIT STRING (SIZE (10))      OPTIONAL,
                ...
                },
        nr-r15  SEQUENCE {
                nrPhysCellId-r15    INTEGER (0..1007),
                nrCellGlobalID-r15  NCGI-r15                    OPTIONAL,
                nr-sfn-r15          BIT STRING (SIZE (10)),
                ...
                }
        }       OPTIONAL,
    ...
}

-- ASN1STOP
```

***MeasurementReferenceTime* field descriptions**
gnss-TOD-msec This field specifies the GNSS TOD for which the measurements and/or location estimate are valid. The 22 bits of GNSS TOD are the least significant bits. The most significant bits shall be derived by the location server to unambiguously derive the GNSS TOD. The value for GNSS TOD is derived from the GNSS specific system time indicated in *gnss-TimeID* rounded down to the nearest millisecond unit. Scale factor 1 millisecond.
gnss-TOD-frac This field specifies the fractional part of the GNSS TOD in 250 ns resolution. The total GNSS TOD is given by *gnss-TOD-msec* + *gnss-TOD-frac*. Scale factor 250 nanoseconds.
gnss-TOD-unc This field provides the accuracy of the relation GNSS-network time when GNSS-network time association is provided. When GNSS-network time association is not provided, this element can be included to provide the accuracy of the reported *gnss-TOD-msec*. If GNSS TOD is the given GNSS time, then the true GNSS time, corresponding to the provided network time if applicable, as observed at the target device location, lies in the interval [GNSS TOD – *gnss-TOD-unc*, GNSS TOD + *gnss-TOD-unc*]. The uncertainty *r*, expressed in microseconds, is mapped to a number K, with the following formula: $r = C*(((1+x)^K)-1)$ with C = 0.5 and x = 0.14. To encode any higher value of uncertainty than that corresponding in the above formula to K=127, the same value, K=127, shall also be used. The uncertainty is then coded on 7 bits, as the binary encoding of K. Examples of *gnss-TOD-unc* value are as in the table Value of K to Value of uncertainty relation below. This field shall be included if the target device provides GNSS-network time relationship.
gnss-TimeID This field specifies the GNSS system time for which the *gnss-TOD-msec* (and *gnss-TOD-frac* if applicable) is provided.
networkTime These fields specify the network time event which the GNSS TOD time stamps. This field shall be included if the target device provides GNSS-network time relationship.
physCellId This field identifies the reference cell (E-UTRA), as defined in TS 36.331 [12], that is used for the GNSS-network time relation.
cellGlobalId This field specifies the globally unique cell identifier (Evolved Cell Global Identifier (ECGI) in E-UTRA, global UTRAN Cell Identifier in UTRA, or Cell Global Identification (CGI) in GERAN) of the reference cell, as defined in TS 36.331 [12] for E-UTRA and in TS 25.331 [13] for UTRA, for which the GNSS network time relation is provided.
systemFrameNumber This field specifies the system frame number in E-UTRA which the GNSS time time stamps, as defined in TS 36.331 [12].
mode This field identifies the reference cell for the GNSS-network time relation, as defined in TS 25.331 [13].
referenceSystemFrameNumber This field specifies the system frame number in UTRA, as defined in TS 25.331 [13], which is used for time stamping.
bcchCarrier, bsic This field identifies the reference cell for the GNSS-network time relation in GERAN, as defined in TS 44.031 [14].
referenceFN, referenceFNMSB These fields specify the frame number in GERAN which the GNSS time time stamps, as defined in TS 44.031 [14]. The time of the reference frame boundary is as observed by the target device, i.e. without Timing Advance compensation. The *referenceFNMSB* field indicates the most significant bits of the frame number of the reference BTS corresponding to the *GNSS-MeasurementList*. Starting from the complete GSM frame number denoted FN, the target device calculates Reference FN MSB as Reference FN MSB = floor(FN/42432) The complete GSM frame number FN can then be reconstructed in the location server by combining the fields *referenceFN* with *referenceFNMSB* in the following way FN = *referenceFNMSB* *42432 + *referenceFN*
deltaGNSS-TOD This field specifies the difference in milliseconds between *gnss-TOD-msec* reported and the milli-second part of the SV time tsv_1 of the first SV in the list reported from the target device, as defined in TS 44.031 [14]. The *deltaGNSS-TOD* is defined as *deltaGNSS-TOD* = *gnss-TOD-msec* - fix(tsv_1) where fix() denotes rounding to the nearest integer towards zero.
nbPhysCellId This field identifies the reference cell, as defined in TS 36.331 [12] that is used for the GNSS-network time relation.
nbCellGlobalId This field specifies the global cell identifier of the NB-IoT reference cell, as defined in TS 36.331 [12], for which the GNSS network time relation is provided.

***MeasurementReferenceTime* field descriptions**
sfn This field specifies the system frame number in NB-IoT which the GNSS time time stamps, as defined in TS 36.331 [12].
hyperSFN This field specifies the hyper-SFN in NB-IoT which the GNSS time time stamps, as defined in TS 36.331 [12].
nrPhysCellId This field identifies the reference cell (NR), as defined in 3GPP TS 38.331 [35], that is used for the GNSS-network time relation.
nrCellGlobalID This field specifies the NR globally unique cell identifier (NR Cell Global Identifier (NCGI) in NR) of the reference cell, as defined in 3GPP TS 38.331 [35], for which the GNSS network time relation is provided.
nr-sfn This field specifies the system frame number in NR which the GNSS time time stamps, as defined in 3GPP TS 38.331 [35],

Value of K to Value of uncertainty relation

Value of K	Value of uncertainty
0	0 microseconds
1	0.07 microseconds
2	0.1498 microseconds
-	-
50	349.62 microseconds
-	-
127	≥ 8430000 microseconds

– *GNSS-MeasurementList*

The IE *GNSS-MeasurementList* is used by the target device to provide measurements of code phase, Doppler, C/N_o and optionally accumulated carrier phase, also called accumulated deltarange (ADR).

```
-- ASN1START

GNSS-MeasurementList ::= SEQUENCE (SIZE(1..16)) OF GNSS-MeasurementForOneGNSS

GNSS-MeasurementForOneGNSS ::= SEQUENCE {
    gnss-ID                 GNSS-ID,
    gnss-SgnMeasList        GNSS-SgnMeasList,
    ...
}

GNSS-SgnMeasList ::= SEQUENCE (SIZE(1..8)) OF GNSS-SgnMeasElement

GNSS-SgnMeasElement ::= SEQUENCE {
    gnss-SignalID           GNSS-SignalID,
    gnss-CodePhaseAmbiguity INTEGER (0..127)        OPTIONAL,
    gnss-SatMeasList        GNSS-SatMeasList,
    ...
}

GNSS-SatMeasList ::= SEQUENCE (SIZE(1..64)) OF GNSS-SatMeasElement

GNSS-SatMeasElement ::= SEQUENCE {
    svID                SV-ID,
    cNo                 INTEGER (0..63),
    mpathDet            ENUMERATED {notMeasured (0), low (1), medium (2), high (3), ...},
    carrierQualityInd   INTEGER (0..3)              OPTIONAL,
    codePhase           INTEGER (0..2097151),
    integerCodePhase    INTEGER (0..127)            OPTIONAL,
    codePhaseRMSError   INTEGER (0..63),
    doppler             INTEGER (-32768..32767) OPTIONAL,
    adr                 INTEGER (0..33554431)       OPTIONAL,
    ...,
    [[
        adrMSB-r15          INTEGER (0..15)                     OPTIONAL,
        adrSign-r15         ENUMERATED {positive, negative}     OPTIONAL,
        adrRMSerror-r15     INTEGER (0..127)                    OPTIONAL,
        delta-codePhase-r15 INTEGER (0..7)                      OPTIONAL
```

```
    ]]
}

-- ASN1STOP
```

***GNSS-MeasurementList* field descriptions**
gnss-ID This field identifies the GNSS constellation on which the GNSS signal measurements were measured. Measurement information for up to 16 GNSSs can be included.
gnss-SgnMeasList This list provides GNSS signal measurement information for up to 8 GNSS signal types per GNSS.
gnss-SignalID This field identifies the signal on which GNSS signal measurement parameters were measured.
gnss-CodePhaseAmbiguity This field provides the ambiguity of the code phase measurement. It is given in units of milli-seconds in the range between between 0 and 127 milli-seconds. The total code phase for a satellite k (Satk) is given modulo this *gnss-CodePhaseAmbiguity* and is reconstructed with: Code_Phase_Tot(Satk) = *codePhase*(Satk) + *integerCodePhase*(Satk) + n * *gnss-CodePhaseAmbiguity*, n= 0,1,2,... If there is no code phase ambiguity, the *gnss-CodePhaseAmbiguity* shall be set to 0. The field is optional. If *gnss-CodePhaseAmbiguity* is absent, the default value is 1 milli-second.
gnss-SatMeasList This list provides GNSS signal measurement information for up to 64 GNSS satellites.
svID This field identifies the satellite on which the GNSS signal measurements were measured.
cNo This field provides an estimate of the carrier-to-noise ratio of the received signal from the particular satellite. The target device shall set this field to the value of the satellite C/N_0, as referenced to the antenna connector, in units of 1 dB-Hz, in the range from 0 to 63 dB-Hz. Scale factor 1 dB-Hz.
mpathDet This field contains the multipath indicator value, defined in the table Value of mpathDet to Multipath Indication relation below.
carrierQualityInd If the fields *adrMSB*, *adrSign*, *adrRMSerror*, and *delta-codePhase* are not present: This field indicates the quality of a carrier phase measurement. The LSB indicates the data polarity, that is, if the data from a specific satellite is received inverted, this is indicated by setting the LSB value to '1'. In the case the data is not inverted, the LSB is set to '0'. The MSB indicates if accumulation of the carrier phase has been continuous, that is, without cycle slips since the previous measurement report. If the carrier phase accumulation has been continuous, the MSB value is set to '1X'. Otherwise, the MSB is set to '0X'. This field is optional but shall be included if the *adr* field is included. See table Bit to Polarity Indication relation below. If any of the fields *adrMSB*, *adrSign*, *adrRMSerror*, or *delta-codePhase* are present: This field indicates the quality of a carrier phase measurement. The LSB indicates the half-cycle ambiguity, that is, if there are no half-cycle ambiguities present in the ADR measurement report the LSB is set to '0'. In case there are half-cycle ambiguities present in the ADR measurement report the LSB is set to '1'. When reporting ADR with unresolved polarity encoding the target device shall set this bit to 1. The MSB indicates if accumulation of the carrier phase has been continuous, that is, without cycle slips since the previous measurement report. If the carrier phase accumulation has been continuous (no cycle slips), the MSB value is set to '1X'. Otherwise, the MSB is set to '0X'. If polarity resolution forced the ADR measurement to be corrected by half-a-cycle, then the MSB must be set to '0', indicating that despite continuous tracking the reported ADR experienced non-continuity. See table Bit to Ambiguity Indication relation below. The target device shall include this field if the *adr* field is included.
codePhase This field contains the whole and fractional value of the code-phase measurement made by the target device for the particular satellite signal at the time of measurement in the units of ms. GNSS specific code phase measurements (e.g. chips) are converted into unit of ms by dividing the measurements by the nominal values of the measured signal chipping rate. Scale factor 2^{-21} milli-seconds, in the range from 0 to $(1-2^{-21})$ milli-seconds.
integerCodePhase This field indicates the integer milli-second part of the code phase that is expressed modulo the *gnss-CodePhaseAmbiguity*. The value of the ambiguity is given in the *gnss-CodePhaseAmbiguity* field. The *integerCodePhase* is optional. If *integerCodePhase* is absent, the default value is 0 milli-second. Scale factor 1 milli-second, in the range from 0 to 127 milli-seconds.
codePhaseRMSError This field contains the pseudorange RMS error value. This parameter is specified according to a floating-point representation shown in the table below.

***GNSS-MeasurementList* field descriptions**
doppler This field contains the Doppler measured by the target device for the particular satellite signal. This information can be used to compute the 3-D velocity of the target device. Doppler measurements are converted into unit of m/s by multiplying the Doppler measurement in Hz by the nominal wavelength of the measured signal. Scale factor 0.04 meter/seconds. This field is optional, but shall be included, if the *velocityRequest* in *CommonIEsRequestLocationInformation* is set to TRUE.
adr This field contains the absolute value of the ADR measurement measured by the target device for the particular satellite signal. This information can be used to compute the 3-D velocity or high-accuracy position of the target device. ADR measurements are converted into units of meter by multiplying the ADR measurement by the nominal wavelength of the measured signal. Scale factor 2^{-10} meters, in the range from 0 to 32767.5 meters. This field is optional, but shall be included, if the *adrMeasReq* in *GNSS-PositioningInstructions* is set to TRUE and if ADR measurements are supported by the target device (i.e., *adr-Support* is set to TRUE in *A-GNSS-ProvideCapabilities*).
adrMSB This field contains the 4-MSBs of the ADR measurement in case the ADR measurement is outside the range of the field *adr* alone. Scale factor 32768 meters. If present, the full ADR measurement is constructed as *adrMSB* × 32768 + *adr* × 2^{-10} meters, representing measurements in the range from 0 to 524287.9990234375 meters. This field is optional, but shall be included, if the capability *adrEnhancementsSupport* is set to TRUE and the ADR measurement is outside the range of the *adr* field.
adrSign This field indicates the sign of the ADR measurement.
adrRMSerror This field contains the ADR root mean squared error value. Scale factor 2^{-10} meters.
delta-codePhase This field specifies the higher resolution of the *codePhase* measurement. Scale factor 2-24 milli-seconds. The full code phase measurement is constructed as *codePhase* × 2^{-21} + *delta-codePhase* × 2^{-24} milli-seconds, in the range from 0 to (1-2^{-24}) milli-seconds.

Value of mpathDet to Multipath Indication relation

Value of *mpathDet*	Multipath Indication
00	Not measured
01	Low, MP error < 5m
10	Medium, 5m < MP error < 43m
11	High, MP error > 43m

Bit to Polarity Indication relation

Value	Polarity Indication
0	Data Direct, carrier phase not continuous
1	Data Inverted, carrier phase not continuous
2	Data Direct, carrier phase continuous
3	Data Inverted, carrier phase continuous

Bit to Ambiguity Indication relation

Value	Value MSB, LSB	Polarity Indication
0	00	carrier phase not continuous, no half-cycle ambiguity
1	01	carrier phase not continuous, half-cycle ambiguity
2	10	carrier phase continuous, no half-cycle ambiguity
3	11	carrier phase continuous, half-cycle ambiguity

floating-point representation

Index	Mantissa	Exponent	Floating-Point value, x_i	Pseudorange value, P
0	000	000	0.5	P < 0.5
1	001	000	0.5625	0.5 <= P < 0.5625
I	x	y	0.5 * (1 + x/8) * 2^y	x_{i-1} <= P < x_i
62	110	111	112	104 <= P < 112
63	111	111	--	112 <= P

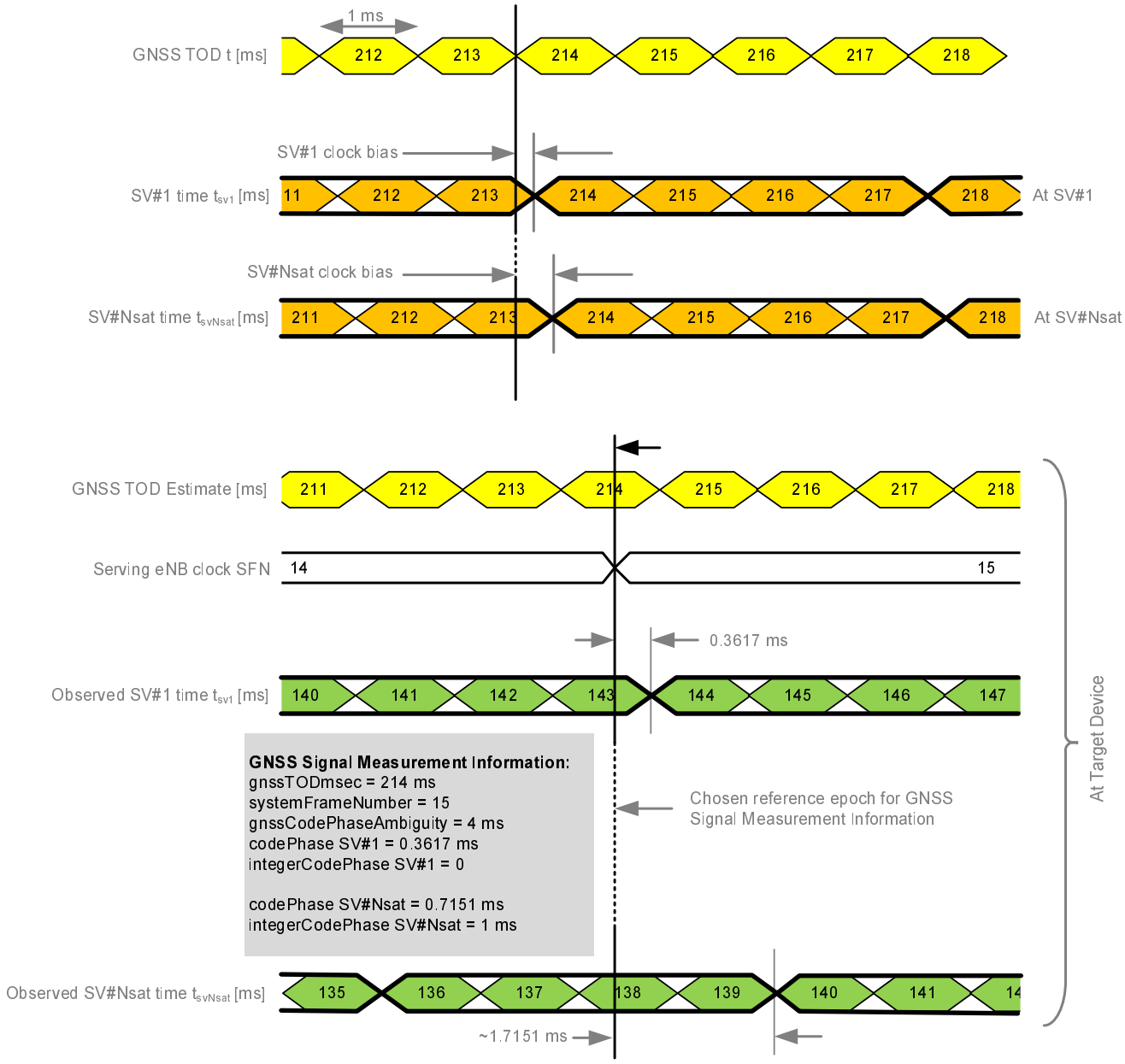

Figure 6.5.2.6-1: Exemplary calculation of some GNSS Signal Measurement Information fields.

– *GNSS-LocationInformation*

The IE *GNSS-LocationInformation* is included by the target device when location and optionally velocity information derived using GNSS or hybrid GNSS and other measurements is provided to the location server.

```
-- ASN1START
```

```
GNSS-LocationInformation ::= SEQUENCE {
    measurementReferenceTime        MeasurementReferenceTime,
    agnss-List                      GNSS-ID-Bitmap,
    ...
}

-- ASN1STOP
```

***GNSS-LocationInformation* field descriptions**
measurementReferenceTime This field specifies the GNSS system time for which the location estimate and optionally velocity are valid. It may also include GNSS-network time relationship, if requested by the location server and supported by the target device.
agnss-List This field provides a list of satellite systems used by the target device to calculate the location estimate and velocity estimate, if included. This is represented by a bit string in *GNSS-ID-Bitmap*, with a one-value at the bit position means the particular method has been used; a zero-value means not used.

6.5.2.7 GNSS Location Information Request

– *A-GNSS-RequestLocationInformation*

The IE *A-GNSS-RequestLocationInformation* is used by the location server to request location information from the target device using GNSS.

```
-- ASN1START

A-GNSS-RequestLocationInformation ::= SEQUENCE {
    gnss-PositioningInstructions        GNSS-PositioningInstructions,
    ...
}

-- ASN1STOP
```

6.5.2.8 GNSS Location Information Request Elements

– *GNSS-PositioningInstructions*

The IE *GNSS-PositioningInstructions* is used to provide GNSS measurement instructions.

```
-- ASN1START

GNSS-PositioningInstructions ::= SEQUENCE {
    gnss-Methods                GNSS-ID-Bitmap,
    fineTimeAssistanceMeasReq   BOOLEAN,
    adrMeasReq                  BOOLEAN,
    multiFreqMeasReq            BOOLEAN,
    assistanceAvailability      BOOLEAN,
    ...,
    [[
        ha-GNSS-Req-r15         ENUMERATED { true }     OPTIONAL    -- Cond UEB
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
UEB	The field is optionally present, need OP, if the *locationInformationType* is set to *locationEstimateRequired, locationEstimatePreferred, or locationMeasurementsPreferred*; oltherwise it is not present.

***GNSS-PositioningInstructions* field descriptions**
gnssMethods
This field indicates the satellite systems allowed by the location server. This is represented by a bit string in *GNSS-ID-Bitmap*, with a one-value at the bit position means the particular GNSS is allowed; a zero-value means not allowed. The target device shall not request assistance data or report or obtain measurements for systems that are not indicated in this bit map. At least one of the bits in this bit map shall be set to value one.
fineTimeAssistanceMeasReq
This field indicates whether the target device is requested to report GNSS-network time association. TRUE means requested.
adrMeasReq
This field indicates whether the target device is requested to include ADR measurements in *GNSS-MeasurementList* IE or not. TRUE means requested.
multiFreqMeasReq
This field indicates whether the target device is requested to report measurements on multiple supported GNSS signal types in *GNSS-MeasurementList* IE or not. TRUE means requested.
assistanceAvailability
This field indicates whether the target device may request additional GNSS assistance data from the server. TRUE means allowed and FALSE means not allowed.
ha-GNSS-Req
This field, if present, indicates that any location estimate provided by the target device should be obtained using high accuracy RTK/PPP methods.

6.5.2.9 GNSS Capability Information

– *A-GNSS-ProvideCapabilities*

The IE *A-GNSS-Provide-Capabilities* is used by the target device to indicate its capability to support A-GNSS and to provide its A-GNSS location capabilities (e.g., GNSSs and assistance data supported) to the location server.

```
-- ASN1START

A-GNSS-ProvideCapabilities ::= SEQUENCE {
    gnss-SupportList            GNSS-SupportList                OPTIONAL,
    assistanceDataSupportList   AssistanceDataSupportList       OPTIONAL,
    locationCoordinateTypes     LocationCoordinateTypes         OPTIONAL,
    velocityTypes               VelocityTypes                   OPTIONAL,
    ...,
    [[ periodicalReportingNotSupported-r14
                                PositioningModes                OPTIONAL,
        idleStateForMeasurements-r14
                                ENUMERATED { required }         OPTIONAL
    ]],
    [[ periodicAssistanceData-r15
                                BIT STRING { solicited   (0),
                                             unsolicited (1)    } (SIZE (1..8))     OPTIONAL
    ]]
}

GNSS-SupportList ::= SEQUENCE (SIZE(1..16)) OF GNSS-SupportElement

GNSS-SupportElement ::= SEQUENCE {
    gnss-ID                         GNSS-ID,
    sbas-IDs                        SBAS-IDs                    OPTIONAL,   -- Cond GNSS-ID-SBAS
    agnss-Modes                     PositioningModes,
    gnss-Signals                    GNSS-SignalIDs,
    fta-MeasSupport                 SEQUENCE {
                                        cellTime    AccessTypes,
                                        mode        PositioningModes,
                                        ...
                                    }                           OPTIONAL,   -- Cond fta
    adr-Support                     BOOLEAN,
    velocityMeasurementSupport      BOOLEAN,
    ...,
    [[
        adrEnhancementsSupport-r15  ENUMERATED { true }         OPTIONAL,
        ha-gnss-Modes-r15           PositioningModes            OPTIONAL
    ]]
}

AssistanceDataSupportList ::= SEQUENCE {
    gnss-CommonAssistanceDataSupport    GNSS-CommonAssistanceDataSupport,
```

```
    gnss-GenericAssistanceDataSupport   GNSS-GenericAssistanceDataSupport,
    ...
}


-- ASN1STOP
```

Conditional presence	Explanation
GNSS-ID-SBAS	The field is mandatory present if the *GNSS-ID* = *sbas*; otherwise it is not present.
fta	The field is mandatory present if the target device supports the reporting of fine time assistance measurements; otherwise it is not present.

***A-GNSS-ProvideCapabilities* field descriptions**
gnss-SupportList This field specifies the list of GNSS supported by the target device and the target device capabilities associated with each of the supported GNSS. This field shall be present if the *gnss-SupportListReq* in the A-GNSS - *RequestCapabilities* IE is set to TRUE and if the target device supports the A-GNSS positioning method. If the IE *A-GNSS-Provide-Capabilities* is provided unsolicited, this field shall be included if the target device supports the assisted GNSS positioning method.
gnss-ID This field specifies the GNSS supported by the target device for which the capabilities in *GNSS-SupportElement* are provided.
sbas-IDs This field specifies the SBAS(s) supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular SBAS is supported; a zero-value means not supported.
agnss-Modes This field specifies the GNSS mode(s) supported by the target device for the GNSS indicated by *gnss-ID*. This is represented by a bit string, with a one-value at the bit position means the particular GNSS mode is supported; a zero-value means not supported.
gnss-Signals This field specifies the GNSS signal(s) supported by the target device for the GNSS indicated by *gnss-ID*. This is represented by a bit string, with a one-value at the bit position means the particular GNSS signal type is supported; a zero-value means not supported.
fta-MeasSupport This field specifies that the target device is capable of performing fine time assistance measurements (i.e., GNSS-cellular time association reporting). The *cellTime* field specifies for which cellular network(s) this capability is supported. This is represented by a bit string, with a one-value at the bit position means FTA measurements for the specific cellular network time is supported; a zero-value means not supported. The *mode* field specifies for which GNSS mode(s) FTA measurements are supported by the target device. This is represented by a bit string, with a one-value at the bit position means FTA measurements for the GNSS mode is supported; a zero-value means not supported.
adr-Support This field specifies whether the target device supports ADR measurement reporting. TRUE means supported.
velocityMeasurementSupport This field specifies whether the target device supports measurement reporting related to velocity. TRUE means supported.
assistanceDataSupportList This list defines the assistance data and assistance data choices supported by the target device. This field shall be present if the *assistanceDataSupportListReq* in the A-GNSS-*RequestCapabilities* IE is set to TRUE and if the target device supports GNSS assistance data. If the IE *A-GNSS-Provide-Capabilities* is provided unsolicited, this field shall be included if the target device supports any GNSS assistance data.

***A-GNSS-ProvideCapabilities* field descriptions**
locationCoordinateTypes This parameter identifies the geographical location coordinate types that a target device supports for GNSS. TRUE indicates that a location coordinate type is supported and FALSE that it is not. This field shall be present if the *locationVelocityTypesReq* in the A-GNSS-*RequestCapabilities* IE is set to TRUE and if the target device supports UE-based or standalone GNSS positioning method. If the IE *A-GNSS-Provide-Capabilities* is provided unsolicited, this field shall be included if the target device supports UE-based or standalone GNSS positioning method.
velocityTypes This parameter identifies the velocity types that a target device supports for GNSS. TRUE indicates that a velocity type is supported and FALSE that it is not. FALSE for all velocity types indicates that velocity reporting is not supported. This field shall be present if the *locationVelocityTypesReq* in the A-GNSS-*RequestCapabilities* IE is set to TRUE and if the target device supports UE-based or standalone GNSS positioning method. If the IE *A-GNSS-Provide-Capabilities* is provided unsolicited, this field shall be included if the target device supports UE-based or standalone GNSS positioning method.
periodicalReportingNotSupported This field, if present, specifies the positioning modes for which the target device does not support *periodicalReporting.* This is represented by a bit string, with a one-value at the bit position means *periodicalReporting* for the positioning mode is not supported; a zero-value means supported. If this field is absent, the location server may assume that the target device supports *periodicalReporting* in *CommonIEsRequestLocationInformation* for each supported positioning mode.
idleStateForMeasurements This field, if present, indicates that the target device requires idle state to perform GNSS measurements.
periodicAssistanceData This field identifies the periodic assistance data delivery procedures supported by the target device. This is represented by a bit string, with a one value at the bit position means the periodic assistance data delivery procedure is supported; a zero value means not supported. Bit 0 (solicited) represents the procedure according to sub-clause 5.2.1a; bit (1) (unsolicited) represents the procedure according to sub-clause 5.2.2a.
adrEnhancementsSupport This field, if present, indicates that the target device supports the fields *adrMSB*, *adrSign*, *adrRMSerror*, and *delta-codePhase* in IE *GNSS-MeasurementList*. This field may only be present if *adr-Support* is set to TRUE, and shall be absent if *adr-Support* is set to FALSE.
ha-gnss-Modes This field specifies the High-Accuracy GNSS mode(s) supported by the target device for the GNSS indicated by *gnss-ID*. This is represented by a bit string, with a one-value at the bit position means the particular GNSS mode is supported; a zero-value means not supported.

6.5.2.10 GNSS Capability Information Elements

– *GNSS-CommonAssistanceDataSupport*

The IE *GNSS-CommonAssistanceDataSupport* is used by the target device to provide information on supported GNSS common assistance data types to the location server.

```
-- ASN1START

GNSS-CommonAssistanceDataSupport ::= SEQUENCE {
    gnss-ReferenceTimeSupport               GNSS-ReferenceTimeSupport
                                                        OPTIONAL, -- Cond RefTimeSup
    gnss-ReferenceLocationSupport           GNSS-ReferenceLocationSupport
                                                        OPTIONAL, -- Cond RefLocSup
    gnss-IonosphericModelSupport            GNSS-IonosphericModelSupport
                                                        OPTIONAL, -- Cond IonoModSup
    gnss-EarthOrientationParametersSupport  GNSS-EarthOrientationParametersSupport
                                                        OPTIONAL, -- Cond EOPSup
    ...,
    [[
        gnss-RTK-ReferenceStationInfoSupport-r15
                                            GNSS-RTK-ReferenceStationInfoSupport-r15
                                                        OPTIONAL, -- Cond ARPSup
        gnss-RTK-AuxiliaryStationDataSupport-r15
                                            GNSS-RTK-AuxiliaryStationDataSupport-r15
                                                        OPTIONAL -- Cond AuxARPSup
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
RefTimeSup	The field is mandatory present if the target device supports *GNSS-ReferenceTime*; otherwise it is not present.
RefLocSup	This field is mandatory present if the target device supports *GNSS-ReferenceLocation*; otherwise it is not present.
IonoModSup	This field is mandatory present if the target device supports *GNSS-IonosphericModel*; otherwise it is not present.
EOPSup	This field is mandatory present if the target device supports *GNSS-EarthOrientationParameters*; otherwise it is not present.
ARPSup	This field is mandatory present if the target device supports *GNSS-RTK-ReferenceStationInfo*; otherwise it is not present.
AuxARPSup	This field is mandatory present if the target device supports *GNSS-RTK-AuxiliaryStationData*; otherwise it is not present.

– *GNSS-ReferenceTimeSupport*

```
-- ASN1START

GNSS-ReferenceTimeSupport ::=   SEQUENCE {
    gnss-SystemTime     GNSS-ID-Bitmap,
    fta-Support         AccessTypes                                     OPTIONAL, -- Cond fta
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
fta	The field is mandatory present if the target device supports fine time assistance in *GNSSReferenceTime* IE; otherwise it is not present.

***GNSS-ReferenceTimeSupport* field descriptions**
gnss-SystemTime This field specifies the GNSS system time(s) supported by the target device. This is represented by a bit string in *GNSS-ID-Bitmap*, with a one-value at the bit position means the particular GNSS system time is supported; a zero-value means not supported.
fta-Support This field specifies that the target device supports fine time assistance (i.e., GNSS-cellular time association) in *GNSS-ReferenceTime* IE. This is represented by a bit string in *AccessTypes*, with a one-value at the bit position means FTA for the specific cellular network time is supported; a zero-value means not supported.

– *GNSS-ReferenceLocationSupport*

```
-- ASN1START

GNSS-ReferenceLocationSupport ::=   SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-IonosphericModelSupport*

```
-- ASN1START

GNSS-IonosphericModelSupport ::=    SEQUENCE {
    ionoModel       BIT STRING {    klobuchar   (0),
                                    neQuick     (1) } (SIZE (1..8)),
    ...
}

-- ASN1STOP
```

***GNSS-IonosphericModelSupport* field descriptions**
ionoModel
This field specifies the ionospheric model(s) supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular ionospheric model is supported; a zero-value means not supported.

– *GNSS-EarthOrientationParametersSupport*

```
-- ASN1START

GNSS-EarthOrientationParametersSupport ::=  SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-RTK-ReferenceStationInfoSupport*

```
-- ASN1START

GNSS-RTK-ReferenceStationInfoSupport-r15 ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-RTK-AuxiliaryStationDataSupport*

```
-- ASN1START

GNSS-RTK-AuxiliaryStationDataSupport-r15 ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-GenericAssistanceDataSupport*

The IE *GNSS-GenericAssistanceDataSupport* is used by the target device to provide information on supported GNSS generic assistance data types to the location server for each supported GNSS.

```
-- ASN1START

GNSS-GenericAssistanceDataSupport ::=
                                SEQUENCE (SIZE (1..16)) OF GNSS-GenericAssistDataSupportElement

GNSS-GenericAssistDataSupportElement ::= SEQUENCE {
    gnss-ID                             GNSS-ID,
    sbas-ID                             SBAS-ID                     OPTIONAL, -- Cond GNSS-ID-SBAS
    gnss-TimeModelsSupport              GNSS-TimeModelListSupport
                                                                    OPTIONAL, -- Cond TimeModSup
    gnss-DifferentialCorrectionsSupport GNSS-DifferentialCorrectionsSupport
                                                                    OPTIONAL, -- Cond DGNSS-Sup
    gnss-NavigationModelSupport         GNSS-NavigationModelSupport
                                                                    OPTIONAL, -- Cond NavModSup
    gnss-RealTimeIntegritySupport       GNSS-RealTimeIntegritySupport
                                                                    OPTIONAL, -- Cond RTISup
    gnss-DataBitAssistanceSupport       GNSS-DataBitAssistanceSupport
                                                                    OPTIONAL, -- Cond DataBitsSup
    gnss-AcquisitionAssistanceSupport   GNSS-AcquisitionAssistanceSupport
                                                                    OPTIONAL, -- Cond AcquAssistSup
    gnss-AlmanacSupport                 GNSS-AlmanacSupport
                                                                    OPTIONAL, -- Cond AlmanacSup
    gnss-UTC-ModelSupport               GNSS-UTC-ModelSupport
                                                                    OPTIONAL, -- Cond UTCModSup
    gnss-AuxiliaryInformationSupport    GNSS-AuxiliaryInformationSupport
                                                                    OPTIONAL, -- Cond AuxInfoSup
    ...,
```

```
    [[
        bds-DifferentialCorrectionsSupport-r12
                                    BDS-DifferentialCorrectionsSupport-r12
                                                                OPTIONAL, -- Cond DBDS-Sup
        bds-GridModelSupport-r12    BDS-GridModelSupport-r12
                                                                OPTIONAL -- Cond BDS-GridModSup
    ]],
    [[
        gnss-RTK-ObservationsSupport-r15
                                    GNSS-RTK-ObservationsSupport-r15
                                                                OPTIONAL,   -- Cond RTK-OSR-Sup
        glo-RTK-BiasInformationSupport-r15
                                    GLO-RTK-BiasInformationSupport-r15
                                                                OPTIONAL,   -- Cond GLO-CPB-Sup
        gnss-RTK-MAC-CorrectionDifferencesSupport-r15
                                    GNSS-RTK-MAC-CorrectionDifferencesSupport-r15
                                                                OPTIONAL,   -- Cond MAC-Sup
        gnss-RTK-ResidualsSupport-r15   GNSS-RTK-ResidualsSupport-r15
                                                                OPTIONAL,   -- Cond Res-Sup
        gnss-RTK-FKP-GradientsSupport-r15
                                    GNSS-RTK-FKP-GradientsSupport-r15
                                                                OPTIONAL,   -- Cond FKP-Sup
        gnss-SSR-OrbitCorrectionsSupport-r15
                                    GNSS-SSR-OrbitCorrectionsSupport-r15
                                                                OPTIONAL, -- Cond OC-Sup
        gnss-SSR-ClockCorrectionsSupport-r15
                                    GNSS-SSR-ClockCorrectionsSupport-r15
                                                                OPTIONAL, -- Cond CC-Sup
        gnss-SSR-CodeBiasSupport-r15    GNSS-SSR-CodeBiasSupport-r15
                                                                OPTIONAL -- Cond CB-Sup
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
GNSS-ID-SBAS	The field is mandatory present if the *GNSS-ID* = *sbas*; otherwise it is not present.
TimeModSup	The field is mandatory present if the target device supports *GNSS-TimeModelList*; otherwise it is not present.
DGNSS-Sup	The field is mandatory present if the target device supports *GNSS-DifferentialCorrections*; otherwise it is not present.
NavModSup	The field is mandatory present if the target device supports *GNSS-NavigationModel*; otherwise it is not present.
RTISup	The field is mandatory present if the target device supports *GNSS-RealTimeIntegrity*; otherwise it is not present.
DataBitsSup	The field is mandatory present if the target device supports *GNSS-DataBitAssistance*; otherwise it is not present.
AcquAssistSup	The field is mandatory present if the target device supports *GNSS-AcquisitionAssistance*; otherwise it is not present.
AlmanacSup	The field is mandatory present if the target device supports *GNSS-Almanac*; otherwise it is not present.
UTCModSup	The field is mandatory present if the target device supports *GNSS-UTC-Model*; otherwise it is not present.
AuxInfoSup	The field is mandatory present if the target device supports *GNSS-AuxiliaryInformation*; otherwise it is not present.
DBDS-Sup	The field is mandatory present if the target device supports *BDS-DifferentialCorrections*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'.
BDS-GridModSup	The field is mandatory present if the target device supports *BDS-GridModel*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'.
RTK-OSR-Sup	The field is mandatory present if the target device supports *GNSS-RTK-Observations*; otherwise it is not present. Note, support for *GNSS-RTK-Observations* implies support for *GNSS-RTK-CommonObservationInfo* as well.
GLO-CPB-Sup	The field is mandatory present if the target device supports *GLO-RTK-BiasInformation*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'glonass'.
MAC-Sup	The field is mandatory present if the target device supports *GNSS-RTK-MAC-CorrectionDifferences*; otherwise it is not present.
Res-Sup	The field is mandatory present if the target device supports *GNSS-RTK-Residuals*; otherwise it is not present.
FKP-Sup	The field is mandatory present if the target device supports *GNSS-RTK-FKP-Gradients*; otherwise it is not present.

Conditional presence	Explanation
OC-Sup	The field is mandatory present if the target device supports *GNSS-SSR-OrbitCorrections*; otherwise it is not present.
CC-Sup	The field is mandatory present if the target device supports *GNSS-SSR-ClockCorrections*; otherwise it is not present.
CB-Sup	The field is mandatory present if the target device supports *GNSS-SSR-CodeBias*; otherwise it is not present.

– *GNSS-TimeModelListSupport*

```
-- ASN1START

GNSS-TimeModelListSupport ::=   SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-DifferentialCorrectionSupport*

```
-- ASN1START

GNSS-DifferentialCorrectionsSupport ::= SEQUENCE {
    gnssSignalIDs           GNSS-SignalIDs,
    dgnss-ValidityTimeSup   BOOLEAN,
    ...
}

-- ASN1STOP
```

***GNSS-DifferentialCorrectionsSupport* field descriptions**
gnssSignalIDs   This field specifies the GNSS signal types for which differential corrections are supported by the target device. This is represented by a bit string in *GNSS-SignalIDs*, with a one-value at the bit position means differential corrections for the particular GNSS signal type is supported; a zero-value means not supported.
dgnss-ValidityTimeSup   This field specifies if the target device supports estimation of UDRE based on growth rate and validity time for differential corrections. TRUE means supported.

– *GNSS-NavigationModelSupport*

```
-- ASN1START

GNSS-NavigationModelSupport ::= SEQUENCE {
    clockModel      BIT STRING {    model-1     (0),
                                    model-2     (1),
                                    model-3     (2),
                                    model-4     (3),
                                    model-5     (4),
                                    model-6     (5) } (SIZE (1..8))     OPTIONAL,
    orbitModel      BIT STRING {    model-1     (0),
                                    model-2     (1),
                                    model-3     (2),
                                    model-4     (3),
                                    model-5     (4),
                                    model-6     (5) } (SIZE (1..8))     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-NavigationModelSupport* field descriptions**
clockModel This field specifies the *gnss-ClockModel* choice(s) in *GNSS-NavigationModel* IE supported by the target device for the GNSS indicated by *GNSS-ID*. This is represented by a bit string, with a one-value at the bit position means the particular clock model is supported; a zero-value means not supported. If the target device supports GPS and *GNSS-NavigationModel* assistance, it shall support *clockModel* Model-2. If the target device supports SBAS and *GNSS-NavigationModel* assistance, it shall support *clockModel* Model-5. If the target device supports QZSS and *GNSS-NavigationModel* assistance, it shall support *clockModel* Model-2. If the target device supports Galileo and *GNSS-NavigationModel* assistance, it shall support *clockModel* Model-1. If the target device supports GLONASS and *GNSS-NavigationModel* assistance, it shall support *clockModel* Model-4. If the target device supports BDS and *GNSS-NavigationModel* assistance, it shall support *clockModel* Model-6. If this field is absent, the target device supports the mandatory (native) *clockModel* choice only as listed above for the GNSS indicated by *GNSS-ID*.
orbitModel This field specifies the *gnss-OrbitModel* choice(s) in *GNSS-NavigationModel* IE supported by the target device for the GNSS indicated by *GNSS-ID*. This is represented by a bit string, with a one-value at the bit position means the particular orbit model is supported; a zero-value means not supported. If the target device supports GPS and *GNSS-NavigationModel* assistance, it shall support *orbitModel* Model-2. If the target device supports SBAS and *GNSS-NavigationModel* assistance, it shall support *orbitModel* Model-5. If the target device supports QZSS and *GNSS-NavigationModel* assistance, it shall support *orbitModel* Model-2. If the target device supports Galileo and *GNSS-NavigationModel* assistance, it shall support*orbitModel* Model-1. If the target device supports GLONASS and *GNSS-NavigationModel* assistance, it shall support *orbitModel* Model-4. If the target device supports BDS and *GNSS-NavigationModel* assistance, it shall support *orbitModel* Model-6. If this field is absent, the target device supports the mandatory (native) *orbitModel* choice only as listed above for the GNSS indicated by *GNSS-ID*.

– *GNSS-RealTimeIntegritySupport*

```
-- ASN1START

GNSS-RealTimeIntegritySupport ::=   SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-DataBitAssistanceSupport*

```
-- ASN1START

GNSS-DataBitAssistanceSupport ::=   SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-AcquisitionAssistanceSupport*

```
-- ASN1START

GNSS-AcquisitionAssistanceSupport ::=   SEQUENCE {
    ...,
    confidenceSupport-r10                   ENUMERATED { true }     OPTIONAL,
    dopplerUncertaintyExtSupport-r10        ENUMERATED { true }     OPTIONAL
}

-- ASN1STOP
```

***GNSS-AcquisitionAssistanceSupport* field descriptions**
confidenceSupport If this field is present, the target device supports the *confidence* field in *GNSS-AcquisitionAssistance*.
dopplerUncertaintyExtSupport If this field is present, the target device supports the *dopplerUncertaintyExt* field in *GNSS-AcquisitionAssistance*.

– *GNSS-AlmanacSupport*

```
-- ASN1START

GNSS-AlmanacSupport ::= SEQUENCE {
    almanacModel        BIT STRING {    model-1     (0),
                                        model-2     (1),
                                        model-3     (2),
                                        model-4     (3),
                                        model-5     (4),
                                        model-6     (5),
                                        model-7     (6) } (SIZE (1..8))     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-AlmanacSupport* field descriptions**
almanacModel
This field specifies the *almanacModel* choice(s) in *GNSS-Almanac* IE supported by the target device for the GNSS indicated by *GNSS-ID*. This is represented by a bit string, with a one-value at the bit position means the particular almanac model is supported; a zero-value means not supported. If the target device supports GPS and *GNSS-Almanac* assistance, it shall support Model-2. If the target device supports SBAS and *GNSS-Almanac* assistance, it shall support Model-6. If the target device supports QZSS and *GNSS-Almanac* assistance, it shall support Model-2. If the target device supports Galileo and *GNSS-Almanac* assistance, it shall support Model-1. If the target device supports GLONASS and *GNSS-Almanac* assistance, it shall support Model-5. If the target device supports BDS and *GNSS-Almanac* assistance, it shall support Model-7. If this field is absent, the target device supports the mandatory (native) *almanacModel* choice only as listed above for the GNSS indicated by *GNSS-ID*.

– *GNSS-UTC-ModelSupport*

```
-- ASN1START

GNSS-UTC-ModelSupport ::=   SEQUENCE {
    utc-Model       BIT STRING {    model-1     (0),
                                    model-2     (1),
                                    model-3     (2),
                                    model-4     (3),
                                    model-5     (4) } (SIZE (1..8))     OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-UTC-ModelSupport* field descriptions**
utc-Model
This field specifies the *GNSS-UTC-Model* choice(s) in *GNSS-UTC-Model* IE supported by the target device for the GNSS indicated by *GNSS-ID*. This is represented by a bit string, with a one-value at the bit position means the particular UTC model is supported; a zero-value means not supported. If the target device supports GPS and *GNSS-UTC-Model* assistance, it shall support Model-1. If the target device supports SBAS and *GNSS-UTC-Model* assistance, it shall support Model-4. If the target device supports QZSS and *GNSS-UTC-Model* assistance, it shall support Model-1. If the target device supports Galileo and *GNSS-UTC-Model* assistance, it shall support Model-1. If the target device supports GLONASS and *GNSS-UTC-Model* assistance, it shall support Model-3. If the target device supports BDS and *GNSS-UTC-Model* assistance, it shall support Model-5. If this field is absent, the target device supports the mandatory (native) *utc-Model* choice only as listed above for the GNSS indicated by *GNSS-ID*.

– *GNSS-AuxiliaryInformationSupport*

```
-- ASN1START

GNSS-AuxiliaryInformationSupport ::=    SEQUENCE {
    ...
```

```
}

-- ASN1STOP
```

– *BDS-DifferentialCorrectionsSupport*

```
-- ASN1START

BDS-DifferentialCorrectionsSupport-r12 ::=  SEQUENCE {
    gnssSignalIDs           GNSS-SignalIDs,
    ...
}

-- ASN1STOP
```

***BDS-DifferentialCorrectionsSupport* field descriptions**
gnssSignalIDs
This field specifies the BDS signal types for which differential corrections are supported by the target device. This is represented by a bit string in *GNSS-SignalIDs*, with a one-value at the bit position means differential corrections for the particular BDS signal type is supported; a zero-value means not supported.

– *BDS-GridModelSupport*

```
-- ASN1START

BDS-GridModelSupport-r12 ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-RTK-ObservationsSupport*

```
-- ASN1START

GNSS-RTK-ObservationsSupport-r15 ::=    SEQUENCE {
    gnssSignalIDs-r15           GNSS-SignalIDs,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-ObservationsSupport* field descriptions**
gnssSignalIDs
This field specifies the GNSS signal types for which *GNSS-RTK-Observations* are supported by the target device. This is represented by a bit string in *GNSS-SignalIDs*, with a one-value at the bit position means *GNSS-RTK-Observations* for the particular GNSS signal type is supported; a zero-value means not supported.

– *GLO-RTK-BiasInformationSupport*

```
-- ASN1START

GLO-RTK-BiasInformationSupport-r15 ::=  SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-RTK-MAC-CorrectionDifferencesSupport*

```
-- ASN1START
```

```
GNSS-RTK-MAC-CorrectionDifferencesSupport-r15 ::=   SEQUENCE {
    link-combinations-support-r15       GNSS-Link-CombinationsList-r15,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-MAC-CorrectionDifferencesSupport* field descriptions**
link-combinations-support
This field specifies the GNSS link/frequency combinations for which *GNSS-RTK-MAC-CorrectionDifferences* are supported by the target device for the GNSS indicated by *GNSS-ID*.

– *GNSS-RTK-ResidualsSupport*

```
-- ASN1START

GNSS-RTK-ResidualsSupport-r15 ::=   SEQUENCE {
    link-combinations-support-r15       GNSS-Link-CombinationsList-r15,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-ResidualsSupport* field descriptions**
link-combinations-support
This field specifies the GNSS link/frequency combinations for which *GNSS-RTK-Residuals* are supported by the target device for the GNSS indicated by *GNSS-ID*.

– *GNSS-RTK-FKP-GradientsSupport*

```
-- ASN1START

GNSS-RTK-FKP-GradientsSupport-r15 ::=   SEQUENCE {
    link-combinations-support-r15       GNSS-Link-CombinationsList-r15,
    ...
}

-- ASN1STOP
```

***GNSS-RTK-FKP-GradientsSupport* field descriptions**
link-combinations-support
This field specifies the GNSS link/frequency combinations for which *GNSS-RTK-FKP-Gradients* are supported by the target device for the GNSS indicated by *GNSS-ID*.

– *GNSS-SSR-OrbitCorrectionsSupport*

```
-- ASN1START

GNSS-SSR-OrbitCorrectionsSupport-r15 ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-SSR-ClockCorrectionsSupport*

```
-- ASN1START

GNSS-SSR-ClockCorrectionsSupport-r15 ::=    SEQUENCE {
    ...
}

-- ASN1STOP
```

– *GNSS-SSR-CodeBiasSupport*

```
-- ASN1START

GNSS-SSR-CodeBiasSupport-r15 ::= SEQUENCE {
    signal-and-tracking-mode-ID-Sup-r15     GNSS-SignalIDs,
    ...
}

-- ASN1STOP
```

GNSS-SSR-CodeBiasSupport field descriptions
signal-and-tracking-mode-ID-Sup   This field specifies the GNSS signal(s) for which the *GNSS-SSR-CodeBias* is supported by the target device.

6.5.2.11 GNSS Capability Information Request

– *A-GNSS-RequestCapabilities*

The IE *A-GNSS-Request-Capabilities* is used by the location server to request A-GNSS location capabilities (e.g., GNSSs and assistance data supported) from the target device.

```
-- ASN1START

A-GNSS-RequestCapabilities ::= SEQUENCE {
    gnss-SupportListReq             BOOLEAN,
    assistanceDataSupportListReq    BOOLEAN,
    locationVelocityTypesReq        BOOLEAN,
    ...
}

-- ASN1STOP
```

***A-GNSS-RequestCapabilities* field descriptions**
gnss-SupportListReq   This field specifies whether the target device is requested to include the *gnss-SupportList* field in the *A-GNSS-ProvideCapabilities* IE or not. TRUE means requested.
assistanceDataSupportListReq   This field specifies whether the target device is requested to include the *assistanceDataSupportList* field in the *A-GNSS-ProvideCapabilities* IE or not. TRUE means requested.
locationVelocityTypesReq   This field specifies whether the target device is requested to include the *locationCoordinateTypes* field and *velocityTypes* field in the *A-GNSS-ProvideCapabilities* IE or not. TRUE means requested.

6.5.2.12 GNSS Error Elements

– *A-GNSS-Error*

The IE *A-GNSS-Error* is used by the location server or target device to provide GNSS error reasons.

```
-- ASN1START

A-GNSS-Error ::= CHOICE {
    locationServerErrorCauses       GNSS-LocationServerErrorCauses,
    targetDeviceErrorCauses         GNSS-TargetDeviceErrorCauses,
    ...
}

-- ASN1STOP
```

– *GNSS-LocationServerErrorCauses*

The IE *GNSS-LocationServerErrorCauses* is used by the location server to provide GNSS error reasons to the target device.

```
-- ASN1START

GNSS-LocationServerErrorCauses ::= SEQUENCE {
    cause       ENUMERATED  {
                    undefined,
                    undeliveredAssistanceDataIsNotSupportedByServer,
                    undeliveredAssistanceDataIsSupportedButCurrentlyNotAvailableByServer,
                    undeliveredAssistanceDataIsPartlyNotSupportedAndPartlyNotAvailableByServer,
                    ...,
                unconfirmedPeriodicAssistanceDataIsNotSupported-v1510,
                unconfirmedPeriodicAssistanceDataIsSupportedButCurrentlyNotAvailable-v1510,
                unconfirmedPeriodicAssistanceDataIsPartlyNotSupportedAndPartlyNotAvailable-v1510,
                undeliveredPeriodicAssistanceDataIsCurrentlyNotAvailable-v1510
                    },
    ...
}

-- ASN1STOP
```

***GNSS-LocationServerErrorCauses* field descriptions**
cause
This field provides a GNSS specific error cause. The cause values '*unconfirmedPeriodicAssistanceDataIsNotSupported*', '*unconfirmedPeriodicAssistanceDataIsSupportedButCurrentlyNotAvailable*' and '*unconfirmedPeriodicAssistanceDataIsPartlyNotSupportedAndPartlyNotAvailable*' may only be included in the control transaction of a periodic assistance data transfer procedure, as described in sub-clause 5.2.1a. The cause value '*undeliveredPeriodicAssistanceDataIsCurrentlyNotAvailable*' may only be included in the data transaction of a periodic assistance data transfer procedure when periodic assistance data are not available when the periodicity condition occurs, as described in sub-clause 5.2.1a and 5.2.2a.

– *GNSS-TargetDeviceErrorCauses*

The IE *GNSS-TargetDeviceErrorCauses* is used by the target device to provide GNSS error reasons to the location server.

```
-- ASN1START

GNSS-TargetDeviceErrorCauses ::= SEQUENCE {
    cause       ENUMERATED {    undefined,
                                thereWereNotEnoughSatellitesReceived,
                                assistanceDataMissing,
                                notAllRequestedMeasurementsPossible,
                                ...
                            },
    fineTimeAssistanceMeasurementsNotPossible       NULL        OPTIONAL,
    adrMeasurementsNotPossible                      NULL        OPTIONAL,
    multiFrequencyMeasurementsNotPossible           NULL        OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-TargetDeviceErrorCauses* field descriptions**
cause
This field provides a GNSS specific error cause. If the cause value is '*notAllRequestedMeasurementsPossible*', the target device was not able to provide all requested GNSS measurements (but may be able to report a location estimate or location measurements). In this case, the target device should include any of the *fineTimeAssistanceMeasurementsNotPossible*, *adrMeasurementsNotPossible*, or *multiFrequenceMeasurementsNotPossible* fields, as applicable.

6.5.2.13 Common GNSS Information Elements

– *GNSS-FrequencyID*

The IE *GNSS-FrequencyID* is used to indicate a specific GNSS link/frequency. The interpretation of *GNSS-FrequencyID* depends on the *GNSS-ID*.

```
-- ASN1START

GNSS-FrequencyID-r15    ::= SEQUENCE {
    gnss-FrequencyID-r15        INTEGER (0 .. 7),
    ...
}

-- ASN1STOP
```

***GNSS-FrequencyID* field descriptions**
gnss-FrequencyID   This field specifies a particular GNSS link/frequency. The interpretation of *gnss-FrequencyID* depends on the *GNSS-ID* and is as shown in the table Value & Explanation relation below.

Value & Explanation relation

System	Value	Explanation	
		Link	Centre Frequency [MHz]
GPS	0	L1	1575.42
	1	L2	1227.60
	2	L5	1176.45
	3-7	reserved	
SBAS	0	L1	1575.42
	1	L5	1176.45
	2-7	reserved	
QZSS	0	L1	1575.42
	1	L2	1227.60
	2	L5	1176.45
	3-7	reserved	
GLONASS k = -7..13	0	G1	1602+k×0.5625
	1	G2	1246+k×0.4375
	2	G3	1202.025
	3-7	reserved	
Galileo	0	E1	1575.420
	1	E6	1278.750
	2	E5a	1176.450
	3	E5b	1207.140
	4	E5	1191.795
	5-7	reserved	
BDS	0	B1 (Phase II)	1561.098
	1	B1 (Phase III)	1575.420
	2	B2	1207.140
	3	B3	1268.520
	4-7	reserved	

– *GNSS-ID*

The IE *GNSS-ID* is used to indicate a specific GNSS.

```
-- ASN1START

GNSS-ID ::= SEQUENCE {
    gnss-id             ENUMERATED{ gps, sbas, qzss, galileo, glonass, ..., bds },
    ...
}
```

```
-- ASN1STOP
```

– GNSS-ID-Bitmap

The IE *GNSS-ID-Bitmap* is used to indicate several GNSSs using a bit map.

```
-- ASN1START

GNSS-ID-Bitmap ::= SEQUENCE {
    gnss-ids            BIT STRING {    gps         (0),
                                        sbas        (1),
                                        qzss        (2),
                                        galileo     (3),
                                        glonass     (4),
                                        bds         (5) } (SIZE (1..16)),
    ...
}

-- ASN1STOP
```

***GNSS-ID-Bitmap* field descriptions**
gnss-ids
This field specifies the GNSS(s). This is represented by a bit string, with a one-value at the bit position means the particular GNSS is addressed; a zero-value means not addressed.

– GNSS-Link-CombinationsList

```
-- ASN1START

GNSS-Link-CombinationsList-r15 ::= SEQUENCE (SIZE(1..8)) OF GNSS-Link-Combinations-r15

GNSS-Link-Combinations-r15 ::= SEQUENCE {
    l1-r15      GNSS-FrequencyID-r15,
    l2-r15      GNSS-FrequencyID-r15,
    ...
}

-- ASN1STOP
```

– GNSS-NavListInfo

```
-- ASN1START

GNSS-NavListInfo-r15 ::= SEQUENCE (SIZE (1..64)) OF SatListElement-r15

SatListElement-r15 ::= SEQUENCE {
    svID-r15        SV-ID,
    iod-r15         BIT STRING (SIZE(11)),
    ...
}

-- ASN1STOP
```

– GNSS-NetworkID

The IE *GNSS-NetworkID* defines the reference network and the source of the particular set of reference stations and their observation information. This IE is used for MAC Network RTK as described in [30].

```
-- ASN1START

GNSS-NetworkID-r15 ::= SEQUENCE {
    networkID-r15                   INTEGER (0..255),
    ...
}
```

```
-- ASN1STOP
```

– GNSS-PeriodicControlParam

The IE *GNSS-PeriodicControlParam* is used to specify control parameters for a periodic assistance data delivery.

```
-- ASN1START

GNSS-PeriodicControlParam-r15 ::= SEQUENCE {
    deliveryAmount-r15          INTEGER (1..32),
    deliveryInterval-r15        INTEGER (1..64),
    ...
}

-- ASN1STOP
```

***GNSS-PeriodicControlParam* field descriptions**
deliveryAmount
This field specifies the number of periodic assistance data deliveries. Integer values *N*=1…31 correspond to an amount of 2^N. Integer value *N*=32 indicates an 'infinite/indefinite' amount, which means that the assistance data delivery should continue until a LPP *Abort* message is received.
deliveryInterval
This field specifies the interval between assistance data deliveries in seconds.

– GNSS-ReferenceStationID

The IE *GNSS-ReferenceStationID* is used to identify a specific GNSS Reference Station.

```
-- ASN1START

GNSS-ReferenceStationID-r15 ::= SEQUENCE {
    referenceStationID-r15          INTEGER (0..65535),
    providerName-r15                VisibleString (SIZE (1..32))        OPTIONAL,
    ...
}

-- ASN1STOP
```

***GNSS-ReferenceStationID* field descriptions**
referenceStationID
This field provides the reference station identity.
providerName
This field is associated to a GNSS correction data provider to ensure that the *referenceStationID*'s are unique from a target device perspective.

– GNSS-SignalID

The IE *GNSS-SignalID* is used to indicate a specific GNSS signal type. The interpretation of *GNSS-SignalID* depends on the *GNSS-ID*.

```
-- ASN1START

GNSS-SignalID   ::= SEQUENCE {
    gnss-SignalID       INTEGER (0 .. 7),
    ...,
    [[
        gnss-SignalID-Ext-r15   INTEGER (8..23)         OPTIONAL
    ]]
}

-- ASN1STOP
```

***GNSS-SignalID* field descriptions**
gnss-SignalID, gnss-SignalID-Ext
This field specifies a particular GNSS signal. The interpretation of *gnss-SignalID* and *gnss-SignalID-Ext* depends on the *GNSS-ID* and is as shown in the table System to Value & Explanation relation below.
If the field *gnss-SignalID-Ext* is present, the *gnss-SignalID* should be set to value 7 and shall be ignored by the receiver.

System to Value & Explanation relation

System	Value	Explanation
GPS	0	GPS L1 C/A
	1	GPS L1C
	2	GPS L2C
	3	GPS L5
	4	GPS L1 P
	5	GPS L1 Z-tracking
	6	GPS L2 C/A
	7	GPS L2 P
	8	GPS L2 Z-tracking
	9	GPS L2 L2C(M)
	10	GPS L2 L2C(L)
	11	GPS L2 L2C(M+L)
	12	GPS L5 I
	13	GPS L5 Q
	14	GPS L5 I+Q
	15	GPS L1 L1C(D)
	16	GPS L1 L1C(P)
	17	GPS L1 L1C(D+P)
	18-23	Reserved
SBAS	0	L1 C/A
	1	L5 I
	2	L5 Q
	3	L5 I+Q
	4-7	Reserved
QZSS	0	QZS-L1 C/A
	1	QZS-L1C
	2	QZS-L2C
	3	QZS-L5
	4	QZS-LEX S
	5	QZS-LEX L
	6	QZS-LEX S+L
	7	QZS-L2 L2C(M)
	8	QZS-L2 L2C(L)
	9	QZS-L2 L2C(M+L)
	10	QZS-L5 I
	11	QZS-L5 Q
	12	QZS-L5 I+Q
	13	QZS L1 L1C(D)
	14	QZS L1 L1C(P)
	15	QZS L1 L1C(D+P)
	16-23	Reserved
GLONASS	0	GLONASS G1 C/A
	1	GLONASS G2 C/A
	2	GLONASS G3
	3	GLONASS G1 P
	4	GLONASS G2 P
	5-23	Reserved
Galileo	0	Galileo E1
	1	Galileo E5A
	2	Galileo E5B
	3	Galileo E6
	4	Galileo E5A + E5B
	5	Galileo E1 C No data
	6	Galileo E1 A
	7	Galileo E1 B I/NAV OS/CS/SoL
	8	Galileo E1 B+C
	9	Galileo E1 A+B+C
	10	Galileo E6 C
	11	Galileo E6 A
	12	Galileo E6 B
	13	Galileo E6 B+C
	14	Galileo E6 A+B+C
	15	Galileo E5B I

	16	Galileo E5B Q
	17	Galileo E5B I+Q
	18	Galileo E5(A+B) I
	19	Galileo E5(A+B) Q
	20	Galileo E5(A+B) I+Q
	21	Galileo E5A I
	22	Galileo E5A Q
	23	Galileo E5A I+Q
BDS	0	B1 I
	1	B1 Q
	2	B1 I+Q
	3	B3 I
	4	B3 Q
	5	B3 I+Q
	6	B2 I
	7	B2 Q
	8	B2 I+Q
	9-23	Reserved

– *GNSS-SignalIDs*

The IE *GNSSSignal-IDs* is used to indicate several GNSS signals using a bit map. The interpretation of *GNSSSignal-IDs* depends on the *GNSS-ID.*

```
-- ASN1START

GNSS-SignalIDs  ::= SEQUENCE {
    gnss-SignalIDs      BIT STRING (SIZE(8)),
    ...,
    [[
        gnss-SignalIDs-Ext-r15  BIT STRING (SIZE(16))          OPTIONAL
    ]]
}

-- ASN1STOP
```

***GNSS-SignalIDs* field descriptions**
gnss-SignalIDs, gnss-SignalIDs-Ext
This field specifies one or several GNSS signals using a bit map. A one-value at the bit position means the particular signal is addressed; a zero-value at the particular bit position means the signal is not addressed. The interpretation of the bit map in *gnssSignalIDs* and *gnss-SignalIDs-Ext* depends on the *GNSS-ID* and is shown in the table below. Unfilled table entries indicate no assignment and shall be set to zero.

interpretation of the bit map in *gnssSignalIDs*

GNSS	Bit 1 (MSB)	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8 (LSB)
GPS	L1 C/A	L1C	L2C	L5	L1P	L1 Z	L2 C/A	L2 P
SBAS	L1 C/A	L5 I	L5 Q	L5 I+Q				
QZSS	QZS-L1 C/A	QZS-L1C	QZS-L2C	QZS-L5	LEX S	LEX L	LEX S+L	L2C(M)
GLONASS	G1 C/A	G2 C/A	G3	G1 P	G2 P			
Galileo	E1	E5a	E5b	E6	E5a+E5b	E1 C No Data	E1 A	E1 B I/NAV OS/CS/SoL
BDS	B1 I	B1 Q	B1 I+Q	B3 I	B3 Q	B3 I+Q	B2 I	B2 Q

interpretation of the bit map in *gnssSignalIDs-Ext*

GNSS	Bit 1 (MSB)	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
GPS	L2 Z	L2C(M)	L2C(L)	L2C(M+L)	L5 I	L5 Q	L5 I+Q	L1C(D)
SBAS								
QZSS	L2C(L)	L2C(M+L)	L5 I	L5 Q	L5 I+Q	L1C(D)	L1C(P)	L1C(D+P)
GLONASS								
Galileo	E1 B+C	E1 A+B+C	E6C	E6A	E6B	E6 B+C	E6 A+B+C	E5B I
BDS	B2 I+Q							

GNSS	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16 (LSB)
GPS	L1C(P)	L1C(D+P)						
SBAS								
QZSS								
GLONASS								
Galileo	E5B Q	E5B I+Q	E5(A+B) I	E5(A+B) Q	E5(A+B) I+Q	E5A I	E5A Q	E5A I+Q
BDS								

– *GNSS-SubNetworkID*

The IE *GNSS-SubNetworkID* defines the subnetwork of a network identified by *GNSS-NetworkID*. This IE is used for MAC Network RTK as described in [30].

```
-- ASN1START

GNSS-SubNetworkID-r15 ::= SEQUENCE {
    subNetworkID-r15                INTEGER (0..15),
    ...
}

-- ASN1STOP
```

– *SBAS-ID*

The IE *SBAS-ID* is used to indicate a specific SBAS.

```
-- ASN1START

SBAS-ID ::= SEQUENCE {
    sbas-id             ENUMERATED { waas, egnos, msas, gagan, ...},
    ...
}

-- ASN1STOP
```

– *SBAS-IDs*

The IE *SBAS-IDs* is used to indicate several SBASs using a bit map.

```
-- ASN1START

SBAS-IDs ::= SEQUENCE {
    sbas-IDs        BIT STRING {    waas        (0),
                                    egnos       (1),
                                    msas        (2),
                                    gagan       (3) } (SIZE (1..8)),
    ...
}

-- ASN1STOP
```

***SBAS-IDs* field descriptions**
sbas-IDs
This field specifies one or several SBAS(s) using a bit map. A one-value at the bit position means the particular SBAS is addressed; a zero-value at the particular bit position means the SBAS is not addressed.

– *SV-ID*

The IE *SV-ID* is used to indicate a specific GNSS satellite. The interpretation of *SV-ID* depends on the *GNSS-ID*.

```
-- ASN1START

SV-ID ::= SEQUENCE {
    satellite-id        INTEGER(0..63),
    ...
}

-- ASN1STOP
```

***SV-ID* field descriptions**
satellite-id
This field specifies a particular satellite within a specific GNSS. The interpretation of *satellite-id* depends on the *GNSS-ID* see the table below.

interpretation of *satellite-id*

System	Value of *satellite-id*	Interpretation of *satellite-id*
GPS	'0' – '62' '63'	Satellite PRN Signal No. 1 to 63 Reserved
SBAS	'0' – '38' '39' – '63'	Satellite PRN Signal No. 120 to 158 Reserved
QZSS	'0' – '4' '5 – '63'	Satellite PRN Signal No. 193 to 197 Reserved
GLONASS	'0' – '23' '24 – '63'	Slot Number 1 to 24 Reserved
Galileo	'0' – '35' '36' – '63'	Code No. 1 to 36 Reserved
BDS	'0' – '36' '37' – '63'	Satellite ranging code number signal No.1 to 37 [23] Reserved

6.5.3 Enhanced Cell ID Positioning

6.5.3.1 E-CID Location Information

– *ECID-ProvideLocationInformation*

The IE *ECID-ProvideLocationInformation* is used by the target device to provide E-CID location measurements to the location server. It may also be used to provide ECID positioning specific error reason.

```
-- ASN1START

ECID-ProvideLocationInformation ::= SEQUENCE {
    ecid-SignalMeasurementInformation   ECID-SignalMeasurementInformation       OPTIONAL,
    ecid-Error                          ECID-Error                              OPTIONAL,
    ...
}

-- ASN1STOP
```

6.5.3.2 E-CID Location Information Elements

– *ECID-SignalMeasurementInformation*

The IE *ECID-SignalMeasurementInformation* is used by the target device to provide various UE-measurements to the location server.

```
-- ASN1START

ECID-SignalMeasurementInformation ::= SEQUENCE {
    primaryCellMeasuredResults  MeasuredResultsElement  OPTIONAL,
    measuredResultsList         MeasuredResultsList,
    ...
}

MeasuredResultsList ::= SEQUENCE (SIZE(1..32)) OF MeasuredResultsElement

MeasuredResultsElement ::= SEQUENCE {
    physCellId                      INTEGER (0..503),
    cellGlobalId                    CellGlobalIdEUTRA-AndUTRA   OPTIONAL,
    arfcnEUTRA                      ARFCN-ValueEUTRA,
    systemFrameNumber               BIT STRING (SIZE (10))      OPTIONAL,
    rsrp-Result                     INTEGER (0..97)             OPTIONAL,
    rsrq-Result                     INTEGER (0..34)             OPTIONAL,
    ue-RxTxTimeDiff                 INTEGER (0..4095)           OPTIONAL,
    ...,
    [[  arfcnEUTRA-v9a0             ARFCN-ValueEUTRA-v9a0       OPTIONAL        -- Cond EARFCN-max
    ]],
    [[  nrsrp-Result-r14            INTEGER (0..113)            OPTIONAL,
        nrsrq-Result-r14            INTEGER (0..74)             OPTIONAL,
        carrierFreqOffsetNB-r14     CarrierFreqOffsetNB-r14     OPTIONAL,       -- Cond NB-IoT
        hyperSFN-r14                BIT STRING (SIZE (10))      OPTIONAL
    ]],
    [[
        rsrp-Result-v1470           INTEGER (-17..-1)           OPTIONAL,
        rsrq-Result-v1470           INTEGER (-30..46)           OPTIONAL
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
EARFCN-max	The field is mandatory present if the corresponding *arfcnEUTRA* (i.e. without suffix) is set to *maxEARFCN*. Otherwise the field is not present.
NB-IoT	The field is mandatory present if the measured cell is a NB-IoT cell. Otherwise it is not present.

***ECID-SignalMeasurementInformation* field descriptions**
primaryCellMeasuredResults This field contains measurements for the primary cell (if the primary cell is a E-UTRA or NB-IoT cell), when the target device reports measurements for both primary cell (E-UTRA or NB-IoT) and neighbour cells. This field shall be omitted when the target device reports measurements for the primary cell (E-UTRA or NB-IoT) only, in which case the measurements for the primary cell (E-UTRA or NB-IoT) is reported in the *measuredResultsList*. This field shall be omitted when the primary cell is not a E-UTRA or NB-IoT cell.
measuredResultsList This list contains the E-CID measurements for up to 32 E-UTRA or NB-IoT cells.
physCellId This field specifies the physical cell identity of the measured cell.
cellGlobalId This field specifies cell global ID of the measured cell. The target device shall provide this field if it was able to determine the ECGI of the measured cell at the time of measurement.
arfcnEUTRA This field specifies the ARFCN of the measured E-UTRA carrier frequency, as defined in TS 36.331 [12]. In case the target device includes *arfcnEUTRA-v9a0*, the target device shall set the corresponding *arfcnEUTRA* (i.e. without suffix) to *maxEARFCN*.
systemFrameNumber This field specifies the system frame number of the measured cell during which the measurements have been performed. The target device shall include this field if it was able to determine the SFN of the cell at the time of measurement.

ECID-SignalMeasurementInformation field descriptions
rsrp-Result This field specifies the reference signal received power (RSRP) measurement, as defined in TS 36.331 [12], TS 36.214 [17]. In case the target device includes *rsrp-Result-v1470*, the target device shall set the corresponding *rsrp-Result* (i.e. without suffix) to value 0.
rsrq-Result This field specifies the reference signal received quality (RSRQ) measurement, as defined in TS 36.331 [12], TS 36.214 [17]. In case the target device includes *rsrq-Result-v1470*, the target device shall set the corresponding *rsrq-Result* (i.e. without suffix) to value 0 or 34.
ue-RxTxTimeDiff This field specifies the UE Rx–Tx time difference measurement, as defined in TS 36.214 [17]. It is provided only for measurements on the UE's primary cell. Measurement report mapping is according to 3GPP TS 36.133 [18].
nrsrp-Result This field specifies the narrowband reference signal received power (NRSRP) measurement, as defined in TS 36.214 [17]. Measurement report mapping is according to TS 36.133 [18].
nrsrq-Result This field specifies the narrowband reference signal received quality (NRSRQ) measurement, as defined in TS 36.214 [17]. Measurement report mapping to the value defined in 3GPP TS 36.133 [18]. Values 0..29 map to values NRSRQ_-30..NRSRQ_-1. Values 30..62 map to NRSRQ_01..NRSRQ_33. Values 63..74 map to NRSRQ_35..NRSRQ_46. The UE does not report NRSRQ_00 nor NRSRQ_34.
carrierFreqOffsetNB This field specifies the offset of the NB-IoT channel number to ARFCN given by *arfcnEUTRA* as defined in TS 36.101 [21].
hyperSFN This field specifies the hyper-SFN of the measured cell during which the measurements have been performed. The target device shall include this field if it was able to determine the hyper-SFN of the cell at the time of measurement.

6.5.3.3 E-CID Location Information Request

– *ECID-RequestLocationInformation*

The IE *ECID-RequestLocationInformation* is used by the location server to request E-CID location measurements from a target device.

```
-- ASN1START

ECID-RequestLocationInformation ::= SEQUENCE {
    requestedMeasurements       BIT STRING {    rsrpReq     (0),
                                                rsrqReq     (1),
                                                ueRxTxReq   (2),
                                                nrsrpReq-r14    (3),
                                                nrsrqReq-r14    (4)} (SIZE(1..8)),
    ...
}

-- ASN1STOP
```

ECID-RequestLocationInformation field descriptions
requestedMeasurements This field specifies the E-CID measurements requested. This is represented by a bit string, with a one-value at the bit position means the particular measurement is requested; a zero-value means not requested.

6.5.3.4 E-CID Capability Information

– *ECID-ProvideCapabilities*

The IE *ECID-ProvideCapabilities* is used by the target device to indicate its capability to support E-CID and to provide its E-CID location capabilities to the location server.

```
-- ASN1START

ECID-ProvideCapabilities ::= SEQUENCE {
```

```
    ecid-MeasSupported  BIT STRING {    rsrpSup     (0),
                                        rsrqSup     (1),
                                        ueRxTxSup   (2),
                                        nrsrpSup-r14    (3),
                                        nrsrqSup-r14    (4)} (SIZE(1..8)),
    ...,
    [[  ueRxTxSupTDD-r13                    ENUMERATED { true }             OPTIONAL
    ]],
    [[  periodicalReporting-r14             ENUMERATED { supported }        OPTIONAL,
        triggeredReporting-r14              ENUMERATED { supported }        OPTIONAL,
        idleStateForMeasurements-r14        ENUMERATED { required }         OPTIONAL
    ]]
}

-- ASN1STOP
```

***ECID-Provide-Capabilities* field descriptions**
ecid-MeasSupported This field specifies the E-CID measurements supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular measurement is supported; a zero-value means not supported. A zero-value in all bit positions in the bit string means only the basic Cell ID positioning method is supported by the target device. If the UE Rx-Tx time difference measurement is supported by the target device (i.e., *ueRxTxSup* field is set to one), it means that the UE supports the UE Rx-Tx time difference measurement reporting via both LPP signaling and RRC signalling. If a target device doesn't support LPP, the E-SMLC may assume the target device can not report the UE Rx-Tx time difference measurement results via RRC signalling.
ueRxTxSupTDD This field, if present, indicates that any UE Rx-Tx time difference measurement reporting for TDD from the target device includes the $N_{TAoffset}$ according to TS 36.211 [16], TS 36.214 [17] and uses the UE Rx-Tx time difference measurement report mapping for TDD as specified in 3GPP TS 36.133 [18]. This field may only be included if the *ueRxTxSup* field in *ecid-MeasSupported* is set to value one.
periodicalReporting This field, if present, indicates that the target device supports *periodicalReporting* of ECID measurements. If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonIEsRequestLocationInformation*.
triggeredReporting This field, if present, indicates that the target device supports *triggeredReporting* for the *cellChange* event. If this field is absent, the location server may assume that the target device does not support *triggeredReporting* in *CommonIEsRequestLocationInformation*.
idleStateForMeasurements This field, if present, indicates that the target device requires idle state to perform ECID measurements.

6.5.3.5 E-CID Capability Information Request

– *ECID-RequestCapabilities*

The IE *ECID-RequestCapabilities* is used by the location server to request E-CID positioning capabilities from a target device.

```
-- ASN1START

ECID-RequestCapabilities ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.3.6 E-CID Error Elements

– *ECID-Error*

The IE *ECID-Error* is used by the location server or target device to provide E-CID error reasons to the target device or location server, respectively.

```
-- ASN1START

ECID-Error ::= CHOICE {
    locationServerErrorCauses       ECID-LocationServerErrorCauses,
    targetDeviceErrorCauses         ECID-TargetDeviceErrorCauses,
    ...
}

-- ASN1STOP
```

– *ECID-LocationServerErrorCauses*

The IE *ECID-LocationServerErrorCauses* is used by the location server to provide E-CID error reasons to the target device.

```
-- ASN1START

ECID-LocationServerErrorCauses ::= SEQUENCE {
    cause       ENUMERATED  {   undefined,
                                ...
                            },
    ...
}

-- ASN1STOP
```

– *ECID-TargetDeviceErrorCauses*

The IE *ECID-TargetDeviceErrorCauses* is used by the target device to provide E-CID error reasons to the location server.

```
-- ASN1START

ECID-TargetDeviceErrorCauses ::= SEQUENCE {
    cause       ENUMERATED {    undefined,
                                requestedMeasurementNotAvailable,
                                notAllrequestedMeasurementsPossible,
                                ...
                            },
    rsrpMeasurementNotPossible              NULL        OPTIONAL,
    rsrqMeasurementNotPossible              NULL        OPTIONAL,
    ueRxTxMeasurementNotPossible            NULL        OPTIONAL,
    ...,
    [[
     nrsrpMeasurementNotPossible-r14        NULL        OPTIONAL,
     nrsrqMeasurementNotPossible-r14        NULL        OPTIONAL
    ]]
}

-- ASN1STOP
```

***ECID-TargetDeviceErrorCauses* field descriptions**
cause   This field provides a ECID specific error cause. If the cause value is 'notAllRequestedMeasurementsPossible', the target device was not able to provide all requested ECID measurements (but may be able to provide some measurements). In this case, the target device should include any of the *rsrpMeasurementNotPossible*, *rsrqMeasurementNotPossible*, *ueRxTxMeasurementNotPossible*, *nrsrpMeasurementNotPossible*, or *nrsrqMeasurementNotPossible* fields, as applicable.

6.5.4 Terrestrial Beacon System Positioning

6.5.4.1 TBS Location Information

– *TBS-ProvideLocationInformation*

The IE *TBS-ProvideLocationInformation* is used by the target device to provide TBS location measurements to the location server. It may also be used to provide TBS positioning specific error reason.

```
-- ASN1START

TBS-ProvideLocationInformation-r13 ::= SEQUENCE {
    tbs-MeasurementInformation-r13          TBS-MeasurementInformation-r13      OPTIONAL,
    tbs-Error-r13                           TBS-Error-r13                       OPTIONAL,
    ...
}

-- ASN1STOP
```

6.5.4.2 TBS Location Information Elements

– *TBS-MeasurementInformation*

The IE *TBS-MeasurementInformation* is used by the target device to provide TBS location measurements to the location server.

```
-- ASN1START

TBS-MeasurementInformation-r13 ::= SEQUENCE {
    measurementReferenceTime-r13    UTCTime                     OPTIONAL,
    mbs-SgnMeasList-r13             MBS-BeaconMeasList-r13      OPTIONAL,   -- Cond MBS
    ...
}

-- ASN1STOP
```

Conditional presence	Explanation
MBS	The field is mandatory present if the *TBS-MeasurementInformation* is provided for an MBS system; otherwise it is not present.

***TBS-MeasurementInformation* field descriptions**
measurementReferenceTime This field provides the UTC time when the TBS measurements are performed and should take the form of *YYMMDDhhmmssZ*.
mbs-SgnMeasList This field provides the MBS measurements for up to 64 MBS beacons.

– *MBS-BeaconMeasList*

The IE *MBS-BeaconMeasList* is used by the target device to provide MBS location measurements to the location server, as defined in the MBS ICD [24].

```
-- ASN1START

MBS-BeaconMeasList-r13 ::= SEQUENCE (SIZE(1..64)) OF MBS-BeaconMeasElement-r13

MBS-BeaconMeasElement-r13 ::= SEQUENCE {
    transmitterID-r13               INTEGER (0..32767),
    codePhase-r13                   INTEGER (0..2097151),
    codePhaseRMSError-r13           INTEGER (0..63),
    ...,
    [[ rssi-r14                     INTEGER (-130..-30)     OPTIONAL
    ]]
```

```
}

-- ASN1STOP
```

MBS-BeaconMeasList field descriptions
transmitterID This field contains the MBS transmitter identifier.
codePhase This field contains the value of the code-phase measurement made by the target device for the particular beacon signal at the time of measurement in the units of ms. MBS specific code phase measurements (e.g. chips) are converted into unit of ms by dividing the measurements by the nominal values of the measured signal chipping rate. Scale factor 2^{-21} milli-seconds, in the range from 0 to ($1-2^{-21}$) milli-seconds.
codePhaseRMSError This field contains the pseudorange RMS error value. This parameter is specified according to a floating-point representation shown in the table below.
rssi This field provides an estimate of the received signal strength from the MBS beacon as referenced to the UE antenna connector. If the estimated received signal strength for the MBS beacon is less than -130 dBm, the UE shall report an RSSI value of -130. If the estimated received signal strength for the MBS beacon is greater than -30 dBm, the UE shall report an RSSI value of -30. Scale factor 1 dBm.

floating-point representation

Index	Mantissa	Exponent	Floating-Point value, x_i	Pseudorange value, P [m]
0	000	000	0.5	P < 0.5
1	001	000	0.5625	0.5 <= P < 0.5625
i	x	y	$0.5 * (1 + x/8) * 2^y$	x_{i-1} <= P < x_i
62	110	111	112	104 <= P < 112
63	111	111	--	112 <= P

6.5.4.3 TBS Location Information Request

– *TBS-RequestLocationInformation*

The IE *TBS-RequestLocationInformation* is used by the location server to request location information for TBS-based methods from the target device.

```
-- ASN1START

TBS-RequestLocationInformation-r13 ::= SEQUENCE {
    mbsSgnMeasListReq-r13               BOOLEAN,
    ...,
    [[  mbsAssistanceAvailability-r14   BOOLEAN                         OPTIONAL,   -- Need ON
        mbsRequestedMeasurements-r14    BIT STRING {
                                        rssi        (0)} (SIZE(1..8))   OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

TBS-RequestLocationInformation field descriptions
mbsSgnMeasListReq This field indicates whether the target device is requested to report MBS measurements in *TBS-MeasurementInformation* IE or not. TRUE means requested.
mbsAssistanceAvailability This field indicates whether the target device may request additional MBS assistance data from the server. TRUE means allowed and FALSE means not allowed.

TBS-RequestLocationInformation field descriptions
mbsRequestedMeasurements
This field indicates the additional MBS measurements requested and may only be included if *mbsSgnMeasListReq* is set to TRUE. This field is represented by a bit string, with a one-value at the bit position means the particular measurement is requested; a zero-value means not requested. The following measurement requests can be included. rssi: Beacon signal strength at the target

6.5.4.4 TBS Capability Information

– *TBS-ProvideCapabilities*

The IE *TBS-ProvideCapabilities* is used by the target device to indicate its capability to support TBS and to provide its TBS location capabilities to the location server.

```
-- ASN1START

TBS-ProvideCapabilities-r13 ::= SEQUENCE {
    tbs-Modes-r13           BIT STRING {    standalone      (0),
                                            ue-assisted     (1),
                                            ue-based        (2)} (SIZE (1..8)),
    ...,
    [[  mbs-AssistanceDataSupportList-r14   MBS-AssistanceDataSupportList-r14       OPTIONAL,
        periodicalReportingSupported-r14    PositioningModes                        OPTIONAL,
        mbs-ConfigSupport-r14   BIT STRING {    tb1     (0),
                                                tb2     (1),
                                                tb3     (2),
                                                tb4     (3)} (SIZE (1..8))          OPTIONAL,
        mbs-IdleStateForMeasurements-r14        ENUMERATED { required }             OPTIONAL
    ]]
}

-- ASN1STOP
```

TBS-ProvideCapabilities field descriptions
tbs-Modes
This field specifies the TBS mode(s) supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular TBS mode is supported; a zero-value means not supported.
mbs-AssistanceDataSupportList
This list defines the MBS assistance data supported by the target device. This field shall be present if the target device supports MBS assistance data.
periodicalReportingSupported
This field, if present, specifies the positioning modes for which the target device supports *periodicalReporting.* This is represented by a bit string, with a one-value at the bit position means *periodicalReporting* for the positioning mode is supported; a zero-value means not supported. If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonIEsRequestLocationInformation*.
mbs-ConfigSupport
This field specifies the MBS configurations supported by the target device. This field shall be present if the target device supports MBS [24].
mbs-IdleStateForMeasurements
This field, if present, indicates that the target device requires idle state to perform MBS measurements.

- *MBS-AssistanceDataSupportList*

The IE *MBS-AssistanceDataSupportList* is used by the target device to indicate its capability to support MBS Assistance Data and to provide its capabilities to the location server.

```
-- ASN1START

MBS-AssistanceDataSupportList-r14 ::= SEQUENCE {
    mbs-AcquisitionAssistanceDataSupport-r14    BOOLEAN,
    mbs-AlmanacAssistanceDataSupport-r14        BOOLEAN,
    ...
}
```

```
-- ASN1STOP
```

***MBS-AssistanceDataSupportList* field descriptions**
mbs-AcquisitionAssistanceDataSupport
This field specifies whether the target device supports MBS Acquisition Assistance Data. TRUE means supported.
mbs-AlmanacAssistanceDataSupport
This field specifies whether the target device supports MBS Almanac Assistance Data. TRUE means supported.

6.5.4.5 TBS Capability Information Request

– *TBS-RequestCapabilities*

The IE *TBS-RequestCapabilities* is used by the location server to request TBS positioning capabilities from a target device.

```
-- ASN1START

TBS-RequestCapabilities-r13 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.4.6 TBS Error Elements

– *TBS-Error*

The IE *TBS-Error* is used by the location server or target device to provide TBS error reasons to the target device or location server, respectively.

```
-- ASN1START

TBS-Error-r13 ::= CHOICE {
    locationServerErrorCauses-r13       TBS-LocationServerErrorCauses-r13,
    targetDeviceErrorCauses-r13         TBS-TargetDeviceErrorCauses-r13,
    ...
}

-- ASN1STOP
```

– *TBS-LocationServerErrorCauses*

The IE *TBS-LocationServerErrorCauses* is used by the location server to provide error reasons for TBS positioning to the target device.

```
-- ASN1START

TBS-LocationServerErrorCauses-r13 ::= SEQUENCE {
    cause-r13       ENUMERATED  {   undefined,
                                    ...,
                                    assistanceDataNotSupportedByServer-v1420,
                                    assistanceDataSupportedButCurrentlyNotAvailableByServer-v1420
                                },
    ...
}

-- ASN1STOP
```

– *TBS-TargetDeviceErrorCauses*

The IE *TBS-TargetDeviceErrorCauses* is used by the target device to provide error reasons for TBS positioning to the location server.

```
-- ASN1START

TBS-TargetDeviceErrorCauses-r13 ::= SEQUENCE {
    cause-r13       ENUMERATED {    undefined,
                                    thereWereNotEnoughMBSBeaconsReceived,
                                    ...,
                                    assistanceDataMissing-v1420
                                },
    ...
}

-- ASN1STOP
```

***TBS-TargetDeviceErrorCauses* field descriptions**
cause
This field provides a TBS specific error cause.

6.5.4.7 TBS Assistance Data

– *TBS-ProvideAssistanceData*

The IE *TBS-ProvideAssistanceData* is used by the location server to provide assistance data to assist in position estimation at the UE (e.g. for UE-based mode) and/or to expedite the acquisition of TBS signals. It may also be used to provide TBS positioning specific error reasons.

```
-- ASN1START

TBS-ProvideAssistanceData-r14 ::= SEQUENCE {
    tbs-AssistanceDataList-r14  TBS-AssistanceDataList-r14  OPTIONAL,   -- Need ON
    tbs-Error-r14               TBS-Error-r13               OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

6.5.4.8 TBS Assistance Data Elements

– *TBS-AssistanceDataList*

The IE *TBS-AssistanceDataList* is used by the location server to provide the TBS specific assistance data to the UE.

```
-- ASN1START

TBS-AssistanceDataList-r14 ::= SEQUENCE {
    mbs-AssistanceDataList-r14      MBS-AssistanceDataList-r14      OPTIONAL,   -- Need ON
    ...
}

MBS-AssistanceDataList-r14 ::= SEQUENCE (SIZE (1..maxMBS-r14)) OF MBS-AssistanceDataElement-r14

MBS-AssistanceDataElement-r14 ::= SEQUENCE {
    mbs-AlmanacAssistance-r14       MBS-AlmanacAssistance-r14           OPTIONAL,   -- Need ON
    mbs-AcquisitionAssistance-r14   MBS-AcquisitionAssistance-r14       OPTIONAL,   -- Need ON
    ...
}

maxMBS-r14      INTEGER ::= 64

-- ASN1STOP
```

– *MBS-AlmanacAssistance*

The IE *MBS-AlmanacAssistance* is used by the location server to provide LLA of MBS transmitters to enable position estimation at the UE.

```
-- ASN1START

MBS-AlmanacAssistance-r14 ::= SEQUENCE {
    transmitterID-r14           INTEGER (0..32767),
    transmitterLatitude-r14     BIT STRING (SIZE (26)),
    transmitterLongitude-r14    BIT STRING (SIZE (27)),
    transmitterAltitude-r14     BIT STRING (SIZE (15)),
    timeCorrection-r14          INTEGER (0..25)     OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***MBS-AlmanacAssistance* field descriptions**
transmitterID   This field specifies the MBS transmitter ID [24].
transmitterLatitude   This field specifies latitude of the MBS transmitter, degrees. Scale factor $4/2^{20}$ decimal degrees, added to -90°. Valid range -90° to 90° [24].
transmitterLongitude   This field specifies longitude of the MBS transmitter, degrees. Scale factor $4/2^{20}$ decimal degrees, added to -180°. Valid range -180° to 180° [24].
transmitterAltitude   This field specifies altitude of the MBS transmitter, meters. Scale factor 0.29 meters, added to -500 meters. Valid range -500 to 9002.43 meters [24].
timeCorrection   This field contains the residual timing error for a particular beacon, in units of nano-seconds, in the range from 0 to 25. This field is used for UE-based mode only, by subtracting from the *codePhase* measurement made by the target device [24].

– *MBS-AcquisitionAssistance*

The IE *MBS-AcquisitionAssistance* is used by the location server to provide parameters that support acquisition of the MBS signals [24].

```
-- ASN1START

MBS-AcquisitionAssistance-r14 ::= SEQUENCE {
    transmitterID-r14               INTEGER (0..32767)                      OPTIONAL,   -- Need ON
    mbsConfiguration-r14            ENUMERATED {tb1, tb2, tb3, tb4, ...}    OPTIONAL,   -- Need ON
    pnCodeIndex-r14                 INTEGER (1..128)                        OPTIONAL,   -- Need ON
    freq-r14                        INTEGER (919750000..927250000)          OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

***MBS-AcquisitionAssistance* field descriptions**
transmitterID   This field contains the MBS transmitter identifier [24].
mbsConfiguration   This field specifies MBS configuration as defined in the MBS ICD [24].
pnCodeIndex   This field specifies the index of the MBS PN code [24].
freq   This field specifies the MBS signal center frequency in units of Hz [24].

6.5.4.9 TBS Assistance Data Request

– *TBS-RequestAssistanceData*

The IE *TBS-RequestAssistanceData* is used by the target device to request TBS assistance data from a location server.

```
-- ASN1START
```

```
TBS-RequestAssistanceData-r14 ::= SEQUENCE {
    mbs-AlmanacAssistanceDataReq-r14        BOOLEAN,
    mbs-AcquisitionAssistanceDataReq-r14    BOOLEAN,
    ...
}

-- ASN1STOP
```

6.5.5 Sensor based Positioning

6.5.5.0 Introduction

This clause defines support for sensor-based positioning. The supported sensor methods are "Barometric pressure sensor" and "Motion sensor" as described in 3GPP TS 36.305, clauses 8.6 and 8.10 respectively [2].

6.5.5.1 Sensor Location Information

– *Sensor-ProvideLocationInformation*

The IE *Sensor-ProvideLocationInformation* is used by the target device to provide location information for sensor-based methods to the location server. It may also be used to provide sensor specific error reason.

```
-- ASN1START

Sensor-ProvideLocationInformation-r13 ::= SEQUENCE {
    sensor-MeasurementInformation-r13       Sensor-MeasurementInformation-r13       OPTIONAL,
    sensor-Error-r13                        Sensor-Error-r13                        OPTIONAL,
    ...,
    [[
    sensor-MotionInformation-r15            Sensor-MotionInformation-r15            OPTIONAL
    ]]
}

-- ASN1STOP
```

6.5.5.2 Sensor Location Information Elements

– *Sensor-MeasurementInformation*

The IE *Sensor-MeasurementInformation* is used by the target device to provide UE sensor measurements to the location server.

```
-- ASN1START

Sensor-MeasurementInformation-r13 ::= SEQUENCE {
    measurementReferenceTime-r13        UTCTime                     OPTIONAL,
    uncompensatedBarometricPressure-r13 INTEGER (30000..115000)     OPTIONAL, -- Cond Barometer
    ...,
    [[
    uncertainty-r14                 SEQUENCE {
                                    range-r14       INTEGER (0..1000),
                                    confidence-r14  INTEGER (1..100)
                                    }                                   OPTIONAL
    ]]
}

-- ASN1STOP
```

Conditional presence	Explanation
Barometer	The field is mandatory present if the *Sensor-MeasurementInformation* is provided for barometric pressure; otherwise it is not present.

***Sensor-MeasurementInformation* field descriptions**
measurementReferenceTime This field provides the UTC time when the sensor measurements are performed and should take the form of *YYMMDDhhmmssZ.*
uncompensatedBarometricPressure This field provides the uncompensated barometric pressure as measured by the UE sensor, in units of Pa.
uncertainty This field provides the expected range for the pressure measurement in units of Pa and the confidence as a percentage that the true pressure lies in a range of (measurement – range) to (measurement + range).

– *Sensor-MotionInformation*

The IE *Sensor-MotionInformation* is used by the target device to provide UE movement information to the location server. The movement information comprises an ordered series of points. This information may be obtained by the target device using one or more motion sensors.

```
-- ASN1START

Sensor-MotionInformation-r15 ::= SEQUENCE {
    refTime-r15                 DisplacementTimeStamp-r15,
    displacementInfoList-r15    DisplacementInfoList-r15,
    ...
}

DisplacementInfoList-r15 ::= SEQUENCE (SIZE (1..128)) OF DisplacementInfoListElement-r15

DisplacementInfoListElement-r15 ::= SEQUENCE {
    deltaTimeStamp-r15          DeltaTime-r15,
    displacement-r15            Displacement-r15            OPTIONAL,
    ...
}

DisplacementTimeStamp-r15 ::= CHOICE {
    utcTime-r15                 UTC-Time-r15,
    gnssTime-r15                MeasurementReferenceTime,
    systemFrameNumber-r15       SFN-r15,
    measurementSFN-r15          INTEGER(-8192..9214),
    ...
}

DeltaTime-r15 ::= CHOICE {
    deltaTimeSec-r15            INTEGER (1..16384),
    deltaTimeSFN-r15            INTEGER (1..4096),
    ...
}

SFN-r15 ::= SEQUENCE {
    sfn-r15                     BIT STRING (SIZE (10)),
    hyperSFN-r15                BIT STRING (SIZE (10))      OPTIONAL,
    ...
}

Displacement-r15 ::= SEQUENCE {
    bearing-r15                 INTEGER (0..3599),
    bearingUncConfidence-r15    INTEGER (0..100)                OPTIONAL,
    bearingRef-r15              ENUMERATED { geographicNorth, magneticNorth, local },
    horizontalDistance-r15      INTEGER (0..8191),
    horizontalDistanceUnc-r15   INTEGER (0..255)                OPTIONAL,
    horizontalUncConfidence-r15 INTEGER (0..100)                OPTIONAL,
    verticalDirection-r15       ENUMERATED{upward, downward}    OPTIONAL,
    verticalDistance-r15        INTEGER(0..8191)                OPTIONAL,
    verticalDistanceUnc-r15     INTEGER (0..255)                OPTIONAL,
    verticalUncConfidence-r15   INTEGER (0..100)                OPTIONAL,
    ...
}

UTC-Time-r15 ::= SEQUENCE {
    utcTime-r15                 UTCTime,
    utcTime-ms-r15              INTEGER (0..999),
    ...
}

-- ASN1STOP
```

***Sensor-MotionInformation* field descriptions**
refTime This field provides the reference time t_0 associated to the starting position of the first displacement in the displacement list.
displacementInfoList This field provides an ordered series of direction and distance travelled by the target device and comprises the following subfields: - ***deltaTimeStamp*** specifies the time between t_{n-1} and t_n, were *n* corresonds to the order of entry in the *DispacementInfoList* (*n*=0 correspond to the time provided in *refTime*). - ***displacement*** provides the direction and distance travelled between time t_{n-1} and t_n.
utcTime This field provides the time stamp of the *refTime* in UTC time and comprises the following subfields: - *utcTime* in the form of YYMMDDhhmmssZ. - *utcTime-ms* specifies the fractional part of the UTC time in ms resolution.
gnssTime This field provides the time stamp of the *refTime* in GNSS time.
systemFrameNumber This field provides the time stamp of the *refTime* in serving cell SFN time.
measurementSFN This field provides the time stamp of the *refTime* in form of the measurement SFN as defined in *deltaSFN* in IE *OTDOA-SignalMeasurementInformation*. This field may be included when OTDOA measurements are included.
deltaTimeSec This field provides the time between t_{n-1} and t_n in units of milliseconds.
deltaTimeSFN This field provides the time between t_{n-1} and t_n in units of system frame numbers.
bearing This field specifies the direction (heading) of the horizontal displacement measured clockwise from *bearingRef*. Scale factor 0.1 degree.
bearingRef This field specifies the reference direction for the *bearing*. Enumerated value '*geographicNorth*' indicates that the *bearing* is measured clockwise from the Geographic North; '*magneticNorth*' indicates that the *bearing* is measured clockwise from the Magnetic North; '*local*' indicates that the *bearing* is measured clockwise from an arbitrary (undefined) reference direction.
horizontalDistance This field specifies the horizonal distance travelled between time t_{n-1} and t_n. Scale factor 1 cm.
horizontalDistanceUnc, horizontalUncConfidence This field specifies the horizontal uncertainty of the displacement (corresponding to t_n). *horizontalDistanceUnc* correspond to the encoded high accuracy uncertainty as defined in 3GPP TS 23.032 [15]. *horizontalUncConfidence* corresponds to confidence as defined in 3GPP TS 23.032 [15].
verticalDistance This field specifies the vertical distance travelled between time t_{n-1} and t_n. Scale factor 1 cm.
verticalDistanceUnc, verticalUncConfidence This field specifies the vertical uncertainty of the displacement (corresponding to t_n). *verticalDistanceUnc* correspond to the encoded high accuracy uncertainty as defined in 3GPP TS 23.032 [15]. *verticalUncConfidence* corresponds to confidence as defined in 3GPP TS 23.032 [15].

6.5.5.3 Sensor Location Information Request

– *Sensor-RequestLocationInformation*

The IE *Sensor-RequestLocationInformation* is used by the location server to request location information for sensor-based methods from a target device.

```
-- ASN1START

Sensor-RequestLocationInformation-r13 ::= SEQUENCE {
    uncompensatedBarometricPressureReq-r13      BOOLEAN,
    ...,
    [[  assistanceAvailability-r14              BOOLEAN     OPTIONAL    -- Need ON
    ]],
    [[  sensor-MotionInformationReq-r15         BOOLEAN     OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

***Sensor-RequestLocationInformation* field descriptions**
uncompensatedBarometricPressureReq This field indicates whether the target device is requested to report Barometric pressure measurements in *Sensor-MeasurementInformation* IE or not. TRUE means requested.
assistanceAvailability This field indicates whether the target device may request additional Sensor assistance data from the server. TRUE means allowed and FALSE means not allowed.
sensor-MotionInformationReq This field indicates whether the target device is requested to report movement information in IE *Sensor-MotionInformation* or not. TRUE means requested.

6.5.5.4 Sensor Capability Information

– *Sensor-ProvideCapabilities*

The IE *Sensor-ProvideCapabilities* is used by the target device to provide capabilities for sensor-based methods from to the location server.

```
-- ASN1START

Sensor-ProvideCapabilities-r13 ::= SEQUENCE {
    sensor-Modes-r13           BIT STRING {    standalone  (0),
                                               ue-assisted (1),
                                               ue-based    (2)} (SIZE (1..8)),
    ...,
    [[  sensor-AssistanceDataSupportList-r14    Sensor-AssistanceDataSupportList-r14    OPTIONAL,
        periodicalReportingSupported-r14        PositioningModes                        OPTIONAL,
        idleStateForMeasurements-r14            ENUMERATED { required }                 OPTIONAL
    ]],
    [[  sensor-MotionInformationSup-r15         ENUMERATED { true }                     OPTIONAL
    ]]
}

Sensor-AssistanceDataSupportList-r14 ::= SEQUENCE {
    ...,
    [[  validityPeriodSupported-v1520           ENUMERATED { true }     OPTIONAL,
        validityAreaSupported-v1520             ENUMERATED { true }     OPTIONAL
    ]]
}

-- ASN1STOP
```

***Sensor-ProvideCapabilities* field descriptions**
sensor-Modes This field specifies the sensor mode(s) supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular sensor mode is supported; a zero-value means not supported.
sensor-AssistanceDataSupportList This field specifies a list of sensor assistance data supported by the target device. This field shall be present if the target device supports assistance data for Barometric pressure sensor.
validityPeriodSupported This field, if present, indicates that the target device supports *period* i.e. pressure validity period and pressure rate as part of the *Sensor-AssistanceDataList*.
valitidyAreaSupported This field, if present, indicates that the target device supports *area* i.e. pressure validity area and North/East pressure gradient as part of the *Sensor-AssistanceDataList*.
periodicalReportingSupported This field, if present, specifies the positioning modes for which the target device supports *periodicalReporting.* This is represented by a bit string, with a one-value at the bit position means *periodicalReporting* for the positioning mode is supported; a zero-value means not supported. If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonIEsRequestLocationInformation*.
idleStateForMeasurements This field, if present, indicates that the target device requires idle state to perform sensor measurements.
sensor-MotionInformationSup This field, if present, indicates that the target device supports displacement reporting in IE *Sensor-MotionInformation*.

6.5.5.5 Sensor Capability Information Request

– *Sensor-RequestCapabilities*

The IE *Sensor-RequestCapabilities* is used by the location server to request capabilities for sensor-based methods from the target device.

```
-- ASN1START

Sensor-RequestCapabilities-r13 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.5.6 Sensor Error Elements

– *Sensor-Error*

The IE *Sensor-Error* is used by the location server or target device to provide Sensor Error Reasons to the target device or location server, respectively.

```
-- ASN1START

Sensor-Error-r13 ::= CHOICE {
    locationServerErrorCauses-r13       Sensor-LocationServerErrorCauses-r13,
    targetDeviceErrorCauses-r13         Sensor-TargetDeviceErrorCauses-r13,
    ...
}

-- ASN1STOP
```

– *Sensor-LocationServerErrorCauses*

The IE *Sensor-LocationServerErrorCauses* is used by the location server to provide error reasons for Sensor positioning to the target device.

```
-- ASN1START

Sensor-LocationServerErrorCauses-r13 ::= SEQUENCE {
    cause-r13       ENUMERATED  {   undefined,
                                    ...,
                                    assistanceDataNotSupportedByServer-v1420,
                                    assistanceDataSupportedButCurrentlyNotAvailableByServer-v1420
                                    },
    ...
}

-- ASN1STOP
```

– *Sensor-TargetDeviceErrorCauses*

The IE *Sensor-TargetDeviceErrorCauses* is used by the target device to provide error reasons for Sensor positioning to the location server.

```
-- ASN1START

Sensor-TargetDeviceErrorCauses-r13 ::= SEQUENCE {
    cause-r13           ENUMERATED      {   undefined,
                                            ...,
                                            assistanceDataMissing-v1420
                                        },
    ...
}

-- ASN1STOP
```

6.5.5.7 Sensor Assistance Data

– *Sensor-ProvideAssistanceData*

The IE *Sensor-ProvideAssistanceData* is used by the location server to provide assistance data to assist in altitude computation at the UE (e.g. for UE-based mode). It may also be used to provide Sensor positioning specific error reasons.

```
-- ASN1START

Sensor-ProvideAssistanceData-r14 ::= SEQUENCE {
    sensor-AssistanceDataList-r14       Sensor-AssistanceDataList-r14       OPTIONAL,   -- Need ON
    sensor-Error-r14                    Sensor-Error-r13                    OPTIONAL,   -- Need ON
    ...
}

-- ASN1STOP
```

6.5.5.8 Sensor Assistance Data Elements

– *Sensor-AssistanceDataList*

The IE *Sensor-AssistanceDataList* is used by the location server to provide the Sensor specific assistance data to the UE.

```
-- ASN1START

Sensor-AssistanceDataList-r14::= SEQUENCE {
    refPressure-r14     INTEGER (-20000..10000),
    refPosition-r14     EllipsoidPointWithAltitudeAndUncertaintyEllipsoid   OPTIONAL,   -- Need ON
    refTemperature-r14  INTEGER (-64..63)                                   OPTIONAL,   -- Need ON
    ...,
    [[
    period-v1520        SEQUENCE {
        pressureValidityPeriod-v1520    PressureValidityPeriod-v1520,
        referencePressureRate-v1520     INTEGER (-128..127)                 OPTIONAL,   -- Need ON
        ...
    }                                                                       OPTIONAL,   -- Need ON
    area-v1520          SEQUENCE {
        pressureValidityArea-v1520      PressureValidityArea-v1520,
        gN-pressure-v1520               INTEGER (-1024..1023)               OPTIONAL,   -- Need ON
        gE-pressure-v1520               INTEGER (-1024..1023)               OPTIONAL,   -- Need ON
        ...
    }                                                                       OPTIONAL    -- Need ON
    ]]
}

PressureValidityArea-v1520 ::= SEQUENCE {
    centerPoint-v1520               Ellipsoid-Point,
    validityAreaWidth-v1520         INTEGER (1..128),
    validityAreaHeight-v1520        INTEGER (1..128),
    ...
}

PressureValidityPeriod-v1520 ::= SEQUENCE {
    beginTime-v1520                 GNSS-SystemTime,
    beginTimeAlt-v1520              INTEGER (0..2881)                       OPTIONAL,   -- Need ON
    duration-v1520                  INTEGER (1..2881),
    ...
}

-- ASN1STOP
```

***Sensor-AssistanceDataList* field descriptions**
refPressure This field specifies the atmospheric pressure (Pa) nominal at sea level, EGM96 [29] to the target. The scale factor is 1 Pa. The value is added to the nominal pressure of 101325 Pa.
refPosition This field specifies the reference position at which the pressure measurement is made, as an ellipsoid point with altitude and uncertainty ellipsoid.
refTemperature Local temperature measurement at the reference where the pressure measurement is made. The scale factor 1K. The value is added to 273K.
period This field specifies the pressure validity period and reference pressure rate.
pressureValidityPeriod - ***beginTime***: this field specifies the start time of the pressure validity period in *GNSS System Time*. - ***beginTimeAlt***: this field specifies an alternative start time. It may be used by the target device if *GNSS-System Time* is not available. The alternative start time is relative to the time the message was received. The scale factor is 15 min. The range is from 0 minutes to 43215 minutes = 30 days. - ***duration***: this field specifies the duration of the validity period after the begin time. The scale factor is 15 minutes. The range is from 15 minutes to 43215 minutes = 30 days.
referencePressureRate This field specifies the rate of change of pressure. When this field is included, the reference pressure applies only at the start of the pressure validity period. The scale factor is 10Pa/hour.
area This field specifies the area within which the provided atmospheric reference pressure is valid and any spatial drift.
pressureValidityArea - ***centerPoint***: this field specifies the coordinates of the center of the rectangular validity area. - ***validityAreaWidth***: this field specifies the width of the rectangular validity area. Width is measured from the center along the latitude and is measured as the total width of the rectangle. The scale factor is 1km. The range is from 1km to 128km. - ***validityAreaHeight***: this fields specifies the height of the rectangular validity area. Height is measured from the center along the longitude and is measured as the total height of the rectangle. The scale factor is 1km. The range is from 1km to 128km. If this field is present, *refPosition* should not be provided by the location server and if provided, shall be ignored by the target device.
gN-pressure This field specifies the northward gradient of the reference pressure calculated from the center of the *pressureValidityArea*. The scale factor is 1 Pa/Km. If this field is not provided, the gradient is assumed to be zero.
gE-pressure This field specifies the eastward gradient of the reference pressure calculated from the center of the *pressureValidityArea*. The scale factor is 1 Pa/Km. If this field is not provided, the gradient is assumed to be zero.

6.5.5.9 Sensor Assistance Data Request

– *Sensor-RequestAssistanceData*

The IE *Sensor-RequestAssistanceData* is used by the target device to request Sensor assistance data from a location server.

```
-- ASN1START

Sensor-RequestAssistanceData-r14 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.6 WLAN-based Positioning

This section defines support for positioning using measurements related to WLAN access points.

6.5.6.1 WLAN Location Information

– *WLAN-ProvideLocationInformation*

The IE *WLAN-ProvideLocationInformation* is used by the target device to provide measurements for one or more WLANs to the location server. It may also be used to provide WLAN positioning specific error reason.

```
-- ASN1START

WLAN-ProvideLocationInformation-r13 ::= SEQUENCE {
    wlan-MeasurementInformation-r13     WLAN-MeasurementInformation-r13     OPTIONAL,
    wlan-Error-r13                      WLAN-Error-r13                      OPTIONAL,
    ...
}

-- ASN1STOP
```

6.5.6.2 WLAN Location Information Elements

– *WLAN-MeasurementInformation*

```
-- ASN1START

WLAN-MeasurementInformation-r13 ::= SEQUENCE {
    measurementReferenceTime-r13        UTCTime                     OPTIONAL,
    wlan-MeasurementList-r13            WLAN-MeasurementList-r13    OPTIONAL,
    ...
}

WLAN-MeasurementList-r13 ::= SEQUENCE (SIZE(1..maxWLAN-AP-r13)) OF WLAN-MeasurementElement-r13

WLAN-MeasurementElement-r13 ::= SEQUENCE {
    wlan-AP-Identifier-r13      WLAN-AP-Identifier-r13,
    rssi-r13                    INTEGER (-127..128)                 OPTIONAL,
    rtt-r13                     WLAN-RTT-r13                        OPTIONAL,
    apChannelFrequency-r13      INTEGER (0..256)                    OPTIONAL,
    servingFlag-r13             BOOLEAN                             OPTIONAL,
    ...
}

WLAN-AP-Identifier-r13 ::= SEQUENCE {
    bssid-r13                   OCTET STRING (SIZE (6)),
    ssid-r13                    OCTET STRING (SIZE (1..32))         OPTIONAL,
    ...
}

WLAN-RTT-r13 ::= SEQUENCE {
    rttValue-r13    INTEGER (0..16777215),
    rttUnits-r13    ENUMERATED {    microseconds,
                                    hundredsofnanoseconds,
                                    tensofnanoseconds,
                                    nanoseconds,
                                    tenthsofnanoseconds,
                                    ... },
    rttAccuracy-r13 INTEGER (0..255)                                OPTIONAL,
    ...
}

maxWLAN-AP-r13          INTEGER ::= 64

-- ASN1STOP
```

***WLAN-MeasurementInformation* field descriptions**
measurementReferenceTime This field provides the UTC time when the WLAN measurements are performed and should take the form of *YYMMDDhhmmssZ*.
wlan-MeasurementList This field provides the WLAN measurements for up to 64 WLAN APs.
wlan-AP-Identifier This field provides the BSSID and optionally the SSID of the wireless network served by the WLAN AP [26].
rssi This field provides the AP signal strength (RSSI) of a beacon frame, probe response frame or measurement pilot frame measured at the target in dBm as defined in Table 6-7 of [26].
rtt This field provides the measured round trip time between the target device and WLAN AP and optionally the accuracy expressed as the standard deviation of the delay. Units for each of these are 1000ns, 100ns, 10ns, 1ns, and 0.1ns.
apChannelFrequency This field provides the AP channel number identification of the reported WLAN AP.
servingFlag This parameter indicates whether a set of WLAN AP measurements were obtained for a serving WLAN AP (TRUE) or a non-serving WLAN AP (FALSE). A target device with multiple radio support may indicate more than one type of serving access for the same time instant.
rttValue This field specifies the Round Trip Time (RTT) measurement between the target device and WLAN AP in units given by the field *rttUnits*.
rttUnits This field specifies the Units for the fields *rttValue* and *rttAccuracy.* The available Units are 1000ns, 100ns, 10ns, 1ns, and 0.1ns.
rttAccuracy This field provides the estimated accuracy of the provided *rttValue* expressed as the standard deviation in units given by the field *rttUnits*.

6.5.6.3 WLAN Location Information Request

– *WLAN-RequestLocationInformation*

The IE *WLAN-RequestLocationInformation* is used by the location server to request WLAN measurements from a target device.

```
-- ASN1START

WLAN-RequestLocationInformation-r13 ::= SEQUENCE {
    requestedMeasurements-r13   BIT STRING {
                                          rssi        (0),
                                          rtt         (1)} (SIZE(1..8)),
    ...,
    [[  assistanceAvailability-r14  BOOLEAN         OPTIONAL    -- Need ON
    ]]
}

-- ASN1STOP
```

***WLAN-RequestLocationInformation* field descriptions**
requestedMeasurements This field specifies the WLAN measurements requested. This is represented by a bit string, with a one-value at the bit position means the particular measurement is requested; a zero-value means not requested. The following measurement requests can be included. rssi: AP signal strength at the target rtt: Round Trip Time between target and AP
assistanceAvailability This field indicates whether the target device may request additional WLAN assistance data from the server. TRUE means allowed and FALSE means not allowed.

6.5.6.4 WLAN Capability Information

– *WLAN-ProvideCapabilities*

The IE *WLAN-ProvideCapabilites* is used by the target device to provide its capabilities for WLAN positioning to the location server.

```
-- ASN1START

WLAN-ProvideCapabilities-r13 ::= SEQUENCE {
    wlan-Modes-r13          BIT STRING  {   standalone      (0),
                                            ue-assisted     (1),
                                            ue-based        (2)}    (SIZE (1..8)),
    wlan-MeasSupported-r13  BIT STRING  {
                                            rssi-r13        (0),
                                            rtt-r13         (1)}    (SIZE(1..8)),
    ... ,
    [[  wlan-AP-AD-Supported-r14
                            BIT STRING {    ap-identifier   (0),
                                            ap-location     (1)}    (SIZE (1..8))
                                                                                OPTIONAL,
        periodicalReportingSupported-r14    PositioningModes                    OPTIONAL,
        idleStateForMeasurements-r14
                            ENUMERATED {    required    }                       OPTIONAL
    ]]
}

-- ASN1STOP
```

***WLAN-ProvideCapabilities* field descriptions**
wlan-Modes This field specifies the WLAN mode(s) supported by the target device. This is represented by a bit string, with a one value at the bit position means the WLAN mode is supported; a zero value means not supported.
wlan-MeasSupported This field specifies the measurements supported by the target device when accessing a WLAN. This is represented by a bit string, with a one-value at the bit position means the particular measurement is supported; a zero-value means not supported. A zero-value in all bit positions in the bit string means only the basic WLAN positioning method is supported by the target device which is reporting of the WLAN identity. The following bits are assigned for the indicated measurements. rssi: AP signal strength at the target rtt: Round Trip Time between target and AP
wlan-AP-AD-Supported This field specifies the WLAN AP assistance data supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular assistance data is supported; a zero-value means not supported. A zero-value in all bit positions or absence of this field means no assistance data is supported. The following bits are assigned for the indicated assistance data. ap-identifier: WLAN AP identity information ap-location: WLAN AP location information
periodicalReportingSupported This field, if present, specifies the positioning modes for which the target device supports *periodicalReporting*. This is represented by a bit string, with a one value at the bit position means *periodicalReporting* for the positioning mode is supported; a zero value means not supported. If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonIEsRequestLocationInformation*.
idleStateForMeasurements This field, if present, indicates that the target device requires idle state to perform WLAN measurements.

6.5.6.5 WLAN Capability Information Request

– *WLAN-RequestCapabilities*

The IE *WLAN-RequestCapabilities* is used by the location server to request WLAN positioning capabilities information from a target device.

```
-- ASN1START

WLAN-RequestCapabilities-r13 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.6.6 WLAN Error Elements

– *WLAN-Error*

The IE *WLAN-Error* is used by the location server or target device to provide error reasons for WLAN positioning to the target device or location server, respectively.

```
-- ASN1START

WLAN-Error-r13 ::= CHOICE {
    locationServerErrorCauses-r13       WLAN-LocationServerErrorCauses-r13,
    targetDeviceErrorCauses-r13         WLAN-TargetDeviceErrorCauses-r13,
    ...
}

-- ASN1STOP
```

– *WLAN-LocationServerErrorCauses*

The IE *WLAN-LocationServerErrorCauses* is used by the location server to provide error reasons for WLAN positioning to the target device.

```
-- ASN1START

WLAN-LocationServerErrorCauses-r13 ::= SEQUENCE {
    cause-r13                               ENUMERATED  {undefined,
                                                         ...,
                                                         requestedADNotAvailable-v1420,
                                                         notAllrequestedADAvailable-v1420
                                                         },
    ...,
    [[  apLocationDataUnavailable-r14       NULL    OPTIONAL        -- Need ON
    ]]
}

-- ASN1STOP
```

***WLAN-LocationServerErrorCauses* field descriptions**
cause   This field provides a WLAN AP specific error cause for the server applicable to provision of assistance data. If the cause value is '*requestedADNotAvailable*', none of the requested assistance data could be provided and no further information needs to be included. If the cause value is '*notAllRequestedADAvailable*', the server was able to provide some but not all requested WLAN AP assistance data. In this case, the server should include any of the specific error indications as applicable. Note that inclusion of these fields is applicable when some of the associated information can be provided for some WLAN APs but not for all WLAN APs.

– *WLAN-TargetDeviceErrorCauses*

The IE *WLAN-TargetDeviceErrorCauses* is used by the target device to provide error reasons for WLAN positioning to the location server.

```
-- ASN1START

WLAN-TargetDeviceErrorCauses-r13 ::= SEQUENCE {
    cause-r13                               ENUMERATED {undefined,
                                                        requestedMeasurementsNotAvailable,
                                                        notAllrequestedMeasurementsPossible,
                                                        ...
```

```
                                                    },
    wlan-AP-RSSI-MeasurementNotPossible-r13         NULL        OPTIONAL,
    wlan-AP-RTT-MeasurementNotPossible-r13          NULL        OPTIONAL,
    ...
}

-- ASN1STOP
```

***WLAN-TargetDeviceErrorCauses* field descriptions**
cause
This field provides a WLAN specific error cause. If the cause value is 'notAllRequestedMeasurementsPossible', the target device was not able to provide all requested WLAN measurements (but may be able to provide some measurements). In this case, the target device should include any of the *wlan-AP-RSSI-MeasurementNotPossible*, or *wlan-AP-RTT-MeasurementNotPossible* fields, as applicable.

6.5.6.7 WLAN Assistance Data

– *WLAN-ProvideAssistanceData*

The IE *WLAN-ProvideAssistanceData* is used by the location server to provide assistance data to enable UE-based and UE-assisted WLAN positioning. It may also be used to provide WLAN positioning specific error reason.

```
-- ASN1START

WLAN-ProvideAssistanceData-r14 ::= SEQUENCE {
    wlan-DataSet-r14    SEQUENCE (SIZE (1..maxWLAN-DataSets-r14)) OF WLAN-DataSet-r14
                                                                    OPTIONAL,   -- Need ON
    wlan-Error-r14      WLAN-Error-r13                              OPTIONAL,   -- Need ON
    ...
}

maxWLAN-DataSets-r14        INTEGER ::= 8

-- ASN1STOP
```

***WLAN-ProvideAssistanceData* field descriptions**
wlan-DataSet
This field provides data for sets of WLAN APs.
wlan-Error
This field provides error information and may be included when a Provide Assistance Data is sent in response to a Request Assistance Data. It is allowed to include both a *wlan-DataSet* field and a *wlan-Error* field (e.g. when only some requested WLAN assistance data is provided).

6.5.6.8 WLAN Assistance Data Elements

– *WLAN-DataSet*

The IE *WLAN-DataSet* is used by the location server to provide WLAN AP information for one set of WLAN APs.

```
-- ASN1START

WLAN-DataSet-r14 ::= SEQUENCE {
    wlan-AP-List-r14                SEQUENCE (SIZE (1..maxWLAN-AP-r14)) OF WLAN-AP-Data-r14,
    supportedChannels-11a-r14       SupportedChannels-11a-r14       OPTIONAL,   -- Need ON
    supportedChannels-11bg-r14      SupportedChannels-11bg-r14      OPTIONAL,   -- Need ON
    ...
}

SupportedChannels-11a-r14 ::= SEQUENCE {
    ch34-r14        BOOLEAN,
    ch36-r14        BOOLEAN,
    ch38-r14        BOOLEAN,
    ch40-r14        BOOLEAN,
    ch42-r14        BOOLEAN,
    ch44-r14        BOOLEAN,
    ch46-r14        BOOLEAN,
```

```
    ch48-r14        BOOLEAN,
    ch52-r14        BOOLEAN,
    ch56-r14        BOOLEAN,
    ch60-r14        BOOLEAN,
    ch64-r14        BOOLEAN,
    ch149-r14       BOOLEAN,
    ch153-r14       BOOLEAN,
    ch157-r14       BOOLEAN,
    ch161-r14       BOOLEAN
}

SupportedChannels-11bg-r14 ::= SEQUENCE {
    ch1-r14         BOOLEAN,
    ch2-r14         BOOLEAN,
    ch3-r14         BOOLEAN,
    ch4-r14         BOOLEAN,
    ch5-r14         BOOLEAN,
    ch6-r14         BOOLEAN,
    ch7-r14         BOOLEAN,
    ch8-r14         BOOLEAN,
    ch9-r14         BOOLEAN,
    ch10-r14        BOOLEAN,
    ch11-r14        BOOLEAN,
    ch12-r14        BOOLEAN,
    ch13-r14        BOOLEAN,
    ch14-r14        BOOLEAN
}

maxWLAN-AP-r14      INTEGER ::= 128


-- ASN1STOP
```

***WLAN-DataSet* field descriptions**
wlan-AP-List This field provides information for WLAN APs in the data set.
supportedChannels-11a This field defines the superset of all channels supported by all WLAN APs in the data set of type 801.11a (5GHz band).
supportedChannels-11bg This field defines the superset of all channels supported by all WLAN APs in the data set of type 801.11b or 802.11g (2.4 GHz band).

– *WLAN-AP-Data*

The IE *WLAN-AP-Data* is used by the location server to provide information for one WLAN AP as part of WLAN AP assistance data.

```
-- ASN1START

WLAN-AP-Data-r14 ::= SEQUENCE {
    wlan-AP-Identifier-r14              WLAN-AP-Identifier-r13,
    wlan-AP-Location-r14                WLAN-AP-Location-r14        OPTIONAL,   -- Need ON
    ...
}

WLAN-AP-Location-r14 ::= SEQUENCE {
    locationDataLCI-r14                 LocationDataLCI-r14,
    ...
}

LocationDataLCI-r14 ::= SEQUENCE {
    latitudeUncertainty-r14             BIT STRING (SIZE (6)),
    latitude-r14                        BIT STRING (SIZE (34)),
    longitudeUncertainty-r14            BIT STRING (SIZE (6)),
    longitude-r14                       BIT STRING (SIZE (34)),
    altitudeUncertainty-r14             BIT STRING (SIZE (6))       OPTIONAL,   -- Need ON
    altitude-r14                        BIT STRING (SIZE (30))      OPTIONAL,   -- Need ON
    datum-r14                           BIT STRING (SIZE (8)),
    ...
}

-- ASN1STOP
```

***WLAN-AP-Data* field descriptions**
wlan-AP-Location
- ***locationDataLCI*** This field provides the location of the WLAN AP in the form of Location Configuration Information (LCI) defined in [27] and includes the following subfields: latitudeUncertainty: 6-bits quantifying the amount of uncertainty in latitude. A value of 0 is reserved to indicate that the uncertainty is unknown; values greater than 34 are reserved. Its relation with the corresponding value in degrees is expressed with the following formula: latitudeUncertainty = 8 - ceil(log2(uncertainty in degrees)) latitude: A 34-bits fixed point value consisting of 9-bits of integer and 25-bits of fraction indicating the Latitude (+/- 90 degrees) of the AP. longitudeUncertainty: 6-bits quantifying the amount of uncertainty in longitude. A value of 0 is reserved to indicate that the uncertainty is unknown; values greater than 34 are reserved. Its relation with the corresponding value in degrees is expressed with the following formula: longitudeUncertainty = 8 - ceil(log2(uncertainty in degrees)) longitude: A 34-bits fixed point value consisting of 9-bits of integer and 25-bits of fraction indicating the Longitude (+/- 180 degrees) of the AP. altitudeUncertainty: 6-bits value quantifying the amount of uncertainty in the altitude value. A value of 0 is reserved to indicate that the uncertainty is unknown; values greater than 30 are reserved. Its relation with the corresponding value in meters is expressed with the following formula: altitudeUncertainty = 21 - ceil(log2(uncertainty in meters)) altitude: A 30-bit fixed point value consisting of 22-bits of integer and 8-bits of fraction indicating the altitude of the AP in meters. datum: 8-bits indicating the map datum used for the coordinates. Defined codes are: Bit 1: World Geodetic System 1984 (WGS-84) Bit 2: North American Datum 1983 (NAD-83) with North American Vertical Datum 1988 (NAVD-88) Bit 3: North American Datum 1983 (NAD-83) with Mean Lower Low Water (MLLW) vertical datum. Bits 4 – 8 are reserved.

6.5.6.9 WLAN Assistance Data Request

– *WLAN-RequestAssistanceData*

The IE *WLAN-RequestAssistanceData* is used by the target device to request WLAN assistance data from a location server.

```
-- ASN1START

WLAN-RequestAssistanceData-r14 ::= SEQUENCE {
    requestedAD-r14         BIT STRING {    ap-identifier       (0),
                                            ap-location         (1)}    (SIZE (1..8)),
    visibleAPs-r14          SEQUENCE (SIZE (1..maxVisibleAPs-r14)) OF WLAN-AP-Identifier-r13
    OPTIONAL,
    wlan-AP-StoredData-r14  SEQUENCE (SIZE (1..maxKnownAPs-r14)) OF WLAN-AP-Identifier-r13
    OPTIONAL,
    ...
}

maxVisibleAPs-r14           INTEGER ::= 32
maxKnownAPs-r14             INTEGER ::= 2048

-- ASN1STOP
```

***WLAN-RequestAssistanceData* field descriptions**
requestedAD This field specifies the WLAN AP assistance data requested. This is represented by a bit string, with a one-value at the bit position means the particular assistance data is requested; a zero-value means not requested. The following assistance data types are included: ap-identifier: WLAN AP identity information ap-location: WLAN AP location information
visibleAPs This field enables a target to indicate to a server the identities of currently visible WLAN APs. This may assist a server to provide assistance data for WLAN APs nearby to the target. A target shall provide visible APs in order of received signal strength with the AP with the highest signal strength provided first.
wlan-AP-StoredData This field enables a target to indicate to a server the identities of WLAN APs for which the target has stored assistance data received previously from the server. This may enable the server to avoid resending data for the same APs.

6.5.7 Bluetooth-based Positioning

6.5.7.1 Bluetooth Location Information

– *BT-ProvideLocationInformation*

The IE *BT-ProvideLocationInformation* is used by the target device to provide measurements for one or more Bluetooth beacons to the location server. It may also be used to provide Bluetooth positioning specific error reason.

```
-- ASN1START

BT-ProvideLocationInformation-r13 ::= SEQUENCE {
    bt-MeasurementInformation-r13       BT-MeasurementInformation-r13   OPTIONAL,
    bt-Error-r13                        BT-Error-r13                    OPTIONAL,
    ...
}

-- ASN1STOP
```

6.5.7.2 Bluetooth Location Information Elements

– *BT-MeasurementInformation*

```
-- ASN1START

BT-MeasurementInformation-r13 ::= SEQUENCE {
    measurementReferenceTime-r13        UTCTime                     OPTIONAL,
    bt-MeasurementList-r13              BT-MeasurementList-r13      OPTIONAL,
    ...
}

BT-MeasurementList-r13 ::= SEQUENCE (SIZE(1..maxBT-Beacon-r13)) OF BT-MeasurementElement-r13


BT-MeasurementElement-r13 ::= SEQUENCE {
    btAddr-r13                      BIT STRING (SIZE (48)),
    rssi-r13                        INTEGER (-128..127)             OPTIONAL,
    ...
}

maxBT-Beacon-r13                INTEGER ::= 32

-- ASN1STOP
```

***BT-MeasurementInformation* field descriptions**
measurementReferenceTime This field provides the UTC time when the Bluetooth measurements are performed and should take the form of *YYMMDDhhmmssZ*.
bt-MeasurementList This field provides the Bluetooth measurements for up to 32 Bluetooth beacons.
btAddr This field specifies the Bluetooth public address of the Bluetooth beacon [25].
rssi This field provides the beacon received signal strength indicator (RSSI) in dBm.

6.5.7.3 Bluetooth Location Information Request

– *BT-RequestLocationInformation*

The IE *BT-RequestLocationInformation* is used by the location server to request Bluetooth measurements from a target device.

```
-- ASN1START

BT-RequestLocationInformation-r13 ::= SEQUENCE {
    requestedMeasurements-r13   BIT STRING {
                                          rssi        (0)} (SIZE(1..8)),
    ...
}

-- ASN1STOP
```

***BT-RequestLocationInformation* field descriptions**
requestedMeasurements This field specifies the Bluetooth measurements requested. This is represented by a bit string, with a one-value at the bit position means the particular measurement is requested; a zero-value means not requested. The following measurement requests can be included. rssi: Bluetooth beacon signal strength at the target

6.5.7.4 Bluetooth Capability Information

– *BT-ProvideCapabilities*

The IE *BT-ProvideCapabilites* is used by the target device to provide its capabilities for Bluetooth positioning to the location server.

```
-- ASN1START

BT-ProvideCapabilities-r13 ::= SEQUENCE {
    bt-Modes-r13            BIT STRING {    standalone      (0),
                                            ue-assisted     (1)}    (SIZE (1..8)),
    bt-MeasSupported-r13    BIT STRING {    rssi-r13        (0)}    (SIZE (1..8)),
    ...,
    [[
    idleStateForMeasurements-r14
                            ENUMERATED {    required    }                           OPTIONAL,
    periodicalReportingSupported-r14
                            PositioningModes                                        OPTIONAL
    ]]
}

-- ASN1STOP
```

***BT-ProvideCapabilities* field descriptions**
bt-Modes This field specifies the Bluetooth mode(s) supported by the target device. This is represented by a bit string, with a one value at the bit position means the Bluetooth mode is supported; a zero value means not supported.
bt-MeasSupported This field specifies the Bluetooth measurements supported by the target device. This is represented by a bit string, with a one-value at the bit position means the particular measurement is supported; a zero-value means not supported. A zero-value in all bit positions in the bit string means only the basic Bluetooth positioning method is supported by the target device which is reporting of the Bluetooth beacon identity. The following bits are assigned for the indicated measurements. rssi: Bluetooth beacon signal strength at the target device
idleStateForMeasurements This field, if present, indicates that the target device requires idle state to perform BT measurements.
periodicalReportingSupported This field, if present, specifies the positioning modes for which the target device supports *periodicalReporting*. This is represented by a bit string, with a one value at the bit position means *periodicalReporting* for the positioning mode is supported; a zero value means not supported. If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonIEsRequestLocationInformation*.

6.5.7.5 Bluetooth Capability Information Request

– *BT-RequestCapabilities*

The IE *BT-RequestCapabilities* is used by the location server to request Bluetooth positioning capabilities from a target device.

```
-- ASN1START

BT-RequestCapabilities-r13 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.7.6 BT Error Elements

– *BT-Error*

The IE *BT-Error* is used by the location server or target device to provide error reasons for Bluetooth positioning to the target device or location server, respectively.

```
-- ASN1START

BT-Error-r13 ::= CHOICE {
    locationServerErrorCauses-r13       BT-LocationServerErrorCauses-r13,
    targetDeviceErrorCauses-r13         BT-TargetDeviceErrorCauses-r13,
    ...
}

-- ASN1STOP
```

– *BT-LocationServerErrorCauses*

The IE *BT-LocationServerErrorCauses* is used by the location server to provide error reasons for Bluetooth positioning to the target device.

```
-- ASN1START

BT-LocationServerErrorCauses-r13 ::= SEQUENCE {
    cause-r13                               ENUMERATED  {undefined, ...},
    ...
}

-- ASN1STOP
```

– *BT-TargetDeviceErrorCauses*

The IE *BT-TargetDeviceErrorCauses* is used by the target device to provide error reasons for Bluetooth positioning to the location server.

```
-- ASN1START

BT-TargetDeviceErrorCauses-r13 ::= SEQUENCE {
    cause-r13                                ENUMERATED {undefined,
                                                         requestedMeasurementsNotAvailable,
                                                         notAllrequestedMeasurementsPossible,
                                                         ...
                                                         },
    bt-Beacon-rssiMeasurementNotPossible-r13    NULL        OPTIONAL,
    ...
}

-- ASN1STOP
```

***BT-TargetDeviceErrorCauses* field descriptions**
cause
This field provides a Bluetooth specific error cause. If the cause value is 'notAllRequestedMeasurementsPossible', the target device was not able to provide all requested Bluetooth measurements (but may be able to provide some measurements). In this case, the target device should include *bt-Beacon-rssiMeasurementNotPossible* field.

– *End of LPP-PDU-Definitions*

```
-- ASN1START

END

-- ASN1STOP
```

7 Broadcast of assistance data

7.1 General

Broadcast of positioning assistance data is supported via Positioning System Information Blocks (posSIBs) as specified in 3GPP TS 36.331 [12]. The posSIBs are carried in RRC System Information (SI) messages (TS 36.331 [12]).

A single *SystemInformationBlockPos* IE is defined in 3GPP TS 36.331 [12] which is carried in IE *PosSystemInformation-r15-IEs* specified in TS 36.331 [12]. The mapping of positioning SIB type (*posSibType*) to assistance data carried in *SystemInformationBlockPos* is specified in sub-clause 7.2.

7.2 Mapping of *posSibType* to assistance data element

The supported *posSibType*'s are specified in Table 7.2-1. The GNSS Common and Generic Assistance Data IEs are defined in sub-clause 6.5.2.2. The OTDOA Assistance Data IEs are defined in sub-clause 7.4.2.

Table 7.2-1: Mapping of posSibType to assistanceDataElement

	***posSibType* [12]**	***assistanceDataElement***
GNSS Common Assistance Data (clause 6.5.2.2)	*posSibType1-1*	*GNSS-ReferenceTime*
	posSibType1-2	*GNSS-ReferenceLocation*
	posSibType1-3	*GNSS-IonosphericModel*
	posSibType1-4	*GNSS-EarthOrientationParameters*
	posSibType1-5	*GNSS-RTK-ReferenceStationInfo*
	posSibType1-6	*GNSS-RTK-CommonObservationInfo*

	posSibType1-7	*GNSS-RTK-AuxiliaryStationData*
GNSS Generic Assistance Data (clause 6.5.2.2)	*posSibType2-1*	*GNSS-TimeModelList*
	posSibType2-2	*GNSS-DifferentialCorrections*
	posSibType2-3	*GNSS-NavigationModel*
	posSibType2-4	*GNSS-RealTimeIntegrity*
	posSibType2-5	*GNSS-DataBitAssistance*
	posSibType2-6	*GNSS-AcquisitionAssistance*
	posSibType2-7	*GNSS-Almanac*
	posSibType2-8	*GNSS-UTC-Model*
	posSibType2-9	*GNSS-AuxiliaryInformation*
	posSibType2-10	*BDS-DifferentialCorrections*
	posSibType2-11	*BDS-GridModelParameter*
	posSibType2-12	*GNSS-RTK-Observations*
	posSibType2-13	*GLO-RTK-BiasInformation*
	posSibType2-14	*GNSS-RTK-MAC-CorrectionDifferences*
	posSibType2-15	*GNSS-RTK-Residuals*
	posSibType2-16	*GNSS-RTK-FKP-Gradients*
	posSibType2-17	*GNSS-SSR-OrbitCorrections*
	posSibType2-18	*GNSS-SSR-ClockCorrections*
	posSibType2-19	*GNSS-SSR-CodeBias*
OTDOA Assistance Data (clause 7.4.2)	*posSibType3-1*	*OTDOA-UE-Assisted*

7.3 Procedures related to broadcast information elements

Upon receiving *AssistanceDataSIBelement*, the target device shall:

1> if the *segmentationInfo* is not included:

2> if the *cipheringKeyData* is included:

3> if the UE has obtained a valid cipher key value and the first portion of the initial Counter denoted C_0 corresponding to the *cipherSetID* using NAS signalling:

4> if the *d0* field contains less than 128-bits:

5> pad out the bit string with zeroes in least significant bit positions to achieve 128 bits, denoted D_0.

4> determine the initial Counter $C_1 = (C_0 + D_0) \bmod 2^{128}$ (where all values are treated as non-negative integers);

4> determine any subsequent counter C_i from the previous counter C_{i-1} as $C_i = (C_{i-1} + 1) \bmod 2^{128}$;

4> use the sequence of counters $<C_1, C_2, C_3, \ldots>$ and the cipher key value to decipher the *assistanceDataElement;*

4> decode the deciphered *assistanceDataElement* and deliver the related assistance data to upper layers.

3> else:

4> discard the *AssistanceDataSIBelement.*

2> else:

3> decode the *assistanceDataElement* and deliver the related assistance data to upper layers.

1> else:

2> if *segmentationOption* indicates '*pseudo-seg*':

3> if the *cipheringKeyData* is included:

4> if the UE has obtained a valid cipher key value and the first portion of the initial Counter denoted C_0 corresponding to the *cipherSetID* using NAS signalling:

5> if the *d0* field contains less than 128-bits:

6> pad out the bit string with zeroes in least significant bit positions to achieve 128 bits, denoted D_0.

5> determine the initial Counter $C_1 = (C_0 + D_0) \bmod 2^{128}$ (where all values are treated as non-negative integers);

5> determine any subsequent counter C_i from the previous counter C_{i-1} as $C_i = (C_{i-1} + 1) \bmod 2^{128}$;

5> use the sequence of counters $<C_1, C_2, C_3, \ldots>$ and the cipher key value to decipher the *assistanceDataElement* segment*;*

5> decode the deciphered *assistanceDataElement* segment and deliver the related assistance data portion together with the *assistanceDataSegmentType* and *assistanceDataSegmentNumber* to upper layers.

4> else:

5> discard the *AssistanceDataSIBelement* segment.

3> else:

4> decode the *assistanceDataElement* segment and deliver the related assistance data portion together with the *assistanceDataSegmentType* and *assistanceDataSegmentNumber* to upper layers.

2> if *segmentationOption* indicates '*octet-string-seg*':

3> if all segments of *assistanceDataElement* have been received:

4> assemble the assistance data element from the received *assistanceDataElement* segments;

5> if the *cipheringKeyData* is included in the first segment:

6> if the UE has obtained a valid cipher key value and the first portion of the initial Counter denoted C_0 corresponding to the *cipherSetID* using NAS signalling:

7> if the *d0* field contains less than 128-bits:

8> pad out the bit string with zeroes in least significant bit positions to achieve 128 bits, denoted D_0.

7> determine the initial Counter $C_1 = (C_0 + D_0) \bmod 2^{128}$ (where all values are treated as non-negative integers);

7> determine any subsequent counter C_i from the previous counter C_{i-1} as $C_i = (C_{i-1} + 1) \bmod 2^{128}$;

7> use the sequence of counters $<C_1, C_2, C_3, \ldots>$ and the cipher key value to decipher the assembled assistance data element;

7> decode the assembled and deciphered assistance data element and deliver the related assistance data to upper layers.

6> else:

7> discard the assembled assistance data element.

5> else:

6> decode the assembled assistance data element and deliver the related assistance data to upper layers.

NOTE: As an optional optimisation when *segmentationOption* indicates '*octet-string-seg*', a target device may verify if the *cipheringKeyData* is included in the first segment as soon as the first segment is received and, if included, may verify that the UE has obtained a valid cipher key value and the first portion of the initial Counter denoted C_0 corresponding to the *cipherSetID* using NAS signalling. When the UE has not obtained a valid cipher key value and initial Counter C_0 using NAS signalling, the UE may discard the first segment and ignore all subsequent segments.

The value for D_0 shall be different for different *AssistanceDataSIBelement*'s to ensure that the counters derived from C_1 for any *assistanceDataElement* are different to the counters for any other *assistanceDataElement* for a given ciphering key.

D_0 shall contain at least 16 least significant bits (LSBs) set to zero to ensure that the values of D_0 differ from another by a large value.

7.4 Broadcast information elements

7.4.1 Basic production

This sub-clause defines the broadcast information elements which are encoded as 'basic production' for other purposes than encoding the IE within an LPP message.

The 'basic production' is obtained from their ASN.1 definitions by use of Basic Packed Encoding Rules (BASIC-PER), Unaligned Variant, as specified in ITU-T Rec. X.691 [22]. It always contains a multiple of 8 bits.

7.4.2 Element definitions

– *AssistanceDataSIBelement*

The IE *AssistanceDataSIBelement* is used in the IE *SystemInformationBlockPos* as specified in TS 36.331 [12].

```
-- ASN1START

AssistanceDataSIBelement-r15 ::= SEQUENCE {
    valueTag-r15                        INTEGER (0..63)                                 OPTIONAL,
    expirationTime-r15                  UTCTime                                         OPTIONAL,
    cipheringKeyData-r15                CipheringKeyData-r15                            OPTIONAL,
    segmentationInfo-r15                SegmentationInfo-r15                            OPTIONAL,
    assistanceDataElement-r15           OCTET STRING,
    ...
}

CipheringKeyData-r15 ::= SEQUENCE {
    cipherSetID-r15                     INTEGER (0..65535),
    d0-r15                              BIT STRING (SIZE (1..128)),
    ...
}

SegmentationInfo-r15 ::= SEQUENCE {
    segmentationOption-r15              ENUMERATED {pseudo-seg, octet-string-seg},
    assistanceDataSegmentType-r15       ENUMERATED {notLastSegment, lastSegment},
    assistanceDataSegmentNumber-r15     INTEGER (0..63),
    ...
}

-- ASN1STOP
```

***AssistanceDataSIBelement* field descriptions**
valueTag
This field is used to indicate to the target device any changes in the broadcast assistance data content. The *valueTag* is incremented by one, by the location server, every time a modified assistance data content is provided. This field is not included if the broadcast assistance data changes too frequently. If *valueTag* and *expirationTime* are absent, the UE assumes that the broadcast assistance data content changes at every broadcast interval.

***AssistanceDataSIBelement* field descriptions**
expirationTime This field indicates how long the broadcast assistance data content is valid. It is specified as UTC time and indicates when the broadcast assistance data content will expire.
cipheringKeyData If present, indicates that the *assistanceDataElement* octet string is ciphered.
segmentationInfo If present, indicates that the *assistanceDataElement* is one of many segments.
assistanceDataElement The *assistanceDataElement* OCTET STRING depends on the *posSibType* and is specified in Table 7.2-1. NOTE.
cipherSetID This field identifies a cipher set comprising a cipher key value and the first component C_0 of the initial counter C_1.
d0 This field provides the second component for the initial ciphering counter C_1. This field is defined as a bit string with a length of 1 to 128 bits. A target device first pads out the bit string if less than 128 bits with zeroes in least significant bit positions to achieve 128 bits. C_1 is then obtained from D_0 and C_0 (defined by the *cipherSetID*) as: $C_1 = (D_0 + C_0) \bmod 2^{128}$ (with all values treated as non-negative integers).
segmentationOption Indicates the used segmentation option.
assistanceDataSegmentType Indicates whether the included *assistanceDataElement* segment is the last segment or not.
assistanceDataSegmentNumber Segment number of the *assistanceDataElement* segment. A segment number of zero corresponds to the first segment, one corresponds to the second segment, and so on. Segments numbers wraparound should there be more than 64 segments

NOTE: For example, if the *posSibType* in IE *PosSIB-Type* defined in TS 36.331 [12] indicates '*posSibType1-7*', the *assistanceDataElement* OCTET STRING includes the LPP IE *GNSS-RTK-AuxiliaryStationData*.

– *OTDOA-UE-Assisted*

The IE *OTDOA-UE-Assisted* is used in the *assistanceDataElement* if the *posSibType* in IE *PosSIB-Type* defined in TS 36.331 [12] indicates '*posSibType3-1*'.

```
-- ASN1START

OTDOA-UE-Assisted-r15 ::= SEQUENCE {
    otdoa-ReferenceCellInfo-r15         OTDOA-ReferenceCellInfo,
    otdoa-NeighbourCellInfo-r15         OTDOA-NeighbourCellInfoList,
    ...
}

-- ASN1STOP
```

***OTDOA-UE-Assisted* field descriptions**
otdoa-ReferenceCellInfo LPP IE *OTDOA-ReferenceCellInfo* as defined in sub-clause 6.5.1.2.
otdoa-NeighbourCellInfo LPP IE *OTDOA-NeighbourCellInfoList* as defined in sub-clause 6.5.1.2.

7.5 Broadcast ciphering (informative)

The *assistanceDataElement* OCTET STRING included in IE *AssistanceDataSIBelement* may be ciphered using the 128-bit Advanced Encryption Standard (AES) algorithm (with counter mode).

AES as specified in [32] and [33] is a block mode cipher algorithm that ciphers blocks of 128 bits at a time. However, Counter mode enables usage for a bit string that is not an exact multiple of 128 bits. Further, Counter mode enables a target (or a server) to perform most of the deciphering (or ciphering) processing independently of receipt of the data to be deciphered (or ciphered) which may enable more efficient processing. Provided counters are chosen in a non-repeating manner by the server (which is a requirement for Counter mode), every block of data will be ciphered in a unique manner.

The algorithm makes use of a sequence of counters <C_1, C_2, C_3, …> each containing 128 bits, where C_1 is specified by the server and each subsequent counter (C_2, C_3 etc.) is obtained from the previous counter by adding one modulo 2^{128}. Each counter C_i is ciphered using the AES algorithm with a common 128-bit key to produce an output block O_i of 128 bits. To perform ciphering, the *assistanceDataElement* is divided into blocks B_1, B_2, … B_n of 128 bits each, except for the last block B_n which may contain fewer than 128 bits. The ciphered *assistanceDataElement* is obtained as a sequence of *n* blocks containing 128 bits each (except possibly for the last block) given by (O_1 XOR B_1), (O_2 XOR B_2), … (O_n XOR B_n), where XOR denotes bitwise exclusive OR. In the case of the last block, if B_n contains *m* bits (*m*<128), then the *m* most significant bits of O_n would be used for the exclusive OR. Deciphering is performed in the same way except that the blocks B_1, B_2, … B_n are now obtained from the ciphered message and the result of the exclusive OR operations yields the original unciphered message. Figure 7.5-1 provides an illustration of Counter mode for the generic case of an arbitrary block cipher algorithm $CIPH_k$.

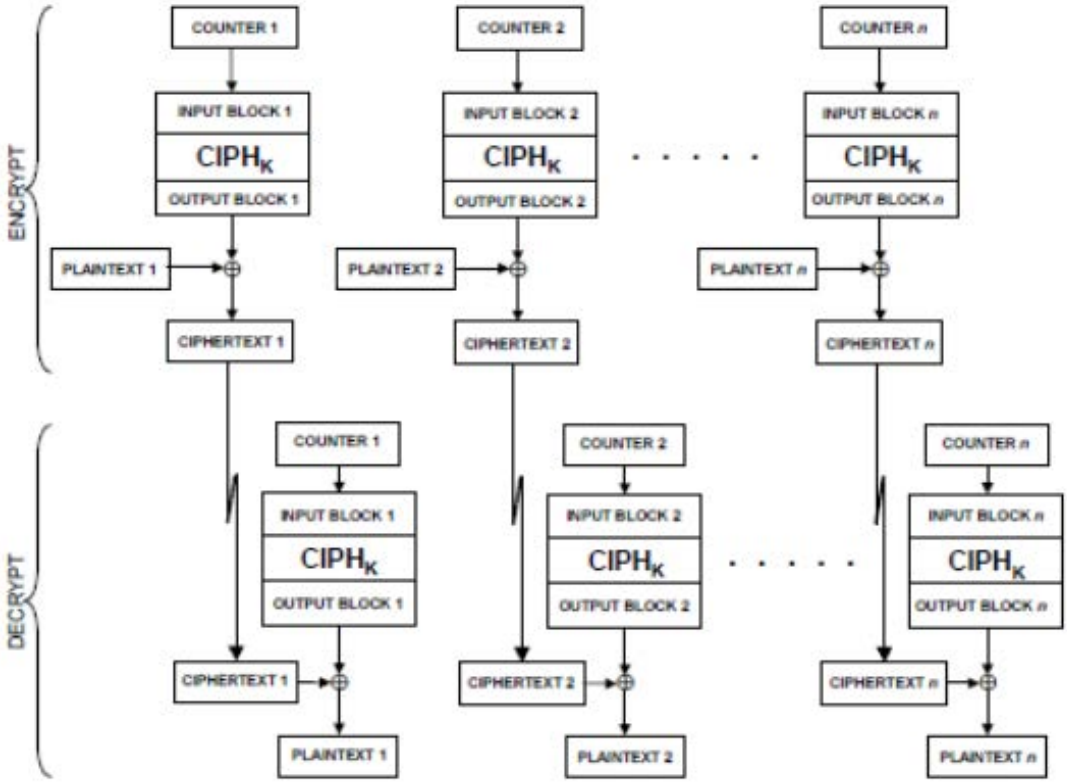

Figure 7.5-1: Illustration of Block Ciphering with Counter Mode [33].

The algorithms require specific conventions for bit ordering. The bit ordering applicable to ciphering for a ASN.1 PER encoded *assistanceDataElement* is the bit ordering produced by the ASN.1 PER encoding where the first bit is the leading bit number zero, the second bit is bit one etc..

The initial counter C_1 used to cipher an entire *assistanceDataElement* is provided to a target by a server in two portions. The first portion, denoted C_0, is provided using point to point mode along with the 128-bit ciphering key and an identifier for both of these values as specified in TS 23.271 [3]. The second portion, denoted D_0 (*d0*), is provided in unciphered form in IE *CipheringKeyData*. A target then obtains C_1 as:

$C_1 = (C_0 + D_0) \bmod 2^{128}$(where all values are treated as non-negative integers)

To obtain any subsequent counter C_i from the previous counter C_{i-1} for any message, the following operation is used:

$C_i = (C_{i-1} + 1) \bmod 2^{128}$

NOTE: As specified in sub-clause 7.3 the value for D_0 is different for different *AssistanceDataSIBelement*'s to ensure that the counters derived from C_1 for any *assistanceDataElement* can be different to the counters for any other *assistanceDataElement*. However, a long *assistanceDataElement* or a segmented *assistanceDataElement* would require the use of consecutive counter values C_1 to C_n, where *n* is the *assistanceDataElement* size in bits divided by 128 (and rounded up). There would then be a danger of small changes in the value of D_0 for ciphering of different *assistanceDataElement*'s (e.g. D_0 being chosen as 1 larger than a previous D_0 value) reusing previous counter values. To avoid this, the values of D_0 contain 16 least significant bits (LSBs) set to zero, as specified in sub-clause 7.3.

Annex A (informative): Change History

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2009-10	RAN2 #67bis	R2-096252				RAN2 agreed TS 36.355 v0.1.0	0.1.0
2009-11	RAN2 #68	R2-097492				RAN2 agreed TS 36.355 v2.0.0	2.0.0
2009-12	RP-46	RP-091208				RAN #46 approval of TS 36.355	9.0.0
2010-03	RP-47	RP-100304	0001	-		Clarification on Position location	9.1.0
	RP-47	RP-100304	0002	-		Clarification on UE Rx-Tx time difference supporting capability	9.1.0
	RP-47	RP-100304	0003	2		Completion of LPP common material	9.1.0
	RP-47	RP-100304	0004	5		Completion of OTDOA in LPP	9.1.0
	RP-47	RP-100304	0006	-		Provision of Frame Drift Information in Network Time	9.1.0
	RP-47	RP-100304	0007	-		Clarification of measurement reference point	9.1.0
	RP-47	RP-100304	0010	-		GNSS-DifferentialCorrectionsSupport	9.1.0
	RP-47	RP-100304	0011	-		BSAlign Indication in GNSS Reference Time	9.1.0
	RP-47	RP-100304	0012	1		Changes to reflect LPP ASN.1 review	9.1.0
	RP-47	RP-100304	0013	1		Introduction of LPP reliability sublayer	9.1.0
	RP-47	RP-100304	0015	-		LPP error procedures and conditions	9.1.0
	RP-47	RP-100304	0016	-		Triggered Location Information Transfer due to Cell Change	9.1.0
2010-06	RP-48	RP-100558	0018	2		Addition of need codes to optional LPP information elements	9.2.0
	RP-48	RP-100558	0019	1		Miscellaneous corrections to LPP stage 3	9.2.0
	RP-48	RP-100558	0020	1		Small corrections to LPP specification	9.2.0
	RP-48	RP-100558	0021	-		Clarifications of OTDOA parameters	9.2.0
	RP-48	RP-100558	0022	1		Signalling support for PRS muting in OTDOA	9.2.0
	-	-	-	-		Two times capital R replaced by lower case r in "MeasuredResultsElement" (undoing not intended change)	9.2.1
2010-09	RP-49	RP-100852	0024	-		Addition of an EPDU to an LPP Error and LPP Abort	9.3.0
	RP-49	RP-100852	0026	-		Division of LPP into Separate ASN.1 Modules with a Global Identifier	9.3.0
	RP-49	RP-100852	0028	-		Proposed Corrections to LPP Reliable Transport	9.3.0
	RP-49	RP-100852	0029	-		Proposed Corrections to the PeriodicalReportingCriteria in LPP	9.3.0
	RP-49	RP-100852	0030	1		Various corrections and clarifications to LPP	9.3.0
	RP-49	RP-100852	0031	-		Support of functional components for LPP reliable transport	9.3.0
	RP-49	RP-100852	0032	1		Introduction of EPDU ID requested by OMA LOC	9.3.0
	RP-49	RP-100852	0035	1		Several corrections in LPP	9.3.0
	RP-49	RP-100852	0036	-		Clarification to Assistance Data Transfer Procedure	9.3.0
2010-12	RP-50	RP-101207	0037	-		Correction of reliable transport terminology in description of LPP-Message	9.4.0
	RP-50	RP-101207	0038	-		One cell with known SFN in OTDOA assistance data	9.4.0
	RP-50	RP-101207	0039	1		UE frequency capability for LPP	9.4.0
	RP-50	RP-101207	0041	-		Correction to LPP reliable transport	9.4.0
	RP-50	RP-101207	0042	-		Correction to LPP Error procedure	9.4.0
	RP-50	RP-101207	0043	-		Addition of missing reference to LPPe	9.4.0
	RP-50	RP-101207	0044	2		Correction to the ODTOA assistance data	9.4.0
	RP-50	RP-101226	0040	-		Update of 'serving cell' terminology in 36.355	10.0.0
2011-03	RP-51	RP-110269	0046	-		Editorial corrections to 36.355	10.1.0
	RP-51	RP-110269	0048	-		Removal of FFS for retransmission timer in LPP	10.1.0
	RP-51	RP-110269	0050	-		Correction to code phase encoding in GNSS acquisition assistance	10.1.0
	RP-51	RP-110269	0052	1		Clarification on SFN provided with OTDOA measurement	10.1.0
	RP-51	RP-110269	0053	1		Introduction of OTDOA inter-freq RSTD measurement indication procedure	10.1.0
	RP-51	RP-110269	0057	-		Small corrections in 36.355	10.1.0
	RP-51	RP-110269	0058	3		Further corrections to the OTDOA assistance data	10.1.0
2011-06	RP-52	RP-110830	0060	-		Clarifications to description of OTDOA positioning fields	10.2.0
2011-09	RP-53	RP-111279	0062	1		Various corrections to LPP	10.3.0
	RP-53	RP-111279	0064	-		Mandatory support of PRS for OTDOA measurements	10.3.0
2011-12	RP-54	RP-111709	0066	-		Clarification of packed encoding rules of LPP	10.4.0
	RP-54	RP-111709	0068	-		Clarification of first bit in BIT STRING definitions	10.4.0
2012-06	RP-56	RP-120808	0071	-		Usage of additionalInformation IE	10.5.0
2012-09	RP-57	RP-121424	0074	2		Corrections to GNSS Acquisition Assistance Data	10.6.0
	RP-57	-	-	-		Upgrade to the Release 11 - no technical change	11.0.0

2012-12	RP-58	RP-121931	0077	-		Correcting the referencing of QoS parameters	11.1.0
	RP-58	RP-121931	0080	-		Correction to missing field description in GNSS-AcquisitionAssistance IE	11.1.0
2013-03	RP-59	RP-130237	0083	1		Extending E-UTRA Frequency Band and EARFCN value range	11.2.0
	RP-59	RP-130230	0086	-		Correction to PRS Muting Configuration	11.2.0
2013-06	RP-60	RP-130803	0088	-		Correction for ASN.1 errors from CR0083r1	11.3.0
	RP-60	RP-130803	0091	-		Correction to integer code phase field description in GNSS Acquisition Assistance	11.3.0
	RP-60	RP-130803	0093	-		Correction to serving cell terminology	11.3.0
	RP-60	RP-130803	0094	-		Encoding of LPP IEs	11.3.0
2013-09	RP-61	RP-131314	0098	-		Correction on svReqList	11.4.0
2013-12	RP-62	RP-131984	0103	-		Correction to missing capability indication for inter-frequency RSTD measurements	11.5.0
	RP-62	RP-131984	0107	1		Correction to Galileo assistance data elements	11.5.0
	RP-62	RP-132000	0104	1		Stage 3 CR of TS 36.355 for introducing BDS in LTE	12.0.0
	RP-62	RP-131984	0108	-		Correction to Galileo assistance data elements	12.0.0
2014-03	RP-63	RP-140342	0112	1		Clarification to gnss-DayNumber	12.1.0
2014-06	RP-64	RP-140871	0119	-		Signaling of OTDOA Neighbour Cell Information and Measurements	12.2.0
2014-12	RP-66	RP-142114	0122	-		Correction to Galileo Assistance Data	12.3.0
	RP-66	RP-142114	0123	-		Addition of an Early Position Fix to LPP	12.3.0
	RP-66	RP-142120	0124	-		BDS update to version 2.0	12.3.0
2015-03	RP-67	RP-150369	0126	2		Correction of GLONASS system time	12.4.0
	RP-67	RP-150376	0125	1		LPP clean-up	12.4.0
2015-12	RP-70	RP-152055	0134	1		Correction to the definition of Need codes	12.5.0
2015-12	RP-70	RP-152068	0137	3		RAT-Independent positioning enhancements	13.0.0
2016-03	RP-71	RP-160463	0138	1		Correction to GLONASS IOD value range	13.1.0
	RP-71	RP-160470	0140	1		r13 Information Element correction	13.1.0
	RP-71	RP-160470	0141	-		WLAN AP Identifier correction	13.1.0
	RP-71	RP-160470	0142	1		LPP clean-up	13.1.0
2016-09	RP-73	RP-161750	0143	4		Correction of ECID positioning for TDD	13.2.0
2016-12	RP-74	RP-162317	0160	1		Clarification of WLAN RSSI value range	13.3.0
2016-12	RP-74	RP-162326	0155	1		CR for 36.355 Further Indoor positioning enhancements	14.0.0
	RP-74	RP-162327	0157	-		Barometric Pressure Uncertainty IEs	14.0.0
	RP-74	RP-162326	0161	1		Introduction of Further Indoor Positioning Enhancements	14.0.0
2017-03	RP-75	RP-170636	0162	3	B	Introduction of positioning for further enhanced MTC	14.1.0
	RP-75	RP-170642	0163	-	C	Addition of periodical and triggered reporting capabilitiy signalling	14.1.0
	RP-75	RP-170642	0165	2	F	Further Indoor positioning enhancements corrections	14.1.0
	RP-75	RP-170637	0166	-	B	Introduction of positioning support for NB-IoT	14.1.0
2017-06	RP-76	RP-171224	0169	3	F	Compact Signal Measurement Information for OTDOA	14.2.0
	RP-76	RP-171223	0171	1	F	Correction to PRS Subframe Offset	14.2.0
	RP-76	RP-171223	0173	1	F	Correction to SFN time stamp in OTDOA Signal Measurement Information	14.2.0
	RP-76	RP-171223	0174	1	F	Correction to OTDOA capabilities	14.2.0
	RP-76	RP-171224	0175	1	F	Correction to NPRS	14.2.0
	RP-76	RP-171225	0176	2	F	LPP clean-up	14.2.0
	RP-76	RP-171224	0177	-	F	Corrections to number of NPRS carriers and ECID measurements for NB-IoT	14.2.0
	RP-76	RP-171224	0178	1	F	Removal of FFS for retransmission timer in LPP	14.2.0
	RP-76	RP-171224	0181	1	F	Signalling optimisation for NB-IoT Enhancements	14.2.0
2017-09	RP-77	RP-171913	0182	2	F	Clarification on definition of PRS Occasion Group	14.3.0
	RP-77	RP-171914	0183	1	F	Additional OTDOA Capabilities	14.3.0
	RP-77	RP-171911	0184	-	F	Clarification to *GNSS-TimeModelList*	14.3.0
	RP-77	RP-171913	0185	1	F	Minor corrections on TS 36.355 for Rel-14 MTC	14.3.0
2017-12	RP-78	RP-172616	0187	2	F	Correction on PRS hopping configuration	14.4.0
2018-03	RP-79	RP-180446	0189	1	F	Segmentation of LPP Messages	14.5.0
2018-04	RP-79					New version to fix ASN.1 formatting	14.5.1
2018-06	RP-80	RP-181235	0202	2	F	Clarification for NRSRQ reporting with E-CID	14.6.0
2018-06	RP-80	RP-181219	0204	2	B	Introduction of IMU support for OTDOA	15.0.0
	RP-80	RP-181219	0205	1	B	Addition of RTK and PPP support	15.0.0
	RP-80	RP-181219	0207	1	B	Addition of broadcast of positioning assistance data	15.0.0
	RP-80	RP-181215	0209	1	B	Addition of NR Support	15.0.0
	RP-80	RP-181252	0210	1	B	Addition of NB-IoT TDD support	15.0.0
2018-09	RP-81	RP-181963	0215	1	A	Support for NPRS enhancements	15.1.0
	RP-81	RP-181945	0218	1	F	Corrections to TDD in 36.355	15.1.0
	RP-81	RP-181961	0221	3	A	Correction to RSRQ range in 36.355	15.1.0
	RP-81	RP-181942	0222	1	F	OTDOA Assistance Data Request for NR	15.1.0
	RP-81	RP-181960	0223	-	F	LPP clean-up	15.1.0
	RP-81	RP-181952	0224	1	F	GAD shapes for high accuracy positioning	15.1.0
	RP-81	RP-181952	0226	1	B	Positioning SIB value tag and expiration time	15.1.0
2018-12	RP-82	RP-182672	0213	3	F	Addition of TDD UL/DL configuration to OTDOA assistance data	15.2.0
	RP-82	RP-182681	0228	2	F	Introduction of TDD UL/DL configuration for NB-IoT in 36.355	15.2.0
	RP-82	RP-182659	0229	3	F	SFN offset for OTDOA	15.2.0
	RP-82	RP-182674	0230	1	F	Alignment of IE/field names between LPP and RRC specifications	15.2.0

	RP-82	RP-182672	0232	1	F	Sensor Assistance Data Elements Correction	15.2.0
2019-03	RP-83	RP-190550	0234	3	F	Stage 2 and stage 3 sensor methods description alignment	15.3.0

History

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