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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document contains the definition of the LTE Positioning Protocol (LPP) for the radio access technologies E-UTRA/LTE and NR.

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*.

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[18]	3GPP TS 36.133: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management".
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[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-B1I-3.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I (Version 3.0)", February, 2019.
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[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.
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[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 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".
[35]	3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".
[36]	3GPP TS 38.215: "NR; Physical layer measurements".
[37]	3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".
[38]	IRNSS Signal-In-Space (SPS) Interface Control Document (ICD) for standard positioning service version 1.1, Aug 2017.
[39]	BDS-SIS-ICD-B1C-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C (Version 1.0)", December, 2017.
[40]	3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".
[41]	3GPP TS 38.211: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; Physical channels and modulation".
[42]	3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[43]	IS-QZSS-L6-001, Quasi-Zenith Satellite System Interface Specification – Centimetre Level Augmentation Service, Cabinet Office, November 5, 2018.
[44]	3GPP TR 38.901: "Technical Specification Group Radio Access Network; Study on channel model for frequencies from 0.5 to 100 GHz".
[45]	3GPP TS 38.214: "NR; Physical layer procedures for data".
[46]	3GPP TS 38.133: "NR; Requirements for support of radio resource management".

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], TS 23.271 [3], 38.305 [40] and TS 23.273 [42] 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, SUPL SLP, or LMF) 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 allows access to network services via E-UTRA with a channel bandwidth limited to 200 kHz.

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.

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.

Relative Time Difference (RTD): The relative time difference between a TRP i and a TRP j, is defined as $t_j - t_i$, where t_i and t_j are defined as the time when TRP i and j transmit the start of one subframe respectively.

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 (e.g. antenna array (with one or more antenna elements)) 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.

Transmission-Reception Point (TRP): A set of geographically co-located antennas (e.g. antenna array (with one or more antenna elements)) supporting TP and/or RP functionality.

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

BIPM Bureau International des Poids et Mesures (International Bureau of Weights and Measures)

BSSID Basic Service Set Identifier

BTS Base Transceiver Station (GERAN)
CID Cell-ID (positioning method)

CNAV Civil Navigation

CRS Cell-specific Reference Signals DL-AoD Downlink Angle-of-Departure

DL-TDOA Downlink Time Difference Of Arrival

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-UTRA Evolved Universal Terrestrial Radio Access

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

IRNSS Indian Regional Navigation Satellite System

IS Interface Specification

LLA Latitude Longitude Altitude

LMF Location Management Function

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

Multi-RTT Multiple-Round Trip Time

NAV Navigation

NavIC NAVigation with Indian Constellation
NB-IoT NarrowBand Internet of Things
NCGI NR Cell Global Identifier

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

PBCH Physical Broadcast Channel

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 RP Reception Point **RRC** Range-Rate Correction Radio Resource Control **RSRP** Reference Signal Received Power Reference Signal Received Quality **RSRQ RSTD** Reference Signal Time Difference Real-Time Kinematic RTK Round Trip Time RTT RU Russia **SBAS** Space Based Augmentation System **SET SUPL Enabled Terminal** System Frame Number **SFN SUPL Location Platform** SLP SRS Sounding Reference Signal SS Synchronization Signal SSB Synchronization Signal Block, SS/PBCH Block **SSID** Service Set Identifier State Space Representation SSR Slant TEC STEC **SUPL** Secure User Plane Location SVSpace Vehicle TB Terrestrial Beacon Terrestrial Beacon System **TBS TEC Total Electron Content TEC Units TECU** TLM Telemetry Time Of Arrival TOA TOD Time Of Day TOW Time Of Week TP **Transmission Point** TRP Transmission-Reception Point **UDRE** User Differential Range Error ULP User Plane Location Protocol URA User Range Accuracy **USNO US Naval Observatory** Universal Time No.1 UT1

4 Functionality of Protocol

Coordinated Universal Time

World Geodetic System 1984

Wireless Local Area Network

Wide Area Augmentation System

4.1 General

UTC

WAAS

WGS-84

WLAN

4.1.1 LPP Configuration

LPP is used point-to-point between a location server (E-SMLC, LMF 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 and NG-RAN (as defined in TS 36.305 [2], TS 38.305 [40], TS 23.273 [42] 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.

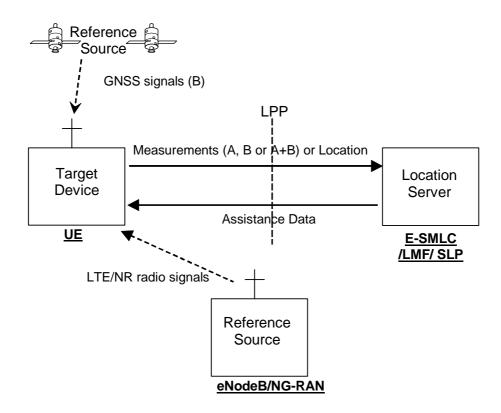


Figure 4.1.1-1: LPP Configuration for Control- and User-Plane Positioning in E-UTRAN or NG-RAN

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 and NG-RAN, 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 (based on LTE signals), A-GNSS, E-CID (based on LTE signals), Sensor, TBS, WLAN, Bluetooth, NR E-CID, NR DL-TDOA, NR DL-AoD and NR Multi-RTT 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.

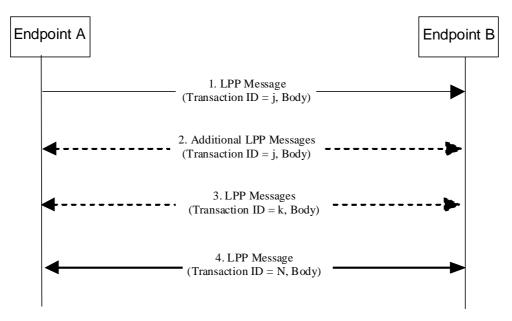


Figure 4.2-1 LPP Session Procedure

- 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 clause 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 clauses 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.

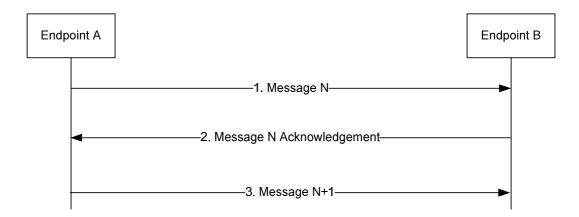


Figure 4.3.3.2-1: LPP Acknowledgement procedure

- 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 250 ms.

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.

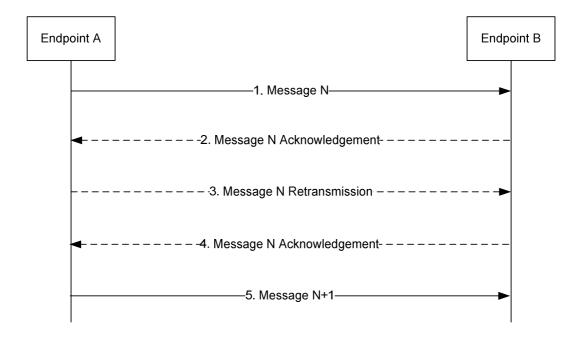


Figure 4.3.4.2-1: LPP Retransmission procedure

- 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 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 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*.

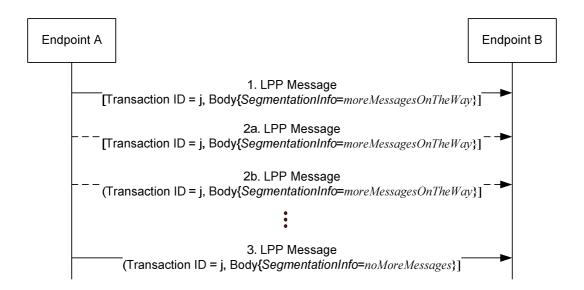


Figure 4.3.5-1: LPP Message Segmentation procedure

- 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 clause 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 TS 36.305 [2] and TS 38.305 [40].

5.1.1 Capability Transfer procedure

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

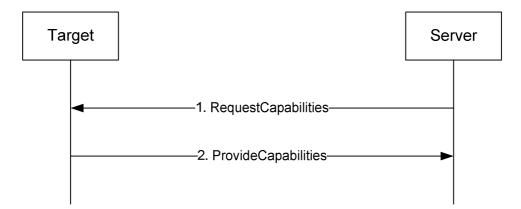


Figure 5.1.1-1: LPP Capability Transfer procedure

- 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.

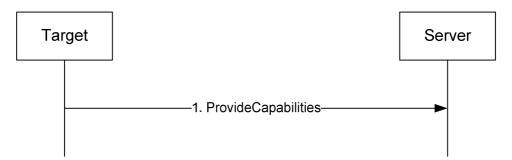


Figure 5.1.2-1: LPP Capability Indication procedure

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 clause 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 TS 36.305 [2] and TS 38.305 [40].

5.2.1 Assistance Data Transfer procedure

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

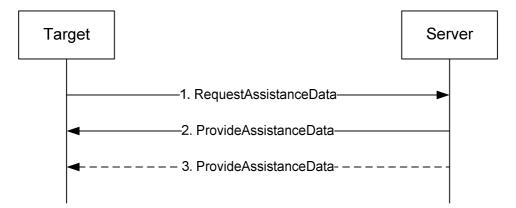


Figure 5.2.1-1: LPP Assistance data transfer procedure

- 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.

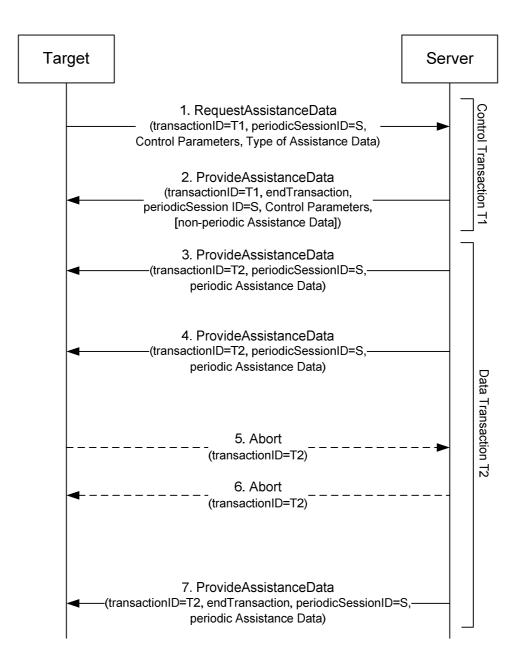


Figure 5.2.1a-1: LPP Periodic Assistance data transfer procedure

- 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.

5.2.1b Periodic Assistance Data Transfer with Update procedure

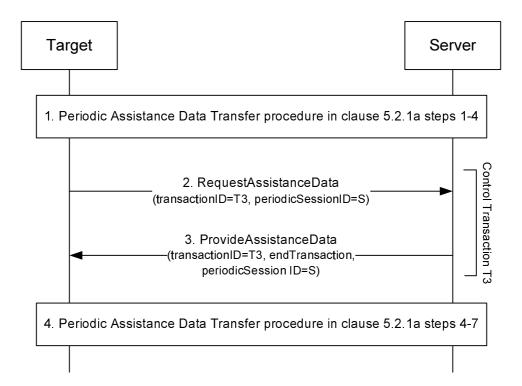


Figure 5.2.1b-1: LPP Periodic Assistance data transfer with update procedure

1. Steps 1-2 and optionally steps 3-4 are performed for the Periodic Assistance Data Transfer procedure in clause 5.2.1a with the following exceptions:

- The RequestAssistanceData message in step 1 indicates the update capabilities of the target device.
- The *ProvideAssistanceData* message in step 2 indicates the update capabilities of the target device which are supported by the server.
- 2. If the target device changes its primary cell and if the update capabilities of the target device supported by the server in step 1 include update of a primary cell ID, the target device sends a *RequestAssistanceData* message to the server using some available *transactionID* T3, which is different from T2 (previously used in step 2). The message contains the *periodicSessionID* S (previously used in step 1) and the new primary cell ID in the IE *CommonIEsRequestAssistanceData*.
- 3. The server responds with a *ProvideAssistanceData* message to the target. The message uses the *transactionID* T3 in step 2 and indicates the end of this transaction. The message contains the *periodicSessionID* S in IE *CommonIEsProvideAssistanceData*. Steps 2-3 are repeated each time the target device changes its primary cell.
- 4. Steps 4-7 are performed for the Periodic Assistance Data Transfer procedure in clause 5.2.1a.

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.

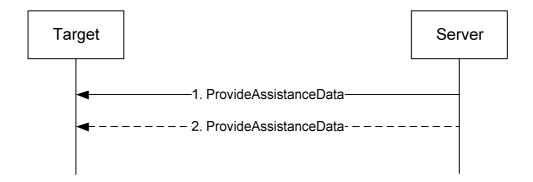


Figure 5.2.2-1: LPP Assistance data transfer procedure

- 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.

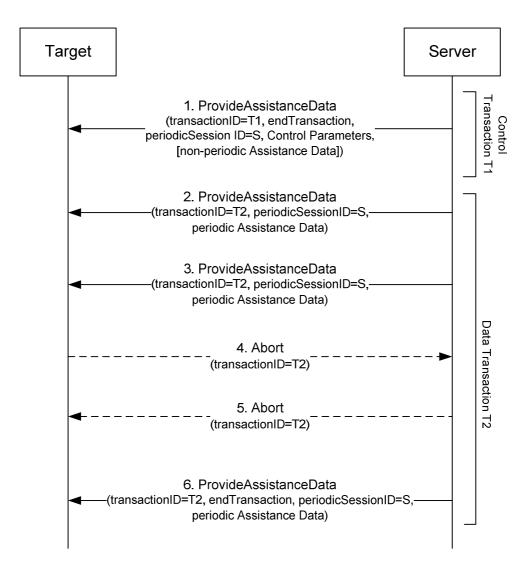


Figure 5.2.2a-1: LPP Periodic Assistance data delivery procedure

- 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 clause 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 TS 36.305 [2] and TS 38.305 [40].

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.

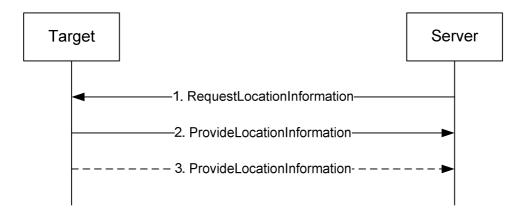


Figure 5.3.1-1: LPP Location Information transfer procedure

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.

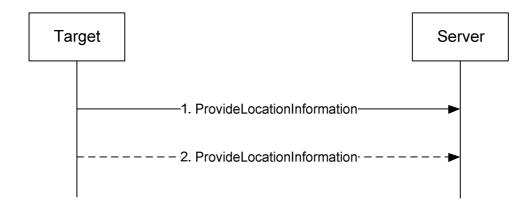


Figure 5.3.2-1: LPP Location Information Delivery procedure

- 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 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.

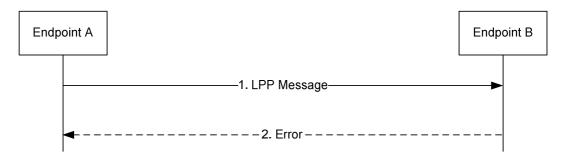


Figure 5.4.2-1: LPP Error Indication procedure

- 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.

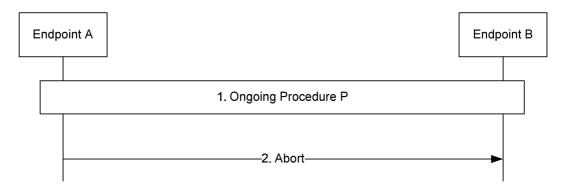


Figure 5.5.2-1: LPP Abort procedure

- 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 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 clause 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.

LPP-Message field descriptions

transactionID

This field is omitted if an *Ipp-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 *Ipp-MessageBody* is not present.

endTransaction

This field indicates whether an LPP message is the last message carrying an *Ipp-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 *Ipp-MessageBody* is included.

ackIndicator

This field indicates the sequence number of the message being acknowledged.

Ipp-MessageBody

This field may be omitted in the 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.

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 {
                              CHOICE {
            requestCapabilities-r9
                                         RequestCapabilities-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        criticalExtensionsFuture
                                     SEQUENCE {}
}
RequestCapabilities-r9-IEs ::= SEQUENCE {
                                                                             OPTIONAL,
    commonIEsRequestCapabilities CommonIEsRequestCapabilities
                                                                                           -- Need ON
    a-gnss-RequestCapabilities
                                         A-GNSS-RequestCapabilities
                                                                               OPTIONAL,
                                                                                            -- Need ON
    a-gnss-requestCapabilities
otdoa-RequestCapabilities
ecid-RequestCapabilities
                                        OTDOA-RequestCapabilities
                                                                              OPTIONAL,
                                                                                            -- Need ON
                                                                              OPTIONAL,
                                        ECID-RequestCapabilities
                                                                                            -- Need ON
    epdu-RequestCapabilities
                                         EPDU-Sequence
                                                                               OPTIONAL,
                                                                                            -- Need ON
    [[ sensor-RequestCapabilities-r13 Sensor-RequestCapabilities-r13 tbs-RequestCapabilities-r13 TBS-RequestCapabilities-r13
                                                                               OPTIONAL,
                                                                                            -- Need ON
                                                                               OPTIONAL,
                                                                                            -- Need ON
        wlan-RequestCapabilities-r13
                                         WLAN-RequestCapabilities-r13
                                                                               OPTIONAL,
                                                                                           -- Need ON
        bt-RequestCapabilities-r13
                                         BT-RequestCapabilities-r13
                                                                               OPTIONAL
                                                                                            -- Need ON
    ]],
    [[ nr-ECID-RequestCapabilities-r16 NR-ECID-RequestCapabilities-r16
                                                                               OPTIONAL,
                                                                                            -- Need ON
        {\tt nr-Multi-RTT-RequestCapabilities-r16}
                                         NR-Multi-RTT-RequestCapabilities-r16
                                                                               OPTIONAL,
                                                                                            -- Need ON
        nr-DL-AoD-RequestCapabilities-r16
                                         NR-DL-AoD-RequestCapabilities-r16
                                                                              OPTIONAL,
                                                                                            -- Need ON
        nr-DL-TDOA-RequestCapabilities-r16
                                         NR-DL-TDOA-RequestCapabilities-r16 OPTIONAL,
                                                                                            -- Need ON
        nr-UL-RequestCapabilities-r16 NR-UL-RequestCapabilities-r16
                                                                               OPTIONAL
                                                                                            -- Need ON
    11
-- ASN1STOP
```

ProvideCapabilities

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

```
spare3 NULL, spare2 NULL, spare1 NULL
        criticalExtensionsFuture SEOUENCE {}
    }
}
ProvideCapabilities-r9-IEs ::= SEQUENCE {
   commonIEsProvideCapabilities CommonIEsProvideCapabilities
                                                                                OPTIONAL,
    a-gnss-ProvideCapabilities
                                       A-GNSS-ProvideCapabilities
                                                                                 OPTIONAL,
   otdoa-ProvideCapabilities
ecid-ProvideCapabilities
epdu-ProvideCapabilities
                                        OTDOA-ProvideCapabilities
                                                                                 OPTIONAL,
                                       ECID-ProvideCapabilities
                                                                                 OPTIONAL,
                                      EPDU-Sequence
                                                                                OPTIONAL,
    [[ sensor-ProvideCapabilities-r13 Sensor-ProvideCapabilities-r13
        sensor-ProvideCapabilities-r13
                                                                               OPTIONAL,
                                        TBS-ProvideCapabilities-r13
                                                                                 OPTIONAL,
        wlan-ProvideCapabilities-r13
                                        WLAN-ProvideCapabilities-r13
                                                                                 OPTIONAL,
        bt-ProvideCapabilities-r13
                                      BT-ProvideCapabilities-r13
                                                                                OPTIONAL
    [[ nr-ECID-ProvideCapabilities-r16 NR-ECID-ProvideCapabilities-r16
                                                                                OPTIONAL,
        nr-Multi-RTT-ProvideCapabilities-r16
                                        NR-Multi-RTT-ProvideCapabilities-r16
                                                                                 OPTIONAL,
        nr-DL-AoD-ProvideCapabilities-r16
                                        NR-DL-AoD-ProvideCapabilities-r16
                                                                                 OPTIONAL,
       nr-DL-TDOA-ProvideCapabilities-r16
                                        NR-DL-TDOA-ProvideCapabilities-r16
                                                                                 OPTIONAL.
       nr-UL-ProvideCapabilities-r16 NR-UL-ProvideCapabilities-r16
                                                                                 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
                             CHOICE {
           requestAssistanceData-r9 RequestAssistanceData-r9-IEs,
           spare3 NULL, spare2 NULL, spare1 NULL
       }
RequestAssistanceData-r9-IEs ::= SEQUENCE {
   OPTIONAL,
                                     A-GNSS-RequestAssistanceData
   a-gnss-RequestAssistanceData
                                                                       OPTIONAL,
   otdoa-RequestAssistanceData
                                     OTDOA-RequestAssistanceData
                                                                      OPTIONAL,
   epdu-RequestAssistanceData
                                                                      OPTIONAL,
                                    EPDU-Sequence
   [[ sensor-RequestAssistanceData-r14
                                     Sensor-RequestAssistanceData-r14
                                                                       OPTIONAL,
       tbs-RequestAssistanceData-r14
                                     TBS-RequestAssistanceData-r14
                                                                       OPTIONAL.
       wlan-RequestAssistanceData-r14 WLAN-RequestAssistanceData-r14
                                                                      OPTIONAL
   ]],
   [[ nr-Multi-RTT-RequestAssistanceData-r16 NR-Multi-RTT-RequestAssistanceData-r16 OPTIONAL,
       nr-DL-AoD-RequestAssistanceData-r16 NR-DL-AoD-RequestAssistanceData-r16 NR-DL-TDOA-RequestAssistanceData-r16 NR-DL-TDOA-RequestAssistanceData-r16
                                                                                  OPTIONAL,
                                                                                  OPTIONAL
   11
-- 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 ::= SEOUENCE {
                       CHOICE
   criticalExtensions
                            CHOICE {
          provideAssistanceData-r9
                                    ProvideAssistanceData-r9-IEs,
          spare3 NULL, spare2 NULL, spare1 NULL
       }
ProvideAssistanceData-r9-IEs ::= SEQUENCE {
   OPTIONAL,
                                                                                -- Need ON
                                    A-GNSS-ProvideAssistanceData
   a-gnss-ProvideAssistanceData
otdoa-ProvideAssistanceData
                                                                     OPTIONAL,
                                                                                -- Need ON
                                                                     OPTIONAL,
                                                                                -- Need ON
                                    OTDOA-ProvideAssistanceData
                                                                    OPTIONAL,
                                                                                -- Need ON
   epdu-Provide-Assistance-Data
                                  EPDU-Sequence
   ] ]
   sensor-ProvideAssistanceData-r14
                                    Sensor-ProvideAssistanceData-r14
                                                                     OPTIONAL,
                                                                                -- Need ON
                                                                                -- Need ON
   tbs-ProvideAssistanceData-r14
                                    TBS-ProvideAssistanceData-r14
                                                                     OPTIONAL,
   wlan-ProvideAssistanceData-r14
                                   WLAN-ProvideAssistanceData-r14
                                                                     OPTIONAL
                                                                                -- Need ON
   ]],
   [[ nr-Multi-RTT-ProvideAssistanceData-r16
                                    NR-Multi-RTT-ProvideAssistanceData-r16
                                                                     OPTIONAL,
                                                                                -- Need ON
       nr-DL-AoD-ProvideAssistanceData-r16
                                    NR-DL-AoD-ProvideAssistanceData-r16 OPTIONAL,
                                                                                -- Need ON
       nr-DL-TDOA-ProvideAssistanceData-r16
                                    NR-DL-TDOA-ProvideAssistanceData-r16
                                                                     OPTIONAL
                                                                                -- Need ON
   ]]
-- ASN1STOP
```

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 {
                               CHOICE {
           requestLocationInformation-r9 RequestLocationInformation-r9-IEs,
           spare3 NULL, spare2 NULL, spare1 NULL
        }
RequestLocationInformation-r9-IEs ::= SEQUENCE {
    {\tt commonIEsRequestLocationInformation}
                                       CommonIEsRequestLocationInformation OPTIONAL,
                                                                                      -- Need ON
                                                                                      -- Need ON
    a-gnss-RequestLocationInformation
                                       A-GNSS-RequestLocationInformation OPTIONAL,
    otdoa-RequestLocationInformation
                                                                                      -- Need ON
                                       OTDOA-RequestLocationInformation OPTIONAL,
                                       ECID-RequestLocationInformation
                                                                          OPTIONAL,
    ecid-RequestLocationInformation
                                                                                      -- Need ON
    epdu-RequestLocationInformation
                                       EPDU-Sequence
                                                                          OPTIONAL,
                                                                                      -- Need ON
    1.1
    sensor-RequestLocationInformation-r13
                                       Sensor-RequestLocationInformation-r13
                                                                          OPTIONAL,
                                                                                      -- Need ON
    {\tt tbs-RequestLocationInformation-r13} \quad {\tt TBS-RequestLocationInformation-r13} \quad {\tt OPTIONAL},
                                                                                      -- Need ON
                                                                                      -- Need ON
    wlan-RequestLocationInformation-r13 WLAN-RequestLocationInformation-r13 OPTIONAL,
    bt-RequestLocationInformation-r13 BT-RequestLocationInformation-r13 OPTIONAL
                                                                                      -- Need ON
    [[ nr-ECID-RequestLocationInformation-r16
                                       NR-ECID-RequestLocationInformation-r16
                                                                          OPTIONAL,
                                                                                       -- Need ON
       nr-Multi-RTT-RequestLocationInformation-r16
                                       NR-Multi-RTT-RequestLocationInformation-r16
                                                                          OPTIONAL,
                                                                                      -- Need ON
```

```
nr-DL-AoD-RequestLocationInformation-r16
NR-DL-AoD-RequestLocationInformation-r16
OPTIONAL, -- Need ON
nr-DL-TDOA-RequestLocationInformation-r16
NR-DL-TDOA-RequestLocationInformation-r16
OPTIONAL -- Need ON
]]
}
-- ASN1STOP
```

RequestLocationInformation field descriptions

commonlEsRequestLocationInformation

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 {
                                 CHOICE {
        c1
            provideLocationInformation-r9
                                              ProvideLocationInformation-r9-IEs,
            spare3 NULL, spare2 NULL, spare1 NULL
        criticalExtensionsFuture
                                     SEOUENCE {}
}
ProvideLocationInformation-r9-IEs ::= SEQUENCE {
    \verb|commonIEsProvideLocationInformation| \\
                                          CommonIEsProvideLocationInformation OPTIONAL,
    a-gnss-ProvideLocationInformation
                                          \hbox{A-GNSS-ProvideLocationInformation} \quad \hbox{OPTIONAL}\,,
    otdoa-ProvideLocationInformation OTDOA-ProvideLocationInformation ecid-ProvideLocationInformation ECID-ProvideLocationInformation
                                          OTDOA-ProvideLocationInformation
                                                                                OPTIONAL,
                                                                                OPTIONAL,
    epdu-ProvideLocationInformation
                                         EPDU-Sequence
                                                                                OPTIONAL,
    sensor-ProvideLocationInformation-r13
                                          Sensor-ProvideLocationInformation-r13
                                                                                OPTIONAL,
    tbs-ProvideLocationInformation-r13 TBS-ProvideLocationInformation-r13
    wlan-ProvideLocationInformation-r13 WLAN-ProvideLocationInformation-r13 OPTIONAL,
    bt-ProvideLocationInformation-r13
                                         BT-ProvideLocationInformation-r13
    [[ nr-ECID-ProvideLocationInformation-r16
                                      NR-ECID-ProvideLocationInformation-r16
                                                                                     OPTIONAL,
        nr-Multi-RTT-ProvideLocationInformation-r16
                                      NR-Multi-RTT-ProvideLocationInformation-r16 OPTIONAL,
        nr-DL-AoD-ProvideLocationInformation-r16
                                      NR-DL-AoD-ProvideLocationInformation-r16
        nr-DL-TDOA-ProvideLocationInformation-r16
                                      NR-DL-TDOA-ProvideLocationInformation-r16 OPTIONAL
    ]]
-- ASN1STOP
```

– Abort

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

```
c1 CHOICE {
    abort-r9 Abort-r9-IEs,
    spare3 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.

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 {
        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)

-- 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 TS 38.101-2 [34] and TS 38.101-1 [37].

```
-- 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].

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.

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.

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 the 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.

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.

- Ellipsoid-Point

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

Ellipsoid-PointWithUncertaintyCircle

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

EllipsoidPointWithUncertaintyEllipse

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

```
orientationMajorAxis INTEGER (0..179),
confidence INTEGER (0..100)
}
-- ASN1STOP
```

EllipsoidPointWithAltitude

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

EllipsoidPointWithAltitudeAndUncertaintyEllipsoid

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

EllipsoidArc

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

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

FreqBandIndicatorNR

The IE FreqBandIndicatorNR specifies the NR band indicator (TS 38.331 [35]).

```
-- ASN1START

FreqBandIndicatorNR-r16 ::= INTEGER (1..1024)

-- ASN1STOP
```

HighAccuracyEllipsoidPointWithUncertaintyEllipse

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

```
}
-- ASN1STOP
```

HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid

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

HorizontalVelocity

The IE Horizontal Velocity is used to describe a velocity shape as defined in TS 23.032 [15].

HorizontalWithVerticalVelocity

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

HorizontalVelocityWithUncertainty

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

HorizontalWithVerticalVelocityAndUncertainty

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

LocationCoordinateTypes

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

```
-- ASN1START
LocationCoordinateTypes ::= SEQUENCE {
    ellipsoidPoint
                                                             BOOLEAN,
    ellipsoidPointWithUncertaintyCircle
                                                             BOOLEAN,
    ellipsoidPointWithUncertaintyEllipse
                                                             BOOLEAN,
                                                             BOOLEAN.
    polygon
    \verb"ellipsoidPointWithAltitude"
                                                             BOOLEAN,
    ellipsoidPointWithAltitudeAndUncertaintyEllipsoid
                                                             BOOLEAN,
    ellipsoidArc
                                                             BOOLEAN,
    П
        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 (TS 38.331 [35]).

NR-PhysCellId

The IE NR-PhysCellId specifies the NR physical cell identifier (TS 38.331 [35]).

```
-- ASN1START

NR-PhysCellID-r16 ::= INTEGER (0..1007)

-- ASN1STOP
```

PeriodicAssistanceDataControlParameters

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

PeriodicAssistanceDataControlParameters field descriptions

periodicSessionID

This field identifies a particular periodic assistance data delivery session and the initiator of the session.

updateCapabilities

This field identifies the capabilities of the sending entity to support an update of periodic assistance data. A bit value set to one indicates a capability is supported and a bit value set to zero indicates a capability is not supported.

– Polygon

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

PositioningModes

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

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 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 TS 23.032 [15].

6.4.2 Common Positioning

CommonlEsRequestCapabilities

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

CommonlEsRequestCapabilities field descriptions

Ipp-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.

CommonlEsProvideCapabilities

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

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

CommonlEsProvideCapabilities field descriptions

segmentationInfo

This field indicates whether this ProvideCapabilities message is one of many segments, as specified in clause 4.3.5.

Ipp-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.

CommonlEsRequestAssistanceData

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
   ]],
   11
       periodicAssistanceDataReq-r15
                                 PeriodicAssistanceDataControlParameters-r15
                                                           OPTIONAL, -- Cond PerADreq
       primaryCellID-r15
                                NCGI-r15
                                                           OPTIONAL
   11
-- 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 <i>lpp-message-segmentation-req</i> has been received from the location server with bit 1 (<i>targetToServer</i>) set to value 1. The field shall
	be omitted if <i>Ipp-message-segmentation-req</i> has not been received in this location session, or has been received with bit 1 (<i>targetToServer</i>) 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.

CommonlEsRequestAssistanceData 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 clause 4.3.5.

periodicAssistanceDataReg

This field indicates a request for periodic assistance data delivery, as specified in clause 5.2.1a.

CommonlEsProvideAssistanceData

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

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

CommonlEsRequestAssistanceData field descriptions

segmentationInfo

This field indicates whether this *ProvideAssistanceData* message is one of many segments, as specified in clause 4.3.5.

periodicAssistanceData

This field indicates a periodic assistance data delivery, as specified in clauses 5.2.1a and 5.2.2a.

CommonlEsRequestLocationInformation

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

```
-- ASN1START
CommonIEsRequestLocationInformation ::= SEQUENCE {
    {\tt locationInformationType} \qquad {\tt LocationInformationType},
    triggeredReporting TriggeredReportingCriteria OPTIONAL,
periodicalReporting PeriodicalReportingCriteria OPTIONAL,
additionalInformation AdditionalInformation OPTIONAL,
qos QoS OPTIONAL,
                                                                                 -- Cond ECID
                                                                                  -- Need ON
                                                                                 -- Need ON
                                                                     OPTIONAL,
                                                                                   -- Need ON
                                    QoS
                                                                    OPTIONAL,
    environment
                                   Environment
                                                                                  -- Need ON
    locationCoordinateTypes LocationCoordinateTypes OPTIONAL,
                                                                                  -- Need ON
                                                                                  -- Need ON
    velocityTypes
                                    VelocityTypes
                                                                    OPTIONAL,
    ] ]
         messageSizeLimitNB-r14 MessageSizeLimitNB-r14
                                                                   OPTIONAL -- Need ON
    ]],
    [ [
         segmentationInfo-r14 SegmentationInfo-r14 OPTIONAL -- Need ON
    ]]
}
LocationInformationType ::= ENUMERATED {
    locationEstimateRequired,
    locationMeasurementsRequired,
```

```
locationEstimatePreferred,
    locationMeasurementsPreferred,
}
PeriodicalReportingCriteria ::= SEQUENCE {
                                        ENUMERATED {
   reportingAmount
                                            ral, 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 {
                                   BOOLEAN,
ReportingDuration,
   cellChange
   reportingDuration
}
ReportingDuration ::=
                                   INTEGER (0..255)
AdditionalInformation ::= ENUMERATED {
   onlyReturnInformationRequested,
   mayReturnAditionalInformation,
}
  QoS ::= SEQUENCE {
                                                                    -- Need ON
                                                                    -- Need ON
   velocityRequest
                               BOOLEAN,
   [[ responseTimeNB-r14 ResponseTimeNB-r14 OPTIONAL
                                                                     -- Need ON
   1],
   ]],
[[ 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
    1],
    [[ 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 E-CID or NR E-CID is requested. Otherwise it
	is not present.

CommonlEsRequestLocationInformation 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 CommonlEsRequestLocationInformation.

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

CommonlEsRequestLocationInformation field descriptions

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 TS 23.032 [15] and 'confidence' corresponds to confidence as defined in 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 TS 23.032 [15] and 'confidence' corresponds to confidence as defined in 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 *CommonlEsRequestLocationInformation*, 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 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 '*tensecond*' 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 TS 23.032 [15] and 'confidence' corresponds to confidence as defined in 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 TS 23.032 [15] and 'confidence' corresponds to confidence as

CommonlEsRequestLocationInformation field descriptions

defined in 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.

IocationCoordinateTypes

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 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
                                                         OPTIONAL
                               EarlyFixReport-r12
    ]],
       locationSource-r13 LocationSource-r13
    [ [
                                                         OPTIONAL.
        locationTimestamp-r13 UTCTime
                                                         OPTIONAL
    ]],
    [[
        segmentationInfo-r14
                                SegmentationInfo-r14
                                                         OPTIONAL
                                                                         -- Cond Segmentation
    ]]
}
LocationCoordinates ::= CHOICE {
    ellipsoidPoint
                                                Ellipsoid-Point,
   ellipsoidPointWithUncertaintyCircle
ellipsoidPointWithUncertaintyEllipse
                                                 Ellipsoid-PointWithUncertaintyCircle,
                                                EllipsoidPointWithUncertaintyEllipse,
                                                 Polygon,
    ellipsoidPointWithAltitude
                                                 EllipsoidPointWithAltitude,
    ellipsoidPointWithAltitudeAndUncertaintyEllipsoid
                                                 {\tt EllipsoidPointWithAltitudeAndUncertaintyEllipsoid,}
    ellipsoidArc
                                                 EllipsoidArc,
    highAccuracyEllipsoidPointWithUncertaintyEllipse-v1510
                                HighAccuracyEllipsoidPointWithUncertaintyEllipse-r15,
    \verb|highAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-v1510|\\
                                HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-r15
```

```
Velocity ::= CHOICE {
  horizontalVelocity
                                                 HorizontalVelocity,
   horizontalWithVerticalVelocity
horizontalVelocityWithUncertainty
                                                 HorizontalWithVerticalVelocity,
                                                 HorizontalVelocityWithUncertainty,
   horizontalWithVerticalVelocityAndUncertainty
                                                 HorizontalWithVerticalVelocityAndUncertainty,
}
LocationError ::= SEQUENCE {
   locationfailurecause
                                   LocationFailureCause,
LocationFailureCause ::= ENUMERATED {
   undefined,
   requestedMethodNotSupported,
   positionMethodFailure,
   periodicLocationMeasurementsNotAvailable,
EarlyFixReport-r12 ::= ENUMERATED {
   noMoreMessages,
   moreMessagesOnTheWay
                                                         (0),
LocationSource-r13 ::= BIT STRING { a-gnss
                                     wlan
                                                         (1),
                                     bt
                                                         (2),
                                                         (3),
                                     sensor
                                                         (4),
                                    ha-gnss-v1510
                                                         (5),
                                     motion-sensor-v1550 (6),
                                    dl-tdoa-r16 (7),
dl-aod-r16 (8) } (SIZE(1..16))
                                    dl-aod-r16
-- ASN1STOP
```

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

CommonlEsProvideLocationInformation field descriptions

locationEstimate

This field provides a location estimate using one of the geographic shapes defined in 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 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].

IncationError

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 1: In this version of the specification, the entry 'tbs' is used only for TBS positioning based on MBS signals.
- NOTE 2: The entry 'sensor' is used only for positioning technology that uses barometric pressure sensor. The entry 'motion-sensor' is used for positioning technology that uses sensor(s) to detect displacement and movement, e.g. accelerometers, gyros, magnetometers.

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 clause 4.3.5

CommonIEsAbort

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

CommonlEsAbort 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 CommonlEsRequestLocationInformation.

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 clauses 5.2.1a and 5.2.2a.

CommonlEsError

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

CommonlEsError field descriptions

errorCause

This IE defines the cause for an error. 'IppMessageHeaderError', 'IppMessageBodyError' 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. 'IppSegmentationError' is used if a receiver detects an error in LPP message segmentation.

6.4.3 Common NR Positioning Information Elements

DL-PRS-ID-Info

The IE DL-PRS-ID-Info provides the IDs of the reference TRPs' DL-PRS Resources.

DL-PRS-ID-Info field descriptions

nr-DL-PRS-ResourceID-List

This field provides a list of DL-PRS Resource IDs under the same DL-PRS Resource Set.

NR-AdditionalPathList

The IE NR-AdditionalPathList is used by the target device to provide information about additional paths in association to the TOA measurements associated to NR positioning in the form of a relative time difference and a quality value. The additional path nr-relativeTimeDifference is the detected path timing relative to the detected path timing used for the TOA value, and each additional path can be associated with a quality value nr-path-Quality.

```
-- ASN1START
NR-AdditionalPathList-r16 ::= SEQUENCE (SIZE(1..2)) OF NR-AdditionalPath-r16
NR-AdditionalPath-r16 ::= SEQUENCE {
   nr-RelativeTimeDifference-r16 CHOICE {
                                       INTEGER(0..16351),
               k0-r16
               k1-r16
                                       INTEGER (0..8176),
               k2-r16
                                      INTEGER(0..4088),
               k3-r16
                                       INTEGER(0..2044),
               k4-r16
                                     INTEGER(0..1022),
                                      INTEGER(0..511),
               k5-r16
   nr-PathQuality-r16
                          NR-TimingQuality-r16
                                                                          OPTIONAL,
-- ASN1STOP
```

NR-AdditionalPathListfield descriptions

nr-RelativeTimeDifference

This field specifies the additional detected path timing relative to the detected path timing of the reference resource. A positive value indicates that the particular path is later in time than the detected path of the reference; a negative value indicates that the particular path is earlier in time than the detected path of the reference.

nr-PathQuality

This field specifies the target device's best estimate of the quality of the detected timing of the additional path.

NR-DL-PRS-AssistanceData

The IE NR-DL-PRS-AssistanceData is used by the location server to provide DL-PRS assistance data.

- NOTE 1: The location server should include at least one TRP for which the SFN can be obtained by the target device, e.g. the serving TRP.
- NOTE 2: The *nr-DL-PRS-ReferenceInfo* defines the "assistance data reference" TRP whose DL-PRS configuration is included in *nr-DL-PRS-AssistanceDataList*. The *nr-DL-PRS-SFN0-Offset's* and *nr-DL-PRS-expectedRSTD's* in *nr-DL-PRS-AssistanceDataList* are provided relative to the "assistance data reference" TRP.
- NOTE 3: The network signals a value of zero for the *nr-DL-PRS-SFN0-Offset*, *nr-DL-PRS-expectedRSTD*, and *nr-DL-PRS-expectedRSTD-uncertainty* of the "assistance data reference" TRP in *nr-DL-PRS-AssistanceDataList*.
- NOTE 4: For NR DL-TDOA positioning (see clause 6.5.10) the *nr-DL-PRS-ReferenceInfo* defines also the requested "RSTD reference".

```
-- ASN1START
NR-DL-PRS-AssistanceData-r16 ::= SEQUENCE {
   nr-DL-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16,
nr-DL-PRS-AssistanceDataList-r16 SEQUENCE (SIZE (1..
                                         SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF
                                                          NR-DL-PRS-AssistanceDataPerFreq-r16,
   nr-SSB-Config-r16
                                        SEQUENCE (SIZE (1..nrMaxTRPs-r16)) OF
                                                          NR-SSB-Config-r16 OPTIONAL, -- Need ON
NR-DL-PRS-AssistanceDataPerFreq-r16 ::= SEQUENCE {
   nr-DL-PRS-PositioningFrequencyLayer-r16
                                         NR-DL-PRS-PositioningFrequencyLayer-r16,
    nr-DL-PRS-AssistanceDataPerFreq-r16 SEQUENCE (SIZE (1..nrMaxTRPsPerFreq-r16)) OF
                                                          NR-DL-PRS-AssistanceDataPerTRP-r16,
NR-DL-PRS-AssistanceDataPerTRP-r16 ::= SEQUENCE {
   dl-PRS-ID-r16
                                    INTEGER (0..255).
                                                                   OPTIONAL,
    nr-PhysCellID-r16
                                    NR-PhysCellID-r16
                                                                               -- Need ON
                                    NCGI-r15
    nr-CellGlobalID-r16
                                                                   OPTIONAL, -- Need ON
```

```
ARFCN-ValueNR-r15
     nr-ARFCN-r16
                                                                                            OPTIONAL, -- Need ON
    nr-DL-PRS-SFN0-Offset-r16 NR-DL-PRS-SFN0-Offset-r16, nr-DL-PRS-ExpectedRSTD-r16 INTEGER (-3841..3841),
     nr-DL-PRS-ExpectedRSTD-Uncertainty-r16
                                                   INTEGER (0..246)
     nr-DL-PRS-Info-r16
                                                   NR-DL-PRS-Info-r16,
}
NR-DL-PRS-PositioningFrequencyLayer-r16 ::= SEQUENCE {
    dl-PRS-SubcarrierSpacing-r16 ENUMERATED {kHz15, kHz30, kHz60, kHz120, ...},
dl-PRS-ResourceBandwidth-r16 INTEGER (1..63),
dl-PRS-StartPRB-r16 INTEGER (0..2176),
     dl-PRS-StartPRB-r16 INTEGER (0..2176),
dl-PRS-PointA-r16 ARFCN-ValueNR-r15,
dl-PRS-CombSizeN-r16 ENUMERATED {n2, n4
dl-PRS-CyclicPrefix-r16 ENUMERATED {normal
                                                   ENUMERATED {n2, n4, n6, n12, ...},
                                                 ENUMERATED {normal, extended, ...},
NR-DL-PRS-SFN0-Offset-r16 ::= SEQUENCE {
     sfn-Offset-r16 INTEGER (0..1023), integerSubframeOffset-r16 INTEGER (0..9),
-- ASN1STOP
```

NR-DL-PRS-AssistanceData field descriptions

nr-DL-PRS-ReferenceInfo

This field specifies the IDs of the assistance data reference TRP.

nr-DL-PRS-AssistanceDataList

This field specifies the DL-PRS resources for each frequency layer.

nr-SSB-Config

This field specifies the SSB configuration of the TRPs.

nr-DL-PRS-PositioningFrequencyLayer

This field specifies the Positioning Frequency Layer for the nr-DL-PRS-AssistanceDataPerFreq field.

nr-DL-PRS-AssistanceDataPerFreq

This field specifies the DL-PRS Resources for the TRPs within the Positioning Frequency Layer.

dl-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resource ID to uniquely identify a DL-PRS Resource, and is associated with a single TRP.

nr-PhysCellID

This field specifies the physical cell identity of the TRP.

nr-CellGlobalID

This field specifies the NCGI, the globally unique identity of a cell in NR, as defined in TS 38.331 [35].

nr-ARFCN

This field specifies the NR-ARFCN of the TRP.

nr-DL-PRS-SFN0-Offset

This field specifies the time offset of the SFN#0 slot#0 for the given TRP with respect to SFN#0 slot#0 of the assistance data reference TRP and comprises the following subfields:

- sfn-Offset specifies the SFN offset at the TRP antenna location between the assistance data reference TRP and this neighbour TRP.
 - The offset corresponds to the number of full radio frames counted from the beginning of a radio frame #0 of the assistance data reference TRP to the beginning of the closest subsequent radio frame #0 of this neighbour TRP.
- integerSubframeOffset specifies the frame boundary offset at the TRP antenna location between the assistance data reference TRP and this neighbour TRP counted in full subframes. The offset is counted from the beginning of a subframe #0 of the assistance data reference TRP to the beginning of the closest subsequent subframe #0 of this neighbour TRP, rounded down to multiples of

subframes. nr-DL-PRS-ExpectedRSTD

This field indicates the RSTD value that the target device is expected to measure between this TRP and the assistance data reference TRP. The nr-DL-PRS-ExpectedRSTD field takes into account the expected propagation time difference as well as transmit time difference of PRS positioning occasions between the two TRPs. The resolution is $4 \times T_s$, with $T_s = 1/(15000^*2048)$ seconds.

NR-DL-PRS-AssistanceData field descriptions

nr-DL-PRS-ExpectedRSTD-Uncertainty

This field indicates the uncertainty in *nr-DL-PRS-ExpectedRSTD* value. The uncertainty is related to the location server's a-priori estimate of the target device location. The *nr-DL-PRS-ExpectedRSTD* and *nr-DL-PRS-ExpectedRSTD-Uncertainty* together define the search window for the target device.

The resolution R is

- Ts if all PRS resources are in frequency range 2,
- 4×Ts otherwise,

with $T_s=1/(15000*2048)$ seconds.

The target device may assume that the beginning of the subframe for the PRS of this TRP is received within the search window of size

[-nr-DL-PRS-ExpectedRSTD-Uncertainty×R] centred at T_{REF}+1 millisecond×N+nr-DL-PRS-ExpectedRSTD×4×T_s,

where T_{REF} is the reception time of the beginning of the subframe for the PRS of the assistance data reference TRP at the target device antenna connector, and N can be calculated based on

- nr-DL-PRS-SFN0-Offset
- dl-PRS-Periodicity-and-ResourceSetSlotOffset
- dI-PRS-ResourceSlotOffset.

nr-DL-PRS-Info

This field specifies the PRS configuration of the TRP.

dI-PRS-SubcarrierSpacing

This field specifies the subcarrier spacing of the DL-PRS Resource. 15, 30, 60 kHz for FR1; 60, 120 kHz for FR2.

dl-PRS-ResourceBandwidth

This field specifies the number of PRBs allocated for the DL-PRS Resource (allocated DL-PRS bandwidth) in multiples of 4 PRBs. All DL-PRS Resources of the DL-PRS Resource Set have the same bandwidth. All DL-PRS Resource Sets belonging to the same Positioning Frequency Layer have the same value of DL-PRS Bandwidth and Start PRB.

Integer value 1 corresponds to 24 PRBs, value 2 corresponds to 28 PRBs, value 3 corresponds to 32 PRBs and so on.

dI-PRS-StartPRB

This field specifies the start PRB index defined as offset with respect to reference DL-PRS Point A for the Positioning Frequency Layer.

dl-PRS-PointA

This field specifies the absolute frequency of the reference resource block for the DL-PRS. Its lowest subcarrier is also known as DL-PRS Point A. A single DL-PRS Point A for DL-PRS Resource allocation is provided per Positioning Frequency Layer. All DL-PRS Resources belonging to the same DL-PRS Resource Set have the same DL-PRS Point A.

dl-PRS-CombSizeN

This field specifies the Resource Element spacing in each symbol of the DL-PRS Resource. All DL-PRS Resource Sets belonging to the same Positioning Frequency Layer have the same value of comb size N.

dl-PRS-CyclicPrefix

This field specifies the Cyclic Prefix length of the DL-PRS Resource.

NR-DL-PRS-BeamInfo

The IE NR-DL-PRS-BeamInfo is used by the location server to provide spatial direction information of the DL-PRS Resources.

```
-- ASN1START
NR-DL-PRS-BeamInfo-r16 ::= SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF
                                                                  NR-DL-PRS-BeamInfoPerFreqLayer-r16
NR-DL-PRS-BeamInfoPerFreqLayer-r16 ::= SEQUENCE (SIZE (1..nrMaxTRPsPerFreq-r16)) OF
                                                                 NR-DL-PRS-BeamInfoPerTRP-r16
NR-DL-PRS-BeamInfoPerTRP-r16 ::= SEQUENCE {
    dl-PRS-ID-r16
                                         INTEGER (0..255),
   nr-PhysCellID-r16
                                        NR-PhysCellID-r16
                                                                 OPTIONAL,
                                                                             -- Need ON
    nr-CellGlobalID-r16
                                        NCGI-r15
                                                                 OPTIONAL,
                                                                              -- Need ON
                                        ARFCN-ValueNR-r15
INTEGER (0..255)
                                                                              -- Need ON
    nr-ARFCN-r16
                                                                 OPTIONAL,
    associated-DL-PRS-ID-r16
                                                                 OPTIONAL,
    {\tt lcs-GCS-TranslationParameter-r16} \qquad {\tt LCS-GCS-TranslationParameter-r16}
                                                                  OPTIONAL,
                                                                              -- Need OP
    dl-PRS-BeamInfoSet-r16
                                        DL-PRS-BeamInfoSet-r16 OPTIONAL,
DL-PRS-BeamInfoSet-r16 ::= SEQUENCE (SIZE(1..nrMaxSetsPerTrp-r16)) OF
```

Conditional presence	Explanation
AzEIFine	The field is mandatory present if dl-PRS-Azimuth-fine or dl-PRS-Elevation-fine are
	present; otherwise it is not present.

NR-DL-PRS-Beam-Info field descriptions

dI-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP. Each TRP should only be associated with one such ID.

nr-PhysCellID

This field specifies the physical cell identity of the associated TRP, as defined in TS 38.331 [35].

nr-CellGloballD

This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP, as defined in TS 38.331 [35]. The server should include this field if it considers that it is needed to resolve ambiguity in the TRP indicated by *nr-PhysCellID*.

nr-ARFCN

This field specifies the NR-ARFCN of the TRP.

associated-DL-PRS-ID

This field specifies the *dl-PRS-ID* of the associated TRP from which the beam information is adopted. The beam information from the associated TRP is considered to be in GCS if the *lcs-gcs-translation-parameter* field is not provided, and to be in LCS if the *lcs-gcs-translation-parameter* field is provided. If the field is omitted, the beam information is provided via the *dl-prs-BeamInfoSet* field.

Ics-GCS-TranslationParameter

This field provides the angles α (bearing angle), β (downtilt angle) and γ (slant angle) for the translation of a Local Coordinate System (LCS) to a Global Coordinate System (GCS) as defined in TR 38.901 [44]. If this field is absent, the *dl-PRS-Azimuth* and *dl-PRS-Elevation* are provided in a GCS.

dI-PRS-BeamInfoSet

This field provides the DL-PRS beam information for each DL-PRS Resource of the DL-PRS Resource Set associated with this TRP.

dl-PRS-Azimuth

This field specifies the azimuth angle of the boresight direction in which the DL-PRS Resources associated with this DL-PRS Resource ID in the DL-PRS Resource Set are transmitted.

For a Global Coordinate System (GCS), the azimuth angle is measured counter-clockwise from geographical North. For a Local Coordinate System (LCS), the azimuth angle is measured measured counter-clockwise from the x-axis of the LCS.

Scale factor 1 degree; range 0 to 359 degrees.

dI-PRS-Azimuth-fine

This field provides finer granularity for the *dl-PRS-Azimuth*.

The total azimuth angle of the boresight direction is given by *dl-PRS-Azimuth + dl-PRS-Azimuth-fine*.

Scale factor 0.1 degrees; range 0 to 0.9 degrees.

dI-PRS-Elevation

This field specifies the elevation angle of the boresight direction in which the DL-PRS Resources associated with this DL-PRS Resource ID in the DL-PRS Resource Set are transmitted.

For a Global Coordinate System (GCS), the elevation angle is measured relative to zenith and positive to the horizontal direction (elevation 0 deg. points to zenith, 90 deg to the horizon).

For a Local Coordinate System (LCS), the elevation angle is measured relative to the z-axis of the LCS (elevation 0 deg. points to the z-axis, 90 deg to the x-y plane).

Scale factor 1 degree; range 0 to 180 degrees.

dl-PRS-Elevation-fine

This field provides finer granularity for the *dl-PRS-Elevation*.

The total elevation angle of the boresight direction is given by *dl-PRS-Elevation* + *dl-PRS-Elevation-fine*. Scale factor 0.1 degrees; range 0 to 0.9 degrees.

alpha

This field specifies the bearing angle α for the translation of the LCS to a GCS as defined in TR 38.901 [44]. Scale factor 1 degree; range 0 to 359 degrees.

alpha-fine

This field provides finer granularity for the alpha.

The total bearing angle α is given by alpha + alpha-fine.

Scale factor 0.1 degrees; range 0 to 0.9 degrees.

beta

This field specifies the downtilt angle β for the translation of the LCS to a GCS as defined in TR 38.901 [44]. Scale factor 1 degree; range 0 to 359 degrees.

beta-fine

This field provides finer granularity for the beta.

The total downtilt angle β is given by *beta* + *beta-fine*.

Scale factor 0.1 degrees; range 0 to 0.9 degrees.

gamma

This field specifies the slant angle γ for the translation of the LCS to a GCS as defined in TR 38.901 [44]. Scale factor 1 degree; range 0 to 359 degrees.

gamma-fine

This field provides finer granularity for the *gamma*. The total slant angle γ is given by *gamma* + *gamma-fine*. Scale factor 0.1 degrees; range 0 to 0.9 degrees.

– NR-DL-PRS-Info

The IE NR-DL-PRS-Info defines downlink PRS configuration.

```
-- ASN1START
NR-DL-PRS-Info-r16 ::= SEQUENCE {
   nr-DL-PRS-ResourceSetList-r16
                                     SEQUENCE (SIZE (1..nrMaxSetsPerTrp-r16)) OF
                                                                  NR-DL-PRS-ResourceSet-r16,
NR-DL-PRS-ResourceSet-r16 ::= SEQUENCE {
   nr-DL-PRS-ResourceSetID-r16
                                       NR-DL-PRS-ResourceSetID-r16,
   dl-PRS-Periodicity-and-ResourceSetSlotOffset-r16
                                      NR-DL-PRS-Periodicity-and-ResourceSetSlotOffset-r16,
   dl-PRS-ResourceRepetitionFactor-r16 ENUMERATED {n2, n4, n6, n8, n16, n32, ...}
                                                                          OPTIONAL,
   dl-PRS-ResourceTimeGap-r16
                                      ENUMERATED {s1, s2, s4, s8, s16, s32, ...}
                                                                          OPTIONAL, -- Cond Rep
                                 ENUMERON-
DL-PRS-MutingOption1-rio
DL-PRS-MutingOption2-r16
INTEGER (-60..50),
   dl-PRS-NumSymbols-r16
                                      ENUMERATED {n2, n4, n6, n12, ...},
   dl-PRS-MutingOption1-r16
                                      DL-PRS-MutingOption1-r16
                                                                          OPTIONAL,
                                                                                      -- Need OP
   dl-PRS-MutingOption2-r16
                                                                          OPTIONAL,
   dl-PRS-Mutingopeions 11
dl-PRS-ResourcePower-r16
                                                                                      -- Need OP
                                     INTEGER (-60..50),
SEQUENCE (SIZE (1..nrMaxResourcesPerSet-r16)) OF
   dl-PRS-ResourceList-r16
                                                                  NR-DL-PRS-Resource-r16,
}
DL-PRS-MutingOption1-r16 ::= SEQUENCE {
   dl-prs-MutingBitRepetitionFactor-r16
                                       ENUMERATED { n1, n2, n4, n8, ... } OPTIONAL, -- Need OP
   nr-option1-muting-r16
                                       NR-MutingPattern-r16,
}
DL-PRS-MutingOption2-r16 ::= SEQUENCE {
   nr-option2-muting-r16
                                       NR-MutingPattern-r16,
NR-MutingPattern-r16 ::= CHOICE {
   po2-r16
                                       BIT STRING (SIZE(2)),
   po4-r16
                                       BIT STRING (SIZE(4)),
   po6-r16
                                       BIT STRING (SIZE(6)),
   po8-r16
                                      BIT STRING (SIZE(8)),
   po16-r16
                                       BIT STRING (SIZE(16)),
   po32-r16
                                       BIT STRING (SIZE(32)),
    . . .
}
NR-DL-PRS-Resource-r16 ::= SEQUENCE {
   nr-DL-PRS-ResourceID-r16
                                      NR-DL-PRS-ResourceID-r16,
    dl-PRS-SequenceID-r16
                                      INTEGER (0.. 4095),
                                      CHOICE {
   dl-PRS-CombSizeN-AndReOffset-r16
           n2-r16
                                          INTEGER (0..1),
           n4-r16
                                           INTEGER (0..3),
           n6-r16
                                           INTEGER (0..5),
           n12-r16
                                           INTEGER (0..11),
   OPTIONAL.
DL-PRS-QCL-Info-r16 ::= CHOICE {
                               SEQUENCE {
   ssb-r16
       pci-r16
                                      NR-PhysCellID-r16,
```

```
ssb-Index-r16
                                                     INTEGER (0..63),
          rs-Type-r16
                                                     ENUMERATED {typeC, typeD, typeC-plus-typeD}
     dl-PRS-r16
                                          SEQUENCE {
          qcl-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16, qcl-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16
}
NR-DL-PRS-Periodicity-and-ResourceSetSlotOffset-r16 ::= CHOICE {
    scs15-r16 CHOICE {
                               n4-r16
                                                                INTEGER (0..3),
                                n5-r16
                                                                INTEGER (0..4),
                                n8-r16
                                                               INTEGER (0..7),
                                n10-r16
                                                                INTEGER (0..9),
                                                               INTEGER (0..15),
                                n16-r16
                                                              INTEGER (0..19),
                               n20-r16
n32-r16
                                                     INTEGER (0..31),

INTEGER (0..39),

INTEGER (0..63),

INTEGER (0..79),

INTEGER (0..159),

INTEGER (0..319),

INTEGER (0..639),

INTEGER (0..1279),

INTEGER (0..2559),

INTEGER (0..5119),

INTEGER (0..5119),
                                                               INTEGER (0..31),
                                n40-r16
                               n64-r16
n80-r16
                                n160-r16
                                n320-r16
                               n640-r16
                                n1280-r16
                                n2560-r16
                                n5120-r16
                                n10240-r16
                                                               INTEGER (0..10239),
     scs30-r16
                        CHOICE {
                                                            INTEGER (0..7),
INTEGER (0..9),
INTEGER (0..15),
                              n8-r16
                                n10-r16
                               n16-r16
                               n20-r16
n32-r16
                                                              INTEGER (0..19),
                                                                INTEGER (0..31),
                                n40-r16
                                                             INTEGER (0..39),
                               n64-r16
n80-r16
                                                             INTEGER (0..63),
INTEGER (0..79),
                                                        INTEGER (0..79),
INTEGER (0..127),
INTEGER (0..159),
INTEGER (0..319),
INTEGER (0..639),
INTEGER (0..1279),
INTEGER (0..2559),
INTEGER (0..5119),
INTEGER (0..10239),
INTEGER (0..10239),
INTEGER (0..20479),
                                n128-r16
                                n160-r16
                                n320-r16
                                n640-r16
                                n1280-r16
                                n2560-r16
                                n5120-r16
                                n10240-r16
                                n20480-r16
                                                              INTEGER (0..20479),
     scs60-r16
                          CHOICE {
                                                            INTEGER (0..15),
INTEGER (0..19),
                               n16-r16
                                n20-r16
                                                                INTEGER (0..31),
                                n32-r16
                                n40-r16
                                                              INTEGER (0..39),
                                                             INTEGER (0..63),
INTEGER (0..79),
                               n64-r16
n80-r16
                                                             INTEGER (0..127),
INTEGER (0..159),
INTEGER (0..255),
                                n128-r16
                               n160-r16
n256-r16
                               n320-r16
n640-r16
                                                             INTEGER (0..319),
                                                               INTEGER (0..639),
                                n1280-r16
                                                             INTEGER (0..1279),
                               n2560-r16
                                                            INTEGER (0..2559),
INTEGER (0..5119),
                                n5120-r16
                                                             INTEGER (0..10239),
                                n10240-r16
                                                                INTEGER (0..20479),
                                n20480-r16
                                n40960-r16
                                                              INTEGER (0..40959),
                          CHOICE {
     scs120-r16
                                n32-r16
                                                                INTEGER (0..31),
                                n40-r16
                                                               INTEGER (0..39),
                                n64-r16
                                                               INTEGER (0..63),
                                n80-r16
                                                                INTEGER (0..79),
                                n128-r16
                                                               INTEGER (0..127),
                                                                INTEGER (0..159),
                                n160-r16
                                n256-r16
                                                               INTEGER (0..255),
```

```
n320-r16
                                              INTEGER (0..319),
                                              INTEGER (0..511),
                      n512-r16
                      n640-r16
                                             INTEGER (0..639),
                      n1280-r16
                                             INTEGER (0..1279),
                      n2560-r16
                                              INTEGER (0..2559),
                      n5120-r16
                                             INTEGER (0..5119),
                                              INTEGER (0..10239),
                      n10240-r16
                      n20480-r16
                                             INTEGER (0..20479),
                      n40960-r16
                                             INTEGER (0..40959),
                      n81920-r16
                                              INTEGER (0..81919),
  },
- ASN1STOP
```

Conditional presence	Explanation
Rep	The field is mandatory present, if <i>dl-PRS-ResourceRepetitionFactor</i> is present. Otherwise
	it is not present.

NR-DL-PRS-Info field descriptions

dl-PRS-Periodicity-and-ResourceSetSlotOffset

This field specifies the periodicity of DL-PRS allocation in slots configured per DL-PRS Resource Set and the slot offset with respect to SFN #0 slot #0 for a TRP where the DL-PRS Resource Set is configured (i.e. slot where the first DL-PRS Resource of DL-PRS Resource Set occurs).

dI-PRS-ResourceRepetitionFactor

This field specifies how many times each DL-PRS Resource is repeated for a single instance of the DL-PRS Resource Set. It is applied to all resources of the DL-PRS Resource Set. Enumerated values *n*2, *n*4, *n*6, *n*8, *n*16, *n*32 correspond to 2, 4, 6, 8, 16, 32 resource repetitions, respectively. If this field is absent, the value for *dl-PRS-ResourceRepetitionFactor* is 1 (i.e., no resource repetition).

dI-PRS-ResourceTimeGap

This field specifies the offset in units of slots between two repeated instances of a DL-PRS Resource corresponding to the same DL-PRS Resource ID within a single instance of the DL-PRS Resource Set. The time duration spanned by one DL-PRS Resource Set containing repeated DL-PRS Resources should not exceed DL-PRS-Periodicity.

dI-PRS-NumSymbols

This field specifies the number of symbols per DL-PRS Resource within a slot.

dI-PRS-MutingOption1

This field specifies the DL-PRS muting configuration of the TRP for the Option-1 muting, as specified in TS 38.214 [45], and comprises the following sub-fields:

- **dl-prs-MutingBitRepetitionFactor** indicates the number of consecutive instances of the DL-PRS Resource Set corresponding to a single bit of the *nr-option1-muting* bit map. Enumerated values *n1*, *n2*, *n4*, *n8* correspond to 1, 2, 4, 8 consecutive instances, respectively. If this sub-field is absent, the value for *dl-prs-MutingBitRepetitionFactor* is *n1*.
- **nr-option1-muting** defines a bitmap of the time locations where the DL-PRS Resource is transmitted (value '1') or not (value '0') for a DL-PRS Resource Set, as specified in TS 38.214 [45].

If this field is absent, Option-1 muting is not in use for the TRP.

dI-PRS-MutingOption2

This field specifies the DL-PRS muting configuration of the TRP for the Option-2 muting, as specified in TS 38.214 [45], and comprises the following sub-fields:

nr-option2-muting defines a bitmap of the time locations where the DL-PRS Resource is transmitted (value '1') or not (value '0'). Each bit of the bitmap corresponds to a single repetition of the DL-PRS Resource within an instance of a DL-PRS Resource Set, as specified in TS 38.214 [45]. The size of this bitmap should be the same as the value for *dl-PRS-ResourceRepetitionFactor*.

If this field is absent, Option-2 muting is not in use for the TRP.

dl-PRS-ResourcePower

This field specifies the average EPRE of the resources elements that carry the PRS in dBm that is used for PRS transmission. The UE assumes constant EPRE is used for all REs of a given DL-PRS resource.

dl-PRS-SequenceID

This field specifies the sequence Id used to initialize c_{init} value used in pseudo random generator TS 38.211 [41], clause 5.2.1 for generation of DL-PRS sequence for transmission on a given DL-PRS Resource.

dI-PRS-CombSizeN-AndReOffset

This field specifies the Resource Element spacing in each symbol of the DL-PRS Resource and the Resource Element (RE) offset in the frequency domain for the first symbol in a DL-PRS Resource. All DL-PRS Resource Sets belonging to the same Positioning Frequency Layer have the same value of comb size. The relative RE offsets of following symbols are defined relative to the RE Offset in the frequency domain of the first symbol in the DL-PRS Resource according to TS 38.211 [41]. The comb size configuration should be aligned with the comb size configuration for the frequency layer.

NR-DL-PRS-Info field descriptions

dI-PRS-ResourceSlotOffset

This field specifies the starting slot of the DL-PRS Resource with respect to the corresponding DL-PRS-Resource Set Slot Offset.

dI-PRS-ResourceSymbolOffset

This field specifies the starting symbol of the DL-PRS Resource within a slot determined by *dl-PRS-ResourceSlotOffset*.

dI-PRS-QCL-Info

This field specifies the QCL indication with other DL reference signals for serving and neighbouring cells and comprises the following subfields:

- **ssb** indicates the SSB information for QCL source and comprises the following sub-fields:
 - **pci** specifies the physical cell ID of the cell with the SSB that is configured as the source reference signal for the DL-PRS. The UE obtains the SSB configuration for the SSB configured as source reference signal for the DL-PRS by indexing to the field *nr-SSB-Config* with this physical cell identity.
 - ssb-Index indicates the index for the SSB configured as the source reference signal for the DL-PRS.
 - **rs-Type** indicates the QCL type.
- dI-PRS indicates the PRS information for QCL source and comprises the followings sub-fields:
 - qcl-DL-PRS-ResourceID specifies DL-PRS Resource ID as the source reference signal for the DL-PRS.
 - qcl-DL-PRS-ResourceSetID specifies the DL-PRS Resource Set ID.

NR-DL-PRS-ProcessingCapability

The IE *NR-DL-PRS-ProcessingCapability* defines the common DL-PRS Processing capability. In the case of capabilities for multiple NR positioning methods are provided, the IE *NR-DL-PRS-ProcessingCapability* applies across the NR positioning methods and the target device shall indicate the same values for the capabilities in IEs *NR-DL-TDOA-ProvideCapabilities*, *NR-DL-AoD-ProvideCapabilities*, and *NR-Multi-RTT-ProvideCapabilities*.

The NR-DL-PRS-Processing Capability is defined for a single positioning frequency layer (i.e., a target device supporting multiple positioning frequency layers is expected to process one frequency layer at a time).

```
-- ASN1START
NR-DL-PRS-ProcessingCapability-r16 ::= SEQUENCE {
   prs-ProcessingCapabilityBandList-r16 SEQUENCE (SIZE (1..nrMaxBands-r16)) OF
                                               PRS-ProcessingCapabilityPerBand-r16,
                                           INTEGER (1..4),
    maxSupportedFreqLayers-r16
                                           ENUMERATED { supported} OPTIONAL,
    simulLTE-NR-PRS-r16
}
PRS-ProcessingCapabilityPerBand-r16 ::= SEQUENCE {
   supportedBandwidthPRS-r16
                                       FreqBandIndicatorNR-r16,
                                       CHOICE {
                                                ENUMERATED {mhz5, mhz10, mhz20, mhz40,
       fr1
                                                            mhz50, mhz80, mhz100},
        fr2
                                                ENUMERATED {mhz50, mhz100, mhz200, mhz400},
        . . .
    dl-PRS-BufferType-r16
                                       ENUMERATED {type1, type2, ...},
    durationOfPRS-Processing-r16
                                       SEQUENCE {
       durationOfPRS-ProcessingSymbols-r16 ENUMERATED {nDot125, nDot25, nDot5, n1,
                                                            n2, n4, n6, n8, n12, n16, n20, n25,
                                                            n30, n32, n35, n40, n45, n50},
       durationOfPRS-ProcessingSymbolsInEveryTms-r16
                                               ENUMERATED {n8, n16, n20, n30, n40, n80,
                                                            n160,n320, n640, n1280},
    maxNumOfDL-PRS-ResProcessedPerSlot-r16 SEQUENCE {
       scs15-r16
                                                ENUMERATED {n1, n2, n4, n8, n16, n24, n32,
                                                            n48, n64}
                                                                                       OPTIONAL,
        scs30-r16
                                                ENUMERATED {n1, n2, n4, n8, n16, n24, n32,
                                                             n48, n64}
                                                                                        OPTIONAL.
        scs60-r16
                                                ENUMERATED {n1, n2, n4, n8, n16, n24, n32,
                                                            n48, n64}
                                                                                        OPTIONAL,
        scs120-r16
                                                ENUMERATED {n1, n2, n4, n8, n16, n24, n32,
                                                            n48, n64}
                                                                                        OPTIONAL,
    },
```

-- ASN1STOP

NR-DL-PRS-ProcessingCapability field descriptions

maxSupportedFreqLayers

Indicates the maximum number of positioning frequency layers supported by UE.

supportedBandwidthPRS

Indicates the maximum number of DL-PRS bandwidth in MHz, which is supported and reported by UE.

dI-PRS-BufferType

Indicates DL-PRS buffering capability. Value *type1* indicates sub-slot/symbol level buffering and value *type2* indicates slot level buffering.

durationOfPRS-Processing

Indicates the duration *N* of DL-PRS symbols in units of ms a UE can process every T ms assuming maximum DL-PRS bandwidth provided in *supportedBandwidthPRS* and comprises the following subfields:

- durationOfPRS-ProcessingSymbols: This field specifies the values for N. Enumerated values indicate 0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50 ms.
- *durationOfPRS-ProcessingSymbolsInEveryTms*: This field specifies the values for *T*. Enumerated values indicate 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280 ms.

See NOTE

maxNumOfDL-PRS-ResProcessedPerSlot

Indicates the maximum number of DL-PRS resources that UE can process in a slot. SCS: 15 kHz, 30 kHz, 60 kHz are applicable for FR1 bands. SCS: 60 kHz, 120 kHz are applicable for FR2 bands.

simulLTE-NR-PRS

Indicates whether the UE supports parallel processing of LTE PRS and NR PRS.

NOTE: When the target device provides the *durationOfPRS-Processing* capability (N, T) for any $P(\ge T)$ time window defined in TS 38. 214 [45] clause 5.1.6.5, the target device should be capable of processing all DL-PRS resources within P, if

- $N \ge K$ where K is defined in the TS 38.214 [45] clause 5.1.6.5, and
- the number of DL-PRS Resources in each slot does not exceed the *maxNumOfDL-PRS-ResProcessedPerSlot*, and
- the configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) is as specified in TS 38.133 [46].

NR-DL-PRS-QCL-ProcessingCapability

The IE *NR-DL-PRS-QCL-ProcessingCapability* defines the common UE DL-PRS QCL Processing capability. The UE can include this IE only if the UE supports *NR-DL-PRS-ProcessingCapability*. Otherwise, the UE does not include this IE

In the case of capabilities for multiple NR positioning methods are provided, the IE NR-DL-PRS-QCL-Processing Capability applies across the NR positioning methods and the target device shall indicate the same values for the capabilities in IEs NR-DL-TDOA-ProvideCapabilities, NR-DL-AoD-ProvideCapabilities, and NR-Multi-RTT-ProvideCapabilities.

NR-DL-PRS-QCL-ProcessingCapability field descriptions

ssbFromNeighCellAsQCL

Indicates the support of SSB from neighbour cell as QCL source of a DL-PRS. UE supporting this feature also support reusing SSB measurement from RRM for receiving PRS.

Note: It refers to Type-C for FR1 and Type-C & Type-D support for FR2.

prs-FromServNeighCellAsQCL

Indicates the support of DL-PRS from serving/neighbour cell as QCL source of a DL-PRS.

Note: It refers to Type-D support for FR2.

NR-DL-PRS-ResourceID

The IE NR-DL-PRS-ResourceID defines the identity of a DL-PRS Resource of a DL-PRS Resource Set of a TRP.

```
-- ASN1START

NR-DL-PRS-ResourceID-r16 ::= INTEGER (0..nrMaxNumDL-PRS-ResourcesPerSet-1-r16)

-- ASN1STOP
```

NR-DL-PRS-ResourcesCapability

The IE *NR-DL-PRS-ResourcesCapability* defines the DL-PRS resources capability for each positioning method. The UE can include this IE only if the UE supports *NR-DL-PRS-ProcessingCapability*. Otherwise, the UE does not include this IE.

```
-- ASN1START
NR-DL-PRS-ResourcesCapability-r16 ::= SEQUENCE {
   maxNrOfDL-PRS-ResourceSetPerTrpPerFrequencyLayer-r16
                                                INTEGER (1..2),
   maxNrOfTRP-AcrossFregs-r16
                                                ENUMERATED { n4, n6, n12, n16, n32,
                                                             n64, n128, n256, ...},
    maxNrOfPosLayer-r16
                                               INTEGER (1..4),
   dl-PRS-ResourcesCapabilityBandList-r16 SEQUENCE (SIZE (1..nrMaxBands-r16)) OF
                                                   DL-PRS-ResourcesCapabilityPerBand-r16,
    dl-PRS-ResourcesBandCombinationList-r16
                                               DL-PRS-ResourcesBandCombinationList-r16.
DL-PRS-ResourcesCapabilityPerBand-r16 ::= SEQUENCE {
    freqBandIndicatorNR-r16
                                               FreqBandIndicatorNR-r16,
    maxNrOfDL-PRS-ResourcesPerResourceSet-r16
                                               ENUMERATED { n1, n2, n4, n8, n16, n32, n64, ...},
   maxNrOfDL-PRS-ResourcesPerPositioningFrequencylayer-r16
                                                ENUMERATED { n6, n24, n32, n64, n96, n128,
                                                             n256, n512, n1024, ...},
DL-PRS-ResourcesBandCombinationList-r16 ::= SEQUENCE (SIZE (1..maxBandComb-r16)) OF
                                                        DL-PRS-ResourcesBandCombination-r16
DL-PRS-ResourcesBandCombination-r16 ::= SEQUENCE {
   bandList-r16
                                            SEQUENCE (SIZE (1..maxSimultaneousBands-r16)) OF
                                                            FreqBandIndicatorNR-r16,
    maxNrOfDL-PRS-ResourcesAcrossAllFL-TRP-ResourceSet-r16
                                            CHOICE {
       fr1-Only-r16
                                                ENUMERATED {n6, n24, n64, n128, n192,
                                                             n256, n512, n1024, n2048},
        fr2-Only-r16
                                                ENUMERATED {n24, n64, n96, n128, n192
                                                             n256, n512, n1024, n2048},
        fr1-FR2Mix-r16
                                                SEOUENCE {
                                                    ENUMERATED {n6, n24, n64, n96, n128,
            fr1-r16
                                                                 n192, n256, n512, n1024, n2048},
            fr2-r16
                                                    ENUMERATED {n24, n64, n96, n128, n192
                                                                n256, n512, n1024, n2048},
        },
    },
```

-- ASN1STOP

NR-DL-PRS-ResourcesCapability field descriptions

maxNrOfDL-PRS-ResourceSetPerTrpPerFrequencyLayer

Indicates the maximum number of DL-PRS Resource Sets per TRP per frequency layer supported by UE.

maxNrOfTRP-AcrossFreqs

Indicates the maximum number of TRPs across all positioning frequency layers.

maxNrOfPosLayer

Indicates the maximum number of supported positioning layer.

dl-PRS-ResourcesBandCombinationList

Provides the capabilities of DL-PRS Resources for the indicated band combination in *bandList*. This field is provided for all band combinations for which the target device supports DL-PRS.

maxNrOfDL-PRS-ResourcesPerResourceSet

Indicates the maximum number of DL-PRS Resources per DL-PRS Resource Set. Value 16, 32, 64 are only applicable to FR2 bands. Value 1 is not applicable for DL-AoD.

maxNrOfDL-PRS-ResourcesPerPositioningFrequencylayer

Indicates the maximum number of DL-PRS resources per TRP across all frequency layers. Value 6 is only applicable to FR1 bands.

maxNrOfDL-PRS-ResourcesAcrossAllFL-TRP-ResourceSet

Indicates the maximum number of DL-PRS Resources supported by UE across all frequency layers, TRPs and DL-PRS Resource Sets.

fr1-Only: This is applicable for FR1 only band combinations;

fr2-Only: This is applicable for FR2 only band combinations;

fr1-FR2Mix: This is applicable for band combinations containing FR1 and FR2 bands. fr1 means for FR1 in FR1/FR2 mixed operation, and fr2 means for FR2 in FR1/FR2 mixed operation.

NR-DL-PRS-ResourceSetID

The IE NR-DL-PRS-Resource Set1D defines the identity of a DL-PRS Resource Set of a TRP.

```
-- ASN1START

NR-DL-PRS-ResourceSetID-r16 ::= INTEGER (0..nrMaxNumDL-PRS-ResourceSetsPerTRP-1-r16)

-- ASN1STOP
```

NR-PositionCalculationAssistance

The IE NR-PositionCalculationAssistance is used by the location server to provide assistance data to enable UE-based downlink positioning.

NR-PositionCalculationAssistance field descriptions

nr-TRP-LocationInfo

This field provides the location coordinates of the antenna reference points of the TRPs.

nr-DL-PRS-BeamInfo

This field provides the spatial directions of DL-PRS Resources for TRPs.

nr-RTD-Info

This field provides the time synchronization information between the reference TRP and neighbour TRPs.

NR-RTD-Info

The IE *NR-RTD-Info* is used by the location server to provide time synchronization information between a reference TRP and a list of neighbour TRPs.

```
-- ASN1START
NR-RTD-Info-r16 ::= SEQUENCE {
    referenceTRP-RTD-Info-r16
rtd-InfoList-r16
                                             ReferenceTRP-RTD-Info-r16,
                                          Reference III.
RTD-InfoList-r16,
ReferenceTRP-RTD-Info-r16 ::= SEQUENCE {
    dl-PRS-ID-Ref-r16 INTEGER (0..255),
nr-PhysCellID-Ref-r16 NR-PhysCellID-r16 OPTIONAL, -- Need ON
nr-CellGlobalID-Ref-r16 NCGI-r15 OPTIONAL, -- Need ON
nr-ARFCN-Ref-r16 ARFCN-ValueNR-r15 OPTIONAL, -- Need ON
refTime-r16 CHOICE {
                                             CHOICE {
    refTime-r16
              systemFrameNumber-r16 BIT STRING (SIZE (10)), utc-r16 UTCTime,
                                 NR-TimingQuality-r16 OPTIONAL, -- Need ON
    rtd-RefQuality-r16
RTD-InfoList-r16 ::= SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF RTD-InfoListPerFreqLayer-r16
RTD-InfoListPerFreqLayer-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPsPerFreq-r16)) OF RTD-InfoElement-r16
RTD-InfoElement-r16 ::= SEQUENCE {
                                              INTEGER (0..255),
    dl-PRS-ID-r16
    nr-ARFCN-r16 NCGI-r15 OPTIONAL, -- Need ON SubframeOffset-r16 INTEGER (0..1966079), rtd-Quality-r16 NR-TimingOvality
}
-- ASN1STOP
```

NR-RTD-Info field descriptions

referenceTRP-RTD-Info

This field defines the reference TRP for the RTD and comprises the following sub-fields:

- **dl-PRS-ID-Ref**: This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource, and is associated to the reference TRP.
- nr-PhysCellId-Ref: This field specifies the physical cell identity of the reference TRP.
- **nr-CellGloballd-Ref**. This field specifies the NCGI, the globally unique identity of a cell in NR, of the reference TRP
- **nr-ARFCN-Ref**: This field specifies the NR-ARFCN of the TRP.
- **refTime**: This field specifies the reference time at which the *rtd-InfoList* is valid. The *systemFrameNumber* choice refers to the SFN of the reference TRP.
- rtd-RefQuality: This field specifies the quality of the timing of reference TRP, used to determine the RTD values provided in rtd-InfoList.

dI-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP for which the *RTD-InfoElement* is applicable.

nr-PhysCellID

This field specifies the physical cell identity of the associated TRP for which the *RTD-InfoElement* is applicable, as defined in TS 38.331 [35].

nr-CellGlobalID

This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP for which the *RTD-InfoElement* is applicable, as defined in TS 38.331 [35]. The server should include this field if it considers that it is needed to resolve ambiguity in the TRP indicated by *nr-PhysCellID*.

nr-ARFCN

This field specifies the NR-ARFCN of the TRP for which the RTD-InfoElement is applicable.

subframeOffset

This field specifies the subframe boundary offset at the TRP antenna location between the reference TRP and this neighbour TRP in time units $T_{\rm c}=1/(\Delta f_{\rm max}\cdot N_{\rm f})$ where $\Delta f_{\rm max}=480\cdot 10^3$ Hz and $N_{\rm f}=4096$ (TS 38.211 [41]).

The offset is counted from the beginning of a subframe #0 of the reference TRP to the beginning of the closest subsequent subframe of this neighbour TRP.

Scale factor 1 Tc.

rtd-Quality

This field specifies the quality of the RTD.

NR-SelectedDL-PRS-IndexList

The IE NR-SelectedDL-PRS-IndexList is used by the location server to provide the selected Frequency Layer index of nr-DL-PRS-AssistanceDataList to the target device.

In the case of assistance data for multiple NR positioning methods are provided, the IE NR-DL-PRS-ProvideAssistanceData shall be present in only one of NR-Multi-RTT-ProvideAssistanceData, NR-DL-AoD-ProvideAssistanceData, or NR-DL-TDOA-ProvideAssistanceData.

```
-- ASN1START
NR-SelectedDL-PRS-IndexList-r16 ::= SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF
                                        NR-SelectedDL-PRS-PerFreg-r16
NR-SelectedDL-PRS-PerFreq-r16 ::= SEQUENCE {
   nr-SelectedDL-PRS-FrequencyLayerIndex-r16
                                              INTEGER (0..nrMaxFreqLayers-1-r16),
    nr-SelectedDL-PRS-IndexListPerFreq-r16
                                                SEQUENCE (SIZE (1..nrMaxTRPsPerFreq-r16)) OF
                                                        NR-SelectedDL-PRS-IndexPerTRP-r16
                                                                            OPTIONAL,
                                                                                       --Need ON
    . . .
}
NR-SelectedDL-PRS-IndexPerTRP-r16 ::= SEQUENCE {
   nr-SelectedTRP-Index-r16
                                                INTEGER (0..nrMaxTRPsPerFreq-1-r16),
    dl-SelectedPRS-ResourceSetIndexList-r16
                                                SEQUENCE (SIZE (1..nrMaxSetsPerTrp-r16)) OF
                                                       DL-SelectedPRS-ResourceSetIndex-r16
                                                                            OPTIONAL,
                                                                                       --Need ON
}
DL-SelectedPRS-ResourceSetIndex-r16 ::= SEQUENCE {
   nr-DL-SelectedPRS-ResourceSetIndex-r16
                                                INTEGER (0..nrMaxSetsPerTrp-1-r16),
    dl-SelectedPRS-ResourceIndexList-r16
                                                SEQUENCE (SIZE (1..nrMaxResourcesPerSet-r16)) OF
                                                        DL-SelectedPRS-ResourceIndex-r16
```

NR-SelectedDL-PRS-IndexList field descriptions

nr-SelectedDL-PRS-FrequencyLayerIndex

This field indicates the frequency layer provided in IE *NR-DL-PRS-AssistanceData*. Value 0 corresponds to the first frequency layer provided in *nr-DL-PRS-AssistanceDataList* in IE *NR-DL-PRS-AssistanceData*, value 1 to the second frequency layer in *nr-DL-PRS-AssistanceDataList*, and so on.

nr-SelectedDL-PRS-IndexListPerFreq

This field provides the list of addressed TRPs of the selected frequency layer. If this field is absent, all DL-PRS Resources of all TRPs of the indicated frequency layer are addressed.

nr-SelectedTRP-Index

This field indicates the addressed TRP of the selected frequency layer. Value 0 corresponds to the first entry in *nr-DL-PRS-AssistanceDataPerFreq* provided in IE *NR-DL-PRS-AssistanceData*, value 1 corresponds to the second entry in *nr-DL-PRS-AssistanceDataPerFreq*, and so on.

dl-SelectedPRS-ResourceSetIndexList

This field provides the list of addressed DL-PRS Resource Sets of the selected TRPs of the selected frequency layer. If this field is absent, all DL-PRS Resource Sets and Resources of the indicated TRP are addressed.

nr-DL-SelectedPRS-ResourceSetIndex

This field indicates the addressed DL-PRS Resource Set of the selected TRP of the selected frequency layer. Value 0 corresponds to the first entry in *nr-DL-PRS-ResourceSetList* in IE *NR-DL-PRS-Info* provided in IE *NR-DL-PRS-AssistanceData*. Value 1 corresponds to the second entry in the *nr-DL-PRS-ResourceSetList* in IE *NR-DL-PRS-Info*.

dl-SelectedPRS-ResourceIndexList

This field provides the list of addressed DL-PRS Resources of the selected DL-PRS Resource Set of the selected TRP of the selected frequency layer. If this field is absent, all DL-PRS Resources of the indicated DL-PRS Resource Set are addressed.

nr-dl-SelectedPRS-ResourceldIndex

This field indicates the addressed DL-PRS Resource of the selected DL-PRS Resource Set of the TRP of the selected frequency layer. Value 0 corresponds to the first entry in *dl-PRS-ResourceList* in IE *NR-DL-PRS-Info* provided in IE *NR-DL-PRS-AssistanceData*. Value 1 corresponds to the second entry in the *dl-PRS-ResourceList* in IE *NR-DL-PRS-Info*, and so on.

NR-SSB-Config

The IE NR-SSB-Config defines SSB configuration.

```
-- ASN1START
NR-SSB-Config-r16 ::= SEQUENCE {
   nr-PhysCellID-r16
                                        NR-PhysCellID-r16,
    nr-ARFCN-r16
                                        ARFCN-ValueNR-r15,
    ss-PBCH-BlockPower-r16
                                        INTEGER (-60..50),
    halfFrameIndex-r16
                                        INTEGER (0..1),
                                        ENUMERATED { ms5, ms10, ms20, ms40, ms80, ms160, ...},
    ssb-periodicity-r16
                                        CHOICE {
    ssb-PositionsInBurst-r16
        shortBitmap-r16
                                            BIT STRING (SIZE (4)),
        mediumBitmap-r16
                                           BIT STRING (SIZE (8)),
                                           BIT STRING (SIZE (64))
        longBitmap-r16
                                                                                OPTIONAL, --Need OR
    ssb-SubcarrierSpacing-r16
                                        ENUMERATED {kHz15, kHz30, kHz60, kHz120, kHz240, ...},
    sfn-SSB-Offset-r16
                                        INTEGER (0..15),
 - ASN1STOP
```

NR-SSB-Config field descriptions

nr-ARFCN

This field specifies the ARFCN of the first RE of SSB's RB#10.

ss-PBCH-BlockPower

Average EPRE of the resources elements that carry secondary synchronization signals in dBm that the NW used for SSB transmission, see TS 38.213 [13], clause 7.

halfFrameIndex

Indicates the 5 msec offset of the SSB within a 10 msec system frame.

ssb-periodicity

The SSB periodicity in ms for the rate matching purpose.

ssb-PositionsInBurst

Indicates the time domain positions of the transmitted SS-blocks in a half frame with SS/PBCH blocks as defined in TS 38.213 [39], clause 4.1. The first/leftmost bit corresponds to SS/PBCH block index 0, the second bit corresponds to SS/PBCH block index 1, and so on. Value 0 in the bitmap indicates that the corresponding SS/PBCH block is not transmitted while value 1 indicates that the corresponding SS/PBCH block is transmitted.

ssb-SubcarrierSpacing

Subcarrier spacing of SSB. Only the values 15 kHz or 30 kHz (FR1), and 120 kHz or 240 kHz (FR2) are applicable.

sfn-SSB-Offset

Indicates the 10 msec system frame offset of the SSB within the SSB periodicity. Value 0 indicates that the SSB is transmitted in the first system frame; 1 indicates that the SSB is transmitted in the second system frame and so on. This field shall be configured according to the field *ssb-Periodicity* and the indicated system frame shall not exceed the configured SSB periodicity.

- NR-TimeStamp

The IE NR-TimeStamp defines the UE measurement associated time stamp.

```
-- ASN1START
NR-TimeStamp-r16 ::= SEQUENCE {
    dl-PRS-ID-r16
                                 INTEGER (0..255),
   dl-PRS-ID-r16 INTEGER (0..255),
nr-PhysCellID-r16 NR-PhysCellID-r16
                                                              OPTIONAL, -- Need ON
                             NCGI-r15
                                                              OPTIONAL, -- Need ON OPTIONAL, -- Need ON
    nr-CellGlobalID-r16
    nr-ARFCN-r16
                                 ARFCN-ValueNR-r15
   nr-SFN-r16
                                INTEGER (0..1023),
   nr-Slot-r16
                                CHOICE {
            scs15-r16
                                 INTEGER (0..9),
            scs30-r16
                                    INTEGER (0..19),
            scs60-r16
                                     INTEGER (0..39),
            scs120-r16
                                    INTEGER (0..79)
    },
}
-- ASN1STOP
```

NR-TimeStamp field descriptions

dI-PRS-ID

This field specifies the DL-PRS ID of the TRP for which the nr-SFN is applicable.

nr-ARFCN

This field specifies the ARFCN of the TRP associated with the *dl-PRS-ID*.

nr-SFN

This field specifies the NR system frame number for the time stamp.

nr-Slot

This field specifies the NR slot number within the NR system frame number indicated by nr-SFN for the time stamp.

NR-TimingQuality

The IE NR-Timing Quality defines the quality of a timing value (e.g., of a TOA measurement).

```
}
-- ASN1STOP
```

NR-TimingQuality field descriptions

timingQualityValue

This field provides an estimate of uncertainty of the timing value for which the IE NR-TimingQuality is provided in units of metres.

timingQualityResolution

This field provides the resolution used in the *timingQualityValue* field. Enumerated values *mdot1*, *m1*, *m10*, *m30* correspond to 0.1, 1, 10, 30 metres, respectively.

NR-TRP-LocationInfo

The IE *NR-TRP-LocationInfo* is used by the location server to provide the coordinates of the antenna reference points for a set of TRPs. For each TRP, the ARP location can be provided for each associated PRS Resource ID per PRS Resource Set.

```
-- ASN1START
NR-TRP-LocationInfo-r16 ::= SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF
                                           NR-TRP-LocationInfoPerFreqLayer-r16
NR-TRP-LocationInfoPerFreqLayer-r16 ::= SEQUENCE {
    referencePoint-r16 ReferencePoint-r16 OPTIONAL, trp-LocationInfoList-r16 SEQUENCE (SIZE (1..nrMaxTRPsPerFreq-r16)) OF
    referencePoint-r16
                                                                                           -- Cond NotSameAsPrev
                                                TRP-LocationInfoElement-r16,
TRP-LocationInfoElement-r16 ::= SEQUENCE {
    dl-PRS-ID-r16 INTEGER (0..255),
nr-PhysCellID-r16 NR-PhysCellID-r16
nr-CellGlobalID-r16 NCGI-r15
nr-ARFCN-r16
                                                                             OPTIONAL,
                                                                                             -- Need ON
                                                                             OPTIONAL, -- Need ON OPTIONAL, -- Need ON
    nr-CellGlobalID-r16
nr-ARFCN-r16
associated-DL-PRS-ID-r16
trp-Location-r16
nr-CellGlobalID-r16
ARFCN-ValueNR-r15
INTEGER (0..255)
RelativeLocation-r16
    nr-ARFCN-r16
                                                                             OPTIONAL,
                                                                                            OPTIONAL, -- Need OP
    trp-DL-PRS-ResourceSets-r16 SEQUENCE (SIZE(1..nrMaxSetsPerTrp-r16)) OF
                                                DL-PRS-ResourceSets-TRP-Element-r16 OPTIONAL,
                                                                                                            -- Need OP
DL-PRS-ResourceSets-TRP-Element-r16 ::= SEQUENCE {
    dl-PRS-ResourceSetARP-r16 RelativeLocation-r16 dl-PRS-Resource-ARP-List-r16 SEQUENCE (SIZE(1..nrM
                                                                                             OPTIONAL,
                                                                                                            -- Need OP
                                                SEQUENCE (SIZE(1..nrMaxResourcesPerSet-r16)) OF
                                                     DL-PRS-Resource-ARP-Element-r16 OPTIONAL,
                                                                                                           -- Need OP
}
DL-PRS-Resource-ARP-Element-r16 ::= SEQUENCE {
    dl-PRS-Resource-ARP-location-r16
                                              RelativeLocation-r16
                                                                                           OPTIONAL,
                                                                                                           -- Need OP
-- ASN1STOP
```

Conditional presence	Explanation
NotSameAsPrev	The field is mandatory present in the first entry of the NR-TRP-LocationInfoPerFreqLayer
	list; otherwise it is optionally present, need OP.

NR-TRP-LocationInfo field descriptions

referencePoint

This field specifies the reference point used to define the TRP location in the *trp-LocationInfoList*. If this field is absent, the reference point is the same as in the previous entry of the *NR-TRP-LocationInfoPerFreqLayer* list.

trp-LocationInfoList

This field provides the antenna reference point locations of the DL-PRS Resources for the TRPs and comprises the following sub-fields:

- **dI-PRS-ID**: This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource, and is associated to a single TRP.
- nr-PhysCellID: This field specifies the physical cell identity of the associated TRP.
- **nr-CellGlobalID**: This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP
- nr-ARFCN: This field specifies the NR-ARFCN of the TRP.
- **associated-DL-PRS-ID**: This field, if present, specifies the *dl-PRS-ID* of the associated TRP from which the *trp-location* information is adopted.
- trp-Location: This field provides the location of the TRP relative to the referencePoint location. If this field is
 absent the TRP location coincides with the referencePoint location, unless the field associated-dl-PRS-ID is
 present, in which case the trp-Location is adopted from the associated TRP indicated by associated-dl-PRS-ID.
- trp-DL-PRS-ResourceSets: This field provides the antenna reference point location(s) of the DL-PRS Resource Set(s) associated with this TRP. If this field is absent, the antenna reference point location(s) of the DL-PRS Resource Set(s) coincides with the trp-Location location. This field comprises the following sub-fields:
 - dI-PRS-ResourceSetARP: This field provides the antenna reference point location of the DL-PRS
 Resource Set relative to the trp-Location location. If this field is absent, the antenna reference point location
 of this DL-PRS Resource Set coincides with the trp-Location location.
 - **dl-PRS-Resource-ARP-List**: This field provides the antenna reference point location(s) of the DL-PRS Resource(s) associated with this Resource Set of the TRP. If this field is absent, the antenna reference point location(s) of the DL-PRS Resources coincides with the **dl-PRS-ResourceSetARP** location. This field comprises the following sub-fields:
 - dI-PRS-Resource-ARP-location: This field provides the antenna reference point location of the DL-PRS Resource associated with the DL-PRS Resource Set of the TRP relative to the dI-PRS-ResourceSetARP location. If this field is absent, the antenna reference point location of this DL-PRS Resource coincides with the dI-PRS-ResourceSetARP location.

NR-UL-SRS-Capability

The IE NR-UL-SRS-Capability defines the UE uplink SRS capability.

```
-- ASN1START
NR-UL-SRS-Capability-r16 ::= SEQUENCE {
    srs-CapabilityBandList-r16
                                                  SEQUENCE (SIZE (1..nrMaxBands-r16)) OF
                                                      SRS-CapabilityPerBand-r16,
    srs-PosResourceConfigCA-BandList-r16
                                                  SEQUENCE (SIZE (1..nrMaxConfiguredBands-r16)) OF
                                                      SRS-PosResourcesPerBand-r16
                                                                                            OPTIONAL,
    maxNumberSRS-PosPathLossEstimateAllServingCells-r16
                                                  ENUMERATED {n1, n4, n8, n16}
                                                                                            OPTIONAL,
    \verb|maxNumberSRS-PosSpatialRelationsAllServingCells-r16|\\
                                                  ENUMERATED {n0, n1, n2, n4, n8, n16}
                                                                                            OPTIONAL,
}
SRS-CapabilityPerBand-r16 ::= SEQUENCE {
    freqBandIndicatorNR-r16 FreqBandIndicatorNR-r16,
    olpc-SRS-Pos-r16
                                     OLPC-SRS-Pos-r16
                                                                                            OPTIONAL,
    spatialRelationsSRS-Pos-r16 SpatialRelationsSRS-Pos-r16
                                                                                            OPTIONAL.
OLPC-SRS-Pos-r16 ::= SEQUENCE {
    olpc-SRS-PosBasedOnPRS-Serving-r16
                                             ENUMERATED {supported}
                                                                                            OPTIONAL.
    olpc-SRS-PosBasedOnSSB-Neigh-r16 ENUMERATED {supported} olpc-SRS-PosBasedOnPRS-Neigh-r16 ENUMERATED {supported}
                                                                                            OPTIONAL,
    olpc-SRS-PosBasedOnPRS-Neigh-r16
                                              ENUMERATED {supported}
                                                                                            OPTIONAL,
    maxNumberPathLossEstimatePerServing-r16 ENUMERATED {n1, n4, n8, n16}
                                                                                            OPTIONAL,
SpatialRelationsSRS-Pos-r16 ::= SEQUENCE {
    spatialRelation-SRS-PosBasedOnSSB-Serving-r16
                                                          ENUMERATED {supported}
                                                                                            OPTIONAL,
    spatialRelation-SRS-PosBasedOnCSI-RS-Serving-r16
                                                          ENUMERATED {supported}
                                                                                            OPTIONAL,
    spatialRelation-SRS-PosBasedOnPRS-Serving-r16
                                                          ENUMERATED
                                                                       supported}
                                                                                            OPTIONAL,
    spatialRelation-SRS-PosBasedOnSRS-r16
                                                          ENUMERATED {supported}
                                                                                            OPTIONAL,
```

```
ENUMERATED {supported}
ENUMERATED {supported}
    spatialRelation-SRS-PosBasedOnSSB-Neigh-r16
                                                                                               OPTIONAL,
    spatialRelation-SRS-PosBasedOnPRS-Neigh-r16
                                                                                               OPTIONAL,
}
SRS-PosResourcesPerBand-r16 ::= SEQUENCE {
                                                        FreqBandIndicatorNR-r16,
    freqBandIndicatorNR-r16
    maxNumberSRS-PosResourceSetsPerBWP-r16
                                                        ENUMERATED {n1, n2, n4, n8, n12, n16},
                                                        ENUMERATED {n1, n2, n4, n8, n16, n32, n64},
    maxNumberSRS-PosResourcesPerBWP-r16
                                                        ENUMERATED {n1, n2, n4, n8, n16, n32, n64}, ENUMERATED {n1, n2, n4, n8, n16, n32, n64}
    maxNumberPeriodicSRS-PosResourcesPerBWP-r16
   maxNumberAP-SRS-PosResourcesPerBWP-r16
                                                                                               OPTIONAL,
   maxNumberSP-SRS-PosResourcesPerBWP-r16
                                                        ENUMERATED {n1, n2, n4, n8, n16, n32, n64}
                                                                                               OPTIONAL,
}
-- ASN1STOP
```

NR-UL-SRS-Capability field descriptions

maxNumberSRS-PosPathLossEstimateAllServingCells

Indicates the maximum number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource sets for positioning across all cells in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions. The UE shall include this field if the UE supports any of olpc-SRS-PosBasedOnPRS-Serving, olpc-SRS-PosBasedOnSSB-Neigh and olpc-SRS-PosBasedOnPRS-Neigh. Otherwise, the UE does not include this field.

maxNumberSRS-PosSpatialRelationsAllServingCells

indicates the maximum number of maintained spatial relations for all the SRS resource sets for positioning across all serving cells in addition to the spatial relations maintained spatial relations per serving cell for the PUSCH/PUCCH/SRS transmissions. It is only applied for FR2. The UE can include this field only if the UE supports any of spatialRelation-SRS-PosBasedOnSSB-Serving, spatialRelation-SRS-PosBasedOnCSI-RS-Serving, spatialRelation-SRS-PosBasedOnSSB-Neigh or spatialRelation-SRS-PosBasedOnPRS-Neigh. Otherwise, the UE does not include this field.

olpc-SRS-Pos

Indicates whether the UE supports open-loop power control for SRS for positioning. The capability signalling comprises the following parameters.

- olpc-SRS-PosBasedOnPRS-Serving indicates whether the UE supports OLPC for SRS for positioning based on PRS from the serving cell in the same band. The UE can include this field only if the UE supports NR-DL-PRS-ProcessingCapability and srs-PosResources TS38.331 [35] Otherwise, the UE does not include this field.
- olpc-SRS-PosBasedOnSSB-Neigh indicates whether the UE supports OLPC for SRS for positioning based on SSB from the neighbouring cell in the same band. The UE can include this field only if the UE supports srs-PosResources TS 38.331 [35]. Otherwise, the UE does not include this field.
- olpc-SRS-PosBasedOnPRS-Neigh indicates whether the UE supports OLPC for SRS for positioning based on PRS from the neighbouring cell in the same band. The UE can include this field only if the UE supports olpc-SRS-PosBasedOnPRS-Serving. Otherwise, the UE does not include this field.
- maxNumberPathLossEstimatePerServing indicates the maximum number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource sets for positioning per serving cell in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions. The UE shall include this field if the UE supports any of olpc-SRS-PosBasedOnPRS-Serving, olpc-SRS-PosBasedOnPRS-Neigh and olpc-SRS-PosBasedOnPRS-Neigh. Otherwise, the UE does not include this field.

spatialRelationsSRS-Pos

Indicates whether the UE supports spatial relations for SRS for positioning. It is only applicable for FR2. The capability signalling comprises the following parameters.

- **spatialRelation-SRS-PosBasedOnSSB-Serving** indicates whether the UE supports spatial relation for SRS for positioning based on SSB from the serving cell in the same band. The UE can include this field only if the UE supports *srs-PosResources* TS 38.331 [35]. Otherwise, the UE does not include this field.
- spatialRelation-SRS-PosBasedOnCSI-RS-Serving indicates whether the UE supports spatial relation for SRS for positioning based on CSI-RS from the serving cell in the same band. The UE can include this field only if the UE supports spatialRelation-SRS-PosBasedOnSSB-Serving. Otherwise, the UE does not include this field.
- spatialRelation-SRS-PosBasedOnPRS-Serving indicates whether the UE supports spatial relation for SRS for positioning based on PRS from the serving cell in the same band. The UE can include this field only if the UE supports any of DL-PRS Resources for DL-AoD, DL-PRS Resources for DL-TDOA or DL-PRS Resources for Multi-RTT, or srs-PosResources TS 38.331 [35]. Otherwise, the UE does not include this field.
- **spatialRelation-SRS-PosBasedOnSRS** indicates whether the UE supports spatial relation for SRS for positioning based on SRS in the same band. The UE can include this field only if the UE supports *srs-PosResources* TS 38.331 [35]. Otherwise, the UE does not include this field.
- spatialRelation-SRS-PosBasedOnSSB-Neigh indicates whether the UE supports spatial relation for SRS for
 positioning based on SSB from the neighbouring cell in the same band. The UE can include this field only if the
 UE supports spatialRelation-SRS-PosBasedOnSSB-Serving. Otherwise, the UE does not include this field.
- **spatialRelation-SRS-PosBasedOnPRS-Neigh** indicates whether the UE supports spatial relation for SRS for positioning based on PRS from the neighbouring cell in the same band. The UE can include this field only if the UE supports **spatialRelation-SRS-PosBasedOnPRS-Serving**. Otherwise, the UE does not include this field.

NR-UL-SRS-Capability field descriptions

srs-PosResourceConfigCA-BandList

This field indicates the number of SRS for positioning resources supported by the target device. The target device includes this field for each band for the current configured CA band combination. The capability signalling comprises the following parameters.

- freqBandIndicatorNR indicates the current configured NR band of the target device.
- **maxNumberSRS-PosResourceSetsPerBWP** indicates the maximum number of SRS Resource Sets for positioning supported by the target device per BWP. Enumerated values *n*1, *n*2, *n*4, *n*8, *n*12, *n*16 correspond to 1, 2, 4, 8, 12, 16 SRS Resource Sets for positioning, respectively.
- **maxNumberSRS-PosResourcesPerBWP** indicates the maximum number of periodic, semi-persistent, and aperiodic SRS Resources for positioning supported by the target device per BWP. Enumerated values *n1*, *n2*, *n4*, *n8*, *n16*, *n32*, *n64* correspond to 1, 2, 4, 8, 16, 32, 64 SRS Resources for positioning, respectively.
- **maxNumberPeriodicSRS-PosResourcesPerBWP** indicates the maximum number of periodic SRS Resources for positioning supported by the target device per BWP. Enumerated values *n1*, *n2*, *n4*, *n8*, *n16*, *n32*, *n64* correspond to 1, 2, 4, 8, 16, 32, 64 periodic SRS Resources for positioning, respectively.
- **maxNumberAP-SRS-PosResourcesPerBWP** indicates the maximum number of aperiodic SRS Resources for positioning supported by the target device per BWP. Enumerated values *n1*, *n2*, *n4*, *n8*, *n16*, *n32*, *n64* correspond to 1, 2, 4, 8, 16, 32, 64 aperiodic SRS Resources for positioning, respectively.
- **maxNumberSP-SRS-PosResourcesPerBWP** indicates the maximum number of semi-persistent SRS Resources for positioning supported by the target device per BWP. Enumerated values *n1*, *n2*, *n4*, *n8*, *n16*, *n32*, *n64* correspond to 1, 2, 4, 8, 16, 32, 64 semi-persistent SRS Resources for positioning, respectively.

ReferencePoint

The IE ReferencePoint provides a well-defined location relative to which other locations may be defined.

ReferencePoint field descriptions

reference Point Geographic Location

This field provides the geodetic location of the reference point.

RelativeLocation

The IE RelativeLocation provides a location relative to some known reference location.

```
-- ASN1START
RelativeLocation-r16 ::= SEQUENCE {
    milli-arc-second-units-r16 ENUMERATED { mas0-03, mas0-3, mas3, mas30, ...},
    height-units-r16 ENUMERATED {mm, cm, m, ...}, delta-latitude-r16 Delta-Latitude-r16.
    delta-latitude-r16
                                Delta-Latitude-r16,
                                Delta-Longitude-r16,
    delta-longitude-r16
delta-height-r16
                                Delta-Height-r16,
    locationUNC-r16
                                LocationUncertainty-r16
                                                                      OPTIONAL,
                                                                                        -- Need OP
Delta-Latitude-r16 ::= SEQUENCE {
    delta-Latitude-r16
                                             INTEGER (-1024..1023),
    coarse-delta-Latitude-r16
                                             INTEGER (0..4095)
                                                                      OPTIONAL.
                                                                                        -- Need OP
Delta-Longitude-r16 ::= SEQUENCE {
                                             INTEGER (-1024..1023),
    delta-Longitude-r16
                                             INTEGER (0..4095)
                                                                      OPTIONAL,
   coarse-delta-Longitude-r16
                                                                                        -- Need OP
```

```
Delta-Height-r16 ::= SEQUENCE {
   delta-Height-r16
                                          INTEGER (-1024..1023),
   coarse-delta-Height-r16
                                          INTEGER (0..4095)
                                                                  OPTIONAL,
                                                                                  -- Need OP
LocationUncertainty-r16 ::= SEQUENCE {
   horizontalUncertainty-r16
                                          INTEGER (0..255),
   horizontalConfidence-r16
                                          INTEGER (0..100),
   verticalUncertainty-r16
                                          INTEGER (0..255),
   verticalConfidence-r16
                                          INTEGER (0..100)
-- ASN1STOP
```

RelativeLocation field descriptions

milli-arc-second-units

This field provides the units and scale factor for the *delta-latitude* and *delta-longitude* fields. Enumerated values *mas0-03*, *mas0-3*, *mas3*, and *mas30*, correspond to 0.03, 0.3, 3, and 30 milliarcseconds, respectively.

height-units

This field provides the units and scale factor for the *delta-height* field. Enumerated values mm, cm, and m correspond to 10^{-3} metre, 10^{-2} metre, and 1 metres, respectively.

delta-latitude

This field specifies the delta value in latitude of the desired location, defined as "desired location" minus "reference point location" and comprises the following sub-fields:

- delta-Latitude specifies the delta value in latitude in the unit provided in milli-arc-second-units field.
- coarse-delta-Latitude specifies the delta value in latitude in 1024 times the size of the unit provided in milliarc-second-units field and with the same sign as in the delta-Latitude field. If this field is absent, the value for coarse-delta-Latitude is zero.
- I.e., the full delta-latitude is given by:

(delta-Latitude x milli-arc-second-units) ± (coarse-delta-Latitude x 1024 x milli-arc-second-units) [milli-arc-seconds]

delta-longitude

This field specifies the delta value in longitude of the desired location, defined as "desired location" minus "reference point location" and comprises the following sub-fields:

- delta-Longitude specifies the delta value in longitude in the unit provided in milli-arc-second-units field.
- **coarse-delta-Longitude** specifies the delta value in longitude in 1024 times the size of the unit provided in *milli-arc-second-units* field and with the same sign as in the *delta-Longitude* field. If this field is absent, the value for *coarse-delta-Longitude* is zero.

I.e., the full *delta-longitude* is given by:

(delta-Longitude × milli-arc-second-units) ± (coarse-delta-Latitude × 1024 × milli-arc-second-units) [milli-arc-seconds]

delta-height

This field specifies the delta value in ellipsoidal height of the desired location, defined as "desired location" minus "reference point location" and comprises the following sub-fields:

- delta-Height specifies the delta value in ellipsoidal height in the unit provided in height-units field.
- coarse-delta-Height specifies the delta value in ellipsoidal height in 1024 times the size of the unit provided in height-units field and with the same sign as in the delta-Height field. If this field is absent, the value for coarsedelta-Height is zero.
- I.e., the full delta-height is given by:

 $(delta-Height \times height-units) \pm (coarse-delta-Height \times 1024 \times height-units)$ [metres]

locationUNC

This field specifies the uncertainty of the location coordinates and comprises the following sub-fields:

- **horizontalUncertainty** indicates the horizontal uncertainty of the ARP latitude/longitude. The 'horizontalUncertainty' corresponds to the encoded high accuracy uncertainty as defined in TS 23.032 [15] and 'horizontalConfidence' corresponds to confidence as defined in 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 TS 23.032 [15] and 'verticalConfidence' corresponds to confidence as defined in TS 23.032 [15].

If this field is absent, the uncertainty is the same as for the associated reference point location.

6.5 Positioning Method IEs

6.5.1 OTDOA Positioning

This clause 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 {
                                                                        OPTIONAL,
   otdoa-ReferenceCellInfo
                                    OTDOA-ReferenceCellInfo
                                                                                     -- Need ON
   otdoa-NeighbourCellInfo
                                    OTDOA-NeighbourCellInfoList
                                                                        OPTIONAL,
                                                                                     -- Need ON
   otdoa-Error
                                    OTDOA-Error
                                                                        OPTIONAL,
                                                                                     -- Need ON
   ГΓ
    otdoa-ReferenceCellInfoNB-r14 OTDOA-ReferenceCellInfoNB-r14
                                                                        OPTIONAL,
                                                                                     -- Need ON
                                                                                     -- Need ON
    otdoa-NeighbourCellInfoNB-r14 OTDOA-NeighbourCellInfoListNB-r14
-- 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),
                                                           OPTIONAL,
    cellGlobalId
                                                                          -- Need ON
                               ECGI
                                                           OPTIONAL,
   earfcnRef ARFCN-ValueEUTRA OPTIONAL,
antennaPortConfig ENUMERATED {ports1-or-2, ports4, ... }
                                                                           -- Cond NotSameAsServ0
                                                           OPTIONAL,
                                                                            -- Cond NotSameAsServ1
    cpLength
                               ENUMERATED { normal, extended, ... },
                                                           OPTIONAL,
                                                                            -- Cond PRS
   prsInfo
                               PRS-Info
    [[ 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
                              ENUMERATED {n6, n15, n25, n50, n75, n100}
       dlBandwidth-r14
                                                           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 OPTIONAL,
INTEGER (0..19) OPTIONAL
        tdd-config-v1520
                                                                                -- Need ON
       nr-LTE-fineTiming-Offset-r15
                                                                               -- 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 <i>prsInfo</i> 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].

cellGloballo

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.

OTDOA-ReferenceCellInfo field descriptions

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.

tpld

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 the 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 LTE 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 0 ms, value 1 corresponds to 0.5 ms, 2 to 1 ms 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)),
                                      BIT STRING (SIZE(4)),
         po8-r9
                                      BIT STRING (SIZE(8)),
                                     BIT STRING (SIZE(16)),
         po16-r9
                        BIT STRING (SIZE(32)),
BIT STRING (SIZE(64)),
BIT STRING (SIZE(128)),
BIT STRING (SIZE(256)),
BIT STRING (SIZE(512)),
BIT STRING (SIZE(1024))
         po32-v1420
         po64-v1420
         po64-v112
po128-v1420
po256-v1420
         po1024-v1420
                                     BIT STRING (SIZE(1024))
                                                                        OPTIONAL,
                                                                                                      -- Need OP
         add-numDL-Frames-r14 INTEGER (0..4095)
prsOccGroupI.en-r14
                                                                        OPTIONAL,
     [[ prsID-r14
                                                                                                     -- Need ON
                                                                        OPTIONAL,
                                                                                                     -- Cond sf-add
                                    ENUMERATED {g2, g4, g8, g16, g32, g64, g128,...}
                                                                                                      -- Cond Occ-Grp
         prsHoppingInfo-r14 CHOICE {
```

Conditional presence	Explanation
sf-add	The field is mandatory present if the <i>numDL-Frames</i> field has the value ' <i>sf-add</i> '; 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 $n_{\rm NB}$ 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.

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),
                                                           OPTIONAL, -- Need UN
-- Cond NotSameAsRef0
    cellGlobalId
                                        ECGI
                                        ARFCN-ValueEUTRA OPTIONAL,
    earfcn
                                       ENUMERATED {normal, extended, ...}
    cpLength
                                                  OPTIONAL, -- Cond NotSameAsRef1
OPTIONAL, -- Cond NotSameAsRef2
   prsInfo
                                       PRS-Info
                                       ENUMERATED {ports-1-or-2, ports-4, ...}
   antennaPortConfig
                                                          OPTIONAL, -- Cond NotsameAsRef3
OPTIONAL, -- Cond NotSameAsRef4
   slotNumberOffset
                                       INTEGER (0..19)
    prs-SubframeOffset
                                        INTEGER (0..1279)
                                                          OPTIONAL,
                                                                          -- Cond InterFreq
                                        INTEGER (0..16383),
    expectedRSTD
    expectedRSTD-Uncertainty
                                       INTEGER (0..1023),
    [[ earfcn-v9a0
                                  ARFCN-ValueEUTRA-v9a0 OPTIONAL
                                                                            -- Cond NotSameAsRef5
    1],
       tpId-r14
                                                        OPTIONAL,
                                   INTEGER (0..4095)
                                                                            -- Need ON
       prs-only-tp-r14
                                    ENUMERATED { true }
                                                                            -- Cond TBS
       cpLengthCRS-r14
                                    ENUMERATED { normal, extended, ... }
                                                           OPTIONAL,
                                                                        -- Cond CRS
```

```
sameMBSFNconfigNeighbour-r14 BOOLEAN
                                                          OPTIONAL,
       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 <i>earfcn-v9a0</i> 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 <i>earfcn</i> is present. If <i>earfcn</i> 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 <i>OTDOA-NeighbourCellInfoElement</i> is provided for a PRS-only TP; otherwise it is not present.
CRS	The field is optionally present, need ON, if <i>prsInfo</i> 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].

cellGloballd

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.

OTDOA-NeighbourCellInfoList field descriptions

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.

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 $3^{\circ}T_s$, 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×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 $[-expectedRSTD-Uncertainty\times3\times T_s]$ centred at

 T_{REF} + 1 millisecond×N + (expectedRSTD–8192) ×3×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×3×T_s, expectedRSTD-Uncertainty×3×T_s] centred at T_x + (expectedRSTD-8192) ×3×T_s,

OTDOA-NeighbourCellInfoList field descriptions

tpla

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 the 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.

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
                                                                      OPTIONAL, -- Cond NoPRS-ADZ
OPTIONAL, -- Cond NotSameAsServ1
    cellGlobalIdNB-r14
                                       CarrierFreq-NB-r14 OPTIONAL,
ARFCN-ValueEUTRA-r14 OPTIONAL,
    carrierFreqRef-r14
    earfcn-r14
                                                                                      -- 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, nprsInfo-r14 PRS-Info-NB-r14 OPTIONAL,
                                                                                      -- Cond NotSameAsServ2
                                                                                      -- 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.

cellGloballdNF

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.

carrierFregRet

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.

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 {
         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 NDRG -- Cond ND
                    tA-r14 SEQUENCE nprsBitmap-r14 CHOICE \{
                              subframePattern10-r14 BIT STRING (SIZE (10)), subframePattern40-r14 BIT STRING (SIZE (40))
                     nprs-MutingInfoA-r14 CHOICE {
                                                         BIT STRING (SIZE(2)),
BIT STRING (SIZE(4))
                              po2-r14
                               po4-r14
                               po8-r14
                                                                                              BIT STRING (SIZE(8)).
                              po16-r14
                                                                                            BIT STRING (SIZE(16)),
                                . . .
                     }
                                                                                                                                                                                  OPTIONAL,
                                                                                                                                                                                                                            -- Cond MutingA
                                                                                                                                                                                   OPTIONAL,
          partB-r14
                                                                                  SEQUENCE {
                                                                                ENUMERATED { ms160, ms320, ms640, ms1280, ..., ms2560-v1510}, ENUMERATED { zero, one-eighth, two-eighths, three-eighths,
                    nprs-Period-r14
nprs-startSF-r14
                                                                                                                  four-eighths, five-eighths, six-eighths,
                                                                                                                   seven-eighths, ...},
                                                                           ENUMERATED { sf10, sf20, sf40, sf80, sf160, sf320,
                    nprs-NumSF-r14
                                                                                                                   sf640, sf1280, ..., sf2560-v1510},
                     nprs-MutingInfoB-r14 CHOICE {
                                                                                  BIT STRING (SIZE(2)),
                             po2-r14
                               po4-r14
                                                                                             BIT STRING (SIZE(4)),
                                                                                           BIT STRING (SIZE(8)),
                               po8-r14
                               po16-r14
                                                                                            BIT STRING (SIZE(16)),
                     }
                                                                                                                                                                                  OPTIONAL.
                                                                                                                                                                                                                            -- Cond MutingB
                    sib1-SF-TDD-r15
                                                                               ENUMERATED {sf0, sf4, sf0and5}
           ГΓ
                                                                                                                                                                                  OPTIONAL
                                                                                                                                                                                                                            -- Cond SIB1-TDD
          ]]
          }
                                                                                                                                                                                   OPTIONAL,
                                                                                                                                                                                                                             -- Cond PartB
          ...,
          partA-TDD-r15
                    tA-TDD-r15 SEQUE
nprsBitmap-r15 CHOICE {
                                                                                             SEQUENCE {
                               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)),
```

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 10 ms or 40 ms. 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 *TNPRS* (TS 36.211 [16]). Enumerated values correspond to 160 ms, 320 ms, 640 ms, 1280 ms, and 2560 ms. 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, 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-MutinaInfoB

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 10 ms or 40 ms. 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	nprsSequenceInfo	E-UTRA PRB index
	$n'_{ m PRB}$ for odd number		$n'_{ m PRB}$ for even number
	of $N_{ m RB}^{ m DL}$ [16]		of $N_{ m RB}^{ m DL}$ [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_{NB-IoT}) can be calculated as follows:

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

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

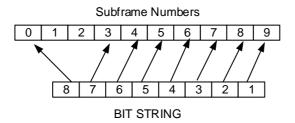


Figure 6.5.1.2-1: NPRS bitmap to subframe number mapping

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
                                                               OPTIONAL,
                                                                                -- Cond NoPRS-AD2
                                     ECGI
                                     ARFCN-ValueEUTRA-r14 OPTIONAL,
ENUMERATER (
                                                                              -- Cond NotSameAsRef1
    carrierFreq-r14
                                     CarrierFreq-NB-r14
    earfcn-r14
                                                                                -- Cond Inband
                                     ENUMERATED {ports-1-or-2, ports-4, ...}
    eutra-NumCRS-Ports-r14
                                                               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)
nprs-SFN-Offset-r14 INTEGER (0..63)
nprs-SubframeOffset-r14 INTEGER (0..1279)
                                                               OPTIONAL,
                                                                                -- Cond NotsameAsRef5
                                                              OPTIONAL,
                                                                                -- Cond NotsameAsRef6
                                                                                -- Need OP
                                                               OPTIONAL,
    expectedRSTD-r14 expectedRSTD-Uncertainty-r14 INTEGER (0..1023
    expectedRSTD-r14
                                    INTEGER (0..16383)
                                                             OPTIONAL,
                                                                                -- Cond NoPRS-AD3
                                     INTEGER (0..1023)
                                                               OPTIONAL,
                                                                                -- Cond NoPRS-AD3
                                                                                -- Cond PRS-AD
                                                               OPTIONAL,
    nprsInfo-Type2-v1470
                                    PRS-Info-NB-r14
                                                                                -- Cond NotSameAsRef4
                                                              OPTIONAL
    11,
                                     TDD-Config-v1520
                                                                                -- Need ON
        tdd-config-r15
                                                               OPTIONAL
                INTEGER ::= 72
maxCells-r14
-- 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.
N 10 1 5 11	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-loT
N (0 A D (0	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
N DD0 4D0	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-Provide Assistance Data and proAleighbour CellInfoList IE is included in
DDC AD	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.

cellGloballdNB

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×3×T_s, expectedRSTD-Uncertainty×3×T_s] centred at

 T_{REF} + 1 millisecond×N + (expectedRSTD-8192) ×3×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.

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
```

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 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),
   physCellIdRef INTEGER (0..503),
cellGlobalIdRef ECGI
earfcnRef ARFCN-ValueEUTRA
referenceQuality OTDOA-MeasQuality
                                                    OPTIONAL,
                                                    OPTIONAL,
                                                                      -- Cond NotSameAsRef0
                                                    OPTIONAL.
    neighbourMeasurementList NeighbourMeasurementList,
    [[ earfcnRef-v9a0
                           ARFCN-ValueEUTRA-v9a0 OPTIONAL
                                                                      -- Cond NotSameAsRef1
       tpIdRef-r14 INTEGER (0..4095)
prsIdRef-r14 INTEGER (0..4095)
    [[ tpIdRef-r14
                                                    OPTIONAL,
                                                                      -- Cond ProvidedByServer0
                                                                      -- Cond ProvidedByServer1
                                                    OPTIONAL,
        additionalPathsRef-r14
                           AdditionalPathList-r14 OPTIONAL,
        AdditionalPathList 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
                                                                  OPTIONAL
        motionTimeSource-r15
    ]]
NeighbourMeasurementList ::= SEQUENCE (SIZE(1..24)) OF NeighbourMeasurementElement
NeighbourMeasurementElement ::= SEQUENCE {
    cellGlobalIdNeighbour
                                                     OPTIONAL,
    earfcnNeighbour ARFCN-ValueEUTRA
                                                     OPTIONAL,
                                                                      -- Cond NotSameAsRef2
                            INTEGER (0..12711),
    rstd
    rstd-Quality
                            OTDOA-MeasQuality,
    [[ earfcnNeighbour-v9a0 ARFCN-ValueEUTRA-v9a0
                                                    OPTIONAL
                                                                      -- Cond NotSameAsRef3
    [[ tpIdNeighbour-r14
                            INTEGER (0..4095)
                                                                      -- Cond ProvidedByServer0
                                                     OPTIONAL,
        prsIdNeighbour-r14 INTEGER (0..4095)
delta-rstd-r14 INTEGER (0..5)
                                                     OPTIONAL,
                                                                      -- Cond ProvidedByServer1
                                                    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 <i>earfcnRef-v9a0</i> 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 <i>earfcnRef</i> 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 <i>earfcnNeighbour-v9a0</i> is present. Otherwise, the target device shall include this field if the EARFCN of this neighbour cell is not the same as the <i>earfcnRef</i> for the RSTD reference cell.
NotSameAsRef3	The field is absent if the corresponding <i>earfcnNeighbour</i> is present. Otherwise, the target device shall include this field if the EARFCN of this neighbour cell is not the same as the <i>earfcnRef</i> for the RSTD reference cell.
ProvidedByServer0	The target device shall include this field if a <i>tpld</i> for this transmission point is included in the <i>OTDOA-ProvideAssistanceData</i> . Otherwise the field is absent.
ProvidedByServer1	The target device shall include this field if a <i>prsID</i> for this transmission point is included in the <i>OTDOA-ProvideAssistanceData</i> . Otherwise the field is absent.
ProvidedByServer2	The target device shall include this field if an <i>nprsID</i> for this cell is included in the <i>OTDOA-ProvideAssistanceData</i> and if this cell is a NB-loT 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-loT 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 the 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.

cellGloballdRef

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.

earfcnRet

This field specifies the EARFCN of the RSTD reference cell.

OTDOA-SignalMeasurementInformation field descriptions

referenceQuality

This field specifies the target device's best estimate of the quality of the TOA measurement from the RSTD reference cell, TsubframeRxRef, where TsubframeRxRef 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).

neighbourMeasurementList

This list contains the measured RSTD values for neighbour cells together with the RSTD reference cell, along with quality for each measurement.

tpldRef

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.

cellGloballdNeighbour

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] clause 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).

tpldNeighbour

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] clause 9.1.10.4. Mapping of the measured quantity is defined as in TS 36.133 [18] clause 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 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 {
         physCellIdRef-r14 INTEGER (C...
cellGlobalIdRef-r14 ECGI OPTIONAL,
referenceQuality-r14 OTDOA-MeasQuality OPTIONAL,
neighbourMeasurementList-r14 INTEGER (C...4095) OPTIONAL,
INTEGER (C...409
           systemFrameNumber-r14 BIT STRING (SIZE (10)),
                                                                                                                                                                                                  -- Cond NotSameAsRef0
                                                                                                                                                                                                 -- Cond ProvidedByServer0
           OPTIONAL, -- Cond ProvidedByServer1
           carrierFreqOffsetNB-Ref-r14 CarrierFreqOffsetNB-r14 OF110......
BIT STRING (SIZE (10)) OPTIONAL,
          nprsIdRef-r14
                                                                                                                                                                                                  -- Cond ProvidedByServer2
                                                                                                                                                                                                  -- Cond NB-IoT
                                                                                                                                                                                               -- 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-r14 INTEGER (0..12711),
rstd-Quality-r14 OTDOA-MeasQuality,
tpIdNeighbour-r14 INTEGER (0..4095)
prsIdNeighbour-r14 INTEGER (0..4095)
delta-rstd-r14 INTEGER (0.5)
                                                                                                                                                      OPTIONAL,
                                                                                                                                                                                                  -- Cond ProvidedByServer0
                                                                                                                                                      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 <i>tpld</i> 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 <i>prsID</i> 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 <i>nprsID</i> 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-loT 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 the 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.

cellGloballdRef

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.

tpldRef

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.

cellGloballdNeighbour

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] clause 9.1.10.3.

rstd-Quality

This field specifies the target device's best estimate of the quality of the measured rstd.

tpldNeighbour

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] clause 9.1.10.4. Mapping of the measured quantity is defined as in TS 36.133 [18] clause 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.

nprsldNeighbour

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

OTDOA-Meas Quality 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 metres
'01' 10 metres
'10' 20 metres
'11' 30 metres
```

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) metres '00001' R*1 to (R*2-1) metres '00010' R*2 to (R*3-1) metres ...
'11111' R*31 metres 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 the 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 associated with 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*.

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,
   11
                          ENUMERATED { requested }
                                                         OPTIONAL,
       multipathRSTD-r14
                                                                         -- 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.
                                                                                    OPTIONAL,
   additional-prs-config-r14
                                      ENUMERATED {
                                                  supported
                                                                                    OPTIONAL,
   prs-based-tbs-r14
                                    ENUMERATED { supported }
   maxSupportedPrsConfigs-r14 ENUMERATED { supported } maxSupportedPrsConfigs-r14 ENUMERATED { c2, c3 } multiPrbNprs-r14
                                                                                    OPTIONAL,
                                                                                    OPTIONAL,
                                                                                    OPTIONAL,
                                   ENUMERATED { supported }
ENUMERATED { required }
ENUMERATED { rx1, ... }
   multiPrbNprs-r14
                                                                                    OPTIONAL,
   idleStateForMeasurements-r14
                                                                                    OPTIONAL,
   numberOfRXantennas-r14
                                                                                    OPTIONAL,
                                     ENUMERATED { supported }
ENUMERATED { supported }
                                                                                    OPTIONAL,
   motionMeasurements-r15
   interRAT-RSTDmeasurement-r15
                                                                                    OPTIONAL
maxBands INTEGER ::= 64
SupportedBandEUTRA ::= SEQUENCE {
   bandEUTRA
                                      INTEGER (1..maxFBI)
SupportedBandEUTRA-v9a0 ::= SEQUENCE {
   bandEUTRA-v9a0
                                      INTEGER (maxFBI-Plus1..maxFBI2)
maxFBI
                                  INTEGER ::= 64 -- Maximum value of frequency band indicator
                                  INTEGER ::= 65 -- lowest value extended FBI range
maxFBI-Plus1
                                  INTEGER ::= 256 -- highest value extended FBI range
maxFBT2
-- 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 the 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 3x24 *OTDOA-NeighbourCellInfoElement* in *OTDOA-NeighbourCellInfoList* in *OTDOA-ProvideAssistanceData* without any restriction for the *earfcn* in each *OTDOA-NeighbourCellInfoElement* as specified in clause 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 the case additional-prs-config is present, this field is not present.

max Supported Prs Bandwidth

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 *CommonlEsRequestLocationInformation*.

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 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 (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.

OTDOA-LocationServerErrorCauses

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

OTDOA-TargetDeviceErrorCauses

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

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 gnss-GenericAssistData GNSS-GenericAssistData
                                                                              OPTIONAL,
                                                                                            -- Need ON
                                      GNSS-GenericAssistData
                                                                              OPTIONAL,
                                                                                           -- Need ON
    gnss-Error
                                      A-GNSS-Error
                                                                              OPTIONAL,
                                                                                            -- Need ON
    11
        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 clauses 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.

```
-- ASN1START
GNSS-CommonAssistData ::= SEQUENCE {
                                                                             OPTIONAL,
    gnss-ReferenceTime GNSS-ReferenceTime gnss-ReferenceLocation GNSS-ReferenceLocation gnss-IonosphericModel GNSS-IonosphericModel
                                                                                           -- Need ON
                                                                             OPTIONAL,
                                                                                           -- Need ON
                                       GNSS-IonosphericModel
                                                                              OPTIONAL,
                                                                                           -- Need ON
    gnss-EarthOrientationParameters GNSS-EarthOrientationParameters
                                                                             OPTIONAL,
                                                                                            -- Need ON
    П
        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
```

```
]],
[[
    gnss-SSR-CorrectionPoints-r16
    GNSS-SSR-CorrectionPoints-r16    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. 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,
    qnss-ID
    sbas-ID
                                   SBAS-ID
                                                                   OPTIONAL,
                                                                               -- Cond GNSS-ID-SBAS
                                                                               -- Need ON
    gnss-TimeModels
                                                                   OPTIONAL,
                                   GNSS-TimeModelList
                                                                  OPTIONAL,
    gnss-DifferentialCorrections GNSS-DifferentialCorrections
                                                                               -- Need ON
                                                                   OPTIONAL,
                                                                              -- Need ON
    gnss-NavigationModel
                                   GNSS-NavigationModel
                            GNSS-RealTimeIntegrity
                                                                              -- Need ON
    gnss-RealTimeIntegrity
                                                                  OPTIONAL,
    gnss-DataBitAssistance
                                   GNSS-DataBitAssistance
                                                                  OPTIONAL,
                                                                               -- Need ON
    gnss-AcquisitionAssistance
                                                                              -- Need ON
                                  GNSS-AcquisitionAssistance
                                                                  OPTIONAL,
                                                                  OPTIONAL,
    gnss-Almanac
                                   GNSS-Almanac
                                                                              -- 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
                                                                               -- Cond GNSS-ID-BDS
                                                                  OPTIONAL
    ]],
    Π
        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
                                                                  OPTIONAL,
                                   GNSS-SSR-ClockCorrections-r15
                                                                               -- Need ON
        gnss-SSR-CodeBias-r15
                                   GNSS-SSR-CodeBias-r15
                                                                   OPTIONAL
                                                                               -- Need ON
    ]],
    [[
        gnss-SSR-URA-r16
                                           GNSS-SSR-URA-r16
                                                                   OPTIONAL,
                                                                               -- Need ON
                                           GNSS-SSR-PhaseBias-r16 OPTIONAL,
                                                                               -- Need ON
        gnss-SSR-PhaseBias-r16
        gnss-SSR-STEC-Correction-r16
                                           GNSS-SSR-STEC-Correction-r16
                                                                   OPTIONAL,
                                                                               -- Need ON
        gnss-SSR-GriddedCorrection-r16
                                           GNSS-SSR-GriddedCorrection-r16
                                                                  OPTIONAL,
                                                                               -- Need ON
       navic-DifferentialCorrections-r16 NavIC-DifferentialCorrections-r16
                                                               OPTIONAL,
                                                                           -- Cond GNSS-ID-NavIC
        navic-GridModel-r16
                                           NavIC-GridModelParameter-r16
                                                               OPTIONAL
                                                                           -- Cond GNSS-ID-NavIC
    11
-- 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-ID-NAVIC	The field may be present if the GNSS-ID = navic; 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 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
                                                                           OPTIONAL,
                                                                                       -- Need ON
    gnss-RTK-PeriodicResiduals-r15
                                           GNSS-PeriodicControlParam-r15
    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
                                                                           OPTIONAL,
                                           GNSS-PeriodicControlParam-r15
                                                                                       -- Need ON
    gnss-SSR-PeriodicCodeBias-r15
                                                                                       -- Need ON
                                           GNSS-PeriodicControlParam-r15
                                                                           OPTIONAL,
    ГΓ
    gnss-SSR-PeriodicURA-r16
                                           GNSS-PeriodicControlParam-r15 OPTIONAL,
                                                                                       -- Need ON
    gnss-SSR-PeriodicPhaseBias-r16
                                           GNSS-PeriodicControlParam-r15
                                                                           OPTIONAL,
                                                                                       -- Need ON
                                                                           OPTIONAL,
    gnss-SSR-PeriodicSTEC-Correction-r16
                                           GNSS-PeriodicControlParam-r15
                                                                                       -- Need ON
    gnss-SSR-PeriodicGriddedCorrection-r16 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 gNB/ng-eNB/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.

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 <code>gnssSystemTime</code> and <code>networkTime</code> time if IE <code>networkTime</code> is provided. When IE <code>networkTime</code> is not provided, this field can be included to provide the accuracy of the provided <code>gnssSystemTime</code>.

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-DavNumber
                                  INTEGER (0..32767),
   gnss-TimeOfDay
                                  INTEGER (0..86399),
   gnss-TimeOfDayFrac-msec
                                   INTEGER (0..999)
                                                          OPTIONAL,
                                                                      -- Need ON
                                                          OPTIONAL, -- Cond gnss-TimeID-glonass
   notificationOfLeapSecond
                                  BIT STRING (SIZE(2))
   gps-TOW-Assist
                                                         OPTIONAL,
                                  GPS-TOW-Assist
                                                                    -- Cond gnss-TimeID-gps
-- ASN1STOP
```

Conditional presence	Explanation	
gnss-TimeID-glonass	The field may be present if <i>gnss-TimeID</i> =`glonass'; otherwise it is not present.	
gnss-TimeID-gps	The field may be present if <i>gnss-TimeID</i> =`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).

NavIC – Days from NavIC System Time start epoch, defined as 13 seconds before midnight between 21st August and 22nd August 1999; i.e., NavIC System Time was equal to 00:00:00 at August 21st, 1999 23:55:47 UTC (BIPM).

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

GPS-TOW-Assist field descriptions

satellitelD

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].

GPS-TOW-Assist field descriptions

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].

antiSpoot

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 ::= SEOUENCE {
                                              INTEGER(0..12533)
    secondsFromFrameStructureStart
    fractional Seconds From Frame Structure Start \qquad {\tt INTEGER(0..39999999)},
    frameDrift
                                               INTEGER (-64..63) OPTIONAL, -- Cond GNSSsynch
               CHOICE {
    cellID
               eUTRA
                           SEQUENCE {
                                               INTEGER (0..503),
                           physCellId
                           cellGlobalidEUTRA CellGlobalidEUTRA-AndUTRA OPTIONAL, -- Need ON
                           earfcn
                                               ARFCN-ValueEUTRA,
                           [[ earfcn-v9a0
                                             ARFCN-ValueEUTRA-v9a0 OPTIONAL -- Cond EARFCN-max
                           ]]
               uTRA
                           SEQUENCE {
                                   CHOICE {
                           mode
                                           SEQUENCE {
                                    fdd
                                           primary-CPICH-Info INTEGER (0..511),
                                    bb+
                                           SEQUENCE {
                                           cellParameters INTEGER (0..127),
                                               CellGlobalIdEUTRA-AndUTRA OPTIONAL, -- Need ON
                           cellGlobalIdUTRA
                                               ARFCN-ValueUTRA,
                           uarfcn
                            . . .
                           SEQUENCE {
               qSM
                           bcchCarrier
                                               INTEGER (0..1023),
                                               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,
                           SEQUENCE {
               nr-r15
                           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 <i>earfcn</i> (i.e. without suffix) is set to
	maxEARFCN. Otherwise the field is not present.
GNSSsynch	The field is present and set to 0 if <i>NetworkTime</i> is synchronized to <i>gnss-SystemTime</i> ;
-	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 the case of E-UTRA, the SFN cycle length is 10.24 seconds.

In the case of UTRA, the SFN cycle length is 40.96 seconds.

In the case of GSM, the hyperfame length is 12533.76 seconds.

In the case of NB-IoT, the Hyper-SFN cycle lengths is 10485.76 seconds.

In the 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.

cellGloballdEUTRA

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].

earfon

This field specifies E-ARFCN of the reference cell for the GNSS-network time relation (E-UTRA). In the 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].

cellGloballdUTRA

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].

cellGloballdGERAN

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.

nbCellGloballd

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 TS 38.331 [35], for which the GNSS network time relation is provided.

nrCellGloballD

This field specifies the NR Cell Global Identifier (NCGI) of the reference cell (NR) for the GNSS-network time relation, as defined in 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.

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. Three Ionospheric Models are supported: The Klobuchar model as defined in [4], the NeQuick model as defined in [8], and the klobuchar Model2 as defined in [39].

KlobucharModelParameter

```
-- ASN1START
KlobucharModelParameter ::= SEQUENCE {
   dataID BIT STRING (SIZE (2)),
   alfa0
                  INTEGER (-128..127),
   alfa1
                  INTEGER (-128..127),
   alfa2
                  INTEGER (-128..127),
                  INTEGER (-128..127),
   alfa3
   beta0
                   INTEGER (-128..127),
   beta1
                  INTEGER (-128..127),
   beta2
                   INTEGER (-128..127),
                  INTEGER (-128..127),
   beta3
-- 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 B1I, and UE shall use these parameters according to the description given in 5.2.4.7 in [23]. When the *dataID* has the value '10', it indicates that the parameters have been generated by NavIC, and UE shall use these parameters according to the description given in [38]. When *dataID* has the value '00' it indicates the parameters are applicable worldwide [4], [7].

alpha0

This field specifies the α_0 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{-30} seconds.

KlobucharModelParamater field descriptions

alpha1

This field specifies the α_1 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2⁻²⁷ seconds/semi-circle.

alpha2

This field specifies the α_2 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{-24} seconds/semi-circle².

alpha3

This field specifies the α_3 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{-24} seconds/semi-circle³.

beta0

This field specifies the β_0 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{11} seconds.

beta1

This field specifies the β_1 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{14} seconds/semi-circle.

beta2

This field specifies the β_2 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{16} seconds/semi-circle².

beta3

This field specifies the β_3 parameter of the Klobuchar model, as specified in [4], [23], [38]. Scale factor 2^{16} seconds/semi-circle³.

KlobucharModel2Parameter

```
-- ASN1START
KlobucharModel2Parameter-r16 ::= SEQUENCE {
    alfal-r16 INTEGER (0..1023)
    alfa2-r16
                       INTEGER (-128..127)
    alfa3-r16
                       INTEGER (0..255),
   alfa4-r16
alfa5-r16
                       INTEGER (0..255),
                       INTEGER (0. 255)
    alfa6-r16
                       INTEGER (-128..127),
    alfa7-r16
                       INTEGER (-128..127),
   alfa8-r16
                       INTEGER (-128..127),
    alfa9-r16
                       INTEGER (-128..127),
-- ASN1STOP
```

KlobucharModel2Parameter field descriptions

alfa1

This field specifies the α_1 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2⁻³ TECU.

alfa2

This field specifies the α_2 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2-3 TECU.

alfa3

This field specifies the α_3 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2-3 TECU.

alfa4

This field specifies the α_4 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2-3 TECU.

alfa5

This field specifies the α_5 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor -2⁻³ TECU.

alfa6

This field specifies the α_6 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2⁻³ TECU.

alfa7

This field specifies the α_7 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2⁻³ TECU.

KlobucharModel2Parameter field descriptions

alfa8

This field specifies the α_8 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2-3 TECU.

alfa9

This field specifies the α_9 parameter of the Klobuchar model, as specified in 7.8.1 in [39]. Scale factor 2⁻³ TECU.

NeQuickModelParameter

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/degree², [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.

GNSS-EarthOrientationParameters field descriptions

teop

This field specifies the EOP data reference time in seconds, as specified in [4], [39]. Scale factor 2⁴ seconds.

GNSS-EarthOrientationParameters field descriptions

pmX

This field specifies the X-axis polar motion value at reference time in arc-seconds, as specified in [4], [39]. 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], [39]. 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], [39]. 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], [39]. Scale factor 2⁻²¹ arc-seconds/day.

deltaUT1

This field specifies the UT1-UTC difference at reference time in seconds, as specified in [4], [39]. 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], [39] 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 ::= SEOUENCE {
    referenceStationID-r15 GNSS-ReferenceStationID-r15,
    referenceStationID-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
                                                                                     OPTIONAL, -- Need ON OPTIONAL, -- Need ON
    antennaDescription-r15
                                               AntennaDescription-r15
    antenna-reference-point-unc-r15
                                               AntennaReferencePointUnc-r15
    physical-reference-station-info-r15
                                               PhysicalReferenceStationInfo-r15 OPTIONAL, -- Cond NP
    equalIntegerAmbiguityLevel-r16
                                               EqualIntegerAmbiguityLevel-r16
                                                                                       OPTIONAL -- Need ON
AntennaDescription-r15 ::= SEQUENCE {
    antennaDescriptor-r15
                                                VisibleString (SIZE (1..256)),
                                                ENUMERATED { non-zero }
                                                                                      OPTIONAL, -- Need OP
    antennaSetUpID-r15
AntennaReferencePointUnc-r15 ::= SEQUENCE {
                                               INTEGER (0..255),
    uncertainty-X-r15
    confidence-X-r15
                                               INTEGER (0..100),
                                                INTEGER (0..255),
    uncertainty-Y-r15
    confidence-Y-r15
                                               INTEGER (0..100),
                                               INTEGER (0..255),
    uncertainty-Z-r15
    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
```

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 $\pm 13,743,895.3471 \text{ m}$.

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 centre 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 TS 23.032 [15]. *confidence-X*, *confidence-Y*, and *confidence-Z* corresponds to confidence as defined in TS 23.032 [15].

physical-reference-station-info

This field provides the earth-centred, earth-fixed (ECEF) coordinates of the antenna reference point (ARP) for the real (or "physical") reference station used. This field may be used in the 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.

equalIntegerAmbiguityLevel

This field specifies the integer ambiguity level of this reference station in relation to other reference stations. Either, the presence or absence of *allReferenceStations* indicates whether the integer ambiguity level may be assumed to be aligned between all reference stations or not (interpreted as no alignment is facilitated from the location server), or *referenceStationList* provides a list of reference stations for which the integer ambiguity level may be assumed to be the same.

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].

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, the receiver clock must be kept in the range of ±1 ms (approximately ±300 km)
- 1 clock steering has been applied
 - In this case, the receiver clock must be kept in the range of ±1 microsecond (approximately ±300 metres).
- 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 Smoothing Interval relation" below.

smoothingInterval value to Smoothing Interval relation

smoothingInterval value	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].

```
master-referenceStationID-r15 GNSS-ReferenceStationID-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
                                                                                -- Need ON
   verticalConfidence-r15
                                        INTEGER (0..100)
                                                                     OPTIONAL,
-- 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 millimetre; 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 TS 23.032 [15] and 'horizontalConfidence' corresponds to confidence as defined in 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 TS 23.032 [15] and 'verticalConfidence' corresponds to confidence as defined in TS 23.032 [15].

GNSS-SSR-CorrectionPoints

The IE GNSS-SSR-CorrectionPoints is used by the location server to provide a list of correction point coordinates or an array of correction points ("grid") for which the GNSS-SSR-GriddedCorrection are valid.

```
-- ASN1START
GNSS-SSR-CorrectionPoints-r16 ::= SEQUENCE {
      correctionPointSetID-r16 INTEGER (0..16383),
            rectionPoints-r16 CHOICE {
listOfCorrectionPoints-r16 GNSS-SSR-ListOfCorrectionPoints-r16,
arrayOfCorrectionPoints-r16 GNSS-SSR-ArrayOfCorrectionPoints-r16
      correctionPoints-r16
      },
}
GNSS-SSR-ListOfCorrectionPoints-r16 ::= SEQUENCE {
     referencePointLatitude-r16 INTEGER (-16384..16383),
referencePointLongitude-r16 INTEGER (-32768..32767),
relativeLocationsList-r16 SEQUENCE (SIZE (0..63)) OF RelativeLocationElement-r16,
RelativeLocationElement-r16 ::= SEQUENCE {
      deltaLatitude-r16 INTEGER (-512..511)
                                                       INTEGER (-1024..1023),
      deltaLongitude-r16
}
GNSS-SSR-ArrayOfCorrectionPoints-r16 ::=SEQUENCE {
    referencePointLatitude-r16 :=SEQUENCE {
referencePointLatitude-r16 : INTEGER (-16384..16383),
referencePointLongitude-r16 : INTEGER (-32768..32767),
numberOfStepsLatitude-r16 : INTEGER (0..63),
stepOfLatitude-r16 : INTEGER (1..511),
stepOfLongitude-r16 : INTEGER (1..511),
stepOfLongitude-r16 : INTEGER (1..1023).
                                                              INTEGER (1..511),
INTEGER (1..1023),
      stepOfLongitude-r16
                                                              BIT STRING (SIZE(64))
     bitmaskOfGrids-r16
                                                                                                                        OPTIONAL.
                                                                                                                                          -- Need OP
-- ASN1STOP
```

GNSS-SSR-CorrectionPoints field descriptions

correctionPointSetID

This field provides the ID of the Atmospheric Correction Point set. It is a regionally unique arbitrary number that is used by the UE to ensure that the atmospheric corrections are being applied to the correct set of points.

referencePointLatitude

This field specifies the latitude for the reference point, expressed in the range of -90° , $+90^{\circ}$, coded as a number between -2^{14} and 2^{14} -1, coded in 2's complement binary on 15 bits. The relation between the latitude X in the range [-90° , 90°] and the coded number N is:

$$N = \left| \frac{X}{90^{\circ}} 2^{14} \right|$$

where |x| denotes the greatest integer less than or equal to x (floor operator).

For the listOfCorrectionPoints, the reference point defines the 1st correction point location.

For the arrayOfCorrectionPoints, the reference point defines the northwest corner of the correction point array.

referencePointLongitude

This field specifies the longitude for the reference point, expressed in the range -180°, +180°, coded as a number between -2¹⁵ and 2¹⁵-1, coded in 2's complement binary on 16 bits. The relation between the longitude X in the range [-180°, 180°) and the coded number N is:

$$N = \frac{X}{180^{\circ}} 2^{15}$$

For the *listOfCorrectionPoints*, the reference point defines the 1st correction point location.

For the arrayOfCorrectionPoints, the reference point defines the northwest corner of the correction point array.

GNSS-SSR-CorrectionPoints field descriptions

relativeLocationsList

This field specifies the 2nd, 3rd, ..., 64th correction point location.

deltaLatitude

This field specifies the delta value in latitude of this correction point location relative to the previous point on the list or the reference point in the case of the first additional point, defined as "correction point location" minus "previous correction point location" in units of 0.01 degrees.

deltaLongitude

This field specifies the delta value in longitude of this correction point location relative to the previous point on the list or the reference point in the case of the first additional point, defined as "correction point location" minus "previous correction point location" in units of 0.01 degrees.

numberOfStepsLatitude, numberOfStepsLongitude

These fields specify the number of steps for latitude and longitude direction respectively.

stepOfLatitude, stepOfLongitude

These fields specify the spacing of the correction points for latitude and longitude respectively. The unit and scale factor is 0.01 degrees.

bitmaskOfGrids

This field specifies the availability of correction data at the correction points in the array. If a specific bit is enabled (set to '1'), the correction is available. Only the first numberOfStepsLatitudexnumberOfStepsLongitude bits are used, the remainder are set to '0'. Starting with the northwest corner of the array (top left on a north oriented map) the correction points are enumerated with row precedence – first row west to east, second row west to east, until last row west to east – ending with the southeast corner of the array. If the field is omitted all correction points are used and none omitted.

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 ::= SECUENCE {
   tA0
                            INTEGER (-67108864..67108863),
                            INTEGER (-4096..4095)
                                                                OPTIONAL,
                                                                            -- Need ON
   tA1
                            INTEGER (-64..63)
   t.A2
                                                                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 24 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/second².

GNSS-TimeModelElement field descriptions

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.

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	NavIC
7-15	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<sub>GGTO</sub>)) + A_{2GGTO} (t_E - t_{GGTO} + 604800 (WN - WN<sub>GGTO</sub>))<sup>2</sup>)
```

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 $t_{\rm E}$. 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 ::= SEOUENCE {
               SV-ID,
BIT STRING (SIZE(11)),
     svID
     iod
                          INTEGER (0..3),
INTEGER (-2047..2047),
     udre
     pseudoRangeCor
     rangeRateCor INTEGER (-127..127), udreGrowthRate INTEGER (0..7)
                                                             OPTIONAL, -- Need ON OPTIONAL, -- Need ON
    udreValidityTime INTEGER (0..7)
}
-- 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 $(1-\sigma)$ 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.

pseudoRangeCor

This field specifies the correction to the pseudorange for the particular satellite at *dgnss-RefTime*, t₀. The value of this field is given in metres and the scale factor is 0.32 metres in the range of ±655.04 metres. 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 metres.

GNSS-DifferentialCorrections field descriptions

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 metres per second and the resolution is 0.032 metres/second in the range of ± 4.064 metres/second. 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 t1, PRm(t1,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 metres/second.

udreGrowthRate

This field provides an estimate of the growth rate of uncertainty $(1-\sigma)$ 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	Indication
udreGrowthRate	
000	1.5
001	2
010	4
011	6
100	8
101	10
110	12
111	16

Value of udre Validity Time to Indication relation

Value of	Indication
udreValidityTime	[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,
{\tt GNSS-NavModelSatelliteList} ::= {\tt SEQUENCE} \ ({\tt SIZE} (1..64)) \ {\tt OF} \ {\tt GNSS-NavModelSatelliteElement}
GNSS-NavModelSatelliteElement ::= SEQUENCE {
                SV-ID,
    svID
     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, cnav-ClockModel CNAV-ClockModel,
                                                                           -- Model-2
                                                                          -- Model-3
    glonass-ClockModel GLONASS-ClockModel,
                                                                          -- Model-4
                                                                          -- Model-5
     sbas-ClockModel
                                  SBAS-ClockModel,
    bds-ClockModel-r12 BDS-ClockModel-r12, bds-ClockModel2-r16 BDS-ClockModel2-r16,
                                                                          -- Model-6
                                                                          -- Model-7
    navic-ClockModel-r16 NavIC-ClockModel-r16
                                                                           -- Model-8
GNSS-OrbitModel ::= CHOICE {
    heplerianSet NavModelKeplerianSet,
nav-KeplerianSet NavModelNAV-KeplerianSet,
nav-KeplerianSet NavModelCNAV-KeplerianSet,
nav-KeplerianSet NavModel-GLONASS-ECEF,
sbas-ECEF NavModel-SBAS-ECEF,
                                                                          -- Model-1
                                                                          -- Model-2
                                                                          -- Model-3
                                  NavModelCNAV-KeplerianSet,
                                  NavModel-GLONASS-ECEF,
                                                                           -- Model-4
                                                                           -- Model-5
    bds-KeplerianSet-r12 NavModel-BDS-KeplerianSet-r12, -- Model-6
bds-KeplerianSet2-r16 NavModel-BDS-KeplerianSet2-r16, -- Model-7
    navic-KeplerianSet-r16 NavModel-NavIC-KeplerianSet-r16 -- Model-8
-- 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.

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.

This field specifies the Issue of Data and contains the identity for GNSS Navigation Model.

In the case of broadcasted GPS NAV ephemeris, the iod contains the IODC as described in [4].

In the case of broadcasted Modernized GPS ephemeris, the iod contains the 11-bit parameter toe as defined in [4, Table 30-I] [6, Table 3.5-1].

In the case of broadcasted SBAS ephemeris, the iod contains the 8 bits Issue of Data as defined in [10] Message Type 9.

In the case of broadcasted QZSS QZS-L1 ephemeris, the iod contains the IODC as described in [7].

In the case of broadcasted QZSS QZS-L1C/L2C/L5 ephemeris, the iod contains the 11-bit parameter toe as defined in

In the case of broadcasted GLONASS ephemeris, the iod contains the parameter to 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 B1I ephemeris, the iod contains 11 MSB bits of the toe as defined in [23].

In the case of broadcasted BDS B1C ephemeris, the iod contains the IODC as described in [39].

In the case of broadcasted NavIC ephemeris, the iod contains 11 MSB bits of the toe as defined in [38].

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			SV Heal	th [4]			'0'	'0'
L1/CA ⁽¹⁾							(reserved)	(reserved)
Modernized	L1C Health	L1 Health	L2 Health	L5 Health	'0'	'0'	'0'	'0'
GPS ⁽²⁾	[6]	[4,5]	[4,5]	[4,5]	(reserved)	(reserved)	(reserved)	(reserved)
SBAS ⁽³⁾	Ranging	Corrections	Integrity	'0'	'0'	'0'	'0'	'0'
	On (0),Off(1) [10]	On(0),Off(1) [10]	On(0),Off(1)[10]	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)
QZSS ⁽⁴⁾			SV Health [7]					'0'
QZS-L1							(reserved)	(reserved)
QZSS ⁽⁵⁾	L1C Health	L1 Health	L2 Health	L5 Health	'0'	'0'	'0'	'0'
QZS-	[7]	[7]	[7]	[7]	(reserved)	(reserved)	(reserved)	(reserved)
L1C/L2C/L5								
GLONASS	B _n (MSB)		F _⊤ [9, Tal	ole 4.4]		'0'	'0'	'0'
	[9, page 30]		(reserved) (reserved) (reserved)				(reserved)	
Galileo	E5a Data	E5b Data	E1-B Data	E5a Sign	al Health	'0'	'0'	'0'
[8, clause	Validity	Validity	Validity	Validity Status (reserved) (reserved)			(reserved)	(reserved)
5.1.9.3]	Status	Status	Status					
BDS B1I ⁽⁶⁾	B1I Health	'0'	'0'	'0'	'0'	'0'	'0'	'0'
[23]	(SatH1) [23]	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)
BDS B1C ⁽⁷⁾	Sat Clock	B1C Health	'0'	'0'	'0'	'0'	'0'	'0'
[39]	Health [39]	[39]	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)
NavIC	L5 health	'0'	'0'	'0'	'0'	'0'	'0'	'0'
A) (4) (6)	01100 15 : 1: 1	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)

If GNSS-ID indicates 'gps', and GNSS Orbit Model-2 is included, this interpretation of svHealth applies. Note 1:

If GNSS-ID indicates 'gps', and GNSS Orbit Model-3 is included, this interpretation of svHealth applies. Note 2:

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 the case that GNSS-ID indicates 'sbas', includes the 5 LSBs of the Health included in GEO Almanac Message Parameters (Type 17) [10].

If GNSS-ID indicates 'qzss', and GNSS Orbit Model-2 is included, this interpretation of svHealth applies. Note 4:

If GNSS-ID indicates 'qzss', and GNSS Orbit Model-3 is included, this interpretation of svHealth applies. Note 5: If GNSS-ID indicates 'bds', and GNSS Orbit Model-6 is included, this interpretation of svHealth applies. If GNSS-ID indicates 'bds', and GNSS Orbit Model-7 is included, this interpretation of svHealth applies. Note 6: Note 7:

GNSS to iod Bit String(11) relation

					iod E	Bit String(11)				
GNSS	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, s	scale facto	r 300, ran	ge 0 – 604	1500) [4,5	,6]		
SBAS	'0'	'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' t₀ (minutes, scale factor 15) [9]									
Galileo	'0'	IODnav [8]									
BDS B1I		11 MSB bits of t _{oe} (seconds, scale factor 512, range 0 – 604672) [23]									
BDS B1C	'0'	Issue of Data, Clock [39]									
NavIC		11 MSB bits of t _{oe} (seconds, scale factor 512) [38]									

GNSS to svHealthExt Bit String(4) relation

	svHealthExt Bit String(4)				
GNSS	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

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 toc defined in [8].

Scale factor 60 seconds.

stanClockAF2

Parameter af₂ defined in [8].

Scale factor 2⁻⁵⁹ seconds/second².

stanClockAF1

Parameter af₁ defined in [8].

Scale factor 2⁻⁴⁶ seconds/second.

stanClockAF0

Parameter af₀ defined in [8].

Scale factor 2⁻³⁴ seconds.

StandardClockModelList field descriptions

stanClockTqd

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.

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 anss-ClockModel.

Value of stanModelID to Identity relation

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

NAV-ClockModel

```
-- ASN1START
{\tt NAV-ClockModel} \; ::= \; {\tt SEQUENCE} \; \; \{
      navToc INTEGER (0..37799),
navaf2 INTEGER (-128..127),
navaf1 INTEGER (-32768..32767),
navaf0 INTEGER (-2097152..20971
navTqd INTEGER (-128..127),
                                       INTEGER (-2097152..2097151),
INTEGER (-128..127),
       navaf0
navTgd
-- ASN1STOP
```

NAV-ClockModel field descriptions

navToc

Parameter toc, time of clock (seconds) [4,7]

Scale factor 24 seconds.

navaf2

Parameter a_{f2}, clock correction polynomial coefficient (sec/sec²) [4,7].

Scale factor 2⁻⁵⁵ seconds/second².

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)
                                     INTEGER (0..2015),
       cnavTop
      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),
                           INTEGER (-4096..4095),
       cnavTgd
```

```
cnavISCl1cp
                INTEGER (-4096..4095)
                                                OPTIONAL,
                                                            -- Need ON
                INTEGER (-4096..4095)
INTEGER (-4096..4095)
   cnavISC11cd
                                                 OPTIONAL,
                                                             -- Need ON
   cnavISC11ca
                                                OPTIONAL,
                                                            -- Need ON
   cnavISCl2c
cnavISCl5i5
                  INTEGER (-4096..4095)
                                                OPTIONAL,
                                                            -- Need ON
                  INTEGER (-4096..4095)
                                                 OPTIONAL,
                                                            -- Need ON
   OPTIONAL,
                                                            -- Need ON
-- ASN1STOP
```

CNAV-ClockModel field descriptions

cnavToc

Parameter toc, clock data reference time of week (seconds) [4,5,6,7].

Scale factor 300 seconds.

cnavTop

Parameter top, 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].

cnavIIRA1

Parameter URA_{oc1} Index, SV clock accuracy change index (dimensionless) [4,5,6,7].

cnavURA2

Parameter URA_{0c2} Index, SV clock accuracy change rate index (dimensionless) [4,5,6,7].

cnavAf2

Parameter a_{f2-n}, SV clock drift rate correction coefficient (sec/sec²) [4,5,6,7].

Scale factor 2⁻⁶⁰ seconds/second².

cnav∆f1

Parameter a_{f1-n}, SV clock drift correction coefficient (sec/sec) [4,5,6,7].

Scale factor 2⁻⁴⁸ seconds/second.

cnavAf0

Parameter a_{f0-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.

cnavISCI1cp

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 L1c signal.

cnavISCI1cd

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 L1c signal.

cnavISCI1ca

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.

cnavISCI2c

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 L2c signal.

cnavISCI5i5

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.

cnavISCI5q5

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

```
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

SBAS-ClockModel field descriptions

sbasAgfo Parameter

sbasTo

Parameter a_{Gfo} [10].

Parameter t₀ [10]. Scale factor 16 seconds.

Scale factor 2⁻³¹ seconds.

sbasAgf1

Parameter a_{Gf1} [10].

Scale factor 2⁻⁴⁰ seconds/second.

BDS-ClockModel

The IE BDS-ClockModel is used for BDS B1I defined in [23].

BDS-ClockModel field descriptions

bdsAODC

Parameter Age of Data, Clock (AODC), see [23], Table 5-6.

bdsToc

Parameter Toc, Time of clock (seconds) [23].

Scale factor 23 seconds.

bdsA0

Parameter a₀, 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 a₂, Clock correction polynomial coefficient (sec/sec²) [23].

Scale factor 2⁻⁶⁶ sec/sec².

bdsTgd1

Parameter Equipment group delay differential T_{GD1} [23].

Scale factor is 0.1 nanosecond.

- BDS-ClockModel2

The IE BDS-ClockModel2 is used for BDS B1C defined in [39].

BDS-ClockModel2 field descriptions

bdsToc

Parameter Toc, Clock correction parameters reference time (seconds), see [39], 7.5.1.

Scale factor 300 seconds.

bdsA0

Parameter a₀, Satellite clock time bias correction coefficient (seconds), see [39], 7.5.1.

Scale factor 2⁻³⁴ seconds.

bdsA1

Parameter a₁, Satellite clock time drift correction coefficient (sec/sec), see [39], 7.5.1.

Scale factor 2⁻⁵⁰ sec/sec.

bdsA2

Parameter a₂, Satellite clock time drift rate correction coefficient (sec/sec²), see [39], 7.5.1.

Scale factor 2⁻⁶⁶ sec/sec².

bdsTadB1Cp

Parameter T_{GDB1Cp} Group delay differential of the B1C pilot component (seconds), see [39], 7.6.1.

Scale factor is 2⁻³⁴ seconds.

bdslscB1Cd

Parameter ISC_{B1Cd} Group delay differential between the B1C data and pilot components (seconds), see [39], 7.6.1.

Scale factor is 2⁻³⁴ seconds.

- NavIC-ClockModel

```
-- ASN1STOP
```

NavIC-ClockModel field descriptions navic-Toc Parameter toc, time of clock (seconds) [38], Table-11. Scale factor 24 seconds. Parameter a_{f2}, clock correction polynomial coefficient (sec/sec²) [38].

Scale factor 2⁻⁵⁵ seconds/second²

Parameter af1, clock correction polynomial coefficient (sec/sec) [38].

Scale factor 2⁻⁴³ seconds/second.

Parameter a_{f0}, clock correction polynomial coefficient (seconds) [38].

Scale factor 2⁻³¹ seconds.

navic-Tgd

Parameter T_{GD} , group delay (seconds) [38]. Scale factor 2^{-31} seconds.

NavModelKeplerianSet

```
-- ASN1START
NavModelKeplerianSet ::= SEQUENCE {
        keplerDeltaN INTEGER (-32768..32767),
keplerMO INTEGER (-2147483648..2147483647),
        keplerOmegaDot INTEGER (-8388608.. 8388607),
        keplerE INTEGER (0..4294967295),
keplerIDot INTEGER (-8192..8191)
        keplerAPowerHalf INTEGER (0.. 4294967295)
        keplerIO INTEGER (-2147483648..2147483647),
keplerOmegaO INTEGER (-2147483648..2147483647),

        keplerOmegau
        INTEGER (-214/483648..22)

        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 toe, 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.

Parameter M₀, 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.

NavModelKeplerianSet field descriptions

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.

keplerAPowerHalf

Parameter sqrtA, square root of semi-major Axis in (metres) 1/2 [8].

Scale factor 2⁻¹⁹ metres^{1/2}.

keplerl0

Parameter i₀, inclination angle at reference time (semi-circles) [8].

Scale factor 2⁻³¹ semi-circles.

keplerOmega0

Parameter OMEGA₀, 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 (metres) [8].

Scale factor 2⁻⁵ metres.

keplerCis

Parameter Cis, amplitude of the sine harmonic correction term to the angle of inclination (radians) [8].

Scale factor 2⁻²⁹ radians.

keplerCus

Parameter Cus, 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 (metres) [8].

Scale factor 2⁻⁵ metres.

keplerCic

Parameter Cic, 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

```
...
}
-- 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 toe, time of ephemeris (seconds) [4,7].

Scale factor 24 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 Mo, 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 (metres/2) [4,7].

Scale factor 2⁻¹⁹ metres^{1/2}.

navl0

Parameter io, 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 (metres) [4,7].

Scale factor 2⁻⁵ metres.

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 (metres) [4,7].

Scale factor 2⁻⁵ metres.

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 Cuc, 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
    cnavTop INTEGER (0..2015),
cnavURAindex INTEGER (-16..15),
cnavDeltaA INTEGER (-33554432)
NavModelCNAV-KeplerianSet ::= SEQUENCE {
    CHAVAGOT INTEGER (-33554432..33554431),
CHAVAGOT INTEGER (-16777216..16777215),
CHAVAGOT INTEGER (-65536..65535),
CHAVAGOT INTEGER (-4194304..4194303),
CHAVAGOT INTEGER (-4294967296..42042)
                             INTEGER (-4294967296..4294967295),
    cnavDeltaOmegaDot INTEGER (-65536..65535),
                   INTEGER (-4294967296..4294967295),
INTEGER (-16384..16383),
    cnavIo
     cnavIoDot
     cnavCis
                           INTEGER (-32768..32767),
                             INTEGER (-32768..32767)
     cnavCic
                            INTEGER (-8388608..8388607),
    cnavCrs
                            INTEGER (-8388608..8388607),
    cnavCrc
cnavCus
                             INTEGER (-1048576..1048575),
                           INTEGER (-1048576..1048575),
     cnavCuc
}
-- ASN1STOP
```

NavModelCNAV-KeplerianSet field descriptions

cnavTop

Parameter top, 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 (metres) [4,5,6,7].

Scale factor 2⁻⁹ metres.

cnavAdot

Parameter A, change rate in semi-major axis (metres/second) [4,5,6,7].

Scale factor 2⁻²¹ metres/second.

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/sec²) [4,5,6,7].

Scale factor 2⁻⁵⁷ semi-circles/second².

cnavMo

Parameter M_{0-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 $\Delta\Omega$, rate of right ascension difference (semi-circles/sec) [4,5,6,7].

Scale factor 2⁻⁴⁴ semi-circles/second.

cnavlo

Parameter i_{0-n}, inclination angle at reference time (semi-circles) [4,5,6,7].

Scale factor 2⁻³² semi-circles.

cnavloDot

Parameter I_{0-n}-DOT, rate of inclination angle (semi-circles/sec) [4,5,6,7].

Scale factor 2⁻⁴⁴ semi-circles/second.

NavModelCNAV-KeplerianSet field descriptions

cnavCis

Parameter C_{is-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-n} , amplitude of cosine harmonic correction term to the angle of inclination (radians) [4,5,6,7]. Scale factor 2^{-30} radians.

cnavCrs

Parameter C_{rs-n}, amplitude of sine harmonic correction term to the orbit radius (metres) [4,5,6,7]. Scale factor 2⁻⁸ metres.

cnavCro

Parameter C_{rc-n}, amplitude of cosine harmonic correction term to the orbit radius (metres) [4,5,6,7]. Scale factor 2⁻⁸ metres.

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,
                           INTEGER (0..3),
    qloM
    glox
gloxdot INTEGER (-8388666.
gloxdotdot INTEGER (-16..15),
INTEGER (-67108864
INTEGER (-8388608.
                          INTEGER (-67108864..67108863),
                           INTEGER (-8388608..8388607),
                           INTEGER (-67108864..67108863),
                          INTEGER (-8388608..8388607),
    gloYdot INTEGER (-8388608. gloYdotdot INTEGER (-16..15),
                           INTEGER (-67108864..67108863),
    gloZ
    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.

aloP1

Parameter P1, time interval between two adjacent values of t_b (minutes) [9].

gloP2

Parameter P2, change of tb flag (dimensionless) [9].

gloM

Parameter M, type of satellite (dimensionless) [9].

gloX

Parameter $X_n(t_h)$, x-coordinate of satellite at time t_b (kilometres) [9].

Scale factor 2⁻¹¹ kilometres.

gloXdot

Parameter $\dot{x}_n(t_h)$, x-coordinate of satellite velocity at time t_b (kilometres/second) [9].

Scale factor 2⁻²⁰ kilometres/second.

gloXdotdot

Parameter $\ddot{x}_n(t_h)$, x-coordinate of satellite acceleration at time t_b (kilometres/second²) [9].

Scale factor 2⁻³⁰ kilometres/second².

NavModel-GLONASS-ECEF field descriptions

gloY

Parameter $y_n(t_h)$, y-coordinate of satellite at time t_b (kilometres) [9].

Scale factor 2⁻¹¹ kilometres.

gloYdot

Parameter $\dot{y}_n(t_h)$, y-coordinate of satellite velocity at time t_b (kilometres/second) [9].

Scale factor 2⁻²⁰ kilometres/second.

gloYdotdot

Parameter $\ddot{y}_n(t_b)$, y-coordinate of satellite acceleration at time t_b (kilometres/second²) [9].

Scale factor 2⁻³⁰ kilometres/second².

gloZ

Parameter $z_n(t_h)$, z-coordinate of satellite at time t_b (kilometres) [9].

Scale factor 2⁻¹¹ kilometres.

gloZdot

Parameter $\dot{z}_n(t_h)$, z-coordinate of satellite velocity at time t_b (kilometres/second) [9].

Scale factor 2⁻²⁰ kilometres/second.

gloZdotdot

Parameter $\ddot{z}_n(t_h)$, z-coordinate of satellite acceleration at time t_b (kilometres/second²) [9].

Scale factor 2⁻³⁰ kilometres/second².

NavModel-SBAS-ECEF

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 t₀, time of applicability (seconds) [10]. Scale factor 16 seconds. sbasAccuracy Parameter Accuracy, (dimensionless) [10]. sbasXg Parameter X_G, (metres) [10]. Scale factor 0.08 metres. sbasYg Parameter Y_G, (metres) [10]. Scale factor 0.08 metres. sbasZg Parameter Z_G, (metres) [10]. Scale factor 0.08 metres.

NavModel-SBAS-ECEF field descriptions sbasXqDot Parameter X_G, Rate-of-Change, (metres/second) [10]. Scale factor 0.000625 metres/second. sbas YgDot Parameter Y_G, Rate-of-Change, (metres/second) [10] Scale factor 0.000625 metres/second. sbasZgDot Parameter Z_G, Rate-of-Change, (metres/second) [10]. Scale factor 0.004 metres/second. sbasXgDotDot Parameter X_G, Acceleration, (metres/second²) [10]. Scale factor 0.0000125 metres/second². sbagYgDotDot Parameter Y_G, Acceleration, (metres/second²) [10]. Scale factor 0.0000125 metres/second². sbasZgDotDot Parameter Z_G Acceleration, (metres/second²) [10]. Scale factor 0.0000625 metres/second².

NavModel-BDS-KeplerianSet

The IE NavModel-BDS-KeplerianSet is used for BDS B1I defined in [23].

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 metres 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 (metres^{/2}) [23].

Scale factor 2⁻¹⁹ metres/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/second.

Parameter M₀, 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)

Scale factor 2⁻³¹ semi-circles.

bdsOmegaDot

Parameter Ω , Rate of right ascension (semi-circles/sec) [23].

Scale factor 2⁻⁴³ semi-circles/second.

Parameter i₀, 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/second.

Parameter C_{uc.} Amplitude of cosine harmonic correction term to the argument of latitude (radians) [23].

Scale factor 2⁻³¹ radians

bdsCus

Parameter Cus, 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 (metres) [23].

Scale factor 2⁻⁶ metres.

bdsCrs

Parameter C_{rs,} Amplitude of sine harmonic correction term to the orbit radius (metres) [23].

Scale factor 2⁻⁶ metres.

bdsCic

Parameter Cic. Amplitude of cosine harmonic correction term to the angle of inclination (radians) [23].

Scale factor 2⁻³¹ radians

bdsCis

Parameter Cis., Amplitude of sine harmonic correction term to the angle of inclination (radians) [23].

Scale factor 2-31 radians.

NavModel-BDS-KeplerianSet2

The IE NavModel-BDS-KeplerianSet2 is used for BDS B1C defined in [39].

```
-- ASN1START
NavModel-BDS-KeplerianSet2-r16 ::= SEQUENCE {
   bdsIODE-r16
                           INTEGER (0..255)
                            INTEGER (0..2047)
    bdsToe-r16
    bdsDeltaA-r16
                            INTEGER (-33554432..33554431),
```

NavModel-BDS-KeplerianSet2 field descriptions

bdsIODE

Parameter, Issue Of Data, Ephemeris (IODE), see [39], 7.4.1.

bdsToe

Parameter t_{0e}, Ephemeris reference time (seconds), defined in [39], 7.7.1.

Scale factor 300 seconds.

bdsDeltaA

Parameter ΔA, Semi-major axis difference at reference time (metre), defined in [39], 7.7.1.

Scale factor 2⁻⁹ metres.

bdsAdot

Parameter A , Change rate in semi-major axis (metre/second), defined in [39], 7.7.1

Scale factor 2⁻²¹ metre/second.

bdsDeltaN0

Parameter Δn_0 , Mean motion difference from computed value at reference time (semi-circles /sec), defined in [39],

Scale factor 2⁻⁴⁴ semi-circles /second.

bdsDeltaN0dot

Parameter $\Delta n_0 dot$, Rate of mean motion difference from computed value at reference time (semi-circles /sec²), defined in [39], 7.7.1

Scale factor 2⁻⁵⁷ semi-circles /second².

bdsM0

Parameter M₀, Mean anomaly at reference time (semi-circles) [39].

Scale factor 2⁻³² semi-circles.

bdsE

Parameter e, Eccentricity [39].

Scale factor 2-34

bdsOmega

Parameter ω , Argument of perigee (semi-circles) [39].

Scale factor 2⁻³² semi-circles.

bdsOmega0

Parameter Ω₀, Longitude of ascending node of orbital plane at weekly epoch (semi-circles) [39].

Scale factor 2⁻³² semi-circles.

bds10

Parameter i₀, Inclination angle at reference time (semi-circles) [39]

Scale factor 2⁻³² semi-circles.

bdsOmegaDot

Parameter Ω , Rate of right ascension (semi-circles/sec) [39].

Scale factor 2⁻⁴⁴ semi-circles/second.

bdsI0Dot

Parameter i₀dot, Rate of inclination angle (semi-circles/sec) [39].

Scale factor 2⁻⁴⁴ semi-circles/second.

bdsCuc

Parameter C_{uc}, Amplitude of cosine harmonic correction to the argument of latitude (radians) [39].

Scale factor 2⁻³⁰ radians.

bdsCus

Parameter Cus, Amplitude of sine harmonic correction to the argument of latitude (radians) [39].

Scale factor 2⁻³⁰ radians.

bdsCrc

Parameter C_{rc,} Amplitude of cosine harmonic correction term to the orbit radius (metres) [39].

Scale factor 2⁻⁸ metres.

bdsCrs

Parameter C_{rs.} Amplitude of sine harmonic correction term to the orbit radius (metres) [39].

Scale factor 2⁻⁸ metres.

bdsCic

Parameter Cic. Amplitude of cosine harmonic correction term to the angle of inclination (radians) [39].

Scale factor 2⁻³⁰ radians.

bdsCis

Parameter Cis, Amplitude of sine harmonic correction term to the angle of inclination (radians) [39].

Scale factor 2⁻³⁰ radians.

NavModel-NavIC-KeplerianSet

NavModel-NavIC-KeplerianSet field descriptions

navic-Toe

Parameter toe, time-of-ephemeris in seconds [38].

Scale factor 24 seconds.

navic-URAI

Parameter User Range Accuracy Index (in metres). This is a one-sigma estimate of the user range errors in the navigation data for the transmitting satellite as described under clause 6.2.1.4 in [38]

navic-W

Parameter ω, argument of perigee (semi-circles) [38].

Scale factor 2⁻³¹ semi-circles.

navic-DeltaN

Parameter Δn , mean motion difference from computed value (semi-circles/sec) [38]

Scale factor 2-41 semi-circles/second

navic-M0

Parameter M₀, mean anomaly at reference time (semi-circles) [38]

Scale factor 2⁻³¹ semi-circles.

navic-OmegaDot

Parameter OMEGAdot, rate of change of right ascension (semi-circles/sec) [38]

Scale factor 2⁻⁴¹ semi-circles/second

navic-E

Parameter e, eccentricity [38]

Scale factor 2⁻³³.

navic-IDot

Parameter Idot, rate of change of inclination angle (semi-circles/sec) [38]

Scale factor 2⁻⁴³ semi-circles/second.

navic-APowerHalf

Parameter sqrtA, square root of semi-major Axis in (metres) [38]

Scale factor 2⁻¹⁹ metres ½.

navic-10

Parameter i₀, inclination angle at reference time (semi-circles) [38]

Scale factor 2⁻³¹ semi-circles.

navic-Omega0

Parameter OMEGA₀, longitude of ascending node of orbit plane at weekly epoch (semi-circles) [38]

Scale factor 2⁻³¹ semi-circles.

navic-Crs

Parameter C_{rs}, amplitude of the sine harmonic correction term to the orbit radius (metres) [38]

Scale factor 2⁻⁴ metres

navic-Cis

Parameter C_{is}, amplitude of the sine harmonic correction term to the angle of inclination (radians) [38]

Scale factor 2⁻²⁸ radians

navic-Cus

Parameter Cus, amplitude of the sine harmonic correction term to the argument of latitude (radians) [38]

Scale factor 2⁻²⁸ radians

NavModel-NavIC-KeplerianSet field descriptions

navic-Crc

Parameter C_{rc}, amplitude of the cosine harmonic correction term to the orbit radius (metres) [38] Scale factor 2⁻⁴ metres

navic-Cic

Parameter C_{ic} , amplitude of the cosine harmonic correction term to the angle of inclination (radians) [38] Scale factor 2^{-28} radians

navic-Cuc

Parameter C_{uc}, amplitude of the cosine harmonic correction term to the argument of latitude (radians) [38] Scale factor 2⁻²⁸ 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.

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.

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 the case of GPS L1 C/A, it contains the NAV data modulation bits as defined in [4] .

In the case of Modernized GPS L1C, it contains the encoded and interleaved modulation symbols as defined in [6] clause 3.2.3.1. In the 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 the case of Modernized GPS L5, it contains the FEC encoded CNAV data modulation symbols as defined in [5].

In the case of SBAS, it contains the FEC encoded data modulation symbols as defined in [10].

In the case of QZSS QZS-L1, it contains the NAV data modulation bits as defined in [7] clause 5.2. In the case of QZSS QZS-L1C, it contains the encoded and interleaved modulation symbols as defined in [7] clause 5.3. In the case of QZSS QZS-L2C, it contains the encoded modulation symbols as defined in [7] clause 5.5. In the case of QZSS QZS-L5, it contains the encoded modulation symbols as defined in [7] clause 5.6.

In the case of GLONASS, it contains the 100 sps differentially Manchester encoded modulation symbols as defined in [9] clause 3.3.2.2.

In the 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 the case of BDS B1I, it contains the encoded and interleaved modulation symbols as defined in [23], clause 5.1.3. In the case of BDS B1C, it contains the encoded and interleaved modulation symbols as defined in [39], clause 6.2.2. In the case of NavIC, it contains the FEC encoded and interleaved Navigation symbols as defined in [38].

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 ::= SEOUENCE {
                                 SV-ID,
    svID
    doppler0
                            INTEGER (-2048..2047),
    doppler1
                                 INTEGER (0..63),
   dopplerUncertainty
                                INTEGER (0..4),
   dopplerUncertaint;
codePhase
intCodePhase
intCodePhase
codePhaseSearchWindow
intEGER (0..127)
intEGER (0..511)
intEGER (0..511)
integer (0..127)
                                INTEGER (0..1022),
                                 INTEGER (0..127),
                                INTEGER (0..511),
INTEGER (0..127),
    codePhase1023
                                 BOOLEAN
                                                       OPTIONAL, -- Need OP
    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 (0th 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 (1st 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/s² in the range from -0.2 m/s² to +0.1 m/s².

Actual value of Doppler (1st order term) is calculated as (-42 + doppler1) * 1/210 m/s², 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: $2^{-n}(40) \text{ m/s}$; n = 0 - 4.

If the dopplerUncertaintyExt field is present, the target device that supports the dopplerUncertaintyExt shall ignore this field.

GNSS-AcquisitionAssistance field descriptions

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 codePhase 1023 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 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.

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 $(1 - 2 \times 2^{-10})$ 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 $(1 - 2 \times 2^{-10})$ 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 m/s, and "No Information".

codePhaseSearchWindow Value to Code Phase Search Window [ms] relation

codePhaseSearchWindow	Code Phase Search Window [ms]
Value	
'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

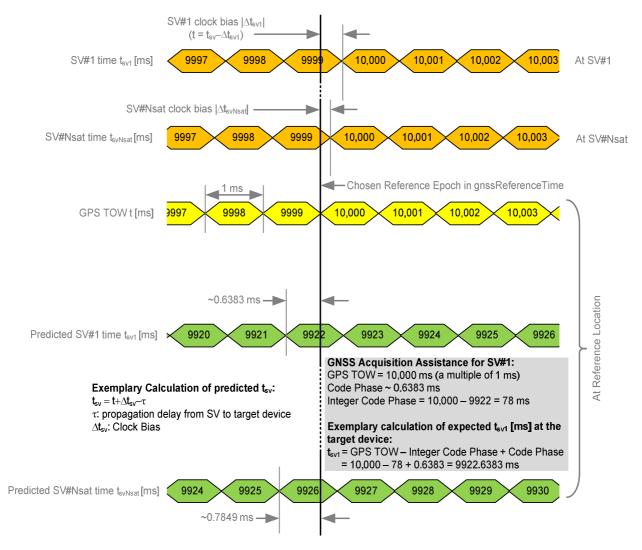


Figure 6.5.2.2-1: Exemplary calculation of some GNSS Acquisition Assistance fields.

– 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.

```
GNSS-Almanac ::= SEQUENCE {
                                       INTEGER (0..255) OPTIONAL,
INTEGER (0..255) OPTIONAL,
INTEGER (0..3) OPTIONAL,
     weekNumber
                                                                                -- Need ON
                                                                                -- Need ON
                                                                              -- Need ON
     ioda
     completeAlmanacProvided BOOLEAN,
     gnss-AlmanacList
                                       GNSS-AlmanacList,
         toa-ext-v1240 INTEGER (256..1023) OPTIONAL, ioda-ext-v1240 INTEGER (4..15) OPTIONAL
     [[ toa-ext-v1240
                                                                                -- Need ON
     11,
                                       OPTIONAL, -- Need ON INTEGER (256..65535) OPTIONAL
     [ [
          weekNumber-ext-r16 INTEGER (256..8191)
          toa-ext2-r16
     11
GNSS-AlmanacList ::= SEQUENCE (SIZE(1..64)) OF GNSS-AlmanacElement
GNSS-AlmanacElement ::= CHOICE {
    keplerianAlmanacSet
                                                                           -- Model-1
-- Model-2
                                            AlmanacKeplerianSet,
     keplerianNAV-Almanac
                                            AlmanacNAV-KeplerianSet,
    keplerianReducedAlmanac AlmanacReducedKeplerianSet, -- Model-2
keplerianReducedAlmanac AlmanacReducedKeplerianSet, -- Model-3
keplerianReducedAlmanac AlmanacMidiAlmanacSet, -- Model-4
                                            AlmanacGLONASS-AlmanacSet, -- Model-5
    keplerianGLONASS
     ecef-SBAS-Almanac
                                            AlmanacECEF-SBAS-AlmanacSet, -- Model-6
    керіегіаnBDS-Almanac-r12 AlmanacBDS-AlmanacSet-r12, -- Model-7
keplerianNavIC-Almanac-r16 AlmanacNavIC-AlmanacSet-r16 Model-7
                                            AlmanacNavIC-AlmanacSet-r16 -- Model-8
-- ASN1STOP
```

GNSS-Almanac field descriptions

weekNumber, weekNumber-ext

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. Either *weekNumber* or *weekNumber-ext* is required for non-GLONASS GNSSs.

In the case of Galileo, the almanac reference week number WN_a natively contains only the 2 LSB's [8], clause 5.1.10]. In the case of BDS B1C, the almanac reference week number is defined in [39], 7.9.1.

In the case of NavIC, the almanac reference week number is defined in [38].

toa, toa-ext, toa-ext2

In the cases that *GNSS-ID* does not indicate Galileo or NavIC, this field specifies the almanac reference time given in GNSS specific system time, in units of seconds with a scale factor of 2¹². *toa* is required for non-GLONASS GNSSs when the *toa-ext2* is not present.

In the case that *GNSS-ID* indicates 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. In the case that *GNSS-ID* indicates NavIC, this field specifies the almanac reference time given in GNSS specific system time, in units of seconds with a scale factor of 16 seconds [38]. Either *toa* or *toa-ext2* is required for NavIC 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

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.

kepAlmanacDeltal

Parameter δi, inclination at reference time relative to i₀=56°; semi-circles [8].

Scale factor 2⁻¹⁴ semi-circles.

kepAlmanacOmegaDot

Parameter Ω , 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, E5bHs and E1-BHs, where E5bHs occupies the 2 MSBs in kepSV-StatusINAV, and E1-BHs the two LSBs.

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, (metres)^{1/2} [8]. Scale factor 2^{-9} metres^{1/2}.

kepAlmanacOmega0

Parameter OMEGA₀, 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 M₀, mean anomaly at reference time (semi-circles) [8].

Scale factor 2⁻¹⁵ semi-circles.

kepAlmanacAF0

Parameter af₀, satellite clock correction bias, seconds [8].

Scale factor 2⁻¹⁹ seconds.

kepAlmanacAF1

Parameter af₁, satellite clock correction linear, sec/sec [8].

Scale factor 2⁻³⁸ seconds/second.

AlmanacNAV-KeplerianSet

```
navAlmOMEGADOT INTEGER (-32768..32767),
   navAlmSVHealth
                          INTEGER (0..255),
                        INTEGER (0..255,,
INTEGER (0..16777215),
   navAlmSgrtA
   navAlmOMEGAo
                         INTEGER (-8388608..8388607),
   navAlmOmega
                          INTEGER (-8388608..8388607),
   navAlmMo
                          INTEGER (-8388608..8388607),
                          INTEGER (-1024..1023),
   navAlmaf0
                          INTEGER (-1024..1023),
   navAlmaf1
-- ASN1STOP
```

AlmanacNAV-KeplerianSet field descriptions

SVID

This field identifies the satellite for which the GNSS Almanac Model is given.

navAlmF

Parameter e, eccentricity, dimensionless [4,7].

Scale factor 2-21.

navAlmDeltal

Parameter δi , correction to inclination, semi-circles [4,7].

Scale factor 2⁻¹⁹ semi-circles.

navAlmOMEGADOT

Parameter Ω , 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, metres $^{\prime 2}$ [4,7]

Scale factor 2⁻¹¹ metres/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 Mo, 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 {
                            SV-ID,
    svID
   svID
redAlmDeltaA
redAlmOmega0
                            INTEGER (-128..127),
                            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 , metres [4], [5], [6], [7], [39].

Scale factor 2⁺⁹ metres.

redAlmOmega0

Parameter Ω_0 , semi-circles [4], [5], [6], [7], [39].

Scale factor 2⁻⁶ semi-circles.

redAlmPhi0

Parameter Φ_0 , semi-circles [4], [5], [6], [7], [39].

Scale factor 2⁻⁶ semi-circles.

redAlmL1Health

Parameter L1 Health, dimensionless [4], [5], [6], [7].

If GNSS-ID = BDS, this field indicates the Satellite clock health state (the 8th bit) defined in table 7-14 [39] for BDS B1C.

redAlmL2Health

Parameter L2 Health, dimensionless [4], [5], [6], [7].

If GNSS-ID = BDS, this field indicates the B1C signal health state (the 7th bit) defined in table 7-14 [39] for BDS B1C.

redAlmL5Health

Parameter L5 Health, dimensionless [4], [5], [6], [7].

AlmanacMidiAlmanacSet

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], [39].

Scale factor 2-16

midiAlmDeltal

Parameter δ_i , semi-circles [4], [5], [6], [7], [39].

Scale factor 2⁻¹⁴ semi-circles.

midiAlmOmegaDot

Parameter Ω , semi-circles/sec [4], [5], [6], [7], [39].

Scale factor 2⁻³³ semi-circles/second.

midiAlmSartA

Parameter \sqrt{A} , metres^{1/2}[4], [5], [6], [7], [39].

Scale factor 2⁻⁴ metres^{1/2}.

midiAlmOmega0

Parameter Ω_0 , semi-circles [4], [5], [6], [7], [39].

Scale factor 2⁻¹⁵ semi-circles.

midiAlmOmega

Parameter ω , semi-circles [4], [5], [6], [7], [39].

Scale factor 2⁻¹⁵ semi-circles.

midiAlmMo

Parameter Mo, semi-circles [4], [5], [6], [7], [39].

Scale factor 2⁻¹⁵ semi-circles.

midiAlmaf0

Parameter a_{fo}, seconds [4], [5], [6], [7], [39].

Scale factor 2⁻²⁰ seconds.

midiAlmaf1

Parameter a_{f1}, sec/sec [4], [5], [6], [7], [39].

Scale factor 2⁻³⁷ seconds/second.

midiAlmL1Health

Parameter L1 Health, dimensionless [4], [5], [6], [7].

If GNSS-ID = BDS, this field indicates the satellite clock health state (the 8th bit) defined in table 7-14 [39] for BDS B1C.

midiAlmL2Health

Parameter L2 Health, dimensionless [4], [5], [6], [7].

If GNSS-ID = BDS, this field indicates the B1C signal health state (the 7th bit) defined in table 7-14 [39] for BDS B1C.

midiAlmL5Health

Parameter L5 Health, dimensionless [4], [5], [6], [7].

AlmanacGLONASS-AlmanacSet

```
-- ASN1START
AlmanacGLONASS-AlmanacSet ::= SEQUENCE {
                           INTEGER (1..1461),
    gloAlm-NA
    gloAlmnA
                           INTEGER (1..24),
    gloAlmHA
                           INTEGER (0..31),
   gloAlmLambdaA
                          INTEGER (-1048576..1048575),
                         INTEGER (0..2097151)
    gloAlmtlambdaA
    gloAlmDeltaIa
                           INTEGER (-131072..131071)
    gloAlmDeltaTA
                         INTEGER (-2097152..2097151),
   gloAlmDeltaTdotA
gloAlmEpsilonA
                           INTEGER (-64..63),
   gloAlmEpsilonA
                          INTEGER (0..32767),
                          INTEGER (-32768..32767),
   gloAlmOmegaA
    gloAlmTauA
                           INTEGER (-512..511),
                           INTEGER (0..1),
   gloAlmCA
    gloAlmMA
                           BIT STRING (SIZE(2))
                                                           OPTIONAL,
                                                                       -- Need ON
-- ASN1STOP
```

AlmanacGLONASS-AlmanacSet field descriptions gloAlm-NA Parameter NA, days [9]. Scale factor 1 days. gloAlmnA Parameter n^A, dimensionless [9]. gloAlmHA Parameter H_nA, 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. gloAlmDeltala Parameter Δi_n^A, semi-circles [9]. Scale factor 2⁻²⁰ semi-circles. gloAlmDeltaTA Parameter ΔT_nA, sec/orbit period [9]. Scale factor 2⁻⁹ seconds/orbit period. gloAlmDeltaTdotA Parameter ΔT_DOT_nA, sec/orbit period² [9]. Scale factor 2⁻¹⁴ seconds/orbit period². 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,
    svid svid, sbasAlmHealth sin string (Size(8)), sbasAlmXg integer (-16384..16383),
    sbasAlmXg
                             INTEGER (-16384..16383),
INTEGER (-256..255),
    sbasAlmYg
    sbasAlmZg
    sbasAlmXgdot
                             INTEGER (-4..3),
    sbasAlmYgDot
sbasAlmZgDot
                               INTEGER (-4..3),
                              INTEGER (-8..7),
    sbasAlmTo
                               INTEGER (0..2047),
-- ASN1STOP
```

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

AlmanacBDS-AlmanacSet

Conditional presence	Explanation
NotSameForAllSV	This field may be present if the toa is not the same for all SVs; otherwise it is not present
	and the toa is provided in GNSS-Almanac.
SV-ID	This field is mandatory present if SV-ID is between 0 and 63; 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 toa, Almanac reference time (seconds) [23]

Scale factor 212 seconds.

bdsAlmSqrtA

Parameter A^{1/2}, Square root of semi-major axis (metres^{1/2}) [23]

Scale factor 2⁻¹¹ metres^{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 M₀, Mean anomaly at reference time (semi-circles) [23]

Scale factor 2⁻²³ semi-circles.

bdsAlmOmega0

Parameter Ω_0 , Longitude of ascending node of orbital plane computed according to reference time (semi-circles) [23] Scale factor 2^{-23} semi-circles.

bdsAlmOmegaDot

Parameter Ω , Rate of right ascension (semi-circles/second) [23]

Scale factor 2⁻³⁸ semi-circles/second.

bdsAlmDeltal

Parameter δ_i , Correction of orbit reference inclination at reference time (semi-circles) [23]

Scale factor 2⁻¹⁹ semi-circles.

bdsAlmA0

Parameter a₀, Satellite clock bias (seconds) [23]

Scale factor 2⁻²⁰ seconds.

bdsAlmA1

Parameter a₁, Satellite clock rate (sec/sec) [23]

Scale factor 2-38 seconds/seconds.

bdsSvHealth

This field indicates satellites health information as defined in [23] Table 5-16. The left most bit is the MSB.

AlmanacNavIC-AlmanacSet

Conditional presence	Explanation	
NotSameForAllSV	This field may be present if the toa is not the same for all SVs; otherwise it is not present	
	and the top is provided in GNSS-Almanac.	

AlmanacNavIC-AlmanacSet field descriptions

svID

This field identifies the satellite for which the Almanac model is given

navic-AlmToa

This field provides the time of almanac set

Scale factor 16 seconds.

navic-AlmE

Parameter e, eccentricity, dimensionless

Scale factor 2-21.

navic-AlmOMEGADOT

Parameter $\dot{\Omega}$, rate of right ascension, semi-circles/sec

Scale factor 2⁻³⁸ semi-circles/second

navic-AlmSqrtA

Parameter \sqrt{A} , square root of the semi-major axis, metres $^{1/2}$. Scale factor 2^{-11} metres $^{1/2}$.

navic-AlmOMEGAo

Parameter Ω_0 , longitude of ascending node of orbit plane at weekly epoch, semi-circles Scale factor 2^{-23} semi-circles.

Scale factor 2 Seriil-Circ

navic-AlmOmega

Parameter ω , argument of perigee semi-circles

Scale factor 2⁻²³ semi-circles.

navic-AlmMo

Parameter M₀, mean anomaly at reference time semi-circles

Scale factor 2⁻²³ semi-circles.

navic-Almaf0

Parameter a_{f0}, apparent satellite clock correction seconds

Scale factor 2⁻²⁰ seconds.

navic-Almaf1

Parameter a_{f1}, apparent satellite clock correction sec/sec

Scale factor 2⁻³⁸ semi-circles seconds/second.

– 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], [38], [39].

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), where UTC-ModelSet2 is used for BDS B1C, and UTC-ModelSet5 is used for BDS B1I; if the GNSS-ID indicates NavIC, the GNSS-UTC-Model contains a set of parameters needed to relate NavIC system time to the UTC (BIPM).

```
-- ASN1START
GNSS-UTC-Model ::= CHOICE {
   utcModel1 UTC-ModelSet1,
utcModel2 UTC-ModelSet2,
                                                   -- Model-1
                         UTC-ModelSet2,
                                                  -- Model-2
    utcModel3
                        UTC-ModelSet3,
                                                  -- Model-3
                        UTC-ModelSet4,
    utcModel4
                                                   -- Model-4
    utcModel5-r12
                        UTC-ModelSet5-r12
                                                   -- Model-5
-- ASN1STOP
```

UTC-ModelSet1

```
-- ASN1START
UTC-ModelSet1 ::= SEQUENCE {
```

```
UTC-ModelSet1 field descriptions
gnss-Utc-A1
Parameter A<sub>1</sub>, scale factor 2<sup>-50</sup> seconds/second [4,7,8].
gnss-Utc-A0
Parameter A<sub>0</sub>, scale factor 2<sup>-30</sup> seconds [4,7,8].
gnss-Utc-Tot
Parameter tot, scale factor 2<sup>12</sup> seconds [4,7,8].
gnss-Utc-WNt
Parameter WNt, scale factor 1 week [4,7,8].
gnss-Utc-DeltaTls
Parameter \Delta t_{LS}, scale factor 1 second [4,7,8].
gnss-Utc-WNIsf
Parameter WN<sub>LSF</sub>, scale factor 1 week [4,7,8].
gnss-Utc-DN
Parameter DN, scale factor 1 day [4,7,8].
gnss-Utc-DeltaTlsf
Parameter \Delta t_{LSF}, scale factor 1 second [4,7,8].
```

UTC-ModelSet2

```
-- ASN1START
UTC-ModelSet2 ::= SEQUENCE {
             INTEGER (-32768..32767),
   utcA0
                       INTEGER (-4096..4095),
   ut.cA1
                       INTEGER (-64..63),
    ut.cA2
   utcDeltaTls
                    INTEGER (-128..127),
   utcTot
utcWNot
                      INTEGER (0..65535),
INTEGER (0..8191),
   utcWNlsf
                      INTEGER (0..255)
   utcDN
utcDeltaTlsf
                       BIT STRING (SIZE(4)),
                     INTEGER (-128..127),
    Π
       utcWNlsf-ext-r16 INTEGER (256..8191) OPTIONAL -- Need ON
   ]]
}
-- ASN1STOP
```

UTC-ModelSet2 field descriptions

utcA0

Parameter A_{0-n}, bias coefficient of GNSS time scale relative to UTC time scale (seconds) [4], [5], [6], [7], [38], [39]. Scale factor 2⁻³⁵ seconds.

utcA1

Parameter A_{1-n}, drift coefficient of GNSS time scale relative to UTC time scale (sec/sec) [4], [5], [6], [7], [38], [39]. Scale factor 2⁻⁵¹ seconds/second.

utcA2

Parameter A_{2-n}, drift rate correction coefficient of GNSS time scale relative to UTC time scale (sec/sec²) [4], [5], [6], [7], [38], [39].

Scale factor 2⁻⁶⁸ seconds/second².

utcDeltaTls

Parameter Δt_{LS} , current or past leap second count (seconds) [4], [5], [6], [7], [38], [39]. Scale factor 1 second.

UTC-ModelSet2 field descriptions

utcTot

Parameter tot, time data reference time of week (seconds) [4], [5], [6], [7], [38], [39].

Scale factor 24 seconds.

utcWNot

Parameter WN_{ot}, time data reference week number (weeks) [4], [5], [6], [7], [38], [39]. Scale factor 1 week.

utcWNIsf, utcWNIsf-ext

Parameter WN_{LSF}, leap second reference week number (weeks) [4], [5], [6], [7], [38], [39].

If the field utcWNlsf-ext is present, the field utcWNlsf shall be ignored by the receiver.

Scale factor 1 week.

utcDN

Parameter DN, leap second reference day number (days) [4], [5], [6], [7], [38], [39].

Scale factor 1 day.

utcDeltaTlsf

Parameter Δt_{LSF} , current or future leap second count (seconds) [4], [5], [6], [7], [38], [39].

Scale factor 1 second.

UTC-ModelSet3

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

nΑ

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 $\Delta UT1$ (seconds) [9].

Scale factor 2⁻¹⁰ seconds.

b2

Parameter B2, coefficient to determine ΔUT1 (seconds/msd) [9].

Scale factor 2⁻¹⁶ seconds/msd.

kр

Parameter KP, notification of expected leap second correction (dimensionless) [9].

UTC-ModelSet4

UTC-ModelSet4 field descriptions utcA1wnt Parameter A_{1WNT}, sec/sec ([10], Message Type 12). Scale factor 2⁻⁵⁰ seconds/second. Parameter A_{0WNT}, seconds ([10], Message Type 12). Scale factor 2⁻³⁰ seconds. utcTot Parameter tot, seconds ([10], Message Type 12). Scale factor 2¹² seconds. utcWNt Parameter WNt, weeks ([10], Message Type 12). Scale factor 1 week. utcDeltaTls Parameter Δt_{LS}, seconds ([10], Message Type 12). Scale factor 1 second. utcWNIsf 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

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

Value of UTC Standard ID to UTC Standard relation

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

UTC-ModelSet5

([10], Message Type 12).

UTC-ModelSet5 field descriptions

utcA0

Parameter A_{OUTC}, BDS clock bias relative to UTC, seconds [23].

Scale factor 2⁻³⁰ seconds.

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.

utcWNIsf

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-BDS-r16
                          GNSS-ID-BDS-r16
    11
GNSS-ID-GPS ::= SEQUENCE
                           (SIZE(1..64)) OF GNSS-ID-GPS-SatElement
GNSS-ID-GPS-SatElement ::= SEQUENCE {
                       SV-ID,
   signalsAvailable GNSS-SignalIDs,
GNSS-ID-GLONASS ::= SEQUENCE (SIZE(1..64)) OF GNSS-ID-GLONASS-SatElement
GNSS-ID-GLONASS-SatElement ::= SEQUENCE {
                      SV-ID,
   signalsAvailable
                      GNSS-SignalIDs,
   channelNumber INTEGER (-7..13)
                                              OPTIONAL.
                                                              -- Cond FDMA
GNSS-ID-BDS-r16 ::= SEQUENCE
                              (SIZE(1..64)) OF GNSS-ID-BDS-SatElement-r16
GNSS-ID-BDS-SatElement-r16 ::= SEQUENCE {
                SV-ID,
   svID-r16
   satType-r16
                     INTEGER (0..3),
-- 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.

gnss-ID-BDS

This choice may only be present if GNSS-ID indicates BDS.

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].

satType

This field identifies the BDS B1C Satellite orbit type, defined in [39].

1 indicates the GEO satellite, 2 indicates the IGSO satellite, 3 indicates the MEO satellite, and 0 is reserved.

BDS-DifferentialCorrections

The IE *BDS-DifferentialCorrections* is used by the location server to provide differential corrections to the target device for BDS B1I.

```
-- 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-RURAI-r12
                                INTEGER (0..15),
                                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. dbds-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 5.3.3.8.2.

bds-RURAI

This field indicates Regional User Range Accuracy (RURA) information by Regional User Range Accuracy Index (UDREI) as defined in [23], clause 5.3.3.7.

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 metre.

BDS-GridModelParameter

The IE *BDS-GridModelParameter* is used by the location server to provide Ionospheric Grid Information to the target device for BDS B1I.

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.

gridlonList

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 5.3.3.9.

dt

This field indicates d_T as defined in [23], clause 5.3.3.9.1, i.e. the vertical delay at the corresponding IGP indicated by *igp-ID*.

The scale factor is 0.125 metre.

aivei

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 5.3.3.9.2.

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{
                                                        SV-ID,
    svID-r15
     integer-ms-r15
                                                        INTEGER (0..254)
                                                                                                 OPTIONAL,
                                                                                                                 -- Need ON
    rough-range-r15
    rough-phase-range-rate-r15
                                                        INTEGER (0..1023),
                                                                                       OPTIONAL, -- Need ON
                                                       INTEGER (-8192..8191)
     gnss-rtk-SatelliteSignalDataList-r15
                                                     GNSS-RTK-SatelliteSignalDataList-r15,
}
{\tt GNSS-RTK-SatelliteSignalDataList-r15} \ ::= \ {\tt SEQUENCE} \ ({\tt SIZE}(1...24)) \ {\tt OF}
                                                                        GNSS-RTK-SatelliteSignalDataElement-r15
    gibss-signalID-r15 ::= SEQUENCE {
gibss-signalID-r15 GNSS-SignalID,
fine-PseudoRange-r15 INTEGER (-5242
fine-PhaseRange-r15 INTEGER (-8388
lockTimeIndicator-r15
halfCycleAmbiguit
GNSS-RTK-SatelliteSignalDataElement-r15 ::= SEQUENCE {
                                                 INTEGER (-524288..524287),
INTEGER (-8388608..8388607),
                                                 INTEGER (0..1023),
    lockTimeIndicator-r15 INTEGER (0..1023)
halfCycleAmbiguityIndicator-r15 BIT STRING (SIZE
carrier-to-noise-ratio-r15 INTEGER (0..1023)
fine-PhaseRangeRate-r15 INTEGER (-16384...
                                                  BIT STRING (SIZE (1)),
                                                                                                 OPTIONAL,
                                                                                                                -- Need ON
                                                                                                 OPTIONAL,
     fine-PhaseRangeRate-r15
                                                 INTEGER (-16384..16383)
                                                                                                                -- 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*.

GNSS-RTK-Observations field descriptions

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.

Full pseudorange corresponding to the given signal is the sum of this field and the fields *integer-ms* and *rough-range*. NOTF 1.

Scale factor 2⁻²⁹ milli-seconds. Range ±(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.

The mapping of lock-time parameters as defined in [30] is according to the table *lockTimeIndicator* value to lock-time parameters relation shown below.

halfCycleAmbiquityIndicator

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) = $c/1000 \times (integer-ms + rough_range/1024 + 2^{-29} \times fine_Pseudorange(i))$, metre.
- NOTE 2: Complete Phaserange for each signal (i) of given satellite can be restored as follows: Phaserange(i) = $c/1000 \times (integer-ms + rough_range/1024 + 2^{-31} \times fine_Phaserange(i))$, metre.
- 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), metre/second.
- NOTE 4: The speed of light c is 299,792,458 metres per second.

lockTimeIndicator value (i)	Supplementary coefficient (k) [30]	Minimum Lock Time (ms) [30]	Range of Indicated Lock Times (t) (ms) [30]
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 x 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 x i − 65536	8192 ≤ t < 16384
320 – 351	512	512 × i – 147456	16384 ≤ t < 32768
352 – 383	1024	1024 x i − 327680	32768 ≤ t < 65536
384 – 415	2048	2048 x 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].

GLO-RTK-BiasInformation field descriptions

referenceStationID

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

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.

GLO-RTK-BiasInformation field descriptions

I1-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 metres.

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.

I1-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 metres.

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.

12-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 metres.

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.

12-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 metres.

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 GNSSs.

```
-- ASN1START
GNSS-RTK-MAC-CorrectionDifferences-r15 ::= SEQUENCE {
    networkID-r15
                                        GNSS-NetworkID-r15.
                                        GNSS-SubNetworkID-r15
    subNetworkID-r15
                                                                              OPTIONAL,
                                                                                          -- Need ON
    master-ReferenceStationID-r15 GNSS-ReferenceStationID-r15,
11-r15 GNSS-FrequencyID-r15
                                                                             OPTIONAL, -- Need OP
                                        GNSS-FrequencyID-r15
                                                                             OPTIONAL,
    12-r15
                                                                                          -- 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,
}
{\tt Geometric-Ionospheric-Corrections-Differences-r15} \ ::= \ {\tt SEQUENCE} \ ({\tt SIZE}(1...64)) \ {\tt OF}
                                     Geometric-Ionospheric-Corrections-Differences-Element-r15
Geometric-Ionospheric-Corrections-Differences-Element-r15 ::= SEQUENCE {
    svID-r15
                                                      SV-ID,
                                                      INTEGER (0..3),
    ambiguityStatusFlag-r15
    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.

I1 I2

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 metres. '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 millimetre; range ±32.767 metres.

iod

This field specifies the IOD value of the broadcast ephemeris used for calculation of Correction Differences (see IE GNSS-NavigationModel).

GNSS-RTK-MAC-CorrectionDifferences field descriptions

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 metres. '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 millimetre; range ±32.767 metres.

L1/L2 default interpretation

GNSS	I1	12
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 GNSSs.

```
-- ASN1START
GNSS-RTK-Residuals-r15 ::= SEQUENCE {
    epochTime-r15
                                        GNSS-SystemTime,
    referenceStationID-r15
                                        GNSS-ReferenceStationID-r15,
   n-Refs-r15
                                       INTEGER (0..127),
                                        GNSS-FrequencyID-r15
                                                                                      -- Need OP
-- Need OP
    11-r15
                                                                            OPTIONAL,
                                       GNSS-FrequencyID-r15
   12-r15
                                                                           OPTIONAL,
                                       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,
                       INTEGER (0..255),
   s-oc-r15
s-od-r15
                       INTEGER (0..511),
    s-oh-r15
                       INTEGER (0..63),
                       INTEGER (0..1023),
    s-lc-r15
    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.

I1. I2

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 millimetre; range 0–127 millimetre. 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-Ic

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 millimetre; range 0-511 millimetre

s-ld

This field specifies the distance dependent term of standard deviation (1 sigma) for dispersive interpolation residuals (as affecting L1 frequency), s_{id.} '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:

$$s_o = \sqrt{s_{0c}^2 + s_{0d}^2 \cdot d_{Ref}^2 + s_{0h}^2 \cdot dh_{Ref}^2}$$
 [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:

$$s_l(L1) = \sqrt{s_{lc}^2 + s_{ld}^2 \cdot d_{Ref}^2}$$
 [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:

 $s_1(L2) = s_1(L1) \cdot \frac{\lambda_2^2}{\lambda_1^2}$ [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 11, 12 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 GNSSs.

```
-- ASN1START

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

```
referenceStationID-r15
                                          GNSS-ReferenceStationID-r15,
    epochTime-r15
                                          GNSS-SystemTime,
    11-r15
                                          GNSS-FrequencyID-r15
                                                                                OPTIONAL,
                                                                                             -- Need OP
                                          GNSS-FrequencyID-r15
                                                                                 OPTIONAL,
                                                                                            -- Need OP
    12-r15
    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-TD.
                                          BIT STRING (SIZE(11)),
    iod-r15
    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),
                                         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*.

11. 12

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.

cvID

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 $\delta \rho_1$ 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_l , 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 GNSSs.

```
-- 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-radial-r15
      INTEGER (-2097152..2097151),

      delta-AlongTrack-r15
      INTEGER (-524288..524287),

      delta-CrossTrack-r15
      INTEGER (-524288..524287),

      dot-delta-radial-r15
      INTEGER (-1048576..1048575)

      dot-delta-AlongTrack-r15
      INTEGER (-262144..262143)

      dot-delta-CrossTrack-r15
      INTEGER (-262144..262143)

                                                                                                                                                 OPTIONAL,
                                                                                                                                                  OPTIONAL,
                                                                                                                                                  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 of *ssrUpdateInterval* 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 GNSSs 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 the cases that *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* + $\frac{1}{2} \times ssrUpdateInterval$. The reference time t_0 for ssrUpdateInterval '0' is *epochTime*.

Value of ssrUpdateInterval to SSR	Update Interval rel	ation
-----------------------------------	---------------------	-------

Value of	SSR Update Interval
ssrUpdateInterval	
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 GNSSs.

```
-- ASN1START
GNSS-SSR-ClockCorrections-r15 ::= SEQUENCE {
   epochTime-r15 GNSS-SystemTime, ssrUpdateInterval-r15 INTEGER (0..15), iod-ssr-r15
                                        INTEGER (0..15),
    iod-ssr-r15
    ssr-ClockCorrectionList-r15
                                        SSR-ClockCorrectionList-r15,
{\tt SSR-ClockCorrectionList-r15} ::= {\tt SEQUENCE} \ ({\tt SIZE}(1...64)) \ {\tt OF} \ {\tt SSR-ClockCorrectionSatelliteElement-r15}
SSR-ClockCorrectionSatelliteElement-r15 ::= SEQUENCE {
   svID-r15
                                        SV-ID,
   svID-r15
delta-Clock-C0-r15
                                        INTEGER (-2097152..2097151),
                                        delta-Clock-C1-r15
                                        INTEGER (-1048576..1048575)
    delta-Clock-C2-r15
-- 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 of *ssrUpdateInterval* 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/s²; range ± 1.34217726 m/s².

NOTE 1: The reference time t_0 is $epochTime + \frac{1}{2} \times ssrUpdateInterval$. 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 GNSSs.

```
-- 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 ::= SEOUENCE {
    svID-r15
                                           SV-TD.
    ssr-CodeBiasSignalList-r15
                                           SSR-CodeBiasSignalList-r15,
{\tt SSR-CodeBiasSignalList-r15} ::= {\tt SEQUENCE} \ ({\tt SIZE} (1..16)) \ {\tt OF} \ {\tt SSR-CodeBiasSignalElement-r15}
SSR-CodeBiasSignalElement-r15 ::= SEQUENCE {
    signal-and-tracking-mode-ID-r15
                                           GNSS-SignalID,
                                           INTEGER (-8192..8191),
    codeBias-r15
-- 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 of *ssrUpdateInterval* 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.

– GNSS-SSR-URA

The IE GNSS-SSR-URA is used by the location server to provide quality information for the provided SSR assistance data.

The parameters provided in IE *GNSS-SSR-URA* are used as specified for the SSR URA Messages (e.g., message type 1061 and 1067) in [30] and apply to all GNSSs.

```
-- ASN1START
GNSS-SSR-URA-r16 ::= SEQUENCE {
    epochTime-r16
                                        GNSS-SystemTime,
    ssrUpdateInterval-r16
                                        INTEGER (0..15),
    iod-ssr-r16
                                        INTEGER (0..15),
    ssr-URA-SatList-r16
                                        SSR-URA-SatList-r16,
}
SSR-URA-SatList-r16 ::= SEQUENCE (SIZE(1..64)) OF SSR-URA-SatElement-r16
SSR-URA-SatElement-r16 ::= SEQUENCE {
                                         SV-ID,
    svID-r16
    ssr-URA-r16
                                         BIT STRING (SIZE (6)),
-- ASN1STOP
```

GNSS-SSR-URA field descriptions

epochTime

This field specifies the epoch time of the SSR User Range Accuracy (URA). 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 of *ssrUpdateInterval* 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 SSR URA is provided.

ssr-URA

This field specifies the User Range Accuracy (URA) (1-sigma) for the range correction provided in the SSR assistance data. The URA is represented by a combination of CLASS and VALUE. The 3 MSB define the CLASS with a range of 0-7 and the 3 LSB define the VALUE with a range of 0-7. The URA is computed by:

$$SSR\ URA\ [mm] \le 3^{CLASS} \left(1 + \frac{VALUE}{4} - 1\right)\ [mm]$$

See Table 'Relationship between SSR troposphere quality and URA indicator and physical quantity' in IE GNSS-SSR-GriddedCorrection.

– GNSS-SSR-PhaseBias

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

The parameters provided in IE GNSS-SSR-PhaseBias are used as specified for Compact SSR GNSS Satellite Phase Bias Messages (e.g., message type 4073,5) in [43] and apply to all GNSSs.

```
-- ASN1START
GNSS-SSR-PhaseBias-r16 ::= SEQUENCE {
   epochTime-r16
                                       GNSS-SystemTime.
    ssrUpdateInterval-r16
                                       INTEGER (0..15),
    iod-ssr-r16
                                       INTEGER (0..15)
    ssr-PhaseBiasSatList-r16
                                       SSR-PhaseBiasSatList-r16,
}
SSR-PhaseBiasSatList-r16 ::= SEQUENCE (SIZE(1..64)) OF SSR-PhaseBiasSatElement-r16
SSR-PhaseBiasSatElement-r16 ::= SEOUENCE {
    svID-r16
                                       SV-TD.
    ssr-PhaseBiasSignalList-r16
                                       SSR-PhaseBiasSignalList-r16,
SSR-PhaseBiasSignalList-r16 ::= SEQUENCE (SIZE(1..16)) OF SSR-PhaseBiasSignalElement-r16
SSR-PhaseBiasSignalElement-r16 ::= SEQUENCE {
    signal-and-tracking-mode-ID-r16 GNSS-SignalID,
    phaseBias-r16
                                       INTEGER (-16384..16383),
    phaseDiscontinuityIndicator-r16
                                       INTEGER (0..3),
                                     INTEGER (0..3)
   phaseBiasIntegerIndicator-r16
                                                                       OPTIONAL,
                                                                                   -- Need OP
-- ASN1STOP
```

GNSS-SSR-PhaseBias field descriptions

epochTime

This field specifies the epoch time of the phase 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 of *ssrUpdateInterval* 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 phase biases are provided.

signal-and-tracking-mode-ID

This field specifies the GNSS signal for which the phase biases are provided.

phaseBias

This field provides the phase bias for the GNSS signal indicated by *signal-and-tracking-mode-ID*. Scale factor 0.001 m; range ±16.383 m.

phaseDiscontinuityIndicator

This field provides the phase discontinuity counter for the GNSS signal indicated by *signal-and-tracking-mode-ID*. This counter is increased for every discontinuity in phase (roll-over from 3 to 0).

phaseBiasIntegerIndicator

This field informs whether the phase bias is Undifferenced Integer (Value 0), Widelane Integer (Value 1) or Non-Integer (Value 2):

Value 0: The Undifferenced Integer Phase Bias supports PPP-RTK fixed, widelane or float mode.

Value 1: The Widelane Integer Phase Bias indicates that after application of the Phase Bias value, this signal can be differenced with any other signal from the same satellite that also has Widelane Integer Phase Bias indicated to form a new combined carrier phase measurement of integer quality, supporting PPP-RTK widelane fixed mode.

Value 2: The Non-Integer Phase Bias supports PPP-RTK float mode.

Value 3: Reserved.

If the phaseBiasIntegerIndicator field is not present then it is interpreted as having Value 0 (Undifferenced Integer).

GNSS-SSR-STEC-Correction

The IE *GNSS-SSR-STEC-Correction* is used by the location server to provide ionosphere slant delay correction. The ionosphere slant delay (STEC) consists of the polynomial part provided in *GNSS-SSR-STEC-Correction* and the residual part provided in *GNSS-SSR-GriddedCorrection*.

The parameters provided in IE *GNSS-SSR-STEC-Correction* are used as specified for Compact SSR STEC Correction Messages (e.g., message type 4073,8) in [43] and apply to all GNSSs.

```
GNSS-SSR-STEC-Correction-r16 ::= SEQUENCE {
   ssrUpdateInterval-r16 GNSS-SystemTime,
                                      INTEGER (0..15),
   iod-ssr-r16
   correctionPointSetID-r16
                                      INTEGER (0..16383),
   stec-SatList-r16
                                       STEC-SatList-r16,
STEC-SatList-r16 ::= SEQUENCE (SIZE(1..64)) OF STEC-SatElement-r16
STEC-SatElement-r16 ::= SEQUENCE {
   svID-r16
                                       SV-ID,
   stecQualityIndicator-r16
                                       BIT STRING (SIZE(6))
   stec-C00-r16
                                      INTEGER (-8192..8191),
   stec-C01-r16
                                       INTEGER (-2048..2047)
                                                                          OPTIONAL,
   stec-C10-r16
                                       INTEGER (-2048..2047)
                                                                          OPTIONAL,
                                       INTEGER (-512..511)
                                                                          OPTIONAL.
   stec-C11-r16
-- ASN1STOP
```

GNSS-SSR-STEC-Correction field descriptions

epochTime

This field specifies the epoch time of the STEC correction 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 of *ssrUpdateInterval* to SSR Update Interval relation in IE *GNSS-SSR-OrbitCorrections*.

correctionPointSetID

This field provides the ID of the GNSS-SSR-CorrectionPoints set. The reference point used for the STEC calculations (see NOTE below) is the reference point provided in IE GNSS-SSR-CorrectionPoints with the same correctionPointSetID.

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 STEC corrections are provided

stecQualityIndicator

This field specifies SSR STEC quality indicator. The STEC quality indicator is represented by a combination of CLASS and VALUE. The 3 MSB define the CLASS with a range of 0-7 and the 3 LSB define the VALUE with a range of 0-7. See Table 'Relationship between SSR STEC quality indicator and physical quantity' below.

stec-C00

This field provides the polynomial coefficient C_{00} used to define the STEC. as defined in [43]. NOTE Scale factor 0.05 TECU; range ± 409.55 TECU.

stec-C01

This field provides the polynomial coefficient C_{01} used to define the STEC as defined in [43]. NOTE Scale factor 0.02 TECU/deg; range ± 40.94 TECU/deg.

stec-C10

This field provides the polynomial coefficient C_{10} used to define the STEC as defined in [43]. NOTE Scale factor 0.02 TECU/deg; range ± 40.94 TECU/deg.

stec-C11

This field provides the polynomial coefficient C_{11} used to define the STEC as defined in [43]. NOTE Scale factor 0.02 TECU/deg²; range ± 10.22 TECU/deg².

NOTE: The polynomial coefficients C_{00} , C_{0l} , C_{10} , C_{1l} are used to define the STEC as follows:

(1) If only C_{00} is included in *STEC-SatElement*:

$$\delta Iai = C_{00}$$
.

(2) If only C_{00} , C_{01} and C_{10} are included in *STEC-SatElement*:

$$\delta Iai = C_{00} + C_{01}(\phi - \phi_0) + C_{10}(\lambda - \lambda_0).$$

(3) If all of C_{00} , C_{01} , C_{10} and C_{11} are included in STEC-SatElement:

$$\delta Iai = C_{00} + C_{01}(\phi - \phi_0) + C_{10}(\lambda - \lambda_0) + C_{11}(\phi - \phi_0) (\lambda - \lambda_0).$$

Other combinations of C_{00} , C_{01} , C_{10} , C_{11} than (1)-(3) above are undefined in this version of the specification.

The equations above depend on the latitude ϕ and longitude λ of an evaluated point and latitude ϕ_0 and longitude λ_0 of the reference point which is defined in IE *GNSS-SSR-CorrectionPoints* (referencePointLatitude and referencePointLongitude).

Relationship between SSR STEC quality indicator and physical quantity

CLASS	VALUE	Index	SSR STEC Quality Indicator Q [TECU]
7	7	63	33.6664 < Q
7	6	62	30.2992 < Q ≤ 33.6664
7	5	61	26.9319 < Q ≤ 30.2992
7	4	60	
7	3		
7	2	59 58	
7	1	57	
7	0	56	
6	7	55	
6	<u>6</u> 5	54 53	10.0956 < Q ≤ 11.2180 8.9732 < Q ≤ 10.0956
-			
6	3	52 51	7.8508 < Q ≤ 8.9732 6.7284 < Q ≤ 7.8508
6	2	50	5.6059 < Q ≤ 6.7284
6	1	49	4.4835 < Q ≤ 5.6059
6	0	48	4.1094 < Q ≤ 4.4835
5	7	47	3.7352 < Q ≤ 4.1094
5	6	46	3.3611 < Q ≤ 3.7352
5	5	45	2.9870 < Q ≤ 3.3611
5	4	44	2.6128 < Q ≤ 2.9870
5	3	43	2.2387 < Q ≤ 2.6128
5	2	42	1.8645 < Q ≤ 2.2387
5	1	41	1.4904 < Q ≤ 1.8645
5	0	40	1.3657 < Q ≤ 1.4904
4	7	39	1.2410 < Q ≤ 1.3657
4	6	38	1.1163 < Q ≤ 1.2410
4	5	37	0.9915 < Q ≤ 1.1163
4	4	36	0.8668 < Q ≤ 0.9915
4	3	35	0.7421 < Q ≤ 0.8668
4	2	34	$0.6174 < Q \le 0.7421$
4	1	33	0.4927 < Q ≤ 0.6174
4	0	32	0.4511 < Q ≤ 0.4927
3	7	31	0.4096 < Q ≤ 0.4511
3	6	30	$0.3680 < Q \le 0.4096$
3	5	29	$0.3264 < Q \le 0.3680$
3	4	28	0.2848 < Q ≤ 0.3264
3	3	27	0.2433 < Q ≤ 0.2848
3	2	26	$0.2017 < Q \le 0.2433$
3	1	25	$0.1601 < Q \le 0.2017$
3	0	24	0.1463 < Q ≤ 0.1601
2	7	23	$0.1324 < Q \le 0.1463$
2	6	22	0.1186 < Q ≤ 0.1324
	5	21	0.1047 < Q ≤ 0.1186
2	4	20	$0.0908 < Q \le 0.1047$
2	3	19	$0.0770 < Q \le 0.0908$
2	2	18	$0.0631 < Q \le 0.0770$
2	1	17	0.0493 < Q ≤ 0.0631
2	0	16	$0.0447 < Q \le 0.0493$
1	7	15	$0.0400 < Q \le 0.0447$
1	6	14	$0.0354 < Q \le 0.0400$
1	5	13	$0.0308 < Q \le 0.0354$
1	4	12	$0.0262 < Q \le 0.0308$
1	3	11	$0.0216 < Q \le 0.0262$
1	2	10	0.0169 < Q ≤ 0.0216
1	1	9	0.0123 < Q ≤ 0.0169
1	0	8	0.0108 < Q ≤ 0.0123
0	7	7	$0.0092 < Q \le 0.0108$
0	6	6	$0.0077 < Q \le 0.0092$
0	5	5	$0.0062 < Q \le 0.0077$
0	4	4	$0.0046 < Q \le 0.0062$
0	3	3	0.0031 < Q ≤ 0.0046
-			

0	2	2	$0.0015 < Q \le 0.0031$
0	1	1	Q ≤ 0.0015
0	0	0	undefined/unknown

GNSS-SSR-GriddedCorrection

The IE *GNSS-SSR-GriddedCorrection* is used by the location server to provide troposphere delay correction, together with the residual part of the STEC corrections.

The parameters provided in IE *GNSS-SSR-GriddedCorrection* are used as specified for Compact SSR Gridded Correction Message (e.g., message type 4073,9) in [43] and apply to all GNSSs.

```
GNSS-SSR-GriddedCorrection-r16 ::= SEQUENCE {
                                                    GNSS-SystemTime,
    epochTime-r16
    ssrUpdateInterval-r16
                                                    INTEGER (0..15),
    iod-ssr-r16
                                                   INTEGER (0..15),
                                                                                OPTIONAL, -- Cond Tropo
    troposphericDelayQualityIndicator-r16
                                                 BIT STRING (SIZE(6))
    correctionPointSetID-r16
                                                    INTEGER (0..16383),
    gridList-r16
                                                    GridList-r16,
}
GridList-r16 ::= SEQUENCE (SIZE(1..64)) OF GridElement-r16
GridElement-r16 ::= SEQUENCE {
    tropospericDelayCorrection-r16 TropospericDelayCorrection-r16 OPTIONAL, stec-ResidualSatList-r16 STEC-ResidualSatList-r16 OPTIONAL,
}
TropospericDelayCorrection-r16 ::= SEQUENCE {
    {\tt tropoHydroStaticVerticalDelay-r16} \qquad \qquad {\tt INTEGER} \ (-256..255) \,,
    tropoWetVerticalDelay-r16
                                               INTEGER (-128..127),
STEC-ResidualSatList-r16 ::= SEQUENCE (SIZE(1..64)) OF STEC-ResidualSatElement-r16
STEC-ResidualSatElement-r16 ::= SEQUENCE {
    svID-r16
                                           SV-ID,
    stecResidualCorrection-r16
                                           CHOICE {
                                              INTEGER (-64..63),
                     b7-r16
                     b16-r16
                                               INTEGER (-32768..32767)
-- ASN1STOP
```

Conditional presence	Explanation
Tropo	The field is mandatory present if tropospericDelayCorrection is included in gridList.
	Otherwise it is not present.

GNSS-SSR-GriddedCorrection field descriptions

epochTime

This field specifies the epoch time of the gridded correction 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 of *ssrUpdateInterval* 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.

troposphericDelayQualityIndicator

This field specifies the quality indicator of the tropospheric delay. The troposphere quality indicator is represented by a combination of CLASS and VALUE. The 3 MSB define the CLASS with a range of 0-7 and the 3 LSB define the VALUE with a range of 0-7. The troposphere quality indicator is computed by:

SSR Troposphere Quality [mm]
$$\leq 3^{\text{CLASS}} \left(1 + \frac{\text{VALUE}}{4}\right) - 1 \text{ [mm]}$$

See Table 'Relationship between SSR troposphere quality and URA indicator and physical quantity' below.

correctionPointSetID

This field provides the ID of the GNSS-SSR-CorrectionPoints set. The GNSS-SSR-GriddedCorrection are valid for the correction points provided in IE GNSS-SSR-CorrectionPoints with the same correctionPointSetID.

gridList

This field provides the troposphere delay correction together with the residual part of the STEC corrections for up to 64 correction points defined in IE GNSS-SSR-CorrectionPoints.

If the IE GNSS-SSR-CorrectionPoints, which belongs to the correctionPointSetID, includes the listOfCorrectionPoints, the gridList includes the same number of entries, and listed in the same order, as in the listOfCorrectionPoints.

If the IE GNSS-SSR-CorrectionPoints, which belongs to this correctionPointSetID, includes the

arrayOfCorrectionPoints the gridList includes the same number of entries, and listed in the same order, as defined by the enabled bits in the bitmaskOfGrids.

tropoHvdroStaticVerticalDelav

This field specifies the variation in the hydro static troposphere vertical delay relative to nominal value. The target device should add the constant nominal value of 2.3 m to calculate the tropospheric hydro-static vertical delay. Scale factor 0.004 m; range ±1.02 m.

tropoWetVerticalDelay

This field specifies the variation in the wet troposphere vertical delay relative to nominal value. The target device should add the constant value of 0.252 m to calculate the tropospheric wet (non hydro-static) vertical delay. Scale factor 0.004 m; range ±0.508 m.

svID

This field specifies the GNSS satellite for which the STEC residual corrections are provided.

stecResidualCorrection

This field specifies the STEC residual correction.

Scale factor 0.04 TECU; range ±2.52 TECU (b7) or ±1310.68 TECU (b16)

Relationship between SSR troposphere quality and URA indicator and physical quantity

CLASS	VALUE	Index	SSR troposphere quality indicator and
			SSR URA
			Q [mm]
7	7	63	5466.50 < Q
7	6	62	4919.75 < Q ≤ 5466.50
7	5	61	4373.75 < Q ≤ 4919.75
7	4	60	$3826.25 < Q \le 4373.00$
7	3	59	$3279.50 < Q \le 3826.25$
7	2	58	$2732.75 < Q \le 3279.50$
7	1	57	$2186.00 < Q \le 2732.75$
7	0	56	2003.75 < Q ≤ 2186.00
6	7	55	$1821.50 < Q \le 2003.75$
6	6	54	1639.25 < Q ≤ 1821.50
6	5	53	1457.00 < Q ≤ 1639.25
6	4	52	1274.75 < Q ≤ 1457.00
6	3	51	1092.50 < Q ≤ 1274.75
6	2	50	910.25 < Q ≤ 1092.50
6	1	49	$728.00 < Q \le 910.25$
6	0	48	667.25 < Q ≤ 728.00

5	7	47	606.50 < Q ≤ 667.25
5	6	46	545.75 < Q ≤ 606.50
5	5	45	485.00 < Q ≤ 545.75
5	4	44	424.25 < Q ≤ 485.00
5	3	43	$363.50 < Q \le 425.25$
5	2	42	$302.75 < Q \le 363.50$
5	1	41	242.00 < Q ≤ 302.75
5	0	40	221.75 < Q ≤ 242.00
4	7	39	201.50 < Q ≤ 221.75
4	6	38	181.25 < Q ≤ 201.50
4	5	37	161.00 < Q ≤ 181.25
4	4	36	140.75 < Q ≤ 161.00
4	3	35	120.50 < Q ≤ 140.75
4	2	34	100.25 < Q ≤ 120.50
4	1	33	80.00 < Q ≤ 100.25
4	0	32	73.25 < Q ≤ 80.00
3	7	31	66.50 < Q ≤ 73.25
3	6	30	59.75 < Q ≤ 66.50
3	5	29	53.00 < Q ≤ 59.75
3	4	28	46.25 < Q ≤ 53.00
3	3	27	39.50 < Q ≤ 46.25
3	2	26	32.75 < Q ≤ 39.50
3	1	25	26.00 < Q ≤ 32.75
3	0	24	23.75 < Q ≤ 26.00
2	7	23	21.50 < Q ≤ 23.75
2	6	22	19.25 < Q ≤ 21.50
2	5	21	17.00 < Q ≤ 19.25
2	4	20	14.75 < Q ≤ 17.00
2	3	19	12.50 < Q ≤ 14.75
2	2	18	10.25 < Q ≤ 12.50
2	1	17	
2	0	16	$8.00 < Q \le 10.25$ $7.25 < Q \le 8.00$
1	7	15	_
1	6	14	
1	5	13	5.00 < Q ≤ 5.75
1	4	12	4.25 < Q ≤ 5.00
1	2	11	3.50 < Q ≤ 4.25
1	1	10	2.75 < Q ≤ 3.50
		9	2.00 < Q ≤ 2.75
1	0	8	1.75 < Q ≤ 2.00
0	7	7	1.50 < Q ≤ 1.75
0	6	6	1.25 < Q ≤ 1.50
0	5	5	1.00 < Q ≤ 1.25
0	4	4	0.75 < Q ≤ 1.00
0	3	3	0.50 < Q ≤ 0.75
0	2	2	0.25 < Q ≤ 0.50
0	1	1	Q ≤ 0.25
0	0	0	undefined/unknown

NavIC-DifferentialCorrections

The IE *NavIC-DifferentialCorrections* parameters provide users with sets of correction terms that apply to the clock and ephemeris data transmitted by other satellites in the AutoNav mode as defined in [38] under clause 6.2.6.

NavIC-DifferentialCorrections field descriptions

navic-RefTOWC

The transmission timing of the navigation message provided through the Time of Week Count (TOWC) corresponding to the given set of grid ionospheric parameters. It indicates the number of 12 second counts represented in 17 bits. The TOW count value ranges from 1 to 50400 to cover one entire week. The Time of Week (TOW) in seconds is obtained by multiplying TOWC with 12 as defined in [38], clause 5.7.

navic-Tod

This field indicates the NavIC Time of Differential Correction in seconds.

Scale factor 16 seconds

navic-ioded

This field indicates Issue of Data Ephemeris and Clock which provides the user with a convenient means of detecting any change in the ephemeris and clock parameters as described under clause 6.2.1.3 in [38]

navic-UDRAI

This field indicates the index for the User Differential Range Accuracy (in metres) value which enables users to estimate the accuracy obtained after differential corrections are applied as described under clause 6.2.6 in [38]

navic-UDRAratel

This field indicates the index for the change rate of User Differential Range Accuracy (metres/second) value which enables users to estimate the accuracy obtained after differential corrections are applied as described under clause 6.2.6 in [38]

navic-AlphaEDC

This field indicates the Alpha correction to Ephemeris parameter ($\Delta\alpha$), which is one of the six keplerian elements defining the ephemeris differential corrections (EDC) for NavIC as defined under clause 6.1.3.5 in [38]. Scale factor 2^{-34}

navic-BetaEDC

This field indicates Beta correction to Ephemeris parameter ($\Delta\beta$), which is one of the six keplerian elements defining the ephemeris differential corrections (EDC) for NavIC as defined under clause 6.1.3.5 in [38]. Scale factor 2^{-34}

navic-GammaEDC

This field indicates the Gamma correction to Ephemeris parameter ($\Delta \gamma$), which is one of the six keplerian elements defining the ephemeris differential corrections (EDC) for NavIC as defined under clause 6.1.3.5 in [38]. Scale factor 2^{-32} semi-circles.

navic-Aolcorrection

This field indicates the Angle of inclination correction (Δi), which is one of the six keplerian elements defining the ephemeris differential corrections (EDC) for NavIC as defined under clause 6.1.3.5 in [38]. Scale factor 2^{-32} semi-circles.

navic-AoRAcorrection

This field indicates the Angle of right ascension correction ($\Delta\Omega$), which is one of the six keplerian elements defining the ephemeris differential corrections (EDC) for NavIC as defined under clause 6.1.3.5 in [38]. Scale factor 2^{-32} semi-circles.

navic-SemiMajorcorrection

This field indicates the Semi-major correction (ΔA), which is one of the six keplerian elements defining the ephemeris differential corrections (EDC) for NavIC as defined under clause 6.1.3.5 in [38]. Scale factor 2^{-9} metres.

navic-ClockBiasCorrection

This field indicates correction to the satellite clock bias coefficient (δ af0), which is one of the two Satellite clock differential corrections (CDC) containing corrections to the NavIC satellite clock polynomial coefficients as defined under clause 6.1.3.5 in [38].

Scale factor 2⁻³⁵ seconds.

navic-ClockDriftCorrection

This field indicates correction to the satellite clock drift coefficient (δ af1), which is one of the two Satellite clock differential corrections (CDC) containing corrections to the NavIC satellite clock polynomial coefficients as defined under clause 6.1.3.5 in [38].

Scale factor 2⁻⁵¹ sec / sec.

NavIC-GridModelParameter

```
regionID-r16 INTEGER (0..15),
     givei1-r16 INTEGER (0..15),
givd1-r16 INTEGER (0..511),
     givei2-r16 INTEGER (0..15),
givd2-r16 INTEGER (0..511)
                         INTEGER (0..511),
     givei3-r16
                       INTEGER (0..15),
     givd3-r16 INTEGER (0..511),
givei4-r16 INTEGER (0..15),
     givd4-r16 INTEGER (0..511),
givei5-r16 INTEGER (0..15),
givd5-r16 INTEGER (0..511),
                       INTEGER (0..15),
     givei6-r16
     givd6-r16
                        INTEGER (0..511),
     givei7-r16 INTEGER (0...511)
     givd7-r16
                         INTEGER (0..511),
     givei8-r16
                        INTEGER (0..15),
     givelo 1
givd8-r16
                      INTEGER (0..511),
                         INTEGER (0..15),
                       INTEGER (0..511),
     givd9-r16
     givei10-r16 INTEGER (0..15),
givd10-r16 INTEGER (0..511),
     giveil1-r16 INTEGER (0..15),
                         INTEGER (0..511),
     givdll-r16
     givei12-r16 INTEGER (0..15),
     givd12-r16 INTEGER (0..511),
givei13-r16 INTEGER (0..15),
givd13-r16 INTEGER (0..511),
     givei14-r16
                         INTEGER (0..15),
     givd14-r16 INTEGER (0..511)
givei15-r16 INTEGER (0..15),
INTEGER (0..511)
                        INTEGER (0..511),
     givd15-r16
                         INTEGER (0..511),
-- ASN1STOP
```

NavIC-GridModelParameter field descriptions

navic-RefTOWC

The transmission timing of the navigation message provided through the Time of Week Count (TOWC) corresponding to the given set of grid ionospheric parameters. It indicates the number of 12 second counts represented in 17 bits. The TOW count value ranges from 1 to 50400 to cover one entire week. The Time of Week (TOW) in seconds is obtained by multiplying TOWC with 12 as defined in [38], clause 5.7.

regionMasked

Total 90 Ionospheric Grid Points(IGP) are defined in [38] clause 6.2.3 table 25. 15 IGP points are grouped into a single region. The region masked indicates the total number of regions for which the corrections are provided. For the current service area of the IRNSS, regions masked are 6.

regionlgpList

This list provides the set of IGPs corresponding to each region. Up to 6 instances (0 to 5) are used in this version of the specification. The values 6 to 15 are reserved for future use.

regionID

regionID along with index of the IGPS point corresponding gives the location of IGPS point as defined in [38], table 25, clause 6.2.3.

givei1, give2, .. , give15

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 the *igp-ID*, the mapping between GIVEI and GIVE is defined in [38], clause 6.2.2 and table 27.

givd1, givd2, ..., givd15

This field indicates the Grid Ionospheric Vertical Delay (GIVD) as defined in [38], clause 5.3.3.8.1, i.e. the vertical delay at the corresponding Ionospheric Grid points (IGPs) indicated by *igp-ID*. The scale factor is 0.125 metre.

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
```

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,
	- GNSS-SSR-CodeBiasReq.
	- GNSS-SSR-URA-Req,
	- GNSS-SSR-PhaseBiasReq,
	- GNSS-SSR-STEC-CorrectionReq, or
	- GNSS-SSR-GriddedCorrectionReg.

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
    ]],
        gnss-SSR-CorrectionPointsReq-r16
                                        GNSS-SSR-CorrectionPointsReq-r16
                                                                OPTIONAL -- Cond PointsReq
    ]]
-- 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-lonosphericModel;
	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.
PointsReq	This field is mandatory present if the target device requests GNSS-SSR-CorrectionPoints;
	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 GNSSs. 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 {
                                                                                  OPTIONAL, -- Cond GNSS-ID-SBAS
    sbas-ID
                                           SBAS-ID
                                           SBAS-ID OPTIONAL, -- Cond GNSS-ID-SBA
GNSS-TimeModelListReq OPTIONAL, -- Cond TimeModReq
    anss-TimeModelsReq
    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 GNSS-DataBitAssistanceReq OPTIONAL, -- Cond DataBitsReq gnss-AcquisitionAssistanceReq GNSS-AcquisitionAssistanceReq GNSS-AlmanacReq GNSS-AlmanacReq GNSS-AlmanacReq OPTIONAL, -- Cond AcquAssistReq gnss-UTCModelReq GNSS-UTC-ModelReq OPTIONAL, -- Cond UTCModReq
    gnss-UTCModelReq GNSS-UTC-ModelReq OPTIONAL, -- Cond UTCModReq gnss-AuxiliaryInformationReq GNSS-AuxiliaryInformationReq OPTIONAL, -- Cond AuxInfoReq
         bds-DifferentialCorrectionsReg-r12
                                           BDS-DifferentialCorrectionsReq-r12
                                                                                  OPTIONAL, -- Cond DBDS-Req
                                                                                  OPTIONAL -- Cond BDS-GridModReq
         bds-GridModelReq-r12
                                        BDS-GridModelReq-r12
    [[
         gnss-RTK-ObservationsReq-r15
                                           GNSS-RTK-ObservationsReq-r15 OPTIONAL,
                                                                                                 -- Cond RTK-OSR-Reg
         glo-RTK-BiasInformationReq-r15
                                           GLO-RTK-BiasInformationReq-r15 OPTIONAL,
                                                                                                 -- Cond GLO-CPB-Req
         gnss-RTK-MAC-CorrectionDifferencesReq-r15
                                           GNSS-RTK-MAC-CorrectionDifferencesReg-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
    ]],
    [ [
         gnss-SSR-URA-Req-r16
                                           GNSS-SSR-URA-Req-r16
                                                                                   OPTIONAL,
                                                                                                 -- Cond URA-Req
         gnss-SSR-PhaseBiasReq-r16
gnss-SSR-STFC-Correction
                                                                                  OPTIONAL,
                                                                                                 -- Cond PB-Req
         gnss-SSR-STEC-CorrectionReq-r16
                                                                                                 -- Cond STEC-Req
                                           GNSS-SSR-STEC-CorrectionReq-r16 OPTIONAL,
         gnss-SSR-GriddedCorrectionReq-r16 GNSS-SSR-GriddedCorrectionReq-r16
                                                                                   OPTIONAL,
                                                                                                 -- Cond Grid-Req
         navic-DifferentialCorrectionsReq-r16
```

```
NavIC-DifferentialCorrectionsReq-r16
OPTIONAL, -- Cond DNavIC-Req
navic-GridModelReq-r16
NavIC-GridModelReq-r16
OPTIONAL -- Cond NavIC-GridModReq
]]
}
-- 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 <i>gnss-ID</i> indicates 'bds'.
BDS-GridModReq	The field is mandatory present if the target device requests BDS-GridModel; otherwise it
DT/(00D D	is not present. This field may only be present if <i>gnss-ID</i> indicates 'bds'.
RTK-OSR-Req	The field is mandatory present if the target device requests GNSS-RTK-Observations;
01.0.000.0	otherwise it is not present.
GLO-CPB-Req	The field is mandatory present if the target device requests GLO-RTK-BiasInformation;
MAC Door	otherwise it is not present.
MAC-Req	The field is mandatory present if the target device requests
Dog Dog	GNSS-RTK-MAC-CorrectionDifferences; otherwise it is not present.
Res-Req	The field is mandatory present if the target device requests GNSS-RTK-Residuals;
FKP-Req	otherwise it is not present. The field is mandatory present if the target device requests GNSS-RTK-FKP-Gradients;
rkr-keq	otherwise it is not present.
OC-Req	The field is mandatory present if the target device requests GNSS-SSR-OrbitCorrections;
OC-Neg	otherwise it is not present.
CC-Req	The field is mandatory present if the target device requests GNSS-SSR-ClockCorrections;
CC-Neg	otherwise it is not present.
CB-Req	The field is mandatory present if the target device requests GNSS-SSR-CodeBias;
OB Neg	otherwise it is not present.
URA-Req	The field is mandatory present if the target device requests <i>GNSS-SSR-URA</i> ; otherwise it
or or riog	is not present.
PB-Req	The field is mandatory present if the target device requests GNSS-SSR-PhaseBias;
. =	otherwise it is not present.
STEC-Reg	The field is mandatory present if the target device requests GNSS-SSR-STEC-Correction;
- · ·	otherwise it is not present.
Grid-Req	The field is mandatory present if the target device requests
•	GNSS-SSR-GriddedCorrection; otherwise it is not present.
DNavIC-Req	The field is mandatory present if the target device requests NavIC-DifferentialCorrections;
	otherwise it is not present. This field may only be present if the <i>gnss-ID</i> indicates 'navic'.
NavIC-GridModReq	The field is mandatory present if the target device requests NavIC-GridModel; otherwise it
	is not present. This field may only be present if the <i>gnss-ID</i> indicates 'navic'.

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-PeriodicControlParam-r15 OPTIONAL, -- Cond pRes
     gnss-RTK-PeriodicResidualsReq-r15
     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-PeriodicCodeBiasReg-r15
                                                       GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pCB
    [[
                                                      GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pURA GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pPB
     gnss-SSR-PeriodicURA-Req-r16
     gnss-SSR-PeriodicPhaseBiasReq-r16
    gnss-SSR-PeriodicPhaseBiasReq-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pPB gnss-SSR-PeriodicSTEC-CorrectionReq-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pSTEC
     gnss-SSR-PeriodicGriddedCorrectionReq-r16
                                                       GNSS-PeriodicControlParam-r15 OPTIONAL -- Cond pGrid
     ]]
-- ASN1STOP
```

Conditional presence	Explanation
pOSR	The field is mandatory present if the target device requests periodic
	GNSS-RTK-Observations; otherwise it is not present.
рСРВ	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.
pURA	The field is mandatory present if the target device requests periodic GNSS-SSR-URA;
	otherwise it is not present.
pPB	The field is mandatory present if the target device requests periodic
	GNSS-SSR-PhaseBias; otherwise it is not present.
pSTEC	The field is mandatory present if the target device requests periodic
	GNSS-SSR-STEC-Correction; otherwise it is not present.
pGrid	The field is mandatory present if the target device requests periodic
	GNSS-SSR-GriddedCorrection; 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.

Conditional presence	Explanation
gps	The field is mandatory present if <i>gnss-TimeReqPrefList</i> includes a <i>GNSS-ID</i> = 'gps';
	otherwise it is not present.
glonass	The field is mandatory present if <i>gnss-TimeReqPrefList</i> includes a <i>GNSS-ID</i> = '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
    ...,
    [[ klobucharModel2Req-r16 NULL OPTIONAL -- Cond klobuchar2
    ]]
}

-- 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.
klobuchar2	The field is mandatory present if the target device requests klobucharModel2; otherwise it
	is not present.

GNSS-EarthOrientationParametersReg

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.

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.

antennaHeightReg

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.

GNSS-RTK-AuxiliaryStationDataReq field descriptions

master-referenceStationID

This field specifies the Master Reference Station ID for which the Auxiliary Stations are requested.

– GNSS-SSR-CorrectionPointsReq

The IE GNSS-SSR-CorrectionPointsReq is used by the target device to request the GNSS-SSR-CorrectionPoints assistance from the location server.

GNSS-SSR-CorrectionPointsReq field descriptions

correctionPointSetID-Req

This field specifies the ID of the Atmospheric Correction Point set for which the *GNSS-SSR-CorrectionPoints* 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-TimeModelElementReg 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.

deltaTrea

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'.

GNSS-DifferentialCorrectionsReq field descriptions

dgnss-ValidityTimeReg

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),
                               INTEGER (0..15),
    satListRelatedDataList SatListRelatedDataList OPTIONAL,
}
SatListRelatedDataList ::= SEQUENCE (SIZE (1..64)) OF SatListRelatedDataElement
SatListRelatedDataElement ::= SEOUENCE {
    svID
                         SV-ID,
    iod
                     BIT STRING (SIZE(11)),
    clockModelID INTEGER (1..8) OPTIONAL, orbitModelID INTEGER (1..8) OPTIONAL,
ReqNavListInfo ::= SEQUENCE {
                     BIT STRING (SIZE (64)),
   svReqList
    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
orbitModeIID-2	The field is mandatory present if orbitModelID-PrefList is absent or includes a Model-ID =
	'2'; otherwise it is not present.

GNSS-NavigationModelReg 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*.

regNavList

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-NavigationModelReq field descriptions

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.

addNavparamReg

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
navic	8	8

GNSS-ID to clockModelID-PrefList & orbitModelID-PrefList relation

GNSS-ID	clockModelID-PrefList	orbitModeIID-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	
navic	Model-8	Model-8	

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.

GNSS-DataBitAssistanceReg 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.

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.

GNSS-AlmanacReq field descriptions

modeIID

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
navic	8

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.

GNSS-UTC-ModelReq field descriptions

modelIL

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
navic	2

– 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-SignalsReg

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'. This only applies for the B1I signal.

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,
    ...
}
```

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.

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.

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.

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-GradientsReg

The IE GNSS-RTK-FKP-GradientsReq is used by the target device to request the GNSS-RTK-FKP-Gradients assistance from the location server.

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-Combinations List 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.

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.

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.

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*.

– GNSS-SSR-URA-Req

The IE GNSS-SSR-URA-Req is used by the target device to request the GNSS-SSR-URA assistance from the location server.

```
-- ASN1START

GNSS-SSR-URA-Req-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

– GNSS-SSR-PhaseBiasReq

The IE GNSS-SSR-PhaseBiasReq is used by the target device to request the GNSS-SSR-PhaseBias assistance from the location server.

GNSS-SSR-PhaseBiasReq field descriptions

signal-and-tracking-mode-ID-Map

This field specifies the GNSS signal(s) for which the GNSS-SSR-PhaseBias 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.

– GNSS-SSR-STEC-CorrectionReq

The IE GNSS-SSR-STEC-CorrectionReq is used by the target device to request the GNSS-SSR-STEC-Correction assistance from the location server.

```
-- ASN1START

GNSS-SSR-STEC-CorrectionReq-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

– GNSS-SSR-GriddedCorrectionReq

The IE GNSS-SSR-GriddedCorrectionReq is used by the target device to request the GNSS-SSR-GriddedCorrection assistance from the location server.

```
-- ASN1START

GNSS-SSR-GriddedCorrectionReq-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

NavIC-DifferentialCorrectionsReq

The IE NavIC-DifferentialCorrectionsReq is used by the target device to request the NavIC-DifferentialCorrections assistance from the location server.

```
-- ASN1START

NavIC-DifferentialCorrectionsReq-r16 ::= SEQUENCE {
    dgnss-SignalsReq-r16 GNSS-SignalIDs,
    ...
}

-- ASN1STOP
```

NavIC-DifferentialCorrectionsReq field descriptions

dgnss-SignalsReq

This field specifies the NavIC Signal(s) for which the *NavIC-DifferentialCorrections* are requested. A one-value at a bit position means the NavIC 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'.

NavIC-GridModelReq

The IE NavIC-GridModelReq is used by the target device to request the NavIC-GridModel assistance from the location server.

```
-- ASN1START

NavIC-GridModelReq-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

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.

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 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
gnss-TimeID GNSS-ID,
networkTime CHOICE {
                         INTEGER (0..127)
                                                        OPTIONAL,
        eUTRA SEQUENCE {
                physCellId INTEGER (0..503), cellGlobalId CellGlobalIdEUTRA
                                      CellGlobalIdEUTRA-AndUTRA
                                                                       OPTIONAL,
                 systemFrameNumber BIT STRING (SIZE (10)),
        uTRA
                 SEQUENCE {
                                           CHOICE {
                 mode
                                                        SECUENCE {
                                           fdd
                                                        primary-CPICH-Info INTEGER (0..511),
                                           bb+
                                                        SEQUENCE {
                                                        cellParameters
                                                                             INTEGER (0..127),
                 cellGlobalId
                                           CellGlobalIdEUTRA-AndUTRA
                                                                              OPTIONAL,
                 referenceSystemFrameNumber
                                           INTEGER (0..4095),
        gSM
                 SEQUENCE {
                 bcchCarrier
                                      INTEGER (0..1023),
                                      INTEGER (0..63),
                 bsic
                 cellGlobalId
                                     CellGlobalIdGERAN
SEQUENCE {
                                                                             OPTIONAL.
                 referenceFrame
                                       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
                                                                     OPTTONAL.
                 sfn-r14 BIT STRING (SIZE (10)),
hyperSFN-r14 BIT STRING (SIZE (10))
                                       BIT STRING (SIZE (10)),
                                                                     OPTIONAL,
```

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.

cellGloballd

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].

MeasurementReferenceTime field descriptions

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.

nbPhvsCellId

This field identifies the reference cell, as defined in TS 36.331 [12] that is used for the GNSS-network time relation.

nbCellGloballd

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.

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 TS 38.331 [35], that is used for the GNSS-network time relation.

nrCellGloballD

This field specifies the NR Cell Global Identifier (NCGI) of the reference cell, as defined in 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 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).

```
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), ...},
    carrierQualityInaccodePhase INTEGER (0..205/151, optional, integerCodePhase INTEGER (0..127) OPTIONAL, codePhaseRMSError INTEGER (0..63), doppler INTEGER (-32768..32767) OPTIONAL, INTEGER (0..33554431) OPTIONAL,
     carrierQualityInd INTEGER (0..3)
                                                                    OPTIONAL,
     [[
          adrSign-r15
                                    INTEGER (0..15)
                                                                                    OPTIONAL,
          adrSign-r15 ENUMERATED {positive, negative} adrRMSerror-r15 INTEGER (0..127)
                                                                                    OPTIONAL.
                                                                                    OPTIONAL,
          delta-codePhase-r15 INTEGER (0..7)
                                                                                    OPTIONAL
     11
-- 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.

GNSS-MeasurementList field descriptions

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 the 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 <code>gnss-CodePhaseAmbiguity</code>. The value of the ambiguity is given in the <code>gnss-CodePhaseAmbiguity</code> field. The <code>integerCodePhase</code> is optional. If <code>integerCodePhase</code> 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.

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 metre/second. This field is optional, but shall be included, if the *velocityRequest* in

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 metre by multiplying the ADR measurement by the nominal wavelength of the measured signal.

Scale factor 2⁻¹⁰ metres, in the range from 0 to 32767.5 metres. 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 the case the ADR measurement is outside the range of the field *adr* alone. Scale factor 32768 metres.

If present, the full ADR measurement is constructed as $adrMSB \times 32768 + adr \times 2^{-10}$ metres, representing measurements in the range from 0 to 524287.9990234375 metres.

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.

CommonlEsRequestLocationInformation is set to TRUE.

adrRMSerror

This field contains the ADR root mean squared error value. Scale factor 2⁻¹⁰ metres.

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 $codePhase \times 2^{-21} + delta-codePhase \times 2^{-24}$ milli-seconds, in the range from 0 to $(1-2^{-24})$ milli-seconds.

Value of mpathDet to Multipath Indication relation

Value of	Multipath Indication

mpathDet	
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
1	х	у	$0.5 * (1 + x/8) * 2^{y}$	$x_{i-1} <= P < x_i$
62	110	111	112	104 <= P < 112
63	111	111		112 <= P

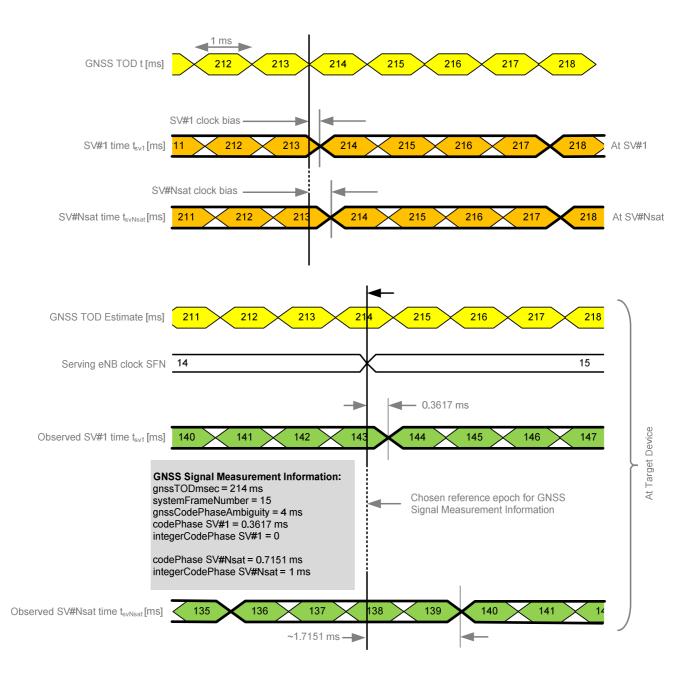


Figure 6.5.2.6-1: Exemplary calculation of some GNSS Signal Measurement Information fields.

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.

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.

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,
   adrMeasReq
   multiFreqMeasReq
                               BOOLEAN,
    assistanceAvailability
                               BOOLEAN,
    Π
       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.

GNSS-PositioningInstructions field descriptions

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-Reg

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 velocityTypes VelocityTypes
                                                                                OPTIONAL.
     velocityTypes
                                                                                OPTIONAL,
     [[ periodicalReportingNotSupported-r14
                                                                                OPTIONAL,
                                       PositioningModes
          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,
                                             SEQUENCE {
     fta-MeasSupport
                                                 cellTime AccessTypes,
                                                         PositioningModes,
                                                  mode
                                                                                OPTIONAL, -- Cond fta
     adr-Support
                                             BOOLEAN,
     velocityMeasurementSupport
                                            BOOLEAN,
          adrEnhancementsSupport-r15 ENUMERATED { true }
                                                                               OPTIONAL,
          ha-gnss-Modes-r15
                                             PositioningModes
     ]]
}
AssistanceDataSupportList ::= SEQUENCE {
    gnss-CommonAssistanceDataSupport
gnss-GenericAssistanceDataSupport
gnss-GenericAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
gnss-CommonAssistanceDataSupport
-- 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-SupportListReg* 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

IocationCoordinateTypes

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 *CommonlEsRequestLocationInformation* 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 clause 5.2.1a; bit (1) (unsolicited) represents the procedure according to 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
    {\tt gnss-EarthOrientationParametersSupport} \quad {\tt GNSS-EarthOrientationParametersSupport}
                                                                 OPTIONAL, -- Cond EOPSup
    Π
        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-lonosphericModel;
	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

GNSS-lonosphericModelSupport 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,
                                                                                                                                                                                                            OPTIONAL, -- Cond GNSS-ID-SBAS
                                                                                                                        SBAS-ID
            gnss-TimeModelsSupport
                                                                                                                       GNSS-TimeModelListSupport
                                                                                                                                                                                                            OPTIONAL, -- Cond TimeModSup
            {\tt gnss-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrectionsSupport~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-DifferentialCorrections~GNSS-Differ
                                                                                                                                                                                                           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
   ]],
   ίí
       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
   [[
                                                               OPTIONAL,
       gnss-SSR-URA-Support-r16
                                      GNSS-SSR-URA-Support-r16
                                                                              -- Cond URA-Sup
       gnss-SSR-PhaseBiasSupport-r16 GNSS-SSR-PhaseBiasSupport-r16
                                                                 OPTIONAL, -- Cond PB-Sup
       gnss-SSR-STEC-CorrectionSupport-r16
                                      GNSS-SSR-STEC-CorrectionSupport-r16
                                                                  OPTIONAL, -- Cond STEC-Sup
       {\tt gnss-SSR-GriddedCorrectionSupport-r16}
                                      GNSS-SSR-GriddedCorrectionSupport-r16
                                                                  OPTIONAL,
                                                                              -- Cond Grid-Sup
       navic-DifferentialCorrectionsSupport-r16
                                      NavIC-DifferentialCorrectionsSupport-r16
                                                              OPTIONAL, -- Cond DNavIC-Sup
       navic-GridModelSupport-r16 NavIC-GridModelSupport-r16
                                                              OPTIONAL
                                                                       -- Cond NavIC-GridModSup
   11
-- 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 <i>GNSS-DifferentialCorrections</i> ; 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 <i>BDS-DifferentialCorrections</i> ; otherwise it is not present. This field may only be present if <i>gnss-ID</i> indicates 'bds'.

Conditional presence	Explanation
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 <i>gnss-ID</i> 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 <i>gnss-ID</i> 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.
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.
URA-Sup	The field is mandatory present if the target device supports GNSS-SSR-URA; otherwise it
	is not present.
PB-Sup	The field is mandatory present if the target device supports GNSS-SSR-PhaseBias;
	otherwise it is not present.
STEC-Sup	The field is mandatory present if the target device supports GNSS-SSR-STEC-Correction;
	otherwise it is not present.
Grid-Sup	The field is mandatory present if the target device supports
	GNSS-SSR-GriddedCorrection; otherwise it is not present. Note, support for
	GNSS-SSR-GriddedCorrection implies support for GNSS-SSR-CorrectionPoints as well.
DNavIC-Sup	The field is mandatory present if the target device supports NavIC-DifferentialCorrections;
	otherwise it is not present. This field may only be present if the <i>gnss-ID</i> indicates 'navic'.
NavIC-GridModSup	The field is mandatory present if the target device supports NavIC-GridModel; otherwise it
	is not present. This field may only be present if the <i>gnss-ID</i> indicates 'navic'.

GNSS-TimeModelListSupport

```
-- ASN1START

GNSS-TimeModelListSupport ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

GNSS-DifferentialCorrectionSupport

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
{\tt GNSS-NavigationModelSupport} ::= {\tt SEQUENCE} \ \{
                                 model-1
   clockModel BIT STRING {
                                               (0),
                                   model-2
                                               (1),
                                   model-3
                                               (2),
                                   model-4
                                               (3),
                                   model-5
                                               (4).
                                   model-6
                                               (5),
                                   model-7-r16 (6),
                                   model-8-r16 (7) } (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),
                                   model-7-r16 (6),
                                   model-8-r16 (7) } (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 the target device supports NavIC and GNSS-NavigationModel assistance, it shall support clockModel Model-8. 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 the target device supports NavIC and GNSS-NavigationModel assistance, it shall support orbitModel Model-8. 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

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 {
                     BIT STRING {
                                      model-1
                                                  (0).
   almanacModel
                                      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

```
}
-- 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

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.

- GNSS-SSR-URA-Support

```
-- ASN1START

GNSS-SSR-URA-Support-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

GNSS-SSR-PhaseBiasSupport

GNSS-SSR-PhaseBiasSupport field descriptions

signal-and-tracking-mode-ID-Sup

This field specifies the GNSS signal(s) for which the GNSS-SSR-PhaseBias is supported by the target device.

GNSS-SSR-STEC-CorrectionSupport

```
-- ASN1START

GNSS-SSR-STEC-CorrectionSupport-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

GNSS-SSR-GriddedCorrectionSupport

```
-- ASN1START

GNSS-SSR-GriddedCorrectionSupport-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

NavIC-DifferentialCorrectionsSupport

```
-- ASN1START

NavIC-DifferentialCorrectionsSupport-r16 ::= SEQUENCE {
    gnssSignalIDs-r16 GNSS-SignalIDs,
    ...
}

-- ASN1STOP
```

NavIC-DifferentialCorrectionsSupport field descriptions

gnssSignalIDs

This field specifies the NavIC 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 NavIC signal type is supported; a zero-value means not supported.

NavIC-GridModelSupport

```
-- ASN1START

NavIC-GridModelSupport-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

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.

assistanceDataSupportListReg

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.

IocationVelocityTypesReq

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.

GNSS-LocationServerErrorCauses

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

GNSS-LocationServerErrorCauses field descriptions

cause

This field provides a GNSS specific error cause. The cause values

'unconfirmedPeriodicAssistanceDataIsNotSupported',

'unconfirmedPeriodicAssistanceDataIsSupportedButCurrentlyNotAvailable' and

'unconfirmedPeriodicAssistanceDatalsPartlyNotSupportedAndPartlyNotAvailable' may only be included in the control transaction of a periodic assistance data transfer procedure, as described in 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 clauses 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 {
          ENUMERATED { undefined,
                              thereWereNotEnoughSatellitesReceived,
                              assistanceDataMissing.
                             notAllRequestedMeasurementsPossible,
                          },
   fineTimeAssistanceMeasurementsNotPossible NULL
                                                            OPTIONAL,
   adrMeasurementsNotPossible
                                                NULL
                                                            OPTIONAL.
                                                            OPTIONAL,
   multiFrequencyMeasurementsNotPossible
                                                NULL
-- 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*.

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
---------	-------------	----------

		Explanation			
System	Value	Link	Centre Frequency [MHz]		
GPS	0	L1	1575.42		
	1	L2	1227.60		
	2	L5	1176.45		
	3-7	res	served		
SBAS	0	L1	1575.42		
	1	L5	1176.45		
	2-7	res	served		
QZSS	0	L1	1575.42		
	1	L2	1227.60		
	2	L5	1176.45		
	3-7	res	served		
GLONASS	0	G1	1602+k×0.5625		
k = -713	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	res	served		
BDS	0	B1I	1561.098		
	1	B1C	1575.420		
	2	B2	1207.140		
	3	B3	1268.520		
	4-7	reserved			
NavIC	0	L5	1176.450		
	1-7	res	served		

– GNSS-ID

The IE GNSS-ID is used to indicate a specific GNSS.

GNSS-ID-Bitmap

The IE GNSS-ID-Bitmap is used to indicate several GNSSs using a bit map.

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

– GNSS-NavListInfo

– 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].

GNSS-PeriodicControlParam

The IE GNSS-PeriodicControlParam is used to specify control parameters for a periodic assistance data delivery.

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.

GNSS-ReferenceStationID field descriptions

referenceStationID

This field provides the reference station identity.

providerName

This field is associated with 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.

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

<u>.</u>		
	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
		QZS-L2C QZS-L5
	3 4	
	3	QZS-L5
	3	QZS-L5 QZS-LEX S
	3 4 5	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L
	3 4 5 6	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M)
	3 4 5 6 7	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L
	3 4 5 6 7 8	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L)
	3 4 5 6 7 8 9	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L) QZS-L2 L2C(M+L)
	3 4 5 6 7 8 9	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L) QZS-L2 L2C(M+L) QZS-L5 I
	3 4 5 6 7 8 9 10	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L) QZS-L2 L2C(M+L) QZS-L5 I QZS-L5 Q
	3 4 5 6 7 8 9 10 11 12	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L) QZS-L2 L2C(M+L) QZS-L5 I QZS-L5 I QZS-L5 I+Q
	3 4 5 6 7 8 9 10 11 12 13	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L) QZS-L2 L2C(M+L) QZS-L5 I QZS-L5 I QZS-L5 I+Q QZS L1 L1C(D)
	3 4 5 6 7 8 9 10 11 12 13 14	QZS-L5 QZS-LEX S QZS-LEX L QZS-LEX S+L QZS-L2 L2C(M) QZS-L2 L2C(L) QZS-L2 L2C(M+L) QZS-L5 I QZS-L5 I QZS-L5 I+Q QZS L1 L1C(D) QZS L1 L1C(P)

OL ONIA CO		01 011 00 04 0/4
GLONASS	0	GLONASS G1 C/A
	1	GLONASS G2 C/A
	2	GLONASS G3
	3	GLONASS G1 P
	4	GLONASS G2 P
	5	GLONASS G1a(D)
	6	GLONASS G1a(P)
	7	GLONASS G1a (D+P)
	8	GLONASS G2a(I)
	9	GLONASS G2a(P)
	10	GLONASS G2a(I+P)
	11	GLONASS G3 I
	12	GLONASS G3 Q
	13	GLONASS G3 I+Q
	14-23	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
		Galileo E5A I
	22	Galileo E5A Q
DDC	23	Galileo E5A I+Q
BDS	0	B1
	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	B1C(D)
	10	B1C(P)
	11	B1C(D+P)
	12-23	Reserved
NavIC	0	NavIC L5 SPS
	1-23	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-SignallDs, gnss-SignallDs-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	G1a(D)	G1a(P)	G1a(D+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
NavIC	L5 SPS							

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	G2a(I)	G2a(P)	G2a(I+P)	G3 I	G3 Q	G3(I+Q)		
Galileo	E1 B+C	E1 A+B+C	E6C	E6A	E6B	E6 B+C	E6	E5B I
							A+B+C	
BDS	B2 I+Q	B1C(D)	B1C(P)	B1C(D+P)				
NavIC						_		

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								
NavIC								

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 {
```

- SBAS-ID

The IE SBAS-ID is used to indicate a specific SBAS.

- SBAS-IDs

The IE SBAS-IDs is used to indicate several SBASs using a bit map.

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.

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'	Satellite PRN Signal No. 1 to 63
	'63'	Reserved
SBAS	'0' – '38'	Satellite PRN Signal No. 120 to 158
	'39' – '63'	Reserved
QZSS	'0' – '9'	Satellite PRN Signal No. 193 to 202
	'10' – '63'	Reserved
GLONASS	'0' – '23'	Slot Number 1 to 24
	'24 – '63'	Reserved
Galileo	'0' – '35'	Code No. 1 to 36
	'36' – '63'	Reserved
BDS	'0' – '62'	Satellite ranging code number No.1 to
		63
	'63'	Reserved
NavIC	'0' – '13'	Satellite PRN Signal No. 1 to 14
	'14'–'63'	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 E-CID positioning specific error reason.

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,
                                                           OPTIONAL,
   systemFrameNumber
                                  BIT STRING (SIZE (10))
   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,
                                   INTEGER (0..74)
       nrsrq-Result-r14
                                                               OPTIONAL,
       carrierFreqOffsetNB-r14 CarrierFreqOffsetNB-r14
                                                               OPTIONAL,
                                                                               -- Cond NB-IoT
                                   BIT STRING (SIZE (10))
                                                               OPTIONAL
       hyperSFN-r14
    11,
   [[
       rsrp-Result-v1470
                                   INTEGER (-17..-1)
                                                               OPTIONAL.
                                   INTEGER (-30..46)
       rsrq-Result-v1470
                                                               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-loT 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.

cellGloballd

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 the 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.

rsrp-Result

This field specifies the reference signal received power (RSRP) measurement, as defined in TS 36.331 [12], TS 36.214 [17]. In the 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 the 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 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 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].

ECID-SignalMeasurementInformation field descriptions

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.

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),
                                            rsrqSup (1),
ueRxTxSup (2),
                                           nrsrpSup-r14 (3),
nrsrqSup-r14 (4)} (SIZE(1..8)),
    [[ ueRxTxSupTDD-r13
                                                ENUMERATED { true }
    11,
                                   ENUMERATED { supported }
    [[ periodicalReporting-r14
                                                                                   OPTIONAL.
                                                ENUMERATED { supported }
ENUMERATED { required }
        triggeredReporting-r14
                                                                                   OPTIONAL,
         idleStateForMeasurements-r14
                                                                                   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 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 E-CID measurements. If this field is absent, the location server may assume that the target device does not support *periodicalReporting* in *CommonlEsRequestLocationInformation*.

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 *CommonlEsRequestLocationInformation*.

idleStateForMeasurements

This field, if present, indicates that the target device requires idle state to perform E-CID 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.

ECID-LocationServerErrorCauses

The IE ECID-LocationServerErrorCauses is used by the location server to provide E-CID error reasons to the target device.

ECID-TargetDeviceErrorCauses

The IE ECID-TargetDeviceErrorCauses is used by the target device to provide E-CID error reasons to the location server.

ECID-TargetDeviceErrorCauses field descriptions

caus

This field provides a E-CID specific error cause. If the cause value is 'notAllRequestedMeasurementsPossible', the target device was not able to provide all requested E-CID measurements (but may be able to provide some measurements). In this case, the target device should include any of the <code>rsrpMeasurementNotPossible</code>, <code>rsrqMeasurementNotPossible</code>, <code>ueRxTxMeasurementNotPossible</code>, or <code>nrsrqMeasurementNotPossible</code> 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.

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.

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].

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.

MBS-BeaconMeasList field descriptions

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	Х	у	$0.5 * (1 + x/8) * 2^{y}$	$x_{i-1} <= P < x_i$
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.

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.

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 {
                                                          (0),
   tbs-Modes-r13
                         BIT STRING {
                                           standalone
                                          ue-assisted
                                                           (1),
                                                          (2)} (SIZE (1..8)),
                                          ue-based
    [[ mbs-AssistanceDataSupportList-r14 MBS-AssistanceDataSupportList-r14
                                                                                  OPTIONAL.
       periodicalReportingSupported-r14
                                          PositioningModes
                                                                                  OPTIONAL,
       mbs-ConfigSupport-r14
                              BIT STRING { tb1
                                              t.b2
                                                      (1),
                                                      (2),
(3)} (SIZE (1..8))
                                              th3
                                              tb4
                                                                                 OPTIONAL.
       mbs-IdleStateForMeasurements-r14
                                              ENUMERATED { required }
                                                                                  OPTIONAL
   11
}
-- 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 *CommonlEsRequestLocationInformation*.

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.

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.

TBS-LocationServerErrorCauses

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

TBS-TargetDeviceErrorCauses

The IE TBS-TargetDeviceErrorCauses is used by the target device to provide error reasons for TBS positioning to the location server.

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.

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.

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.

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 4/2²⁰ decimal degrees, added to -90°. Valid range -90° to 90° [24].

MBS-AlmanacAssistance field descriptions

transmitterLongitude

This field specifies longitude of the MBS transmitter, degrees. Scale factor 4/2²⁰ decimal degrees, added to -180°. Valid range -180° to 180° [24].

transmitterAltitude

This field specifies altitude of the MBS transmitter, metres. Scale factor 0.29 metres, added to -500 metres. Valid range -500 to 9002.43 metres [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].

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].

frea

This field specifies the MBS signal centre 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.

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 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.

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 {
                                                                    OPTIONAL.
    measurementReferenceTime-r13
                                        UTCTime
    uncompensatedBarometricPressure-r13 INTEGER (30000..115000)
                                                                    OPTIONAL, -- Cond Barometer
                                    SEQUENCE {
    uncertainty-r14
                                    range-r14
                                                    INTEGER (0..1000),
                                    confidence-r14 INTEGER (1..100)
                                                                        OPTIONAL
    ]],
                                    INTEGER (-5000..5000)
       adiustment-r16
                                                                        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).

adjustment

This field provides any adjustment available in the UE, in units of Pa, to allow the production of a compensated atmospheric pressure measurement where compensated atmospheric pressure = uncompensatedBarometricPressure + adjustment

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,
     refTime-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),
}
}
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), horizontalUncConfidence-r15 INTEGER (0..100) OPTIONAL,
     bearingRef-r15
     horizontalUncConfidence-r15 INTEGER (0..100)
                                                                               OPTIONAL,
     verticalDirection-r15 ENUMERATED{upward, downward} OPTIONAL, verticalDistance-r15 INTEGER(0..8191) OPTIONAL, verticalDistanceUnc-r15 INTEGER(0..8191) OPTIONAL, verticalDistanceUnc-r15 INTEGER(0..255) OPTIONAL,
     verticalUncConfidence-r15 INTEGER (0..100)
                                                                               OPTIONAL,
UTC-Time-r15 ::= SEQUENCE {
     utcTime-r15
                                       UTCTime,
                                       INTEGER (0..999),
     utcTime-ms-r15
-- ASN1STOP
```

Sensor-MotionInformation field descriptions

refTime

This field provides the reference time to associated with 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 corresponds 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 TS 23.032 [15]. horizontalUncConfidence corresponds to confidence as defined in TS 23.032 [15].

verticalDistance

This field specifies the vertical distance travelled between time t_{0-1} and t_0 .

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 TS 23.032 [15]. *verticalUncConfidence* corresponds to confidence as defined in 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
   ]],
   [ [
       adjustmentReq-r16
                                                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-MotionInformationReg

This field indicates whether the target device is requested to report movement information in IE *Sensor-MotionInformation* or not. TRUE means requested.

adjustmentReq

This field indicates whether the target device is requested to report *adjustment* in IE Sensor-MeasurementInformation or not. TRUE means requested.

6.5.5.4 Sensor Capability Information

Sensor-ProvideCapabilities

The IE Sensor-Provide Capabilities 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
   ]],
       adjustmentSupported-r16
                                               ENUMERATED { true }
   [ [
                                                                                      OPTIONAL
Sensor-AssistanceDataSupportList-r14 ::= SEQUENCE {
    [[ validityPeriodSupported-v1520
                                              ENUMERATED { true }
                                                                    OPTIONAL,
                                              ENUMERATED { true }
       validityAreaSupported-v1520
                                                                      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 *CommonlEsRequestLocationInformation*.

Sensor-ProvideCapabilities field descriptions

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. adjustmentSupported

This field, if present, indicates that the target device supports the adjustment IE in Sensor-MeasurementInformation.

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.

Sensor-LocationServerErrorCauses

The IE Sensor-LocationServerErrorCauses is used by the location server to provide error reasons for Sensor positioning to the target device.

Sensor-TargetDeviceErrorCauses

The IE Sensor-TargetDeviceErrorCauses is used by the target device to provide error reasons for Sensor positioning to the location server.

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.

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
{\tt Sensor-AssistanceDataList-r14::= SEQUENCE } \ \{ \\
    refPressure-r14 INTEGER (-20000..10000),
refPosition-r14 EllipsoidPointWithAltitudeAndUncertaintyEllipsoid OPTIONAL, -- Need ON
    refTemperature-r14 INTEGER (-64..63)
                                                                                         OPTIONAL,
                                                                                                       -- Need ON
    Π
    period-v1520
                           SEQUENCE {
        pressureValidityPeriod-v1520 PressureValidityPeriod-v1520, referencePressureRate-v1520 INTEGER (-128..127)
                                                                                         OPTIONAL.
                                                                                                       -- Need ON
                                                                                         OPTIONAL,
                                                                                                       -- Need ON
        ea-v1520 SEQUENCE {
pressureValidityArea-v1520 PressureValidityArea-v1520,
gN-pressure-v1520 INTEGER (-1024..1023)
gE-pressure-v1520 INTEGER (-1024..1023)
    area-v1520
                                                                                         OPTIONAL,
                                                                                                       -- Need ON
                                                                                         OPTIONAL,
                                                                                                       -- Need ON
                                                                                         OPTIONAL
                                                                                                        -- Need ON
    ]]
PressureValidityArea-v1520 ::= SEQUENCE {
    validityAreaWidth-v1520 Ellipsoid-Point,
                                          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.

pressure Validity Area

- centerPoint: this field specifies the coordinates of the centre of the rectangular validity area.
- validityAreaWidth: this field specifies the width of the rectangular validity area. Width is measured from the
 centre 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
 centre 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 centre of the pressure ValidityArea. 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 centre of the pressure ValidityArea. 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-ReguestAssistanceData

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 clause 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.

6.5.6.2 WLAN Location Information Elements

WLAN-MeasurementInformation

```
-- ASN1START
WLAN-MeasurementInformation-r13 ::= SEQUENCE {
   measurementReferenceTime-r13 UTCTime
                                                                         OPTIONAL,
                                          WLAN-MeasurementList-r13
                                                                         OPTIONAL,
    wlan-MeasurementList-r13
\texttt{WLAN-MeasurementList-r13} \ ::= \ \texttt{SEQUENCE} \ (\texttt{SIZE}(\texttt{1..maxWLAN-AP-r13})) \ \texttt{OF} \ \texttt{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) servingFlag-r13 BOOLEAN
                                                                         OPTIONAL,
                                                                          OPTIONAL,
}
WLAN-AP-Identifier-r13 ::= SEQUENCE {
                OCTET STRING (SIZE (6)),
    bssid-r13
    ssid-r13
                                  OCTET STRING (SIZE (1..32)) OPTIONAL,
WLAN-RTT-r13 ::= SEQUENCE {
   rttValue-r13 INTEGER (0..16777215),
rttUnits-r13 ENUMERATED { micros
                                       microseconds,
                                       hundredsofnanoseconds,
                                       tensofnanoseconds,
                                       nanoseconds,
                                       tenthsofnanoseconds,
                                       ... },
    rttAccuracy-r13 INTEGER (0..255)
                                                                          OPTIONAL,
}
-- 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.

WLAN-RequestLocationInformation field descriptions

requested Measurements

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 {
                           BIT STRING {
                                                            (0),
   wlan-Modes-r13
                                            standalone
                                            ue-assisted
                                                            (1)
                                            ue-based
                                                            (2)}
                                                                    (SIZE (1..8)),
   wlan-MeasSupported-r13 BIT STRING {
                                           rssi-r13
                                                            (0),
                                                                    (SIZE(1..8)),
                                           rtt-r13
                                                            (1)}
   [[ wlan-AP-AD-Supported-r14
                           BIT STRING {
                                            ap-identifier
                                                            (0),
                                            ap-location
                                                                    (SIZE (1..8))
                                                            (1)}
                                                                                    OPTIONAL.
        periodicalReportingSupported-r14
                                            PositioningModes
                                                                                    OPTIONAL,
        idleStateForMeasurements-r14
                            ENUMERATED {
                                                                                    OPTIONAL
                                           required
   ]]
-- 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 *CommonlEsRequestLocationInformation*.

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.

WLAN-LocationServerErrorCauses

The IE WLAN-LocationServerErrorCauses is used by the location server to provide error reasons for WLAN positioning to the target device.

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.

```
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.

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 {
                                   SEQUENCE (SIZE (1..maxWLAN-AP-r14)) OF WLAN-AP-Data-r14,
    wlan-AP-List-r14
    supportedChannels-11a-r14
                                   SupportedChannels-11a-r14 OPTIONAL,
                                                                              -- Need ON
                                                                               -- Need ON
    supportedChannels-11bg-r14
                                   SupportedChannels-11bg-r14
                                                                   OPTIONAL,
}
SupportedChannels-11a-r14 ::= SEQUENCE {
    ch34-r14
                   BOOLEAN,
    ch36-r14
                   BOOLEAN.
    ch38-r14
                   BOOLEAN,
    ch40-r14
                   BOOLEAN,
    ch42-r14
                   BOOLEAN,
                   BOOLEAN.
    ch44-r14
    ch46-r14
                   BOOLEAN,
    ch48-r14
                   BOOLEAN,
    ch52-r14
                   BOOLEAN,
```

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 OPTIONAL, -- Need ON
    wlan-AP-Location-r14
WLAN-AP-Location-r14 ::= SEQUENCE {
   locationDataLCI-r14
                                         LocationDataLCI-r14,
LocationDataLCI-r14 ::= SEQUENCE {
                                        BIT STRING (SIZE (6)),
    latitudeUncertainty-r14
   latitude-r14
                                        BIT STRING (SIZE (34)),
    longitudeUncertainty-r14
                                         BIT STRING (SIZE (6)),
   longitude-r14 BIT STRING (SIZE (34)), altitudeUncertainty-r14 BIT STRING (SIZE (6))
   longitude-r14
                                                                      OPTIONAL, -- Need ON OPTIONAL, -- Need ON
    altitude-r14
                                         BIT STRING (SIZE (30))
   datum-r14
                                         BIT STRING (SIZE (8)),
-- ASN1STOP
```

```
WLAN-AP-Data field descriptions
wlan-AP-Location
```

WLAN-AP-Data field descriptions

- 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 metres is expressed with the

following formula:

altitudeUncertainty = 21 - ceil(log2(uncertainty in metres))

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 metres.

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.

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

WLAN-RequestAssistanceData field descriptions

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.

6.5.7.2 Bluetooth Location Information Elements

BT-MeasurementInformation

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.

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 {
                         BIT STRING {
   bt-Modes-r13
                                                          (0),
                                          standalone
                                                          (1)}
                                                                 (SIZE (1..8)),
                                          ue-assisted
   bt-MeasSupported-r13 BIT STRING { rssi-r13
                                                         (0)} (SIZE (1..8)),
   {\tt idleStateForMeasurements-r14}
                           ENUMERATED {
                                          required
                                                                                  OPTIONAL,
   periodicalReportingSupported-r14
                                                                                  OPTIONAL
                           PositioningModes
   11
-- 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 *CommonlEsRequestLocationInformation*.

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.

BT-LocationServerErrorCauses

The IE *BT-LocationServerErrorCauses* is used by the location server to provide error reasons for Bluetooth positioning to the target device.

BT-TargetDeviceErrorCauses

The IE BT-TargetDeviceErrorCauses is used by the target device to provide error reasons for Bluetooth positioning to the location server.

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.

6.5.8 NR UL Positioning

6.5.8.1 NR UL Capability Information

NR-UL-ProvideCapabilities

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

6.5.8.2 NR UL Capability Information Request

NR-UL-RequestCapabilities

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

```
-- ASN1START

NR-UL-RequestCapabilities-r16 ::= SEQUENCE {
    ...
}
-- ASN1STOP
```

6.5.9 NR E-CID Positioning

This clause defines the information elements for NR E-CID positioning (TS 38.305 [40]).

6.5.9.1 NR E-CID Location Information

NR-ECID-ProvideLocationInformation

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

6.5.9.2 NR E-CID Location Information Elements

NR-ECID-SignalMeasurementInformation

The IE NR-ECID-SignalMeasurementInformation is used by the target device to provide NR E-CID measurements to the location server.

```
-- ASN1START
NR-ECID-SignalMeasurementInformation-r16 ::= SEQUENCE {
    nr-PrimaryCellMeasuredResults-r16 NR-MeasuredResultsElement-r16,
    nr-MeasuredResultsList-r16
                                              NR-MeasuredResultsList-r16
                                                                                              OPTIONAL,
}
NR-MeasuredResultsList-r16 ::= SEQUENCE (SIZE(1..32)) OF NR-MeasuredResultsElement-r16
NR-MeasuredResultsElement-r16 ::= SEQUENCE {
    nr-PhysCellID-r16 NR-PhysCellID-r16,
    nr-ARFCN-r16
                                          CHOICE {
        csi-RS-pointA-r16 ARFCN-ValueNR-r15, ARFCN-ValueNR-r15
    nr-CellGlobalID-r16 NCGI-r15
systemFrameNumber-r16 BIT STRING (SIZE (10))
resultsSSB-Cell-r16 MeasQuantityResults-r16
resultsCSI-RS-Cell-r16 MeasQuantityResults-r16
resultsSSB-Indexes-r16 ResultsPerSSB-IndexList-r16
resultsCSI-RS-Indexes-r16 ResultsPerCSI-RS-IndexList-r16
                                                                                              OPTIONAL,
                                                                                               OPTIONAL,
                                                                                              OPTIONAL,
                                                                                              OPTIONAL.
                                                                                              OPTIONAL,
                                                                                              OPTIONAL,
}
MeasQuantityResults-r16 ::= SEQUENCE {
   nr-RSRP-r16
                                        INTEGER (0..127)
                                                                                              OPTIONAL,
    nr-RSRQ-r16
                                          INTEGER (0..127)
}
ResultsPerSSB-IndexList-r16::= SEQUENCE (SIZE (1..64)) OF ResultsPerSSB-Index-r16
ResultsPerSSB-Index-r16 ::= SEQUENCE {
                                          INTEGER (0..63),
    ssb-Index-r16
    ssb-Results-r16
                                          MeasQuantityResults-r16
ResultsPerCSI-RS-IndexList-r16::= SEQUENCE (SIZE (1..64)) OF ResultsPerCSI-RS-Index-r16
ResultsPerCSI-RS-Index-r16 ::= SEQUENCE {
    csi-RS-Index-r16 INTEGER (0..95),
csi-RS-Results-r16 MeasQuantityResults-r16
-- ASN1STOP
```

NR-ECID-SignalMeasurementInformation field descriptions

nr-PrimaryCellMeasuredResults

This field contains the NR E-CID measurements for the primary cell.

nr-MeasuredResultsList

This field contains the NR E-CID measurements for up to 32 neighbour cells.

nr-PhysCellID

This field specifies the NR physical cell identity of the measured cell.

nr-ARFCN

This field specifies the ARFCN of the first RE of SSB's RB#10 or the point A of CSI-RS.

nr-CellGlobalID

This field specifies the NR cell global ID of the measured cell. The target device shall provide this field if it was able to determine the NCGI of the measured cell at the time of measurement.

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.

resultsSSB-Cell

This field specifies the SS reference signal received power (SS-RSRP) and quality (SS-RSRQ) measurement aggregated at cell level, as defined in TS 38.331 [35].

resultsCSI-RS-Cell

This field specifies the CSI-RS reference signal received power (CSI-RSRP) and quality (CSI-RSRQ) measurement aggregated at cell level, as defined in TS 38.331 [35].

resultsSSB-Indexes

This field specifies the SS reference signal received power (SS-RSRP) and quality (SS-RSRQ) measurement per SSB resource, as defined in TS 38.331 [35].

resultsCSI-RS-Indexes

This field specifies the CSI-RS reference signal received power (CSI-RSRP) and quality (CSI-RSRQ) per CSI-RS resource, as defined in TS 38.331 [35].

nr-RSRP

This field specifies the integer value for RSRP measurements according to Table 10.1.6.1-1 in TS 38.133 [46].

nr-RSRQ

This field specifies the integer value for RSRQ measurements according to Table 10.1.11.1-1 in TS 38.133 [46].

6.5.9.3 NR E-CID Location Information Request

NR-ECID-RequestLocationInformation

The IE NR-ECID-RequestLocationInformation is used by the location server to request NR E-CID location measurements from a target device.

NR-ECID-RequestLocationInformation field descriptions

requestedMeasurements

This field specifies the NR 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.

6.5.9.4 NR E-CID Capability Information

NR-ECID-ProvideCapabilities

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

NR-ECID-ProvideCapabilities field descriptions

nr-ECID-MeasSupported:

Indicates the supported NR ECID measurements:

- ssrsrpSup indicates the UE supports SSB based cell/beam specific RSRP measurement;
- ssrsqpSup indicates the UE supports SSB based cell/beam specific RSRQ measurement;
- csirsrpSup indicates the UE supports CSI-RS based cell/beam specific RSRP measurement;
- csirsrqSup indicates the UE supports CSI-RS based cell/beam specific RSRQ measurement.

6.5.9.5 NR E-CID Capability Information Request

NR-ECID-RequestCapabilities

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

```
-- ASN1START

NR-ECID-RequestCapabilities-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.9.6 NR E-CID Error Elements

NR-ECID-Error

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

NR-ECID-LocationServerErrorCauses

The IE NR-ECID-LocationServerErrorCauses is used by the location server to provide NR E-CID error reasons to the target device.

```
...
}
-- ASN1STOP
```

NR-ECID-TargetDeviceErrorCauses

The IE NR-ECID-TargetDeviceErrorCauses is used by the target device to provide NR E-CID error reasons to the location server.

```
-- ASN1START
NR-ECID-TargetDeviceErrorCauses-r16 ::= SEQUENCE {
              ENUMERATED { undefined,
   cause-r16
                                   requestedMeasurementNotAvailable,
                                   notAllrequestedMeasurementsPossible,
    ss-RSRPMeasurementNotPossible-r16
                                                  NULL
                                                               OPTIONAL,
    ss-RSRQMeasurementNotPossible-r16
                                                   NULL
                                                               OPTIONAL,
   csi-RSRPMeasurementNotPossible-r16
                                                  NULL
                                                               OPTIONAL,
    csi-RSRQMeasurementNotPossible-r16
                                                  NULL
                                                               OPTIONAL.
-- ASN1STOP
```

NR-ECID-TargetDeviceErrorCauses field descriptions

cause

This field provides a NR E-CID specific error cause. If the cause value is 'notAllRequestedMeasurementsPossible', the target device was not able to provide all requested NR E-CID measurements (but may be able to provide some measurements). In this case, the target device should include any of the ss-RSRPMeasurementNotPossible, ss-RSRQMeasurementNotPossible, csi-RSRPMeasurementNotPossible, or csi-RSRQMeasurementNotPossible fields, as applicable.

6.5.10 NR DL-TDOA Positioning

This clause defines the information elements for NR downlink TDOA positioning (TS 38.305 [40]).

6.5.10.1 NR DL-TDOA Assistance Data

NR-DL-TDOA-ProvideAssistanceData

The IE NR-DL-TDOA-ProvideAssistanceData is used by the location server to provide assistance data to enable UE-assisted and UE-based NR DL-TDOA. It may also be used to provide NR DL-TDOA positioning specific error reason.

```
-- ASN1START
NR-DL-TDOA-ProvideAssistanceData-r16 ::= SEQUENCE {
   nr-DL-PRS-AssistanceData-r16 NR-DL-PRS-AssistanceData-r16 nr-SelectedDL-PRS-IndexList-r16 NR-SelectedDL-PRS-IndexList-r
                                                                                       OPTIONAL,
                                                                                                     -- Need ON
                                            NR-SelectedDL-PRS-IndexList-r16
                                                                                       OPTIONAL,
                                                                                                     -- Need ON
    nr-PositionCalculationAssistance-r16
                                             NR-PositionCalculationAssistance-r16
                                                                                       OPTIONAL,
                                                                                                     -- Cond UEB
                                                                                                     -- Need ON
    nr-DL-TDOA-Error-r16
                                             NR-DL-TDOA-Error-r16
                                                                                       OPTIONAL,
-- ASN1STOP
```

Conditional presence	Explanation
UEB	The field is optionally present for UE based NR DL-TDOA; otherwise it is not present.

NR-DL-TDOA-ProvideAssistanceData field descriptions

nr-DL-PRS-AssistanceData

This field specifies the assistance data reference and neighbour TRPs and provides the DL-PRS configuration for the TRPs.

Note, if this field is absent but the *nr-SelectedDL-PRS-IndexList* field is present, the *nr-DL-PRS-AssistanceData* may be provided in IE *NR-Multi-RTT-ProvideAssistanceData* or *NR-DL-AoD-ProvideAssistanceData*.

nr-SelectedDL-PRS-IndexList

This field specifies the DL-PRS Resources which are applicable for this NR-DL-TDOA-ProvideAssistanceData message.

nr-PositionCalculationAssistanceData

This field provides position calculation assistance data for UE-based mode.

nr-DL-TDOA-Error

This field provides DL-TDOA error reasons.

6.5.10.2 NR DL-TDOA Assistance Data Request

NR-DL-TDOA-RequestAssistanceData

The IE NR-DL-TDOA-RequestAssistanceData is used by the target device to request assistance data from a location server.

NR-DL-TDOA-RequestAssistanceData field descriptions

nr-PhysCelIID

This field specifies the NR physical cell identity of the current primary cell of the target device.

nr-AdType

This field indicates the requested assistance data. *dl-prs* means requested assistance data is *nr-DL-PRS-AssistanceData*, *posCalc* means requested assistance data is *nr-PositionCalculationAssistanceData* for UE based positioning.

6.5.10.3 NR DL-TDOA Location Information

NR-DL-TDOA-ProvideLocationInformation

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

Conditional presence	Explanation
UEB	The field is mandatory present for the UE based NR DL-TDOA; otherwise it is not
	present.

6.5.10.4 NR DL-TDOA Location Information Elements

NR-DL-TDOA-SignalMeasurementInformation

The IE NR-DL-TDOA-SignalMeasurementInformation is used by the target device to provide NR DL-TDOA measurements to the location server.

- NOTE 1: The *dl-PRS-ReferenceInfo* defines the "RSTD reference" TRP. The *nr-RSTD's* and *nr-RSTD-ResultDiff*'s in *nr-DL-TDOA-MeasList* are provided relative to the "RSTD reference" TRP.
- NOTE 2: The "RSTD reference" TRP may or may not be the same as the "assistance data reference" TRP provided by *nr-DL-PRS-ReferenceInfo* in IE *NR-DL-PRS-AssistanceData*.
- NOTE 3: The target device includes a value of zero for the *nr-RSTD* and *nr-RSTD-ResultDiff* of the "RSTD reference" TRP in *nr-DL-TDOA-MeasList*.

```
-- ASN1START
\label{eq:nr-dl-tdoa-signalMeasurementInformation-r16} \verb| ::= SEQUENCE | \\
         dl-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16, nr-DL-TDOA-MeasList-r16 NR-DL-TDOA-MeasList-r16,
}
NR-DL-TDOA-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs-r16)) OF NR-DL-TDOA-MeasElement-r16
NR-DL-TDOA-MeasElement-r16 ::= SEQUENCE {
        | INTEGER (0..255),
| NR-PhysCellID-r16 | NR-PhysCellID-r16 | NCGI-r15 | NR-DL-PRS-ResourceID-r16 | NR-DL-PRS-ResourceID-r16 | NR-DL-PRS-ResourceSetID-r16 | NR-DL-PRS-ResourceSetID-r16 | NR-TimeStamp-r16 | NR-TimeStamp-r16 | CHOICE { INTEGER (0..1970049), k1-r16 | k2-r16 | INTEGER (0..985025), NR-DL-PRS-ResourceSetID-r16 | INTEGER (0..985025), NR-DL-PRS-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOURCESETID-RESOUR
         nr-PhysCellID-r16 INTEGER (0..255),
                                                                                                                                                                                                                               OPTIONAL,
                                                                                                                                                                                                                               OPTIONAL,
                                                                                                                                                                                                                              OPTIONAL,
                                                                                                                                                                                                                               OPTIONAL.
                                                                                                                                                                                                                               OPTIONAL,
                               k3-r16
                                                                                                         INTEGER (0..246257),
                               k4-r16
                                                                                                          INTEGER (0..123129),
                                                                                                         INTEGER (0..61565),
                               k5-r16
         nr-AdditionalPathList-r16 NR-AdditionalPathList-r16
                                                                                                                                                                                                                               OPTIONAL,
         OPTIONAL.
         nr-DL-TDOA-AdditionalMeasurements-r16
                                                                                              NR-DL-TDOA-AdditionalMeasurements-r16
                                                                                                                                                                                                                               OPTIONAL,
NR-DL-TDOA-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..3)) OF
                                                                                                                                          NR-DL-TDOA-AdditionalMeasurementElement-r16
NR-DL-TDOA-AdditionalMeasurementElement-r16 ::= SEQUENCE {
         nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16
                                                                                                                                                                                                                               OPTIONAL,
                                                                                                                                                                                                                               OPTIONAL,
         nr-RSTD-ResultDiff-r16
k0-r16
k1-r16
                                                                                             NR-TimeStamp-r16,
                                                                                             CHOICE {
                                                                                                        INTEGER (0..8191),
                                                                                                         INTEGER (0..4095),
                               k2-r16
                                                                                                         INTEGER (0..2047),
                               k3-r16
                                                                                                         INTEGER (0..1023),
                               k4-r16
                                                                                                          INTEGER (0..511),
                               k5-r16
                                                                                                         INTEGER (0..255),
          nr-TimingQuality-r16 NR-TimingQuality-r16,
```

```
nr-DL-PRS-RSRP-ResultDiff-r16 INTEGER (0..61) OPTIONAL, nr-AdditionalPathList-r16 OPTIONAL, ...
}
-- ASN1STOP
```

NR-DL-TDOA-SignalMeasurementInformation field descriptions

dI-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP. Each TRP should only be associated with one such ID.

nr-PhysCellID

This field specifies the physical cell identity of the associated TRP, as defined in TS 38.331 [35].

nr-CellGloballD

This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP, as defined in TS 38.331 [35].

nr-ARFCN

This field specifies the NR-ARFCN of the TRP.

nr-TimeStamp

This field specifies the time instance at which the TOA and DL PRS-RSRP (if included) measurement is performed. Note, the TOA measurement refers to the TOA of this neighbour TRP or the reference TRP, as applicable, used to determine the *nr-RSTD* or *nr-RSTD-ResultDiff*.

nr-RSTD

This field specifies the relative timing difference between this neighbour TRP and the PRS reference TRP, as defined in TS 38.215 [36]. Mapping of the measured quantity is defined as in TS 38.133 [46].

nr-AdditionalPathList

This field specifies one or more additional detected path timing values for the TRP or resource, relative to the path timing used for determining the *nr-RSTD* value. If this field was requested but is not included, it means the UE did not detect any additional path timing values.

nr-TimingQuality

This field specifies the target device's best estimate of the quality of the TOA measurement. Note, the TOA measurement refers to the TOA of this neighbour TRP or the reference TRP, as applicable, used to determine the *nr-RSTD-ResultDiff*.

nr-DL-PRS-RSRP-Result

This field specifies the NR DL-PRS reference signal received power (DL PRS-RSRP) measurement, as defined in TS 38.215 [36]. The mapping of the quantity is defined as in TS 38.133 [46].

nr-RSTD-ResultDiff

This field provides the additional DL RSTD measurement result relative to *nr-RSTD*. The RSTD value of this measurement is obtained by adding the value of this field to the value of the *nr-RSTD* field. The mapping of the field is defined in TS 38.133 [46].

nr-DL-PRS-RSRP-ResultDiff

This field provides the additional DL-PRS RSRP measurement result relative to *nr-DL-PRS-RSRP-Result*. The DL-PRS RSRP value of this measurement is obtained by adding the value of this field to the value of the *nr-DL-PRS-RSRP-Result* field. The mapping of the field is defined in TS 38.133 [46].

NR-DL-TDOA-LocationInformation

The IE *NR-DL-TDOA-LocationInformation* is included by the target device when location information derived using NR DL-TDOA is provided to the location server.

NR-DL-TDOA-LocationInformation field descriptions

measurementReferenceTime

This field specifies the time for which the location estimate is valid.

6.5.10.5 NR DL-TDOA Location Information Request

NR-DL-TDOA-RequestLocationInformation

The IE NR-DL-TDOA-RequestLocationInformation is used by the location server to request NR DL-TDOA location measurements from a target device.

```
-- ASN1START
NR-DL-TDOA-RequestLocationInformation-r16 ::= SEQUENCE {
   OPTIONAL, -- Need ON
   nr-RequestedMeasurements-r16
                                          BIT STRING { prsrsrpReq (0) } (SIZE(1..8)),
   nr-AssistanceAvailability-r16
                                          BOOLEAN,
   nr-DL-TDOA-ReportConfig-r16
                                          NR-DL-TDOA-ReportConfig-r16
                                                                      OPTIONAL, -- Need ON
                                                                      OPTIONAL, -- Need ON
   additionalPaths-r16
                                          ENUMERATED { requested }
}
NR-DL-TDOA-ReportConfig-r16 ::= SEQUENCE {
   maxDL-PRS-RSTD-MeasurementsPerTRPPair-r16 INTEGER (1..4)
                                                                      OPTIONAL, -- Need ON
                                                                      OPTIONAL, -- Need ON
   timingReportingGranularityFactor-r16
                                          INTEGER (0..5)
-- ASN1STOP
```

NR-DL-TDOA-RequestLocationInformation field descriptions

nr-AssistanceAvailability

This field indicates whether the target device may request additional PRS assistance data from the server. TRUE means allowed and FALSE means not allowed.

nr-RequestedMeasurements

This field specifies the NR DL-TDOA 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.

nr-DL-PRS-RstdMeasurementInfoRequest

This field indicates whether the target device is requested to report DL-PRS Resource ID(s) or DL-PRS Resource Set ID(s) used for determining the timing of each TRP in RSTD measurements.

maxDL-PRS-RSTD-MeasurementsPerTRPPair

This field specifies the maximum number of. DL-PRS RSTD measurements per pair of TRPs. The maximum number is defined across all Positioning Frequency Layers.

timingReportingGranularityFactor

This field specifies the recommended reporting granularity for the DL RSTD measurements. Value (0..5) corresponds to (k0..k5) used for nr-RSTD and nr-RSTD-ResultDiff in NR-DL-TDOA-MeasElement. The UE may select a different granularity value for nr-RSTD and nr-RSTD-ResultDiff.

6.5.10.6 NR DL-TDOA Capability Information

NR-DL-TDOA-ProvideCapabilities

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

```
-- ASN1START
NR-DL-TDOA-ProvideCapabilities-r16 ::= SEQUENCE {
                                 PositioningModes,
   nr-DL-TDOA-Mode-r16
   nr-DL-TDOA-PRS-Capability-r16
                                          NR-DL-PRS-ResourcesCapability-r16,
   nr-DL-TDOA-MeasurementCapability-r16
                                          NR-DL-TDOA-MeasurementCapability-r16,
   nr-DL-PRS-QCL-ProcessingCapability-r16 NR-DL-PRS-QCL-ProcessingCapability-r16,
   nr-DL-PRS-ProcessingCapability-r16 NR-DL-PRS-ProcessingCapability-r16,
                                                                                      OPTIONAL,
   additionalPathsReport-r16
                                          ENUMERATED { supported }
   periodicalReporting-r16
                                          PositioningModes
                                                                                      OPTIONAL,
```

```
}
-- ASN1STOP
```

NR-DL-TDOA-ProvideCapabilities field descriptions

nr-DL-TDOA-Mode

This field specifies the NR DL-TDOA mode(s) supported by the target device.

periodicalReporting

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 target device does not support *periodicalReporting* in *CommonlEsRequestLocationInformation*.

NR-DL-TDOA-MeasurementCapability

The IE *NR-DL-TDOA-MeasurementCapability* defines the DL-TDOA measurement capability. The UE can include this IE only if the UE supports *NR-DL-PRS-ResourcesCapability* for DL-TDOA. Otherwise, the UE does not include this IE;

NR-DL-TDOA-MeasurementCapability field descriptions

dI-RSTD-MeasurementPerPairOfTRP-FR1

Indicates number of DL RSTD measurements per pair of TRPs on FR1.

dI-RSTD-MeasurementPerPairOfTRP-FR2

Indicates number of DL RSTD measurements per pair of TRPs on FR2.

supportOfDL-PRS-RSRP-MeasFR1

Indicates whether the UE supports DL-PRS RSRP measurement for DL-TDOA on FR1.

supportOfDL-PRS-RSRP-MeasFR2

Indicates whether the UE supports DL-PRS RSRP measurement for DL-TDOA on FR2.

6.5.10.7 NR DL-TDOA Capability Information Request

NR-DL-TDOA-RequestCapabilities

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

```
-- ASN1START

NR-DL-TDOA-RequestCapabilities-r16 ::= SEQUENCE {
...
}

-- ASN1STOP
```

6.5.10.8 NR DL-TDOA Error Elements

– NR-DL-TDOA-Error

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

NR-DL-TDOA-LocationServerErrorCauses

The IE NR-DL-TDOA-LocationServerErrorCauses is used by the location server to provide NR DL-TDOA error reasons to the target device.

NR-DL-TDOA-TargetDeviceErrorCauses

The IE NR-DL-TDOA-TargetDeviceErrorCauses is used by the target device to provide NR DL-TDOA error reasons to the location server.

6.5.11 NR DL-AoD Positioning

This clause defines the information elements for NR downlink AoD positioning (TS 38.305 [40]).

6.5.11.1 NR DL-AoD Assistance Data

NR-DL-AoD-ProvideAssistanceData

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

```
NR-PositionCalculationAssistance-r16
OPTIONAL, -- Cond UEB
nr-DL-AoD-Error-r16
NR-DL-AoD-Error-r16
OPTIONAL, -- Need ON
...
}
-- ASN1STOP
```

Conditional presence	Explanation
UEB	The field is optionally present for UE based NR DL-AoD; otherwise it is not present.

NR-DL-AoD-ProvideAssistanceData field descriptions

nr-DL-PRS-AssistanceData

This field specifies the assistance data reference and neighbour TRPs and provides the DL-PRS configuration for the TRPs.

Note, if this field is absent but the *nr-SelectedDL-PRS-IndexList* field is present, the *nr-DL-PRS-AssistanceData* may be provided in IE *NR-Multi-RTT-ProvideAssistanceData* or *NR-DL-TDOA-ProvideAssistanceData*.

nr-SelectedDL-PRS-IndexList

This field specifies the DL-PRS Resources which are applicable for this NR-DL-AoD-ProvideAssistanceData message.

nr-PositionCalculationAssistanceData

This field provides position calculation assistance data for UE-based mode.

nr-DL-AoD-Error

This field provides DL-AoD error reasons.

6.5.11.2 NR DL-AoD Assistance Data Request

NR-DL-AoD-RequestAssistanceData

The IE NR-DL-AoD-RequestAssistanceData is used by the target device to request assistance data from a location server.

NR-DL-AoD-RequestAssistanceData field descriptions

nr-PhysCellID

This field specifies the NR physical cell identity of the current primary cell of the target device.

nr-AdTvpe

This field indicates the requested assistance data. *dl-prs* means requested assistance data is *nr-DL-PRS-AssistanceData*, *posCalc* means requested assistance data is *nr-PositionCalculationAssistanceData* for UE based positioning.

6.5.11.3 NR DL-AoD Location Information

NR-DL-AoD-ProvideLocationInformation

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

```
-- ASN1START

NR-DL-AoD-ProvideLocationInformation-r16 ::= SEQUENCE {
    nr-DL-AoD-SignalMeasurementInformation-r16
```

```
NR-DL-AoD-SignalMeasurementInformation-r16
OPTIONAL,
nr-dl-AoD-LocationInformation-r16
NR-DL-AoD-LocationInformation-r16
OPTIONAL, -- Cond UEB
nr-DL-AoD-Error-r16
NR-DL-AoD-Error-r16
OPTIONAL,
...
}
```

Conditional presence	Explanation
UEB	The field is mandatory present for the UE based NR DL-AoD; otherwise it is not present.

6.5.11.4 NR DL-AoD Location Information Elements

NR-DL-AoD-SignalMeasurementInformation

The IE *NR-DL-AoD-SignalMeasurementInformation* is used by the target device to provide NR DL-AoD measurements to the location server. The measurements are provided as a list of TRPs, where the first TRP in the list is used as reference TRP.

```
-- ASN1START
NR-DL-AoD-SignalMeasurementInformation-r16 ::= SEQUENCE {
   nr-DL-AoD-MeasList-r16 NR-DL-AoD-MeasList-r16,
}
NR-DL-AOD-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs-r16)) OF NR-DL-AOD-MeasElement-r16
NR-DL-AoD-MeasElement-r16 ::= SEQUENCE {
    nr-PhysCellID-r16 INTEGER (0..255),
   dl-PRS-ID-r16
                                       NR-PhysCellID-r16
                                                                                    OPTIONAL,
   nr-CellGlobalID-r16
                                      NCGI-r15
                                                                                   OPTIONAL,
    nr-DL-PRS-ResourceID-r16
                                     ARFCN-ValueNR-r15
NR-DL-PRS-ResourceID-r16
                                                                                   OPTIONAL,
                                                                                    OPTIONAL,
   nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16
   nr-TimeStamp-r16 NR-TimeStamp-r16,
nr-DL-PRS-RSRP-Result-r16 INTEGER (0..126),
nr-DL-PRS-RxBeamIndex-r16 INTEGER (1..8)
                                                                                    OPTIONAL, -- Cond SameRx
    nr-DL-AoD-AdditionalMeasurements-r16
                                       NR-DL-AoD-AdditionalMeasurements-r16
                                                                                  OPTIONAL,
NR-DL-AoD-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..7)) OF
                                                         NR-DL-AoD-AdditionalMeasurementElement-r16
NR-DL-AoD-AdditionalMeasurementElement-r16 ::= SEQUENCE {
   nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r nr-TimeStamp-r16 NR-TimeStamp-r16,
                                                                                   OPTIONAL,
                                       NR-DL-PRS-ResourceSetID-r16
                                                                                   OPTIONAL,
    nr-DL-PRS-RSRP-ResultDiff-r16 INTEGER (0..30),
    nr-DL-PRS-RxBeamIndex-r16
                                       INTEGER (1..8)
                                                                                    OPTIONAL, -- Cond SameRx
-- ASN1STOP
```

Conditional presence	Explanation
SameRx	The field is mandatory present if at least two DL-PRS RSRP measurements from the
	same DL-PRS Resource Set have been made with the same RX beam by the target
	device: otherwise it is not present.

NR-DL-AoD-SignalMeasurementInformation field descriptions

dI-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP. Each TRP should only be associated with one such ID.

nr-PhysCellID

This field specifies the physical cell identity of the associated TRP, as defined in TS 38.331 [35].

nr-CellGloballD

This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP, as defined in TS 38.331 [35].

nr-ARFCN

This field specifies the NR-ARFCN of the TRP.

nr-TimeStamp

This field specifies the time instance at which the measurement is performed.

nr-DL-PRS-RSRP-Result

This field specifies the NR DL-PRS reference signal received power (DL PRS-RSRP) measurement, as defined in TS 38.215 [36]. The mapping of the measured quantity is defined as in TS 38.133 [46].

nr-DL-PRS-RxBeamIndex

This field provides an index of the target device receive beam used for DL-PRS measurements. If the value of the receive beam index for two or more DL PRS measurements is the same, it indicates that the target device receive beam for the two or more DL PRS measurements were made with the same RX beam.

nr-DL-PRS-RSRP-ResultDiff

This field provides the additional DL-PRS RSRP measurement result relative to *nr-DL-PRS-RSRP-Result*. The DL-PRS RSRP value of this measurement is obtained by adding the value of this field to the value of the *nr-DL-PRS-RSRP-Result* field. The mapping of the field is defined in TS 38.133 [46].

NR-DL-AoD-LocationInformation

The IE *NR-DL-AoD-LocationInformation* is included by the target device when location information derived using NR DL-AoD is provided to the location server.

NR-DL-AoD-LocationInformation field descriptions

measurementReferenceTime

This field specifies the time for which the location estimate is valid.

6.5.11.5 NR DL-AoD Location Information Request

NR-DL-AoD-RequestLocationInformation

The IE NR-DL-AoD-RequestLocationInformation is used by the location server to request NR DL-AoD location measurements from a target device.

```
...
}
-- ASN1STOP
```

NR-DL-AoD-RequestLocationInformation field descriptions

nr-AssistanceAvailability

This field indicates whether the target device may request additional PRS assistance data from the server. TRUE means allowed and FALSE means not allowed.

maxDL-PRS-RSRP-MeasurementsPerTRP

This field specifies the maximum number of DL-PRS RSRP measurements on different DL-PRS Resources from the same TRP.

6.5.11.6 NR DL-AoD Capability Information

NR-DL-AoD-ProvideCapabilities

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

NR-DL-AoD-ProvideCapabilities field descriptions

nr-DL-AoD-Mode

This field specifies the NR DL-AoD mode(s) supported by the target device.

periodicalReporting

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 target device does not support *periodicalReporting* in *CommonlEsRequestLocationInformation*.

NR-DL-AoD-MeasurementCapability

The IE *NR-DL-AoD-MeasurementCapability* defines the DL-AoD measurement capability. The UE can include this IE only if the UE supports *NR-DL-PRS-ResourcesCapability* for DL-AoD. Otherwise, the UE does not include this IE;

NR-DL-AoD-MeasurementCapability field descriptions

maxDL-PRS-RSRP-MeasurementFR1

Indicates the maximum number of DL-PRS RSRP measurements on different PRS resources from the same TRP supported by the UE on FR1.

maxDL-PRS-RSRP-MeasurementFR2

Indicates the maximum number of DL-PRS RSRP measurements on different PRS resources from the same TRP supported by the UE on FR2.

simul-NR-DL-AoD-DL-TDOA

Indicates whether the UE supports simultaneous processing for DL-AoD and DL-TDOA measurements. The UE can include this field only if the UE supports DL-TDOA and DL-AoD. Otherwise, the UE does not include this field;

simul-NR-DL-AoD-Multi-RTT

Indicates whether the UE supports simultaneous processing for DL-AoD and Multi-RTT measurements. The UE can include this field only if the UE supports Multi-RTT, *srs-PosResources* TS38.331 [35] and DL-AoD. Otherwise, the UE does not include this field;

6.5.11.7 NR DL-AoD Capability Information Request

NR-DL-AoD-RequestCapabilities

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

```
-- ASN1START

NR-DL-AoD-RequestCapabilities-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.11.8 NR DL-AoD Error Elements

NR-DL-AoD-Error

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

NR-DL-AoD-LocationServerErrorCauses

The IE NR-DL-AoD-LocationServerErrorCauses is used by the location server to provide NR DL-AoD error reasons to the target device.

```
}
-- ASN1STOP
```

NR-DL-AoD-TargetDeviceErrorCauses

The IE NR-DL-AoD-TargetDeviceErrorCauses is used by the target device to provide NR DL-AoD error reasons to the location server.

6.5.12 NR Multi-RTT Positioning

This clause defines the information elements for NR Multi-RTT positioning (TS 38.305 [40]).

6.5.12.1 NR Multi-RTT Assistance Data

NR-Multi-RTT-ProvideAssistanceData

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

NR-Multi-RTT-ProvideAssistanceData field descriptions

nr-DL-PRS-AssistanceData

This field specifies the assistance data reference and neighbour TRPs and provides the DL-PRS configuration for the TRPs.

Note, if this field is absent but the *nr-SelectedDL-PRS-IndexList* field is present, the *nr-DL-PRS-AssistanceData* may be provided in IE *NR-DL-TDOA-ProvideAssistanceData* or *NR-DL-AoD-ProvideAssistanceData*.

nr-SelectedDL-PRS-IndexList

This field specifies the DL-PRS Resources which are applicable for this NR-Multi-RTT-ProvideAssistanceData message.

nr-Multi-RTT-Error

This field provides Multi-RTT error reasons.

6.5.12.2 NR Multi-RTT Assistance Data Request

NR-Multi-RTT-RequestAssistanceData

The IE NR-Multi-RTT-RequestAssistanceData is used by the target device to request assistance data from a location server.

NR-Multi-RTT-RequestAssistanceData field descriptions

nr-PhysCellID

This field specifies the NR physical cell identity of the current primary cell of the target device.

6.5.12.3 NR Multi-RTT Location Information

NR-Multi-RTT-ProvideLocationInformation

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

6.5.12.4 NR Multi-RTT Location Information Elements

NR-Multi-RTT-SignalMeasurementInformation

The IE *NR-Multi-RTT-SignalMeasurementInformation* is used by the target device to provide NR Multi-RTT measurements to the location server. The measurements are provided as a list of TRPs, where the first TRP in the list is used as reference TRP.

```
-- ASN1START
NR-Multi-RTT-SignalMeasurementInformation-r16 ::= SEQUENCE
   nr-Multi-RTT-MeasList-r16 NR-Multi-RTT-MeasList-r16,
   nr-NTA-Offset-r16
                                  ENUMERATED { nTA1, nTA2, nTA3, nTA4, ... }
                                                                                OPTIONAL,
NR-Multi-RTT-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs-r16)) OF NR-Multi-RTT-MeasElement-r16
NR-Multi-RTT-MeasElement-r16 ::= SEOUENCE {
                                  INTEGER (0..255),
   dl-PRS-ID-r16
   nr-PhysCellID-r16
                                  NR-PhysCellID-r16
                                                                                 OPTIONAL,
   nr-CellGlobalID-r16
                                  NCGI-r15
                                                                                 OPTIONAL,
   nr-ARFCN-r16
                                 ARFCN-ValueNR-r15
                                                                                 OPTIONAL,
   nr-DL-PRS-ResourceID-r16
                                                                                 OPTIONAL,
                                  NR-DL-PRS-ResourceID-r16
   nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16
                                                                                 OPTIONAL,
```

```
CHOICE {
    nr-UE-RxTxTimeDiff-r16
                                         INTEGER (0..1970049),
            k0-r16
            k1-r16
                                         INTEGER (0..985025),
                                         INTEGER (0..492513),
            k2-r16
            k3-r16
                                         INTEGER (0..246257),
            k4-r16
                                         INTEGER (0..123129),
                                         INTEGER (0..61565),
            k5-r16
    nr-AdditionalPathList-r16
                                    NR-AdditionalPathList-r16
                                                                                       OPTIONAL,
   nr-TimeStamp-r16
                                   NR-TimeStamp-r16,
    nr-TimingQuality-r16
                                                                                       OPTIONAL.
    nr-Multi-RTT-AdditionalMeasurements-r16
                                     NR-Multi-RTT-AdditionalMeasurements-r16
                                                                                       OPTIONAL,
NR-Multi-RTT-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..3)) OF
                                    NR-Multi-RTT-AdditionalMeasurementElement-r16
NR-Multi-RTT-AdditionalMeasurementElement-r16 ::= SEQUENCE {
   nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 INTEGER (0 61)
                                                                                       OPTIONAL,
                                                                                       OPTIONAL,
                                                                                       OPTIONAL.
    nr-UE-RxTxTimeDiffAdditional-r16
                                        CHOICE {
            k0-r16
                                             INTEGER (0..8191),
            k1-r16
                                             INTEGER (0..4095),
            k2-r16
                                             INTEGER (0..2047),
            k3-r16
                                             INTEGER (0..1023),
            k4-r16
                                             INTEGER (0..511),
                                             INTEGER (0..255),
            k5-r16
    nr-AdditionalPathList-rl6 NR-AdditionalPathList-rl6 NR-AdditionalPathList-rl6 NR-AdditionalPathList-
                                         NR-AdditionalPathList-r16
                                                                                       OPTIONAL,
-- ASN1STOP
```

NR-Multi-RTT-SignalMeasurementInformation field descriptions

nr-NTA-Offset

This field provides the $N_{TAoffset}$ used by the target device as specified in TS 38.133 [46], Table 7.1.2-2. Enumerated values nTA1, nTA2, nTA3, and nTA4 correspond to $N_{TAoffset}$ of 25600 Tc, 0 Tc, 39936 Tc, and 13792 Tc, respectively.

dI-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP. Each TRP should only be associated with one such ID.

nr-PhysCellID

This field specifies the physical cell identity of the associated TRP, as defined in TS 38.331 [35].

nr-CellGloballD

This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP, as defined in TS 38.331 [35].

nr-ARFCN

This field specifies the NR-ARFCN of the TRP.

nr-UE-RxTxTimeDiff

This field specifies the UE Rx-Tx time difference measurement, as defined in TS 38.215 [36].

nr-AdditionalPathList

This field specifies one or more additional detected path timing values for the TRP or resource, relative to the path timing used for determining the *nr-UE-RxTxTimeDiff* value. If this field was requested but is not included, it means the UE did not detect any additional path timing values.

nr-TimeStamp

This field specifies the time instance for which the measurement is performed.

nr-TimingQuality

This field specifies the target device's best estimate of the quality of the measurement.

nr-DL-PRS-RSRP-Result

This field specifies the NR DL-PRS reference signal received power (DL PRS-RSRP) measurement, as defined in TS 38.215 [36]. The mapping of the quantity is defined as in TS 38.133 [46].

NR-Multi-RTT-SignalMeasurementInformation field descriptions

nr-NTA-Offset

This field provides the $N_{TAoffset}$ used by the target device as specified in TS 38.133 [46], Table 7.1.2-2. Enumerated values nTA1, nTA2, nTA3, and nTA4 correspond to $N_{TAoffset}$ of 25600 Tc, 0 Tc, 39936 Tc, and 13792 Tc, respectively.

dI-PRS-ID

This field is used along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP. Each TRP should only be associated with one such ID.

nr-PhysCellID

This field specifies the physical cell identity of the associated TRP, as defined in TS 38.331 [35].

nr-CellGlobalID

This field specifies the NCGI, the globally unique identity of a cell in NR, of the associated TRP, as defined in TS 38.331 [35].

nr-ARFCN

This field specifies the NR-ARFCN of the TRP.

nr-DL-PRS-RSRP-ResultDiff

This field provides the additional DL-PRS RSRP measurement result relative to *nr-DL-PRS-RSRP-Result*. The DL-PRS RSRP value of this measurement is obtained by adding the value of this field to the value of the *nr-DL-PRS-RSRP-Result*. The mapping of this field is defined as in TS 38.133 [46].

nr-UE-RxTxTimeDiffAdditional

This field provides the additional UE Rx-Tx Difference measurement result relative to *nr-UE-RxTxTimeDiff*. The UE Rx-Tx Difference value of this measurement is obtained by adding the value of this field to the value of the *nr-UE-RxTxTimeDiff* field. The mapping of the field is defined in TS 38.133 [46].

6.5.12.5 NR Multi-RTT Location Information Request

NR-Multi-RTT-RequestLocationInformation

The IE NR-Multi-RTT-RequestLocationInformation is used by the location server to request NR Multi-RTT location measurements from a target device.

```
-- ASN1START
NR-Multi-RTT-RequestLocationInformation-r16 ::= SEQUENCE {
    nr-UE-RxTxTimeDiffMeasurementInfoRequest-r16
    nr-RequestedMeasurements-r16
nr-AssistanceAvailability-r16
                                           ENUMERATED { true }
                                                                                   OPTIONAL, -- Need ON
                                           BIT STRING { prsrsrpReq(0)} (SIZE(1..8)),
                                            BOOLEAN,
                                           NR-Multi-RTT-ReportConfig-r16,
    additionalPaths-r16
                                           ENUMERATED { requested }
                                                                                   OPTIONAL. -- Need ON
NR-Multi-RTT-ReportConfig-r16 ::= SEQUENCE {
    Multi-RTT-ReportConfig 110
maxDL-PRS-RxTxTimeDiffMeasPerTRP-r16
                                                                                   OPTIONAL, -- Need ON
                                                INTEGER (1..4)
    timingReportingGranularityFactor-r16
                                                INTEGER (0..5)
                                                                                   OPTIONAL
                                                                                                -- Need ON
-- ASN1STOP
```

$\textit{NR-Multi-RTT-RequestLocationInformation} \ field \ descriptions$

nr-UE-RxTxT ime DiffMeasurementInfoRequest

This field, if present, indicates that the target device is requested to report the DL-PRS Resource ID(s) or DL-PRS Resource Set ID(s) associated with the DL-PRS Resources(s) or the DL-PRS Resource Set(s) which are used in determining the UE Rx-Tx time difference measurements.

nr-AssistanceAvailability

This field indicates whether the target device may request additional PRS assistance data from the server. TRUE means allowed and FALSE means not allowed.

maxDL-PRS-RxTxTimeDiffMeasPerTRP

This field specifies the maximum number of UE-Rx-Tx time difference measurements for different DL-PRS Resources or DL-PRS Resource Sets per TRP.

timing Reporting GranularityFactor

This field specifies the recommended reporting granularity for the UE Rx-Tx time difference measurements. Value (0..5) corresponds to (k0..k5) used for nr-UE-RxTxTimeDiff and nr-UE-RxTxTimeDiffAdditional in NR-Multi-RTT-MeasElement. The UE may select a different granularity value for nr-UE-RxTxTimeDiff and nr-UE-RxTxTimeDiffAdditional.

6.5.12.6 NR Multi-RTT Capability Information

NR-Multi-RTT-ProvideCapabilities

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

NR-Multi-RTT-MeasurementCapability

The IE NR-Multi-RTT-MeasurementCapability defines the Multi-RTT measurement capability. The UE can include this IE only if the UE supports NR-DL-PRS-ResourcesCapability for Multi-RTT. Otherwise, the UE does not include this IE;

NR-Multi-RTT-MeasurementCapability field descriptions

maxNrOfRx-TX-MeasFR1

Indicates the maximum number of UE Rx–Tx time difference measurements corresponding to a single SRS resource/resource set for positioning with each measurement corresponding to a single DL-PRS resource/resource set on FR1.

maxNrOfRx-TX-MeasFR2

Indicates the maximum number of UE Rx–Tx time difference measurements corresponding to a single SRS resource/resource set for positioning with each measurement corresponding to a single DL-PRS resource/resource set on FR2.

srs-AssocPRS-MultiLayersFR1

Indicates whether the UE supports measurements derived on one or more DL-PRS resource/resource sets which may be in different positioning frequency layers for SRS transmitted in a single CC. PRS and SRS may be on different bands. This is for FR1 only.

srs-AssocPRS-MultiLayersFR2

Indicates whether the UE supports measurements derived on one or more DL-PRS resource/resource sets which may be in different positioning frequency layers for SRS transmitted in a single CC. PRS and SRS may be on different bands. This is for FR2 only.

supportOfRSRP-MeasFR1

Indicates whether the UE supports RSRP measurement for Multi-RTT on FR1.

supportOfRSRP-MeasFR2

Indicates whether the UE supports RSRP measurement for Multi-RTT on FR2.

6.5.12.7 NR Multi-RTT Capability Information Request

NR-Multi-RTT-RequestCapabilities

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

```
-- ASN1START

NR-Multi-RTT-RequestCapabilities-r16 ::= SEQUENCE {
    ...
}

-- ASN1STOP
```

6.5.12.8 NR Multi-RTT Error Elements

NR-Multi-RTT-Error

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

NR-Multi-RTT-LocationServerErrorCauses

The IE NR-Multi-RTT-LocationServerErrorCauses is used by the location server to provide NR Multi-RTT error reasons to the target device.

NR-Multi-RTT-TargetDeviceErrorCauses

The IE NR-Multi-RTT-TargetDeviceErrorCauses is used by the target device to provide NR Multi-RTT error reasons to the location server.

```
...
}
-- ASN1STOP
```

6.6 Multiplicity and type constraint values

Multiplicity and type constraint definitions

```
-- ASN1START
                               INTEGER ::= 65535 -- Maximum value of EUTRA carrier frequency
INTEGER ::= 65536 -- Lowest value extended EARFCN range
maxEARFCN
maxEARFCN-Plus1
                                INTEGER ::= 262143 -- Highest value extended EARFCN range
maxEARFCN2
maxKnownAPs-r14 INTEGER ::= 64
maxVisibleAPs-r14 INTEGER ::= 2048
maxWLAN-AP-r14 INTEGER ::= 32
maxWLAN-DataSets-r14 INTEGER ::= 128
maxBT-Reacce
maxBT-Beacon-r13
nrMaxBands-r16
                                              INTEGER ::= 1024 -- Maximum number of supported bands in
                                                                     -- UE capability.
                                              -- UE capability.
INTEGER ::= 4 -- Max freq layers
nrMaxFregLavers-r16
nrMaxNumDL-PRS-ResourcesPerSet-1-r16 INTEGER ::= 3
nrMaxNumDL-DRS-ResourcesPerSet-1-r16 INTEGER ::= 62
                                               INTEGER ::= 63
nrMaxNumDL-PRS-ResourceSetsPerTRP-1-r16 INTEGER ::= 7
                                              INTEGER ::= 64
nrMaxResourceIDs-r16
                                                                    -- Max Resource IDs
nrMaxResourceOffsetValue-1-r16
                                             INTEGER ::= 511
nrMaxResourcesPerSet-r16
                                             INTEGER ::= 64 -- Maximum resources for one set
                                             INTEGER ::= 2
INTEGER ::= 1
nrMaxSetsPerTrp-r16
                                                                     -- Maximum resource sets for one TRP
nrMaxSetsPerTrp-1-r16
                                             INTEGER ::= 256
INTEGER ::= 64
                                                                      -- Max TRPs per UE
nrMaxTRPs-r16
nrMaxTRPsPerFreq-r16
                                                                     -- Max TRPs per freq layers
                                        INTEGER ::= 63
nrMaxTRPsPerFreq-1-r16
                                              INTEGER ::= 4
maxSimultaneousBands-r16
                                                                      -- Maximum number of simultaneously
                                                                      -- measured bands
                                              INTEGER ::= 1024
maxBandComb-r16
                                              INTEGER ::= 16
nrMaxConfiguredBands-r16
-- ASN1STOP
```

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 TS 36.331 [12] or TS 38.331 [35]. The posSIBs are carried in RRC System Information (SI) messages (TS 36.331 [12] or TS 38.331 [35]).

For LTE RRC System Information (SI), a single *SystemInformationBlockPos* IE is defined in 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 clause 7.2.

For NR RRC System Information (SI), a single *SIBpos* IE is defined in TS 38.331 [35] which is carried in IE *PosSystemInformation-r16-IEs* specified in TS 38.331 [35]. The mapping of positioning SIB type (*posSibType*) to assistance data carried in *SIBpos* is specified in 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 clause 6.5.2.2. The OTDOA Assistance Data IEs and NR DL-TDOA/DL-AoD Assistance Data IEs are defined in clause 7.4.2. The Barometric Assistance Data IEs are defined in clause 6.5.5.8. The TBS (based on MBS signals) Assistance Data IEs are defined in clause 6.5.4.8.

Table 7.2-1: Mapping of posSibType to assistanceDataElement

	posSibType	assistanceDataElement
GNSS Common Assistance	posSibType1-1	GNSS-ReferenceTime
Data (clause 6.5.2.2)	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
	posSibType1-8	GNSS-SSR-CorrectionPoints
GNSS Generic Assistance	posSibType2-1	GNSS-TimeModelList
Data (clause 6.5.2.2)	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
	posSibType2-20	GNSS-SSR-URA
	posSibType2-21	GNSS-SSR-PhaseBias
	posSibType2-22	GNSS-SSR-STEC-Correction
	posSibType2-23	GNSS-SSR-GriddedCorrection
	posSibType2-24	NavIC-DifferentialCorrections
	posSibType2-25	NavIC-GridModelParameter
OTDOA Assistance Data	posSibType3-1	OTDOA-UE-Assisted
(clause 7.4.2)		

Barometric Assistance Data	posSibType4-1	Sensor-AssistanceDataList
(clause 6.5.5.8)		
TBS Assistance Data	posSibType5-1	TBS-AssistanceDataList
(clause 6.5.4.8)		
NR DL-TDOA/DL-AoD	posSibType6-1	NR-DL-PRS-AssistanceData
Assistance Data (clauses	posSibType6-2	NR-UEB-TRP-LocationData
6.4.3, 7.4.2)	posSibType6-3	NR-UEB-TRP-RTD-Info

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 C₀ corresponding to the *cipherSetID* using NAS signalling:
 - 4> if C_0 contains less than 128-bits:
 - 5> pad out the bit string with zeroes in most significant bit positions to achieve 128 bits.
 - 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 D₀.
 - 4> determine the initial Counter $C_1 = (C_0 + D_0) \mod 2^{128}$ (where all values are treated as non-negative integers);
 - 4> determine any subsequent counter C_i from the previous counter C_{i-1} as $C_i = (C_{i-1} + 1) \mod 2^{128}$;
 - 4> use the sequence of counters <C₁, C₂, C₃, ...> 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 C₀ corresponding to the *cipherSetID* using NAS signalling:
 - 5> if C₀ contains less than 128-bits:
 - 6> pad out the bit string with zeroes in most significant bit positions to achieve 128 bits.
 - 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 Do.
 - 5> determine the initial Counter $C_1 = (C_0 + D_0) \mod 2^{128}$ (where all values are treated as non-negative integers);

- 5> determine any subsequent counter C_i from the previous counter C_{i-1} as $C_i = (C_{i-1} + 1) \mod 2^{128}$;
- 5> use the sequence of counters <C₁, C₂, C₃, ...> 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 C₀ corresponding to the *cipherSetID* using NAS signalling:
 - 7> if C_0 contains less than 128-bits:
 - 8> pad out the bit string with zeroes in most significant bit positions to achieve 128 bits.
 - 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 D₀.
 - 7> determine the initial Counter $C_1 = (C_0 + D_0) \mod 2^{128}$ (where all values are treated as nonnegative integers);
 - 7> determine any subsequent counter C_i from the previous counter C_{i-1} as $C_i = (C_{i-1} + 1) \mod 2^{128}$:
 - 7> use the sequence of counters <C₁, C₂, C₃, ...> 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 C₀ corresponding to the *cipherSetID* using NAS signalling. When the UE has not obtained a valid cipher key value and initial Counter C₀ 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 clause defines the LPP broadcast information elements which are encoded as 'basic production' for system information broadcast purposes (see TS 36.331 [12], TS 38.331 [35]).

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.

LPP-Broadcast-Definitions

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

```
LPP-Broadcast-Definitions

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    OTDOA-ReferenceCellInfo,
    OTDOA-NeighbourCellInfoList,
    NR-TRP-LocationInfo-r16,
    NR-DL-PRS-BeamInfo-r16,
    NR-RTD-Info-r16
FROM LPP-PDU-Definitions;
```

7.4.2 Element definitions

AssistanceDataSIBelement

The IE AssistanceDataSIBelement is used in the IE SystemInformationBlockPos as specified in TS 36.331 [12] and IE SIBpos as specified in TS 38.331 [35].

```
-- ASN1START
AssistanceDataSIBelement-r15 ::= SEQUENCE {
                      INTEGER (0..63)
                                                                                   OPTIONAL,
   valueTag-r15
    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},
    {\tt 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.

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 C₀ of the initial counter C₁.

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: $C_1 = (D_0 + C_0) \mod 2^{128}$ (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] and TS 38.331 [35] 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'.

OTDOA-UE-Assisted field descriptions

otdoa-ReferenceCellInfo

LPP IE OTDOA-ReferenceCellInfo as defined in clause 6.5.1.2.

otdoa-NeighbourCellInfo

LPP IE OTDOA-NeighbourCellInfoList as defined in clause 6.5.1.2.

NR-UEB-TRP-LocationData

The IE NR-UEB-TRP-LocationData is used in the assistanceDataElement if the posSibType in IE PosSiB-Type defined in TS 38.331 [35] indicates 'posSibType6-2'.

```
NR-UEB-TRP-LocationData field descriptions

nr-trp-LocationInfo
LPP IE NR-TRP-LocationInfo as defined in clause 6.4.2.1.

nr-dI-prs-BeamInfo
LPP IE NR-DL-PRS-Beam-Info as defined in clause 6.4.2.1.
```

NR-UEB-TRP-RTD-Info

The IE NR-UEB-TRP-RTD-Info is used in the assistanceDataElement if the posSibType in IE PosSiB-Type defined in TS 38.331 [35] indicates 'posSibType6-3'.

```
NR-UEB-TRP-RTD-Info field descriptions

nr-rtd-Info
LPP IE NR-RTD-Info as defined in clause 6.4.2.1.
```

End of LPP-Broadcast-Definitions

```
-- ASN1START
END
-- ASN1STOP
```

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 $(C_2, C_3 \text{ etc.})$ 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 $(O_1 \text{ XOR } B_1)$, $(O_2 \text{ XOR } B_2)$, ... $(O_n \text{ XOR } B_n)$, 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.

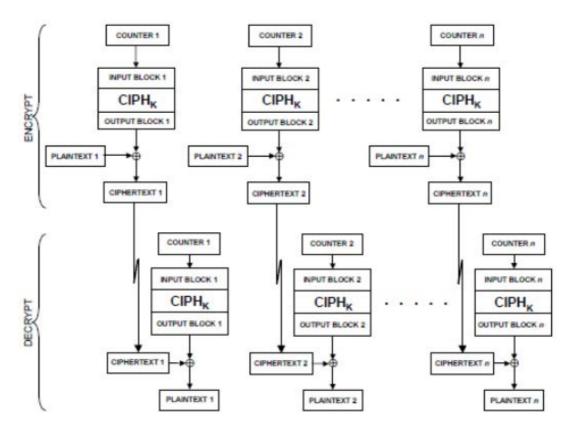


Figure 7.5-1: Illustration of Block Ciphering with Counter Mode [33].

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:

 $C_1 = (C_0 + D_0) \text{ mod } 2^{128} \text{(where all values are treated as non-negative integers)}$

To obtain any subsequent counter C_i from the previous counter C_{i-1} for any message, the following operation is used:

$$C_i = (C_{i-1} + 1) \mod 2^{128}$$

NOTE: As specified in clause 7.3 the value for D₀ is different for different *AssistanceDataSIBelement*'s to ensure that the counters derived from C₁ 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 C₁ 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 D₀ for ciphering of different *assistanceDataElement*'s (e.g. D₀ being chosen as 1 larger than a previous D₀ value) reusing previous counter values. To avoid this, the values of D₀ contain 16 least significant bits (LSBs) set to zero, as specified in clause 7.3.

Annex A (informative): Change History

	Change history of TS 36.355 up to v15.5.0							
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-100304	0007	-		Clarification of measurement reference point	9.1.0	
		RP-100304	0010	-		GNSS-DifferentialCorrectionsSupport	9.1.0	
		RP-100304	0011	 		BSAlign Indication in GNSS Reference Time	9.1.0	
		RP-100304	0011	1		Changes to reflect LPP ASN.1 review	9.1.0	
		RP-100304	0012	1		Introduction of LPP reliability sublayer	9.1.0	
		RP-100304	0015	1		LPP error procedures and conditions	9.1.0	
				-		·		
0040.00		RP-100304	0016	-		Triggered Location Information Transfer due to Cell Change	9.1.0	
2010-06		RP-100558	0018	2		Addition of need codes to optional LPP information elements	9.2.0	
		RP-100558	0019	1		Miscellaneous corrections to LPP stage 3	9.2.0	
		RP-100558 RP-100558	0020 0021	1		Small corrections to LPP specification Clarifications of OTDOA parameters	9.2.0	
		RP-100558	0021	1		Signalling support for PRS muting in OTDOA	9.2.0	
	KF-40	- TUU000	0022	-		Two times capital R replaced by lower case r in	9.2.0	
	_			-		"MeasuredResultsElement" (undoing not intended change)	3.2.1	
2010-09	RP-49	RP-100852	0024	-		Addition of an EPDU to an LPP Error and LPP Abort	9.3.0	
		RP-100852	0026	-		Division of LPP into Separate ASN.1 Modules with a Global Identifier	9.3.0	
		RP-100852	0028	-		Proposed Corrections to LPP Reliable Transport	9.3.0	
		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-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-100852	0035	1		Several corrections in LPP	9.3.0	
		RP-100852	0036	-		Clarification to Assistance Data Transfer Procedure	9.3.0	
2010-12		RP-101207	0037	-		Correction of reliable transport terminology in description of LPP-Message	9.4.0	
		RP-101207	0038	-		One cell with known SFN in OTDOA assistance data	9.4.0	
		RP-101207	0039	1		UE frequency capability for LPP	9.4.0	
		RP-101207	0041 0042	-		Correction to LPP reliable transport Correction to LPP Error procedure	9.4.0	
		RP-101207 RP-101207	0042	-		Addition of missing reference to LPPe	9.4.0	
		RP-101207	0043	2		Correction to the ODTOA assistance data	9.4.0	
			0040	-		Update of 'serving cell' terminology in 36.355	10.0.0	
2011-03		RP-110269	0046	-		Editorial corrections to 36.355	10.1.0	
_000		RP-110269	0048	1-		Removal of FFS for retransmission timer in LPP	10.1.0	
		RP-110269	0050	1-		Correction to code phase encoding in GNSS acquisition assistance	10.1.0	
		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		
		RP-110269	0057	-		Small corrections in 36.355	10.1.0	
-		RP-110269	0058	3		Further corrections to the OTDOA assistance data	10.1.0	
		RP-110830	0060	-		Clarifications to description of OTDOA positioning fields	10.2.0	
2011-09		RP-111279	0062	1		Various corrections to LPP	10.3.0	
		RP-111279	0064	-		Mandatory support of PRS for OTDOA measurements	10.3.0	
2011-12		RP-111709	0066	-		Clarification of packed encoding rules of LPP	10.4.0	
0010.05		RP-111709	0068	-		Clarification of first bit in BIT STRING definitions	10.4.0	
		RP-120808	0071	-		Usage of additionalInformation IE	10.5.0	
ZU12-U9		RP-121424	0074	2		Corrections to GNSS Acquisition Assistance Data	10.6.0	
	RP-57	-	-	1-		Upgrade to the Release 11 - no technical change	11.0.0	

2012-12	RP-58	RP-121931	0077	Τ_		Correcting the referencing of QoS parameters	11.1.0
2012 12		RP-121931	0080	-		Correction to missing field description in GNSS-AcquisitionAssistance IE	11.1.0
2013-03		RP-130237	0083	1		Extending E-UTRA Frequency Band and EARFCN value range	11.2.0
		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-130803	0093	-		Correction to serving cell terminology	11.3.0
		RP-130803	0094	-		Encoding of LPP IEs	11.3.0
		RP-131314	0098	-		Correction on svReqList	11.4.0
2013-12		RP-131984	0103	-		Correction to missing capability indication for inter-frequency RSTD measurements	11.5.0
		RP-131984	0107	1		Correction to Galileo assistance data elements	11.5.0
		RP-132000	0104	1		Stage 3 CR of TS 36.355 for introducing BDS in LTE	12.0.0
0044.00		RP-131984	0108	-		Correction to Galileo assistance data elements	12.0.0
		RP-140342 RP-140871	0112 0119	1		Clarification to gnss-DayNumber Signaling of OTDOA Neighbour Cell Information and Measurements	12.1.0 12.2.0
		RP-142114	0119	-		Correction to Galileo Assistance Data	12.2.0
2014-12		RP-142114	0123	ŧ-		Addition of an Early Position Fix to LPP	12.3.0
		RP-142120	0124	-		BDS update to version 2.0	12.3.0
2015-03		RP-150369	0126	2		Correction of GLONASS system time	12.4.0
		RP-150376	0125	1		LPP clean-up	12.4.0
2015-12		RP-152055	0134	1		Correction to the definition of Need codes	12.5.0
		RP-152068	0137	3		RAT-Independent positioning enhancements	13.0.0
		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-160470	0141	-		WLAN AP Identifier correction	13.1.0
		RP-160470	0142	1		LPP clean-up	13.1.0
		RP-161750	0143	4		Correction of ECID positioning for TDD	13.2.0
		RP-162317	0160	1		Clarification of WLAN RSSI value range	13.3.0
2016-12		RP-162326	0155	1		CR for 36.355 Further Indoor positioning enhancements	14.0.0
		RP-162327	0157	-		Barometric Pressure Uncertainty IEs	14.0.0
2017.02		RP-162326 RP-170636	0161 0162	3	В	Introduction of Further Indoor Positioning Enhancements	14.0.0
2017-03		RP-170636	0163	3	С	Introduction of positioning for further enhanced MTC Addition of periodical and triggered reporting capability signalling	14.1.0
		RP-170642	0165	2	F	Further Indoor positioning enhancements corrections	14.1.0
		RP-170637	0166	-	В	Introduction of positioning support for NB-IoT	14.1.0
2017-06		RP-171224	0169	3	F	Compact Signal Measurement Information for OTDOA	14.2.0
		RP-171223	0171	1	F	Correction to PRS Subframe Offset	14.2.0
		RP-171223	0173	1	F	Correction to SFN time stamp in OTDOA Signal Measurement Information	
	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-171225	0176	2	F	LPP clean-up	14.2.0
		RP-171224	0177	-	F	Corrections to number of NPRS carriers and ECID measurements for NB-loT	14.2.0
		RP-171224	0178	1	F	Removal of FFS for retransmission timer in LPP	14.2.0
		RP-171224	0181	1	F	Signalling optimisation for NB-IoT Enhancements	14.2.0
2017-09		RP-171913	0182	2	F	Clarification on definition of PRS Occasion Group	14.3.0
		RP-171914	0183	1	F	Additional OTDOA Capabilities	14.3.0
		RP-171911	0184	1	F	Clarification to GNSS-TimeModelList	14.3.0
2017 12		RP-171913	0185	2	F	Minor corrections on TS 36.355 for Rel-14 MTC	14.3.0 14.4.0
		RP-172616 RP-180446	0187 0189	1	F	Correction on PRS hopping configuration Segmentation of LPP Messages	14.4.0
2018-04		117-100440	0109	-		New version to fix ASN.1 formatting	14.5.0
		RP-181235	0202	2	F	Clarification for NRSRQ reporting with E-CID	14.6.0
		RP-181219	0204	2	В	Introduction of IMU support for OTDOA	15.0.0
2010 00		RP-181219	0205	1	В	Addition of RTK and PPP support	15.0.0
		RP-181219	0207	1	В	Addition of broadcast of positioning assistance data	15.0.0
		RP-181215	0209	1	В	Addition of NR Support	15.0.0
		RP-181252	0210	1	В	Addition of NB-IoT TDD support	15.0.0
2018-09	RP-81	RP-181963	0215	1	Α	Support for NPRS enhancements	15.1.0
	RP-81	RP-181945	0218	1	F	Corrections to TDD in 36.355	15.1.0
		RP-181961	0221	3	Α	Correction to RSRQ range in 36.355	15.1.0
		RP-181942	0222	1	F	OTDOA Assistance Data Request for NR	15.1.0
		RP-181960	0223	-	F	LPP clean-up	15.1.0
		RP-181952	0224	1	F	GAD shapes for high accuracy positioning	15.1.0
0010 15		RP-181952	0226	1	В	Positioning SIB value tag and expiration time	15.1.0
2018-12		RP-182672 RP-182681	0213 0228	2	F F	Addition of TDD UL/DL configuration to OTDOA assistance data Introduction of TDD UL/DL configuration for NB-IoT in 36.355	15.2.0
			111778	. /	1 -	וווויסטעכוסח סד ועלטב Contiguration for NB-101 IN 36.355	15.2.0
						SEN offect for OTDOA	
	RP-82	RP-182659 RP-182674	0229	3	F F	SFN offset for OTDOA Alignment of IE/field names between LPP and RRC specifications	15.2.0 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
2019-06	RP-84	RP-191376	0239	1	F	Minor corrections on NR Support	15.4.0
	RP-84	RP-191384	0240	4	F	Periodic assistance data transfer with cell ID change procedure	15.4.0
2019-09	RP-85	RP-192196	0243	1	F	Distinguishing Location Source when sensor method is used	15.5.0

NOTE: The table above will not be further updated in the future. It shows all TS 36.355 CRs taken over into TS 37.355 v1.0.0.

	Change history of TS 37.355							
Date	TSG#	TSG Doc.	CR	Rev	Cat	Subject/Comment	New version	
2019-12	RP-86	RP-192450	-	-	-	TS 36.355 v15.5.0 contents was transferred into this new TS 37.355 as by definition 36 series specifications cover E-UTRA/LTE only aspects and multi-RAT aspects need to be covered in 37 series specifications. The only changes compared to TS 36.355 v15.5.0: - new 37 series TS number is added: TS 37.355 - "Evolved Universal Terrestrial Radio Access (E-UTRA)" is removed from the TS title as beginning with Rel-15 TS 36.355 needs to cover also NR - clarification in the Scope clause that this TS covers radio access technologies E-UTRA/LTE and NR - the CR history table of TS 36.355 was kept for easier reference of all changes included in TS 37.355 but a new CR history table was added for TS 37.355.	1.0.0	
2019-12	RP-86					The approved version upgraded to v15.0.0 by MCC.	15.0.0	
2020-03	RP-87	RP-200367	0001	2	С	Addition of broadcast of barometric pressure assistance data	16.0.0	
	RP-87	RP-200357	0002	1	F	Sensor Provide Location Information Elements Correction	16.0.0	
		RP-200365	0247	8	В	CR of TS 37.355 for introducing NavIC in LTE – core part	16.0.0	
	RP-87	RP-200357	0248	1	В	Introduction of B1C signal in BDS system in A-GNSS	16.0.0	
	RP-87	RP-200367	0249	1	С	Addition of broadcast TBS assistance data	16.0.0	
	RP-87	RP-200345	0250	2	В	Introduction of NR positioning	16.0.0	
	RP-87	RP-200357	0252	1	В	Introducing support for GNSS Integer Ambiguity Level Indications	16.0.0	
2020-07	RP-88	RP-201196	0257	2	F	Introduction of NavIC Keplerian set IE	16.1.0	
	RP-88	RP-201190	0259	1	F	Update B1I signal ICD file to v3.0 in BDS system in A-GNSS	16.1.0	
	RP-88	RP-201175	0260	-	F	LPP Clean-Up	16.1.0	
	RP-88	RP-201175	0261	1	В	Introduction of Release-16 UE positioning capabilities	16.1.0	
2020-09	RP-89	RP-201989	0272	-	F	LPP miscellaneous corrections	16.2.0	
2020-12	RP-90	RP-202775	0274	-	F	Clarification of quality and time stamp for RSTD measurements	16.3.0	
	RP-90	RP-202789	0280	2	F	Correction of hanging ASN.1 code after END	16.3.0	
	RP-90	RP-202775	0282	-	F	Correction on LPP spec	16.3.0	
2021-03	RP-91	RP-210695	0284	1	F	Corrections on the field description of commonlEsProvideAssistanceData in TS37.355	16.4.0	

History

Document history						
V16.1.0	July 2020	Publication				
V16.2.0	November 2020	Publication				
V16.3.0	January 2021	Publication				
V16.4.0	April 2021	Publication				