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Technical Specification

**Digital cellular telecommunications system (Phase 2+);
Location Services (LCS);
Mobile Station (MS) - Serving Mobile Location Centre (SMLC)
Radio Resource LCS Protocol (RRLP)
(3GPP TS 44.031 version 8.5.0 Release 8)**



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Foreword

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1 Scope

The present document contains the definition of the Radio Resource LCS Protocol (RRLP) to be used between the Mobile Station (MS) and the Serving Mobile Location Centre (SMLC).

Clause 2 defines the functionality of the protocol. Clause 3 describes the message structure, and Clause 4 the structure of components. Clause 5 contains the ASN.1 description of the components.

1.1 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 43.059: "Functional Stage 2 Description of Location Services in GERAN".
- [3] 3GPP TS 29.002: "Mobile Application Part (MAP) specification".
- [4] ITU-T Recommendation X.691: "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".
- [5] ITU-T Recommendation X.680: "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".
- [6] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".
- [7] 3GPP TS 49.031: "Location Services (LCS); Base Station System Application Part LCS Extension (BSSAP-LE)".
- [8] ICD-GPS-200, Navstar GPS Space Segment/Navigation User Interfaces.
- [9] RTCM-SC104, RTCM Recommended Standards for Differential GNSS Service (v.2.2).
- [10] 3GPP TS 44.064: "General Packet Radio Service (GPRS); Mobile Station - Serving GPRS Support Node (MS-SGSN); Logical Link Control (LLC) layer specification".
- [11] Galileo OS Signal in Space ICD (OS SIS ICD), Draft 0, Galileo Joint Undertaking, May 23rd, 2006.
- [12] IS-GPS-200, Revision D, Navstar GPS Space Segment/Navigation User Interfaces, March 7th, 2006.
- [13] IS-GPS-705, Navstar GPS Space Segment/User Segment L5 Interfaces, September 22, 2005.
- [14] IS-GPS-800, Navstar GPS Space Segment/User Segment L1C Interfaces, March 31, 2008.
- [15] Specification for the Wide Area Augmentation System (WAAS), US Department of Transportation, Federal Aviation Administration, DTFA01-96-C-00025, 2001.
- [16] IS-QZSS, Quasi Zenith Satellite System Navigation Service Interface Specifications for QZSS, Ver.1.0, June 17, 2008.
- [17] Global Navigation Satellite System GLONASS Interface Control Document, Version 5, 2002.

1.2 Abbreviations

For the purposes of the present document, the following abbreviations and the abbreviations given in 3GPP TR 21.905 or in 3GPP TS 43.059 apply.

ADR	Accumulated Delta-Range
CNAV	Civil Navigation
ECEF	Earth-Centered, Earth-Fixed
ECI	Earth-Centered-Inertial
EGNOS	European Geostationary Navigation Overlay Service
FEC	Forward Error Correction
GAGAN	GPS Aided Geo Augmented Navigation
ICD	Interface Control Document
GANSS	Galileo and Additional Navigation Satellite Systems
GLONASS	GLObal'naya NAVigatsionnaya Sputnikovaya Sistema (Engl.: Global Navigation Satellite System)
GNSS	Global Navigation Satellite System
IOD	Issue of Data
LSB	Least Significant Bit
MSAS	Multi-functional Satellite Augmentation System
MSB	Most Significant Bit
msd	mean solar day
NAV	Navigation
NICT	National Institute of Information and Communications Technology
PZ-90	Parametry Zemli 1990 Goda – Parameters of the Earth Year 1990
QZSS	Quasi-Zenith Satellite System
SBAS	Space Based Augmentation System
SV	Space Vehicle
USNO	US Naval Observatory
WAAS	Wide Area Augmentation System
WGS-84	World Geodetic System 1984

2 Functionality of Protocol

2.1 General

The present document defines one generic RRLP message that is used to transfer Location Services (LCS) related information between the Mobile Station (MS) and the Serving Mobile Location Centre (SMLC). Usage of the RRLP protocol on a general level is described in 3GPP TS 43.059 that includes Stage 2 description of LCS.

One message includes one of the following components:

- Measure Position Request;
- Measure Position Response;
- Assistance Data;
- Assistance Data Acknowledgement;
- Protocol Error;
- Positioning Capability Request;
- Positioning Capability Response.

Next sub-clauses describe the usage of these components.

Delivery of components may be supported in the RRLP level using pseudo-segmentation by sending several shorter messages instead of one long message. Any assistance data that is successfully delivered to an MS and acknowledged prior to the interruption of the positioning procedure by an event like handover, or by any other event that causes an MS

to terminate the positioning procedure or delivery of assistance data (see 3GPP TS 43.059), shall be retained by the MS and need not be resent by the SMLC when positioning or delivery of assistance data is again re-attempted.

The RRLP maximum PDU size is 242 octets. If the amount of data that needs to be sent is larger than RRLP maximum PDU size, the RRLP pseudo-segmentation shall be used. The RRLP pseudo-segmentation is the use of several RRLP components (one in each RRLP message) to deliver a large amount of information. For SMLC to MS messages, the Assistance Data component is the one that is sent several times in order to deliver the information. For MS to SMLC messages, the Measure Position Response component may be sent twice in order to deliver the information. Legacy MS and SMLC (3GPP Rel-4 or older) may send RRLP components that are larger than the RRLP maximum PDU size. In this case lower level segmentation will be used.

2.2 Position Measurement Procedure

The purpose of this procedure is to enable the SMLC to request for position measurement data or location estimate from the MS, and the MS to respond to the request with measurements or location estimate.

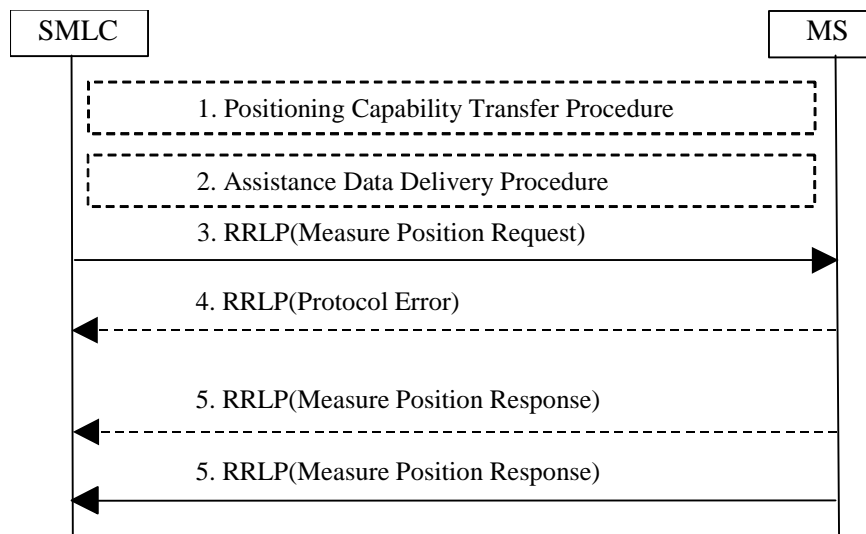


Figure 2.1: Position Measurement procedure

1. The Measure Position Request component and any Assistance Data Delivery Procedure may be preceded by a Positioning Capability Transfer procedure (see sub-clause 2.3a) to transfer the MS positioning capabilities to the SMLC.
2. The Measure Position Request component may be preceded by an Assistance Data Delivery Procedure (see sub-clause 2.3) to deliver some or all of the entire set of assistance data that is needed by the subsequent positioning procedure (steps 3-5).
3. The SMLC sends the Measure Position Request component in a RRLP message to the MS. The component includes QoS, other instructions, and possible assistance data to the MS. The RRLP message contains a reference number and an extended reference ID of the request.
4. The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that prevents the MS to receive a complete and understandable Measure Position Request component. The RRLP message contains the reference number and, if available, the extended reference ID included in the Measure Position Request received incomplete. The Protocol Error component includes a more specific reason. When the SMLC receives the Protocol Error component, it may try to resend the Measure Position Request (go back to the step 3), abort location, or start a new position measurement procedure (e.g. with updated assistance data).
5. The MS tries to perform the requested location measurements, and possibly calculates its own position. When the MS has location measurements, location estimate, or an error indication (measurements/location estimation not possible), it sends the results in the Measure Position Response component to the SMLC. The RRLP message contains the reference number and, if received, the extended reference ID of the request originally received in the step 3. The MS may optionally send one additional Measure Position Response component in a second RRLP message to the SMLC if the amount of information it needs to transfer to the SMLC is too large to fit into one single Measure Position Response component (uplink RRLP pseudo-segmentation). This RRLP message

also contains the reference number and, if received, the extended reference ID of the request originally received in the step 3. If two components are sent, the MS shall indicate in the first component that it is the first of many components and in the second one that it is the second of many components. If there is a problem that prevents the SMLC to receive a complete and understandable Measure Position Response component, the SMLC may decide to abort location, or start a new position measurement procedure instead. If additional Measure Position Response components are received by the SMLC after the 1st and optional 2nd one, they shall be ignored.

2.3 Assistance Data Delivery Procedure

The purpose of this procedure is to enable the SMLC to send assistance data to the MS related to position measurement and/or location calculation. Notice that RRLP protocol is not used by the MS to request assistance data, only to deliver it to the MS. The entire set of assistance data (i.e. the total amount of assistance data that the SMLC has decided to send in the current procedure) may be delivered in one or several Assistance Data components. In this case steps 1 and 3 below may be repeated several times by the SMLC. If several components are sent, the SMLC shall await the acknowledgement of each component before the next Assistance Data component is sent. If Assistance Data Delivery is used as part of the Position Measurement Procedure, as described in sub-clause 2.2, then some assistance data may be delivered in the final RRLP Measure Position Request.

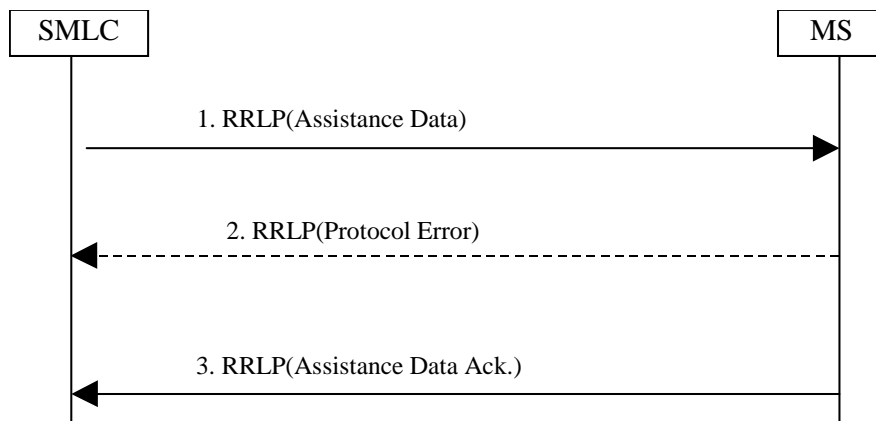


Figure 2.2: Assistance Data Delivery procedure

1. The SMLC sends the Assistance Data component to the MS. The component includes assistance data for location measurement and/or location calculation. The RRLP message contains a reference number and an extended reference ID of the delivery. The More Assistance Data To Be Sent Element in the Assistance Data component is used by the SMLC to indicate to the MS if either more Assistance Data components (in the current Assistance Data Delivery procedure) or a final RRLP Measure Position Request (if the Assistance Data Delivery Procedure forms part of a Position Measurement procedure as described in sub-clause 2.2) will be sent.
2. The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that prevents the MS to receive a complete and understandable Assistance Data component. The RRLP message contains the reference number and, if available, the extended reference ID included in the Assistance Data component received incomplete. The Protocol Error component includes a more specific reason. When the SMLC receives the Protocol Error component, it may try to resend the Assistance Data component (go back to the step 1), send a new measure Assistance Data set (e.g. with updated assistance data), or abort the delivery.
3. When the MS has received a complete Assistance Data component, it send the Assistance Data Acknowledgement component to the SMLC. The RRLP message contains the reference number of the Assistance Data originally received in step 1.

2.3a Positioning Capability Transfer Procedure

The purpose of this procedure is to enable the SMLC to obtain the positioning capabilities of the MS, the types of assistance supported and the types of assistance data that may be needed from the SMLC. MS support for this procedure can be indicated to the SMLC using the MS Classmark 3 IE for GSM (see 3GPP TS 24.008), the PS LCS Capability IE for GERAN Gb mode (see 3GPP TS 24.008) and the MS Positioning Capability IE for GERAN Iu mode (see 3GPP TS 44.118).

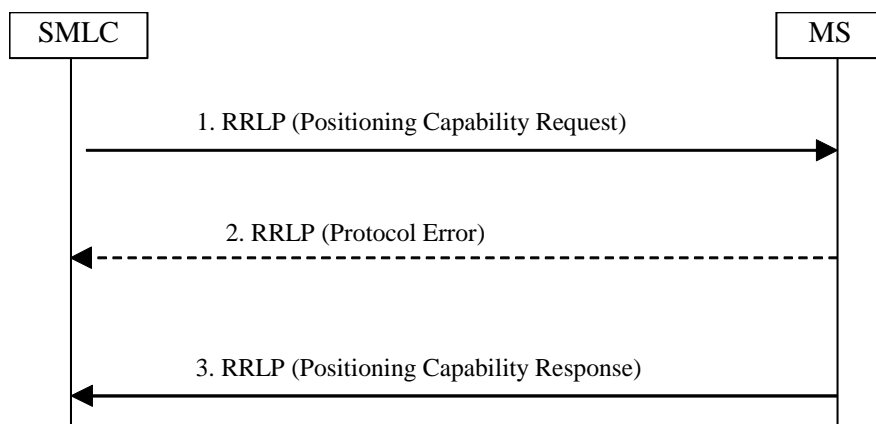


Figure 2.3: Positioning Capability Transfer procedure

1. The SMLC sends the Positioning Capability Request component to the MS. The RRLP message contains a reference number and an extended reference ID of the request. The message may contain indication of GANSS positioning support.
2. The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that prevents the MS to receive a complete and understandable Positioning Capability Request component. The RRLP message contains the reference number and the extended reference ID included in the Positioning Capability Request component. The Protocol Error component includes a more specific reason. When the SMLC receives the Protocol Error component, it may try to resend the Positioning Capability Request component (go back to the step 1) or abort the request.
3. When the MS has received a complete Positioning Capability Request component, it sends the Positioning Capability Response component to the SMLC. The component shall include the positioning capabilities of the MS and the types of supported assistance data. The component may include the types of assistance needed by the MS to obtain a location estimate or positioning measurements. The RRLP message also contains the reference number and extended Reference ID of the Positioning Capability Request originally received in step 1.

2.4 (void)

2.5 Error Handling Procedures

2.5.1 General

In this sub-clause it is described how a receiving entity behaves in cases when it receives erroneous data or detects that certain data is missing.

2.5.1a Message Too Short

When MS receives a RRLP message, that is too short to contain all mandatory IEs, the MS sends a Protocol Error component with indication "Message Too Short". If the Reference Number can be found, it is included. If the Reference Number is not available, the Reference Number of the RRLP message carrying the Protocol Error component is set to '0'. If the Extended Reference IE can be found, it shall be included in the returned Protocol Error Component. If the Extended Reference IE is not available, an Extended Reference IE shall not be included. The original sending entity that receives the Protocol Error, may then resend the original message, or abort the procedure.

2.5.2 Unknown Reference Number

A SMLC detects that it has received a RRLP message with an unknown or invalid Reference Number, when one or more of the following conditions occur:

- a Measure Position Response, Assistance Data Acknowledgement, Positioning Capability Response or Protocol Error component is received with a Reference Number that the SMLC has not sent in a Measure Position

Request, Assistance Data or Positioning Capability Request component during a pending Position Measurement, Assistance Data Delivery or Positioning Capability Transfer procedure.

- a Measure Position Response, Positioning Capability Response or Protocol Error component is received with an Extended Reference IE value that the SMLC has not sent in a Measure Position Request, Assistance Data or Positioning Capability Request component during a pending Position Measurement, Assistance Data Delivery or Positioning Capability Transfer procedure.
- a Measure Position Response, Positioning Capability Response or Protocol Error component is received with a Reference Number and an Extended Reference IE value that the SMLC has not sent together in the same Measure Position Request, the same Assistance Data or the same Positioning Capability Request component during a pending Position Measurement, Assistance Data Delivery or Positioning Capability Transfer procedure.

The SMLC shall then discard the message. If the SMLC receives a Measure Position Response or a Protocol Error component containing no Extended Reference ID, then the SMLC shall assume that the target MS is for Release 4 or earlier and shall only verify the received Reference Number.

2.5.3 Missing Information Element or Component Element

When MS receives a RRLP message, that does not contain IEs or component elements expected to be present, the MS sends a Protocol Error component with indication "Missing Information Element or Component Element". If the Reference Number can be found, it is included. If the Reference Number is not available, the Reference Number of the RRLP message carrying the Protocol Error component is set to '0'. If the Extended Reference IE can be found, it shall be included in the returned Protocol Error Component. If the Extended Reference IE is not available, an Extended Reference IE shall not be included. The SMLC that receives the Protocol Error, may then resend the original message, or abort the procedure.

2.5.4 Incorrect Data

When MS receives a RRLP message, that contains IEs or elements of components that are syntactically incorrect, the MS sends a Protocol Error component with indication "Incorrect Data". If the Reference Number can be found, it is included. If the Reference Number is not available, the Reference Number of the RRLP message carrying the Protocol Error component is set to '0'. If the Extended Reference IE can be found, it shall be included in the returned Protocol Error Component. If the Extended Reference IE is not available, an Extended Reference IE shall not be included. The SMLC that receives the Protocol Error, may then resend the original message, or abort the procedure.

2.5.5 Repeated Component

When after the reception of a Measure Position Request component, but before responding with a Measure Position Response or a Protocol Error component, the MS receives a new RRLP message with the Measure Position Request component, it acts as follows:

- if the old and new Measure Position Request components have the same Reference Number and, if included, the same Extended Reference IE, the MS ignores the later component;
- if the old and new Measure Position Request components have different Reference Numbers or, if included, different Extended Reference IEs or if one Measure Position Request component (old or new) contains an Extended Reference IE but the other component does not, the MS aborts activity for the former component, and starts to act according to the later component, and sends a response to that.

When after the reception of an Assistance Data component, but before responding with an Assistance Data Acknowledgement or a Protocol Error component, the MS receives a new RRLP message with the Assistance Data component, it acts as follows:

- if the old and new Assistance Data components have the same Reference Number and, if included, the same Extended Reference IE and if pseudo-segmentation does not apply (see sub-clause 2.5.9), the MS ignores the later component;
- if the old and new Assistance Data components have different Reference Numbers or, if included, different Extended Reference IEs or if one Assistance Data component (old or new) contains an Extended Reference IE but the other component does not, the MS ignores the former component and sends an acknowledgement to the latter component.

When after the reception of a Positioning Capability Request component, but before responding with a Positioning Capability Response or a Protocol Error component, the MS receives a new RRLP message with the Positioning Capability Request component, it acts as follows:

- if the old and new Positioning Capability Request components have the same Reference Number and the same Extended Reference IE, the MS ignores the later component;
- if the old and new Positioning Capability Request components have different Reference Numbers or different Extended Reference IEs, the MS aborts activity for the former component, starts to act according to the later component and sends a response to that. When after the reception of a Measure Position Response component, the SMLC receives a new RRLP message with the Measure Position Response component, it acts as follows:
 - if the old and new Measure Position Response components have the same Reference Number and, if included, the same Extended Reference IE values, the SMLC may ignore the later component.

2.5.6 (void)

2.5.7 Missing Component

When the SMLC sends a Measure Position Request component to the MS, it starts a timer. If the timer expires before the SMLC receives the last Measure Position Response component or a Protocol Error component from the MS with the same Reference Number and, if included, the same Extended Reference IE value as in the sent component, it may abort location attempt or send a new Measure Position Request.

When the SMLC receives a Measure Position Response component with the same Reference Number and, if included, the same Extended Reference IE value as in the sent component indicating that it is the second of many segments, but the first of the many segments was never received by the SMLC, it may abort location attempt or send a new Measure Position Request.

When the SMLC sends a Assistance Data component to the MS, it starts a timer. If the timer expires before the SMLC receives a Assistance Data Acknowledgement or Protocol Error component from the MS with the same Reference Number as in the sent component and, in the case of a Protocol Error component, either the same extended reference ID as in the sent component or no extended reference ID, it may abort delivery attempt or send a new Assistance Data.

When the SMLC sends a Positioning Capability Request component to the MS, it starts a timer. If the timer expires before the SMLC receives a Positioning Capability Response or Protocol Error component from the MS with the same Reference Number and the same Extended Reference ID as in the sent component, it may abort the Positioning Capability Transfer Procedure attempt or send a new Positioning Capability Request.

2.5.8 Unforeseen Component

When the MS receives a complete Assistance Data pseudo-segmentation sequence or an Assistance Data component that was sent without pseudo-segmentation, that it is not expecting, MS may discard it.

2.5.8a RRLP Procedure

The MS and SMLC shall only support one RRLP procedure at a time for either positioning, delivery of assistance data or positioning capability transfer. The normal sequence of events for either procedure is defined in sub-clause 2.2, sub-clause 2.3 or sub-clause 2.3a, respectively. If the MS is engaged in an RRLP procedure and receives a correctly encoded RRLP message from the SMLC that starts a new procedure, the MS shall abort the first procedure without sending a response and start the second.

2.5.9 Pseudo-Segmentation

When the SMLC employs pseudo-segmentation to send an RRLP Measure Position Request message or an RRLP Assistance Data message, the SMLC shall send one or more RRLP Assistance Data components followed by:

- a final RRLP Measure Position Request component (see sub-clause 2.2) or
- a final RRLP Assistance Data component (see sub-clause 2.3).

The SMLC shall indicate in all but the final component (Measure Position Request or Assistance Data, respectively) that more components are on the way.

When an MS receives an Assistance Data component indicating that more components are on the way, the MS may store the contents of the component. If the MS receives a subsequent Assistance Data component or a final Measure Position Request component that is correctly encoded, the MS shall assume that the new component continues the pseudo-segmentation of the earlier component and may then store the contents of the new component. If the new component is an Assistance Data component indicating that no more components are on the way or if it is a Measure Position Request, the MS shall assume that pseudo-segmentation is complete. The MS may then employ the rules defined in sub-clause 2.5.5 to verify if the new message is a repeated duplicate of a previous message.

3 Message Structure

3.1 General Format of RRLP Message

The general format of the RRLP message is given below, and based on:

- ITU-T Recommendation X.680;
- ITU-T Recommendation X.691;

and is consistent with these ITU-T recommendations. Also further definitions in the present document are based on ASN.1/94 defined in ITU-T Recommendation X.680 (ASN.1 1994). BASIC-PER, unaligned variant is used. Both RRLP ASN.1 modules, RRLP-Messages and RRLP-Components, are based on recommendations presented above.

ASN.1 identifiers have the same name as the corresponding parameters (information elements of the RRLP message, components, elements of components, fields of component elements etc) in other parts of the present document, except for the differences required by the ASN.1 notation (blanks between words are removed, the first letter of the first word is lower-case and the first letter of the following words are capitalized, e.g. "Reference Number" is mapped to "referenceNumber"). In addition some words may be abbreviated as follows:

msr	measure
req	request
rsp	response
nbr	number
ack	acknowledgement

Ellipsis Notation shall be used in the same way as described in 3GPP TS 29.002 and shall be supported on the radio interface by the MS and the network for all operations defined in the present document.

Table 3.1.a: RRLP Message Format

```

RRLP-Messages
-- { RRLP-messages }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    MsrPosition-Req, MsrPosition-Rsp, AssistanceData,
    ProtocolError, PosCapability-Req, PosCapability-Rsp
FROM
    RRLP-Components      -- { RRLP-Components }
;

PDU ::= SEQUENCE {
    referenceNumber      INTEGER (0..7),
    component            RRLP-Component
}

RRLP-Component ::= CHOICE {
    msrPositionReq      MsrPosition-Req,
    msrPositionRsp      MsrPosition-Rsp,
    assistanceData      AssistanceData,
    assistanceDataAck   NULL,
    protocolError       ProtocolError,
    ...,
    posCapabilityReq    PosCapability-Req,
    posCapabilityRsp    PosCapability-Rsp
}

END

```

The message consists of two information elements, that are further described in the following sub-clauses.

3.2 Reference Number IE

This element is mandatory, and appears only once per RRLP message. It has the range from 0 to 7. Value 0 is reserved for indicating unknown Reference Number. Its ASN.1 definition is in sub-clause 3.1. This element contains the Reference Number that shall be used as follows:

- in the Position Measurement procedure the SMLC shall select any number within the range 1- 7 that it is not already using with the particular MS. The Reference Number serves as an identification of the Measure Position request component that it sends to the MS. When the MS responds either with the Measure Position Response component, or the Protocol Error component, it shall use the same Reference Number value and, if an Extended Reference ID was included by the SMLC, the same Extended Reference ID to identify to which Measure Position Request it is responding, if the Reference Number has been obtained. If the MS has not been able to decode the Reference Number (e.g. IE missing), it shall use '0' as the Reference number in the response. This mechanism helps for example in the cases where the SMLC sends a Measure Position Request to the MS, and before it receives the Response, it needs to send another Request (e.g. assistance data changes). Then the SMLC can identify to which Request the Response is related to;
- in the Assistance Data Delivery procedure the SMLC shall select any number within the range 1 - 7 that it is not already using with the MS. The Reference Number serves as an identification of the Assistance Data component that it sends to the MS. When the MS responds either with the Assistance Data Acknowledgement component or the Protocol Error component, it shall use the same Reference Number value if the Reference Number has been obtained and, in the case of Protocol Error, if an Extended Reference ID was included by the SMLC, the same Extended Reference ID to identify to which Assistance Data component it is responding,. If the MS has not been able to decode the Reference Number (e.g. IE missing), it shall use '0' as the Reference number in the response.
- in the Position Capability Transfer procedure the SMLC shall select any number within the range 1 - 7 that it is not already using with the MS. The Reference Number serves as an identification of the Positioning Capability Request component that it sends to the MS. When the MS responds either with the Positioning Capability Response component, or the Protocol Error component, it shall use the same Reference Number value if the Reference Number has been obtained and the same Extended Reference ID value if that has been obtained to

identify to which Positioning Capability Request component it is responding. If the MS has not been able to decode the Reference Number (e.g. IE missing), it shall use '0' as the Reference number in the response.

- the SMLC shall use the same Reference Number and same Extended Reference ID to resend any RRLP component for which a response was not received from the MS.
- the SMLC shall use a different Reference Number to that in any RRLP component for which a response was not received from the MS if the SMLC aborts an existing RRLP procedure and starts a new procedure.
- the SMLC may use the same Reference Number and same Extended Reference ID or different Reference Numbers and Extended Reference IDs for different RRLP components within the same pseudo-segmentation sequence.

In all RRLP messages except Assistance Data Acknowledgement, the Reference Number IE shall be supplemented by an Extended Reference IE in order to distinguish valid from invalid RRLP responses at the SMLC and duplicate from non-duplicate RRLP commands at the MS. In order to remain backward compatible, the receiving entity shall be able to receive Measure Position Request, Measure Position Response, Assistance Data and Protocol Error messages without the Extended Reference IE. The ASN.1 definition of the Extended Reference IE is given in sub-clause 5.1 and the procedures associated with sending and receiving it are given in clause 2 and in Annex A, sub-clauses A.2.2.5, A.3.2.7 and A.6.6.

3.3 Component IE

This element is mandatory, and appears only once per RRLP message. It contains the actual component to be transferred.

Different components are described further in Chapter 4. This IE contains only one component, i.e. it is not possible to include two or more components.

4 Components

This ASN.1 module contains the definitions of the components and datatypes defined in the components.

Table 4.a: RRLP-Components format

```

RRLP-Components
-- { RRLP-Components }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
    Ext-GeographicalInformation, VelocityEstimate
FROM
    MAP-LCS-DataTypes {
        itu-t identified-organization (4) etsi (0) mobileDomain (0)
        gsm-Network (1) modules (3) map-LCS-DataTypes (25) version10 (10)}

    ExtensionContainer
FROM MAP-ExtensionDataTypes {
    itu-t identified-organization (4) etsi (0) mobileDomain (0)
    gsm-Network (1) modules (3) map-ExtensionDataTypes (21) version10 (10)}
;

-- Add here other ASN.1 definitions presented below
-- in chapters 4 and 5.

END

```


4.1 Measure Position Request

This component is used by the SMLC to request location measurements or a location estimate from the MS. It includes QoS, other instructions, and possible assistance data to the MS. This component is defined as follows:

Table 4.1.a: Measure Position Request

```

-- add this definition to RRLP-Components module

-- Measurement Position request component
MsrPosition-Req ::= SEQUENCE {
  positionInstruct      PositionInstruct,
  referenceAssistData   ReferenceAssistData   OPTIONAL,
  msrAssistData         MsrAssistData         OPTIONAL,
  systemInfoAssistData SystemInfoAssistData  OPTIONAL,
  gps-AssistData        GPS-AssistData        OPTIONAL,
  extensionContainer    ExtensionContainer    OPTIONAL,
  ...,
  -- Release 98 extension element
rel98-MsrPosition-Req-extension  Rel98-MsrPosition-Req-Extension  OPTIONAL,
  -- Release 5 extension element
rel5-MsrPosition-Req-extension    Rel5-MsrPosition-Req-Extension    OPTIONAL,
  -- Release 7 extension element
rel7-MsrPosition-Req-extension    Rel7-MsrPosition-Req-Extension    OPTIONAL
}

```

The elements of this component are defined in clause 5.

4.2 Measure Position Response

This component is used by the MS to respond to a Measure Position Request from the SMLC with location measurements, a location estimate, or an error indication. This component is defined as follows:

Table 4.2.a: Measure Position Response

```

-- add this definition to RRLP-Components module

-- Measurement Position response component
MsrPosition-Rsp ::= SEQUENCE {
  multipleSets      MultipleSets      OPTIONAL,
  referenceIdentity ReferenceIdentity  OPTIONAL,
  otd-MeasureInfo   OTD-MeasureInfo   OPTIONAL,
  locationInfo      LocationInfo      OPTIONAL,
  gps-MeasureInfo   GPS-MeasureInfo   OPTIONAL,
  locationError     LocationError     OPTIONAL,
  extensionContainer ExtensionContainer OPTIONAL,
  ...,
  -- Release extension here
rel-98-MsrPosition-Rsp-Extension  Rel-98-MsrPosition-Rsp-Extension  OPTIONAL,
rel-5-MsrPosition-Rsp-Extension    Rel-5-MsrPosition-Rsp-Extension    OPTIONAL,
  -- When RRLP pseudo-segmentation is used, rel-5-MsrPosition-Rsp-Extension
  -- and other possible future extensions should be the ones included in
  -- the 2nd MsrPosition-Rsp component.
rel-7-MsrPosition-Rsp-Extension    Rel-7-MsrPosition-Rsp-Extension    OPTIONAL
}

```

The elements of this component are defined in clause 5.

4.3 Assistance Data

This component is used by the SMLC to deliver assistance data for location measurement and/or location calculation. This component is defined as follows:

Table 4.3.a: Assistance Data

```

-- add this definition to RRLP-Components module

-- Assistance Data component
AssistanceData ::= SEQUENCE {
    referenceAssistData ReferenceAssistData      OPTIONAL,
    msrAssistData       MsrAssistData           OPTIONAL,
    systemInfoAssistData SystemInfoAssistData   OPTIONAL,
    gps-AssistData      GPS-AssistData         OPTIONAL,
    moreAssDataToBeSent MoreAssDataToBeSent    OPTIONAL, -- If not present, interpret as only
                                                         -- Assistance Data component used to
                                                         -- deliver entire set of assistance
                                                         -- data.

    extensionContainer ExtensionContainer       OPTIONAL,
    ...,
    -- Release extension here
    rel198-AssistanceData-Extension Rel198-AssistanceData-Extension OPTIONAL,
    rel5-AssistanceData-Extension  Rel5-AssistanceData-Extension  OPTIONAL,
    rel7-AssistanceData-Extension  Rel7-AssistanceData-Extension  OPTIONAL
}

```

The elements of this component are defined in clause 5.

4.4 Assistance Data Acknowledgement

This component does not have any information contents. Its presence indicates that the MS has received the complete Assistance Data component.

4.5 Protocol Error

This component is used by the receiving entity (SMLC or MS) to indicate to the sending entity, that there is a problem that prevents the receiving entity to receive a complete and understandable component. This component is defined as follows:

Table 4.5.a: Protocol Error

```

-- add this definition to RRLP-Components module

-- Protocol Error component
ProtocolError ::= SEQUENCE {
    errorCause      ErrorCodes,
    extensionContainer ExtensionContainer    OPTIONAL,
    ...,
    -- Release extensions here
    rel-5-ProtocolError-Extension Rel-5-ProtocolError-Extension  OPTIONAL
}

```

The elements of this component are defined in clause 5.

4.6 Positioning Capability Request

This component is used by the SMLC to request the positioning capabilities of the MS and optionally indicating GANSS positioning support. This component is defined as follows:

Table 4.6.a: Positioning Capability Request

```

-- add this definition to RRLP-Components module

-- Positioning Capability request component
PosCapability-Req ::= SEQUENCE {
    extended-reference Extended-reference,
    gANSSPositionMethods GANSSPositionMethods  OPTIONAL,
    extensionContainer ExtensionContainer        OPTIONAL,
}

```

```
}
...
}
```

The elements of this component are defined in clause 5.

4.7 Positioning Capability Response

This component is used by the MS to respond to a Positioning Capability Request from the SMLC with the positioning capabilities of the MS, the types of assistance data supported and the types of assistance data possibly needed by the MS. This component is defined as follows:

Table 4.7.a: Positioning Capability Response

```
-- add this definition to RRLP-Components module

-- Positioning Capability response component
PosCapability-Rsp ::= SEQUENCE {
    extended-reference      Extended-reference,
    posCapabilities         PosCapabilities,
    assistanceSupported     AssistanceSupported    OPTIONAL,
    assistanceNeeded       AssistanceNeeded      OPTIONAL,
    extensionContainer      ExtensionContainer    OPTIONAL,
    ...
}
```

The elements of this component are defined in clause 5.

5 Elements of Components

5.1 ASN.1 Description

The following ASN.1 code defines the elements of components. See the Annex A for further description of the contents of components and their elements.

Table 5.1.a: ASN.1 Description

```
-- add these definitions to RRLP-Components module
-- Position instructions
PositionInstruct ::= SEQUENCE {
    -- Method type
    methodType          MethodType,
    positionMethod      PositionMethod,
    measureResponseTime MeasureResponseTime,
    useMultipleSets     UseMultipleSets,
    environmentCharacter EnvironmentCharacter    OPTIONAL
}

--
MethodType ::= CHOICE {
    msAssisted      AccuracyOpt,    -- accuracy is optional
    msBased         Accuracy,       -- accuracy is mandatory
    msBasedPref     Accuracy,       -- accuracy is mandatory
    msAssistedPref  Accuracy        -- accuracy is mandatory
}

-- Accuracy of the location estimation
AccuracyOpt ::= SEQUENCE {
    accuracy      Accuracy    OPTIONAL
}

-- The values of this field are defined in 3GPP TS 23.032 (Uncertainty code)
Accuracy ::= INTEGER (0..127)
```

```

-- Position Method
PositionMethod ::= ENUMERATED {
    eotd (0),
    gps (1),
    gpsOrEOTD (2)
}

-- Measurement request response time
MeasureResponseTime ::= INTEGER (0..7)

-- useMultiple Sets, FFS!
UseMultipleSets ::= ENUMERATED {
    multipleSets (0),      -- multiple sets are allowed
    oneSet (1)             -- sending of multiple is not allowed
}

-- Environment characterization
EnvironmentCharacter ::= ENUMERATED {
    badArea (0),          -- bad urban or suburban, heavy multipath and NLOS
    notBadArea (1),      -- light multipath and NLOS
    mixedArea (2),       -- not defined or mixed environment
    ...
}

-- E-OTD reference BTS for Assistance data IE
ReferenceAssistData ::= SEQUENCE {
    bcchCarrier          BCCHCarrier,      -- BCCH carrier
    bsic                 BSIC,             -- BSIC
    timeSlotScheme       TimeSlotScheme,   -- Timeslot scheme
    btsPosition          BTSPosition        OPTIONAL
}

-- ellipsoid point and
-- ellipsoid point with altitude and uncertainty ellipsoid shapes are supported
BTSPosition ::= Ext-GeographicalInformation

-- RF channel number of BCCH
BCCHCarrier ::= INTEGER (0..1023)

-- Base station Identity Code
BSIC ::= INTEGER (0..63)

-- Timeslot scheme
TimeSlotScheme ::= ENUMERATED {
    equalLength (0),
    variousLength (1)
}

-- Time slot (modulo)
ModuloTimeSlot ::= INTEGER (0..3)

-- E-OTD measurement assistance data IE
-- The total number of neighbors in this element (MsrAssistData)
-- and in SystemInfoAssistData element (presented neighbors
-- can be at a maximum 15!)
MsrAssistData ::= SEQUENCE {
    msrAssistList SeqOfMsrAssistBTS
}
SeqOfMsrAssistBTS ::= SEQUENCE (SIZE(1..15)) OF MsrAssistBTS

MsrAssistBTS ::= SEQUENCE {
    bcchCarrier          BCCHCarrier,      -- BCCH carrier
    bsic                 BSIC,             -- BSIC
    multiFrameOffset      MultiFrameOffset, -- multiframe offset
    timeSlotScheme        TimeSlotScheme,   -- Timeslot scheme
    roughRTD              RoughRTD,         -- rough RTD value

    -- Location Calculation Assistance data is moved here
    calcAssistanceBTS     CalcAssistanceBTS OPTIONAL
}

-- Multiframe offset
MultiFrameOffset ::= INTEGER (0..51)
-- The Multiframe Offset value 51 shall not be encoded by the transmitting entity and
-- shall be treated by the receiving entity as 0.

```

```

-- Rough RTD value between one base station and reference BTS
RoughRTD ::= INTEGER (0..1250)
-- The RoughRTD value 1250 shall not be encoded by the transmitting entity and shall
-- be treated by the receiving entity as 0.

-- E-OTD Measurement assistance data for system information List IE
-- The total number of base stations in this element (SystemInfoAssistData
-- presented neighbors) and in MsrAssistData element can be at a maximum 15.
SystemInfoAssistData ::= SEQUENCE {
    systemInfoAssistList    SeqOfSystemInfoAssistBTS
}
SeqOfSystemInfoAssistBTS ::= SEQUENCE (SIZE(1..32)) OF SystemInfoAssistBTS

-- whether n.th is present or not ?
SystemInfoAssistBTS ::= CHOICE {
    notPresent    NULL,
    present       AssistBTSData
}

-- Actual assistance data for system information base station
AssistBTSData ::= SEQUENCE {
    bsic          BSIC,          -- BSIC
    multiFrameOffset    MultiFrameOffset, -- multiframe offset
    timeSlotScheme    TimeSlotScheme, -- Timeslot scheme
    roughRTD          RoughRTD,    -- rough RTD value

    -- Location Calculation Assistance data
    calcAssistanceBTS    CalcAssistanceBTS    OPTIONAL
}

-- E-OTD Location calculation assistance data,
-- CalcAssistanceBTS element is optional not subfields
CalcAssistanceBTS ::= SEQUENCE {
    finerRTD          FinerRTD,    -- fine RTD value between base stations
    referenceWGS84    ReferenceWGS84 -- reference coordinates
}

-- Coordinates of neighbour BTS, WGS-84 ellipsoid
ReferenceWGS84 ::= SEQUENCE {
    relativeNorth    RelDistance,    -- relative distance (south negative)
    relativeEast     RelDistance,    -- relative distance (west negative)
    -- Relative Altitude is not always known
    relativeAlt      RelativeAlt     OPTIONAL -- relative altitude
}

-- Fine RTD value between this BTS and the reference BTS
FinerRTD ::= INTEGER (0..255)

-- Relative north/east distance
RelDistance ::= INTEGER (-200000..200000)

-- Relative altitude
RelativeAlt ::= INTEGER (-4000..4000)

-- Measure position response IEs
-- Reference Identity
-- Multiple sets
MultipleSets ::= SEQUENCE {
    -- number of reference sets
    nbrOfSets        INTEGER (2..3),

    -- This field actually tells the number of reference BTSs
    nbrOfReferenceBTSs    INTEGER (1..3),

    -- This field is conditional and included optionally only if
    -- nbrOfSets is 3 and number of reference BTSs is 2.
    referenceRelation    ReferenceRelation    OPTIONAL
}

-- Relation between refence BTSs and sets
ReferenceRelation ::= ENUMERATED {
    secondBTSThirdSet (0), -- 1st BTS related to 1st and 2nd sets
    secondBTSSecondSet (1), -- 1st BTS related to 1st and 3rd sets
    firstBTSFirstSet (2) -- 1st BTS related to 1st set
}

```

```

-- Reference BTS Identity, this element contains number of
-- BTSs told nbrOfReferenceBTSs field in Multiple sets element)
ReferenceIdentity ::= SEQUENCE {
    -- Reference BTS list
    refBTSList      SeqOfReferenceIdentityType
}
SeqOfReferenceIdentityType ::= SEQUENCE (SIZE(1..3)) OF ReferenceIdentityType

-- Cell identity
ReferenceIdentityType ::= CHOICE {
    bsicAndCarrier  BSICAndCarrier,      -- BSIC and Carrier
    ci              CellID,              -- Cell ID, LAC not needed
    requestIndex    RequestIndex,        -- Index to Requested Neighbor List
    systemInfoIndex SystemInfoIndex,     -- Index to System info list, this type of ref. identity
                                                -- shall not be used by the MS unless it has received
                                                -- the SystemInfoAssistData from the SMLC for this cell.
    ciAndLAC        CellIDAndLAC        -- CI and LAC
}

BSICAndCarrier ::= SEQUENCE {
    carrier BCCHCarrier,
    bsic     BSIC
}

RequestIndex ::= INTEGER (1..16)

SystemInfoIndex ::= INTEGER (1..32)

CellIDAndLAC ::= SEQUENCE {
    referenceLAC  LAC,          -- Location area code
    referenceCI   CellID       -- Cell identity
}
CellID ::= INTEGER (0..65535)
LAC ::= INTEGER (0..65535)

-- OTD-MeasureInfo
OTD-MeasureInfo ::= SEQUENCE {
    -- Measurement info elements, OTD-MsrElement is repeated number of times
    -- told in nbrOfReferenceBTSs in MultipleSets, default value is 1
    otdMsrFirstSets      OTD-MsrElementFirst,

    -- if more than one sets are present this element is repeated
    -- NumberOfSets - 1 (-1 = first set)
    otdMsrRestSets       SeqOfOTD-MsrElementRest      OPTIONAL
}

SeqOfOTD-MsrElementRest ::= SEQUENCE (SIZE(1..2)) OF OTD-MsrElementRest

-- OTD meurement information for 1 set
OTD-MsrElementFirst ::= SEQUENCE {
    refFrameNumber      INTEGER (0..42431),          -- Frame number modulo 42432
    referenceTimeSlot    ModuloTimeSlot,
    toaMeasurementsOfRef TOA-MeasurementsOfRef      OPTIONAL,
    stdResolution        StdResolution,
    taCorrection          INTEGER (0..960)           OPTIONAL, -- TA correction

    -- measured neighbors in OTD measurements
    otd-FirstSetMsrs     SeqOfOTD-FirstSetMsrs      OPTIONAL
}
SeqOfOTD-FirstSetMsrs ::= SEQUENCE (SIZE(1..10)) OF OTD-FirstSetMsrs

-- OTD meurement information 2 and 3 sets if exist
OTD-MsrElementRest ::= SEQUENCE {
    refFrameNumber      INTEGER (0..42431),          -- Frame number modulo 42432
    referenceTimeSlot    ModuloTimeSlot,
    toaMeasurementsOfRef TOA-MeasurementsOfRef      OPTIONAL,
    stdResolution        StdResolution,
    taCorrection          INTEGER (0..960)           OPTIONAL, -- TA correction

    -- measured neighbors in OTD measurements
    otd-MsrsOfOtherSets SeqOfOTD-MsrsOfOtherSets    OPTIONAL
}
SeqOfOTD-MsrsOfOtherSets ::= SEQUENCE (SIZE(1..10)) OF OTD-MsrsOfOtherSets

```

```

-- Standard deviation of the TOA measurements from the reference BTS
TOA-MeasurementsOfRef ::= SEQUENCE {
    refQuality          RefQuality,
    numOfMeasurements  NumOfMeasurements
}

RefQuality ::= INTEGER (0..31)          -- St Dev of TOA of reference as defined in annex
NumOfMeasurements ::= INTEGER (0..7)    -- No. of measurements for RefQuality as defined in annex
StdResolution ::= INTEGER (0..3)       -- Values of resolution are defined in annex

OTD-FirstSetMsrs ::= OTD-MeasurementWithID

-- Neighbour info in OTD measurements 0-10 times in TD measurement info
OTD-MsrsOfOtherSets ::= CHOICE {
    identityNotPresent  OTD-Measurement,
    identityPresent     OTD-MeasurementWithID
}

-- For this OTD measurement identity is same as the identity of BTS
-- in the first set with same sequence number
OTD-Measurement ::= SEQUENCE {
    nborTimeSlot      ModuloTimeSlot,
    eotdQuality       EOTDQuality,
    otdValue          OTDValue
}

-- This measurement contains the BTS identity and measurement
OTD-MeasurementWithID ::= SEQUENCE {
    neighborIdentity   NeighborIdentity,
    nborTimeSlot       ModuloTimeSlot,
    eotdQuality        EOTDQuality,
    otdValue           OTDValue
}

EOTDQuality ::= SEQUENCE {
    nbrOfMeasurements  INTEGER (0..7),
    stdOfEOTD          INTEGER (0..31)
}

NeighborIdentity ::= CHOICE {
    bsicAndCarrier     BSICAndCarrier,      -- BSIC and Carrier
    ci                  CellID,              -- Cell ID, LAC not needed
    multiFrameCarrier   MultiFrameCarrier,   -- MultiFrameOffset and BSIC
    requestIndex        RequestIndex,        -- Index to Requested Neighbor List
    systemInfoIndex     SystemInfoIndex,     -- Index to System info list, this type of neighbour
                                                -- identity shall not be used by the MS unless it has
                                                -- received the SystemInfoAssistData from the SMLC for
                                                -- this cell.
    ciAndLAC            CellIDAndLAC        -- CI and LAC
}

-- Multiframe and carrier
MultiFrameCarrier ::= SEQUENCE {
    bcchCarrier         BCCHCarrier,
    multiFrameOffset    MultiFrameOffset
}

-- OTD measurement value for neighbour
OTDValue ::= INTEGER (0..39999)

```

```

-- Location information IE
LocationInfo ::= SEQUENCE {
    refFrame      INTEGER (0..65535),      -- Reference Frame number
    -- If refFrame is within (42432..65535), it shall be ignored by the receiver
    -- in that case the MS should provide GPS TOW if available
    gpsTOW        INTEGER (0..14399999)    OPTIONAL,  -- GPS TOW
    fixType        FixType,
    -- Note that applicable range for refFrame is 0 - 42431
    -- Possible shapes carried in posEstimate are
    -- ellipsoid point,
    -- ellipsoid point with uncertainty circle
    -- ellipsoid point with uncertainty ellipse
    -- ellipsoid point with altitude and uncertainty ellipsoid
    posEstimate    Ext-GeographicalInformation
}

FixType ::= INTEGER {
    twoDFix (0),
    threeDFix (1)
} (0..1)

-- GPS-Measurement information
GPS-MeasureInfo ::= SEQUENCE {
    -- Measurement info elements
    -- user has to make sure that in this element is number of elements
    -- defined in reference BTS identity
    gpsMsrSetList  SeqOfGPS-MsrSetElement
}
SeqOfGPS-MsrSetElement ::= SEQUENCE (SIZE(1..3)) OF GPS-MsrSetElement

-- OTD measurement information 1-3 times in message
GPS-MsrSetElement ::= SEQUENCE {
    refFrame      INTEGER (0..65535)    OPTIONAL,  -- Reference Frame number
    gpsTOW        GPSTOW24b,            -- GPS TOW
    -- Note that applicable range for refFrame is 0 - 42431

--N_SAT can be read from number of elements of gps-msrList

    gps-msrList    SeqOfGPS-MsrElement
}

-- 24 bit presentation for GPSTOW
GPSTOW24b ::= INTEGER (0..14399999)

-- measured elements in measurement parameters field
SeqOfGPS-MsrElement ::= SEQUENCE (SIZE(1..16)) OF GPS-MsrElement

GPS-MsrElement ::= SEQUENCE {
    satelliteID    SatelliteID,          -- Satellite identifier
    cNo            INTEGER (0..63),      -- carrier noise ratio
    doppler        INTEGER (-32768..32767), -- doppler, multiply by 0.2
    wholeChips     INTEGER (0..1022),    -- whole value of the code phase measurement
    fracChips      INTEGER (0..1024),    -- fractional value of the code phase measurement
    -- a value of 1024 shall not be encoded by the sender
    -- the receiver shall consider a value of 1024 to be
    -- invalid data
    mpathIndic     MpathIndic,          -- multipath indicator
    pseuRangerMSErr INTEGER (0..63)     -- index
}

-- Multipath indicator
MpathIndic ::= ENUMERATED {
    notMeasured (0),
    low (1),
    medium (2),
    high (3)
}

```



```

-- Location error IE
LocationError ::= SEQUENCE {
    locErrorReason          LocErrorReason,
    additionalAssistanceData  AdditionalAssistanceData  OPTIONAL,
    ...
}

LocErrorReason ::= ENUMERATED {
    unDefined (0),
    notEnoughBTSs (1),
    notEnoughSats (2),
    eotdLocCalAssDataMissing (3),
    eotdAssDataMissing (4),
    gpsLocCalAssDataMissing (5),
    gpsAssDataMissing (6),
    methodNotSupported (7),
    notProcessed (8),
    refBTSForGPSNotServingBTS (9),
    refBTSForEOTDNotServingBTS (10),
    ...,
    notEnoughGANSSSats (11),
    ganssAssDataMissing (12),
    refBTSForGANSSNotServingBTS (13)
}

-- exception handling:
-- an unrecognized value shall be treated the same as value 0

-- defines additional assistance data needed for any new location attempt
-- MS shall retain any assistance data already received
AdditionalAssistanceData ::= SEQUENCE {
    gpsAssistanceData      GPSAssistanceData      OPTIONAL,
    extensionContainer      ExtensionContainer      OPTIONAL,
    ...,
    ganssAssistanceData GANSSAssistanceData OPTIONAL
}

GPSAssistanceData ::= OCTET STRING (SIZE (1..maxGPSAssistanceData))
-- GPSAssistanceData has identical structure and encoding to octets 3 to n of the
-- GPS Assistance Data IE in 3GPP TS 49.031

maxGPSAssistanceData    INTEGER ::= 40

GANSSAssistanceData ::= OCTET STRING (SIZE (1..maxGANSSAssistanceData))
-- GANSSAssistanceData has identical structure and encoding to octets 3 to n of the
-- GANSS Assistance Data IE in 3GPP TS 49.031

maxGANSSAssistanceData  INTEGER ::= 40

-- Protocol Error Causes
ErrorCodes ::= ENUMERATED {
    unDefined (0),
    missingComponet (1),
    incorrectData (2),
    missingIEorComponentElement (3),
    messageTooShort (4),
    unknowReferenceNumber (5),
    ...
}

-- exception handling:
-- an unrecognized value shall be treated the same as value 0

-- GPS assistance data IE
GPS-AssistData ::= SEQUENCE {
    controlHeader          ControlHeader
}

```

```

-- More Assistance Data To Be Sent IE
-- More Assistance Data Components On the Way indication for delivery of an entire set of assistance
-- data in multiple Assistance Data components.

MoreAssDataToBeSent ::= ENUMERATED {
    noMoreMessages (0),          -- This is the only or last Assistance Data message used to deliver
                                -- the entire set of assistance data.
    moreMessagesOnTheWay (1)    -- The SMLC will send more Assistance Data messages or a final RRLP
                                -- Measure Position Request message to deliver the
                                -- the entire set of assistance data.
}

-- Control header of the GPS assistance data
ControlHeader ::= SEQUENCE {

    -- Field type Present information
    referenceTime      ReferenceTime      OPTIONAL,
    refLocation        RefLocation        OPTIONAL,
    dgpsCorrections    DGPSCorrections    OPTIONAL,
    navigationModel    NavigationModel    OPTIONAL,
    ionosphericModel    IonosphericModel  OPTIONAL,
    utcModel           UTCModel           OPTIONAL,
    almanac            Almanac            OPTIONAL,
    acquisAssist       AcquisAssist       OPTIONAL,
    realTimeIntegrity  SeqOf-BadSatelliteSet OPTIONAL
}

ReferenceTime ::= SEQUENCE {
    gpsTime            GPSTime,
    gsmTime            GSMTIME            OPTIONAL,
    gpsTowAssist       GPSTOWAssist       OPTIONAL
}

-- GPS Time includes week number and time-of-week (TOW)
GPSTime ::= SEQUENCE {
    gpsTOW23b          GPSTOW23b,
    gpsWeek            GPSWeek
}

-- GPSTOW, range 0-604799.92, resolution 0.08 sec, 23-bit presentation
GPSTOW23b ::= INTEGER (0..755999)

-- GPS week number
GPSWeek ::= INTEGER (0..1023)

-- GPSTOWAssist consists of TLM message, Anti-spoof flag, Alert flag, and 2 reserved bits in TLM
Word
-- for each visible satellite.
-- N_SAT can be read from number of elements in GPSTOWAssist
GPSTOWAssist ::= SEQUENCE (SIZE(1..12)) OF GPSTOWAssistElement

GPSTOWAssistElement ::= SEQUENCE {
    satelliteID        SatelliteID,
    tlmWord            TLMWord,
    antiSpoof          AntiSpoofFlag,
    alert              AlertFlag,
    tlmRsvdBits        TLMReservedBits
}

```

```

-- TLM Word, 14 bits
TLMWord ::= INTEGER (0..16383)

-- Anti-Spoof flag
AntiSpoofFlag ::= INTEGER (0..1)

-- Alert flag
AlertFlag ::= INTEGER (0..1)

-- Reserved bits in TLM word, MSB occurs earlier in TLM Word transmitted by satellite
TLMReservedBits ::= INTEGER (0..3)

GSMTIME ::= SEQUENCE {
    bcchCarrier    BCCHCarrier,    -- BCCH carrier
    bsic           BSIC,           -- BSIC
    frameNumber    FrameNumber,
    timeSlot       TimeSlot,
    bitNumber      BitNumber
}

-- Frame number
FrameNumber ::= INTEGER (0..2097151)

-- Time slot number
TimeSlot ::= INTEGER (0..7)

-- Bit number
BitNumber ::= INTEGER (0..156)

-- Reference Location IE
RefLocation ::= SEQUENCE {
    threeDLocation    Ext-GeographicalInformation
}

-- DGPS Corrections IE
DGPSCorrections ::= SEQUENCE {
    gpstOW          INTEGER (0..604799),    -- DGPS reference time
    status          INTEGER (0..7),
    -- N_SAT can be read from number of elements of satList
    satList         SeqOfSatElement
}
SeqOfSatElement ::= SEQUENCE (SIZE (1..16)) OF SatElement

-- number of correction for satellites
SatElement ::= SEQUENCE {
    satelliteID      SatelliteID,

    --- Sequence number for ephemeris
    iode             INTEGER (0..239),
    -- User Differential Range Error
    udre            INTEGER (0..3),

    -- Pseudo Range Correction, range is
    -- -655.04 - +655.04,
    pseudoRangeCor  INTEGER (-2047..2047),

    -- Pseudo Range Rate Correction, range is
    -- -4.064 - +4.064,
    rangeRateCor    INTEGER (-127..127),

    -- Delta Pseudo Range Correction 2
    deltaPseudoRangeCor2    INTEGER (-127..127),    -- This IE shall be ignored by the receiver and
                                                    -- set to zero by the sender

    -- Delta Pseudo Range Correction 2
    deltaRangeRateCor2      INTEGER (-7..7),        -- This IE shall be ignored by the receiver and
                                                    -- set to zero by the sender

    -- Delta Pseudo Range Correction 3
    deltaPseudoRangeCor3    INTEGER (-127..127),    -- This IE shall be ignored by the receiver and
                                                    -- set to zero by the sender

    -- Delta Pseudo Range Correction 3
    deltaRangeRateCor3      INTEGER (-7..7),        -- This IE shall be ignored by the receiver and
                                                    -- set to zero by the sender
}

SatelliteID ::= INTEGER (0..63) -- identifies satellite

```

```

-- Navigation Model IE
NavigationModel ::= SEQUENCE {
    navModelList      SeqOfNavModelElement
}

-- navigation model satellite list
SeqOfNavModelElement ::= SEQUENCE (SIZE(1..16)) OF NavModelElement

NavModelElement ::= SEQUENCE {
    satelliteID      SatelliteID,
    satStatus        SatStatus      -- satellite status
}

-- the Status of the navigation model
SatStatus ::= CHOICE {
    -- New satellite, new Navigation Model
    newSatelliteAndModelUC  UncompressedEphemeris,

    -- Existing satellite, Existing Navigation Model
    oldSatelliteAndModel    NULL,

    -- Existing satellite, new Navigation Model
    newNaviModelUC          UncompressedEphemeris,
    ...
}

-- Uncompressed satellite emhemeris and clock corrections
UncompressedEphemeris ::= SEQUENCE {
    ephemerCodeOnL2      INTEGER (0..3),
    ephemerURA          INTEGER (0..15),
    ephemerSVhealth      INTEGER (0..63),
    ephemerIODC          INTEGER (0..1023),
    ephemerL2Pflag       INTEGER (0..1),
    ephemerSF1Rsvd      EphemerisSubframe1Reserved,
    ephemerTgd           INTEGER (-128..127),
    ephemerToc           INTEGER (0..37799),
    ephemerAF2           INTEGER (-128..127),
    ephemerAF1           INTEGER (-32768..32767),
    ephemerAF0           INTEGER (-2097152..2097151),
    ephemerCrs           INTEGER (-32768..32767),
    ephemerDeltaN        INTEGER (-32768..32767),
    ephemerM0            INTEGER (-2147483648..2147483647),
    ephemerCuc           INTEGER (-32768..32767),
    ephemerE             INTEGER (0..4294967295),
    ephemerCus           INTEGER (-32768..32767),
    ephemerAPowerHalf    INTEGER (0..4294967295),
    ephemerToe           INTEGER (0..37799),
    ephemerFitFlag       INTEGER (0..1),
    ephemerAODA          INTEGER (0..31),
    ephemerCic           INTEGER (-32768..32767),
    ephemerOmegaA0       INTEGER (-2147483648..2147483647),
    ephemerCis           INTEGER (-32768..32767),
    ephemerI0            INTEGER (-2147483648..2147483647),
    ephemerCrc           INTEGER (-32768..32767),
    ephemerW             INTEGER (-2147483648..2147483647),
    ephemerOmegaADot     INTEGER (-8388608..8388607),
    ephemerIDot          INTEGER (-8192..8191)
}

-- Reserved bits in subframe 1 of navigation message
EphemerisSubframe1Reserved ::= SEQUENCE {
    reserved1      INTEGER (0..8388607), -- 23-bit field
    reserved2      INTEGER (0..16777215), -- 24-bit field
    reserved3      INTEGER (0..16777215), -- 24-bit field
    reserved4      INTEGER (0..65535)    -- 16-bit field
}

```

```

-- Ionospheric Model IE
IonosphericModel ::= SEQUENCE {
    alfa0          INTEGER (-128..127),
    alfa1          INTEGER (-128..127),
    alfa2          INTEGER (-128..127),
    alfa3          INTEGER (-128..127),
    beta0          INTEGER (-128..127),
    beta1          INTEGER (-128..127),
    beta2          INTEGER (-128..127),
    beta3          INTEGER (-128..127)
}

-- Universal Time Coordinate Model
UTCModel ::= SEQUENCE {
    utcA1          INTEGER (-8388608..8388607),
    utcA0          INTEGER (-2147483648..2147483647),
    utcTot         INTEGER (0..255),
    utcWnt         INTEGER (0..255),
    utcDeltaTls   INTEGER (-128..127),
    utcWNlsf      INTEGER (0..255),
    utcDN         INTEGER (-128..127),
    utcDeltaTlsf  INTEGER (-128..127)
}

-- Almanac, Long term model
-- NOTE: These are parameters are subset of the ephemeris
-- NOTE: But with reduced resolution and accuracy
Almanac ::= SEQUENCE {
    almanacWNa     INTEGER (0..255),    -- Once per message

    -- navigation model satellite list.
    -- The size of almanacList is actually NumSats_Total field
    almanacList   SeqOfAlmanacElement
}
SeqOfAlmanacElement ::= SEQUENCE (SIZE(1..64)) OF AlmanacElement

-- Almanac info once per satellite
AlmanacElement ::= SEQUENCE {
    satelliteID   SatelliteID,
    almanacE      INTEGER (0..65535),
    almanacToa    INTEGER (0..255),
    almanacKsii   INTEGER (-32768..32767),
    almanacOmegaDot INTEGER (-32768..32767),
    almanacSVhealth INTEGER (0..255),
    almanacAPowerHalf INTEGER (0..16777215),
    almanacOmega0 INTEGER (-8388608..8388607),
    almanacW      INTEGER (-8388608..8388607),
    almanacM0     INTEGER (-8388608..8388607),
    almanacAF0    INTEGER (-1024..1023),
    almanacAF1    INTEGER (-1024..1023)
}

-- Acquisition Assistance
AcquisAssist ::= SEQUENCE {

    -- Number of Satellites can be read from acquistList
    timeRelation  TimeRelation,

    -- Acquisition assistance list
    -- The size of Number of Satellites is actually Number of Satellites field
    acquisList   SeqOfAcquisElement
}
SeqOfAcquisElement ::= SEQUENCE (SIZE(1..16)) OF AcquisElement

-- the relationship between GPS time and air-interface timing
TimeRelation ::= SEQUENCE {
    --
    gpsTOW       GPSTOW23b,    -- 23b presentation
    gsmTime      GSMTIME       OPTIONAL
}

```

```

-- data occurring per number of satellites
AcquisElement ::= SEQUENCE {
    svid                SatelliteID,

    -- Doppler 0th order term,
    -- -5120.0 - 5117.5 Hz (= -2048 - 2047 with 2.5 Hz resolution)
    doppler0            INTEGER (-2048..2047),
    additionalDoppler   AdditionalDopplerFields OPTIONAL,
    codePhase           INTEGER (0..1022), -- Code Phase
    intCodePhase        INTEGER (0..19),  -- Integer Code Phase
    gpsBitNumber        INTEGER (0..3),   -- GPS bit number
    codePhaseSearchWindow INTEGER (0..15), -- Code Phase Search Window
    additionalAngle     AdditionalAngleFields OPTIONAL
}

AdditionalDopplerFields ::= SEQUENCE {
    -- Doppler 1st order term, -1.0 - +0.5 Hz/sec
    -- (= -42 + (0 to 63) with 1/42 Hz/sec. resolution)
    doppler1            INTEGER (0..63),
    dopplerUncertainty  INTEGER (0..7)
    -- a sender shall not encode any DopplerUncertainty value in the range 5 to 7
    -- a receiver shall ignore any value between 5 and 7.
}

AdditionalAngleFields ::= SEQUENCE {
    -- azimuth angle, 0 - 348.75 deg (= 0 - 31 with 11.25 deg resolution)
    azimuth             INTEGER (0..31),
    -- elevation angle, 0 - 78.75 deg (= 0 - 7 with 11.25 deg resolution)
    elevation           INTEGER (0..7)
}

-- Real-Time Integrity
-- number of bad satellites can be read from this element
SeqOf-BadSatelliteSet ::= SEQUENCE (SIZE(1..16)) OF SatelliteID

-- Extension Elements

-- Release 98 Extensions here
Rel98-MsrPosition-Req-Extension ::= SEQUENCE {
    rel98-Ext-ExpOTD      Rel98-Ext-ExpOTD          OPTIONAL, -- ExpectedOTD extension
    ...,
    gpsTimeAssistanceMeasurementRequest NULL OPTIONAL,
    gpsReferenceTimeUncertainty GPSReferenceTimeUncertainty OPTIONAL
}

-- Further R98 extensions here
}

Rel98-AssistanceData-Extension ::= SEQUENCE {
    rel98-Ext-ExpOTD      Rel98-Ext-ExpOTD          OPTIONAL, -- ExpectedOTD extension
    ...,
    gpsTimeAssistanceMeasurementRequest NULL OPTIONAL,
    gpsReferenceTimeUncertainty GPSReferenceTimeUncertainty OPTIONAL
}

-- Further R98 extensions here
}

-- Release 98 ExpOTD extension
Rel98-Ext-ExpOTD ::= SEQUENCE {
    -- If MsrAssistBTS is included in message, msrAssistData-R98-ExpOTD shall be included.
    msrAssistData-R98-ExpOTD MsrAssistData-R98-ExpOTD OPTIONAL,

    -- If SystemInfoAssistaData is included in message, systemInfoAssistData-R98-ExpOTD shall be
    -- included.
    systemInfoAssistData-R98-ExpOTD SystemInfoAssistData-R98-ExpOTD OPTIONAL
}

-- MsrAssistData R98 extension
MsrAssistData-R98-ExpOTD ::= SEQUENCE {
    msrAssistList-R98-ExpOTD SeqOfMsrAssistBTS-R98-ExpOTD
}

-- Indexes in SeqOfMsrAssistBTS-R98-ExpOTD refer to SeqOfMsrAssistBTS
-- If the index exceeds the SegOfMsrAssistBTS range or if there is other
-- inconsistencies between the BTS indices, the MS shall apply protocol
-- error cause incorrectData
SeqOfMsrAssistBTS-R98-ExpOTD ::= SEQUENCE (SIZE(1..15)) OF MsrAssistBTS-R98-ExpOTD

```

```

-- This element completes MsrAssistBTS IE
MsrAssistBTS-R98-ExpOTD ::= SEQUENCE {
    expectedOTD          ExpectedOTD,
    expOTDUncertainty    ExpOTDUncertainty
}

-- SystemInfoAssistData R98 extension
SystemInfoAssistData-R98-ExpOTD ::= SEQUENCE {
    systemInfoAssistListR98-ExpOTD  SeqOfSystemInfoAssistBTS-R98-ExpOTD
}

-- SeqOfSystemInfoAssistBTS-R98-ExpOTD index refer to SeqOfSystemInfoAssistBTS
-- If the index exceeds the SegOfSystemInfoAssistBTS range or if there is other
-- inconsistencies between the BTS indices, the MS shall apply protocol
-- error cause incorrectData
SeqOfSystemInfoAssistBTS-R98-ExpOTD ::= SEQUENCE (SIZE(1..32)) OF SystemInfoAssistBTS-R98-ExpOTD

-- whether n.th is present or not ?
SystemInfoAssistBTS-R98-ExpOTD ::= CHOICE {
    notPresent          NULL,
    present             AssistBTSData-R98-ExpOTD
}

-- This element completes AssistBTSData IE
AssistBTSData-R98-ExpOTD ::= SEQUENCE {
    expectedOTD          ExpectedOTD,
    expOTDUncertainty    ExpOTDUncertainty    -- Uncertainty of expected OTD
}

-- Expected OTD value between nbor base station and reference BTS
-- at MS's current estimated location.
ExpectedOTD ::= INTEGER (0..1250)
-- The ExpectedOTD value 1250 shall not be encoded by the transmitting entity and
-- shall be treated by the receiving entity as 0.
-- Uncertainty of Exptected OTD in bits
ExpOTDUncertainty ::= INTEGER(0..7)

-- Release 98 extensions

GPSReferenceTimeUncertainty ::= INTEGER (0 .. 127)    -- Coding according to Annex

GPSTimeAssistanceMeasurements ::= SEQUENCE {
    referenceFrameMSB INTEGER (0 .. 63)    OPTIONAL,    -- MSB of frame number
    gpsTowSubms INTEGER (0 .. 9999)    OPTIONAL,    -- in units of 100ns, for MS based AGPS
    deltaTow INTEGER (0 .. 127)    OPTIONAL,    -- for MS assisted AGPS
    gpsReferenceTimeUncertainty GPSReferenceTimeUncertainty OPTIONAL
}

Rel-98-MsrPosition-Rsp-Extension ::= SEQUENCE {
    -- First extension to Release 98
    rel-98-Ext-MeasureInfo SEQUENCE {
        otd-MeasureInfo-R98-Ext OTD-MeasureInfo-R98-Ext    OPTIONAL
    },
    ...,
    timeAssistanceMeasurements GPSTimeAssistanceMeasurements OPTIONAL
-- Further R98 extensions here
}

-- This is an addition to OTD-MeasureInfo element defined in original message,
-- If OTD-MeasureInfo is absent, or if one or more OTD-MsrElementRest are present
-- OTD-MeasureInfo-R98-Ext shall be absent.
-- OTD-MeasureInfo-R98-Ext
OTD-MeasureInfo-R98-Ext ::= SEQUENCE {
    -- Measurement info elements
    otdMsrFirstSets-R98-Ext    OTD-MsrElementFirst-R98-Ext
}

```

```

-- OTD measurement information Ext for the first set only
OTD-MsrElementFirst-R98-Ext ::= SEQUENCE {
  -- additional measured neighbors in OTD measurements
  otd-FirstSetMsrs-R98-Ext    SeqOfOTD-FirstSetMsrs-R98-Ext    OPTIONAL
}
SeqOfOTD-FirstSetMsrs-R98-Ext ::= SEQUENCE (SIZE(1..5)) OF OTD-FirstSetMsrs

Rel-5-MsrPosition-Rsp-Extension ::= SEQUENCE {

  extended-reference Extended-reference OPTIONAL,
  -- The extended-reference shall be included by the MS if and only if previously
  -- received from the SMLC in a Measure Position Request. When included, the value sent
  -- by the MS shall equal the value received from the SMLC.

  -- extension to Release 5, for RRLP pseudo-segmentation here
  otd-MeasureInfo-5-Ext    OTD-MeasureInfo-5-Ext    OPTIONAL,
  ulPseudoSegInd          UlpseudoSegInd          OPTIONAL,    -- Included when uplink RRLP
  -- Pseudo-segmentation is used, not included when no uplink pseudo-segmentation is used
  ...
  -- Possibly more extensions for Release 5 here later
}

Extended-reference ::= SEQUENCE {
  smlc-code          INTEGER (0..63),
  transaction-ID     INTEGER (0..262143)
}

OTD-MeasureInfo-5-Ext ::= SeqOfOTD-MsrElementRest
  -- if more than one measurement sets are present this element is repeated
  -- NumberOfSets - 1 (-1 = first set) combined in OTD-MeasureInfo-5-Ext and
  -- OTD-MeasureInfo (e.g. if NumberOfSets is 3, then one otdMsrRestSets may
  -- be sent in OTD-MeasureInfo-5-Ext and one in OTD-MeasureInfo)

-- First part of Uplink RRLP Pseudo-segmentation indication, possibly more may be defined
-- in the future for segmentation with more than two segments.
UlpseudoSegInd ::= ENUMERATED {
  firstOfMany (0),
  secondOfMany(1)
}

Rel5-MsrPosition-Req-Extension ::= SEQUENCE {
  extended-reference    Extended-reference,
  ...
  -- Possibly more extensions for Release 5 here later
}

Rel5-AssistanceData-Extension ::= SEQUENCE {
  extended-reference    Extended-reference,
  ...
  -- Possibly more extensions for Release 5 here later
}

Rel-5-ProtocolError-Extension ::= SEQUENCE {
  extended-reference    Extended-reference OPTIONAL,
  -- The extended-reference shall be included by the MS if and only if previously
  -- received from the SMLC.
  -- When included, the value sent by the MS shall equal the value received from the SMLC.
  ...
  -- Possibly more extensions for Release 5 here later
}

-- Release 7 Extensions here

Rel7-MsrPosition-Req-Extension ::= SEQUENCE {
  velocityRequested          NULL                OPTIONAL,
  ganssPositionMethod        GANSSPositioningMethod  OPTIONAL,
  ganss-AssistData           GANSS-AssistData        OPTIONAL,
  ganssCarrierPhaseMeasurementRequest  NULL                OPTIONAL,
  ganssTODGSMTTimeAssociationMeasurementRequest  NULL                OPTIONAL,
  requiredResponseTime       RequiredResponseTime    OPTIONAL,
  add-GPS-AssistData         Add-GPS-AssistData      OPTIONAL,
  ganssMultiFreqMeasurementRequest  NULL                OPTIONAL,
  ...
  -- Further Release 7 extentions here
}

```



```

-- additional satellite systems may be added in future versions of the protocol
-- Bit 0 of GANSSPositioningMethod bit map shall not be the only one set to TRUE ('1')
GANSSPositioningMethod ::= BIT STRING {
    gps                (0),
    galileo            (1),
    sbas                (2),
    modernizedGPS      (3),
    qzss                (4),
    glonass            (5) } (SIZE (2..16))

GANSS-AssistData ::= SEQUENCE {
    ganss-controlHeader GANSS-ControlHeader
}

GANSS-ControlHeader ::= SEQUENCE {
    ganssCommonAssistData      GANSSCommonAssistData      OPTIONAL,
    ganssGenericAssistDataList SeqOfGANSSGenericAssistDataElement OPTIONAL
}

-- GANSS Common Assistance Data Elements
GANSSCommonAssistData ::= SEQUENCE {
    ganssReferenceTime      GANSSReferenceTime      OPTIONAL,
    ganssRefLocation        GANSSRefLocation        OPTIONAL,
    ganssIonosphericModel   GANSSIonosphericModel   OPTIONAL,
    ... ,
    ganssAddIonosphericModel GANSSAddIonosphericModel   OPTIONAL,
    ganssEarthOrientParam  GANSSEarthOrientParam  OPTIONAL
}

-- List of GANSS Generic Assistance Data Elements, up to 8 GANSS
SeqOfGANSSGenericAssistDataElement ::= SEQUENCE (SIZE (1..8)) OF GANSSGenericAssistDataElement
-- GANSS Generic Assistance Data Elements
GANSSGenericAssistDataElement ::= SEQUENCE {
    ganssID                  INTEGER (0..7)          OPTIONAL, -- Coding according to Annex
    ganssTimeModel           SeqOfGANSSTimeModel     OPTIONAL,
    ganssDiffCorrections     GANSSDiffCorrections    OPTIONAL,
    ganssNavigationModel     GANSSNavModel           OPTIONAL,
    ganssRealTimeIntegrity   GANSSRealTimeIntegrity  OPTIONAL,
    ganssDataBitAssist       GANSSDataBitAssist      OPTIONAL,
    ganssRefMeasurementAssist GANSSRefMeasurementAssist  OPTIONAL,
    ganssAlmanacModel        GANSSAlmanacModel       OPTIONAL,
    ganssUTCModel            GANSSUTCModel           OPTIONAL,
    ganssEphemerisExtension  GANSSSEphemerisExtension  OPTIONAL,
    ganssEphemerisExtCheck   GANSSSEphemerisExtensionCheck  OPTIONAL,
    ... ,
    sbasID                   INTEGER (0..7)          OPTIONAL, -- Coding according to Annex
    ganssAddUTCModel         GANSSAddUTCModel        OPTIONAL,
    ganssAuxiliaryInfo       GANSSAuxiliaryInformation  OPTIONAL
}

-- GANSS COMMON ASSISTANCE DATA ELEMENTS

-- GANSS Reference Time IE
GANSSReferenceTime ::= SEQUENCE {
    ganssRefTimeInfo         GANSSRefTimeInfo,
    ganssTOD-GSMTimeAssociation GANSSSTOD-GSMTimeAssociation OPTIONAL
}

-- GANSS Reference Time includes GANSS TOD, GANSS Day, uncertainty
GANSSRefTimeInfo ::= SEQUENCE {
    ganssDay                 INTEGER(0 .. 8191)      OPTIONAL,
    ganssTOD                 GANSSSTOD,
    ganssTODUncertainty      GANSSSTODUncertainty  OPTIONAL,
    ganssTimeID              INTEGER (0 .. 7)       OPTIONAL
}

-- GANSS TOD integer seconds
GANSSSTOD ::= INTEGER (0 .. 86399)

-- GANSS TOD uncertainty
GANSSSTODUncertainty ::= INTEGER (0 .. 127) -- Coding according to Annex

```

```

-- GANSS TOD-GSM Time association
GANSS TOD-GSM Time Association ::= SEQUENCE {
    bcchCarrier      BCCHCarrier,    -- BCCH carrier
    bsic             BSIC,           -- BSIC
    frameNumber      FrameNumber,
    timeSlot         TimeSlot,
    bitNumber        BitNumber,
    frameDrift       FrameDrift      OPTIONAL
}

-- Frame drift
FrameDrift ::= INTEGER(-64 .. 63)

-- GANSS Reference Location IE
GANSSRefLocation ::= SEQUENCE {
    threeDLocation   Ext-GeographicalInformation
}

-- GANSS Ionospheric Model IE
-- GANSS Ionospheric Model consists of NeQuick model parameters and storm flags
GANSSIonosphericModel ::= SEQUENCE {
    ganssIonoModel   GANSSIonosphereModel,
    ganssIonoStormFlags GANSSIonoStormFlags OPTIONAL,
    ...
}

-- GANSS ionosphere model. Coding according to Annex
GANSSIonosphereModel ::= SEQUENCE {
    ai0 INTEGER (0 .. 4095),
    ai1 INTEGER (0 .. 4095),
    ai2 INTEGER (0 .. 4095)
}

-- GANSS ionosphere storm flags
GANSSIonoStormFlags ::= SEQUENCE {
    ionoStormFlag1  INTEGER (0 .. 1),
    ionoStormFlag2  INTEGER (0 .. 1),
    ionoStormFlag3  INTEGER (0 .. 1),
    ionoStormFlag4  INTEGER (0 .. 1),
    ionoStormFlag5  INTEGER (0 .. 1)
}

-- GANSS Additional Ionospheric Model IE
-- GANSS Additional Ionospheric Model consists of Klobuchar model parameters
GANSSAddIonosphericModel ::= SEQUENCE {
    dataID          BIT STRING (SIZE (2)), -- Coding according to Annex
    ionoModel       IonosphericModel
}

-- GANSS Earth Orientation Parameters IE
GANSSEarthOrientParam ::= SEQUENCE {
    teop            INTEGER (0..65535),
    pmX             INTEGER (-1048576..1048575),
    pmXdots         INTEGER (-16384..16383),
    pmY             INTEGER (-1048576..1048575),
    pmYdots         INTEGER (-16384..16383),
    deltaUT1       INTEGER (-1073741824..1073741823),
    deltaUT1dots   INTEGER (-262144..262143)
}

-- GANSS GENERIC ASSISTANCE DATA ELEMENTS

```

```

-- GANSS Time Model IE consists of time offset and first and second order parameters to relate GNSS
-- specific system time to selected time reference
SeqOfGANSSTimeModel ::= SEQUENCE (SIZE(1..7)) OF GANSSTimeModelElement

GANSSTimeModelElement ::= SEQUENCE {
    ganssTimeModelRefTime    INTEGER(0 .. 65535),
    tA0                      TA0,
    tA1                      TA1                      OPTIONAL,
    tA2                      TA2                      OPTIONAL,
    gnssTOID                 INTEGER (0 .. 7),         -- coding according to annex
    weekNumber               INTEGER (0 .. 8191)       OPTIONAL
}

-- GANSS time model parameter A0
TA0 ::= INTEGER (-2147483648 .. 2147483647)

-- GANSS time model parameter A1
TA1 ::= INTEGER (-8388608 .. 8388607)

-- GANSS time model parameter A2
TA2 ::= INTEGER (-64 .. 63)

-- DGANSS Corrections IE
GANSSDiffCorrections ::= SEQUENCE {
    dganssRefTime            INTEGER (0 .. 119), -- DGANSS reference time

    -- N_SGN_TYPE can be read from number of elements of sgnTypeList
    sgnTypeList              SeqOfSgnTypeElement
}

SeqOfSgnTypeElement ::= SEQUENCE (SIZE (1..3)) OF SgnTypeElement -- max three signals per GNSS

-- DGANSS signal type element, once per GNSS signal type included in DGANSS
SgnTypeElement ::= SEQUENCE {
    ganssSignalID            GANSSSignalID, -- signal type identity
    ganssStatusHealth        INTEGER (0 .. 7),
    -- N_SAT can be read from number of elements of dgansssSgnList
    dgansssSgnList          SeqOfDGANSSSgnElement
}

GANSSSignalID ::= INTEGER (0 .. 7) -- Coding according to Annex
SeqOfDGANSSSgnElement ::= SEQUENCE (SIZE (1..16)) OF DGANSSSgnElement

-- number of correction for signals
DGANSSSgnElement ::= SEQUENCE {
    svID                    SVID, -- Satellite identity

    --- Sequence number for GANSS Navigation Model that matches the DGANSS correction set
    iod                      INTEGER (0 .. 1023),

    -- User Differential Range Error
    udre                     INTEGER (0..3),

    -- Pseudo Range Correction, range is
    -- -655.04 - +655.04,
    pseudoRangeCor           INTEGER (-2047..2047),

    -- Pseudo Range Rate Correction, range is
    -- -4.064 - +4.064,
    rangeRateCor             INTEGER (-127..127)
}

SVID ::= INTEGER (0 .. 63) -- Coding according to Annex

```

```

-- GANSS Navigation Model IE
GANSSNavModel ::= SEQUENCE {
    nonBroadcastIndFlag    INTEGER (0 .. 1),
    ganSSSatelliteList     SeqOfGANSSSatelliteElement
}

SeqOfGANSSSatelliteElement ::= SEQUENCE (SIZE(1..32)) OF GANSSSatelliteElement

GANSSSatelliteElement ::= SEQUENCE {
    svID                    SVID,
    svHealth                BIT STRING (SIZE(5)),    -- Coding according to Annex
    iod                     INTEGER (0 .. 1023),    -- Coding according to Annex
    ganSSClockModel         GANSSClockModel,
    ganSSOrbitModel         GANSSOrbitModel,
    ...,
    svHealthMSB             BIT STRING (SIZE(1))    OPTIONAL, -- Coding according to Annex
    iodMSB                  INTEGER (0 .. 1)        OPTIONAL -- Coding according to Annex
}

-- GANSS orbit model for the GNSS satellite according to the choice
GANSSOrbitModel ::= CHOICE {
    keplerianSet            NavModel-KeplerianSet,    -- Model-1
    ...,
    navKeplerianSet        NavModel-NAVKeplerianSet, -- Model-2
    cnavKeplerianSet       NavModel-CNAVKeplerianSet, -- Model-3
    glonassECEF             NavModel-GLONASSecef,    -- Model-4
    sbasECEF                NavModel-SBAsSecef       -- Model-5
}

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

NavModel-NAVKeplerianSet ::= SEQUENCE {
    navURA                 INTEGER (0..15),
    navFitFlag              INTEGER (0..1),
    navToe                  INTEGER (0..37799),
    navOmega                INTEGER (-2147483648..2147483647),
    navDeltaN               INTEGER (-32768..32767),
    navM0                   INTEGER (-2147483648..2147483647),
    navOmegaADot            INTEGER (-8388608..8388607),
    navE                    INTEGER (0..4294967295),
    navIDot                 INTEGER (-8192..8191),
    navAPowerHalf           INTEGER (0..4294967295),
    navI0                   INTEGER (-2147483648..2147483647),
    navOmegaA0              INTEGER (-2147483648..2147483647),
    navCrs                  INTEGER (-32768..32767),
    navCis                  INTEGER (-32768..32767),
    navCus                  INTEGER (-32768..32767),
    navCrc                  INTEGER (-32768..32767),
    navCic                  INTEGER (-32768..32767),
    navCuc                  INTEGER (-32768..32767)
}

```

```

NavModel-CNAVKeplerianSet ::= SEQUENCE {
    cnavTop          INTEGER (0..2015),
    cnavURAindex    INTEGER (-16..15),
    cnavDeltaA       INTEGER (-33554432..33554431),
    cnavAdot         INTEGER (-16777216..16777215),
    cnavDeltaNo      INTEGER (-65536..65535),
    cnavDeltaNoDot   INTEGER (-4194304..4194303),
    cnavMo           INTEGER (-4294967296..4294967295),
    cnavE            INTEGER (0..8589934591),
    cnavOmega        INTEGER (-4294967296..4294967295),
    cnavOMEGA0       INTEGER (-4294967296..4294967295),
    cnavDeltaOmegaDot INTEGER (-65536..65535),
    cnavIo           INTEGER (-4294967296..4294967295),
    cnavIoDot        INTEGER (-16384..16383),
    cnavCis          INTEGER (-32768..32767),
    cnavCic          INTEGER (-32768..32767),
    cnavCrs          INTEGER (-8388608..8388607),
    cnavCrc          INTEGER (-8388608..8388607),
    cnavCus          INTEGER (-1048576..1048575),
    cnavCuc          INTEGER (-1048576..1048575)
}

NavModel-GLONASScefc ::= SEQUENCE {
    gloEn            INTEGER (0..31),
    gloP1            BIT STRING (SIZE(2)),
    gloP2            BOOLEAN,
    gloM             INTEGER (0..3),
    gloX             INTEGER (-67108864..67108863),
    gloXd            INTEGER (-8388608..8388607),
    gloXd            INTEGER (-16..15),
    gloY             INTEGER (-67108864..67108863),
    gloYd            INTEGER (-8388608..8388607),
    gloYd            INTEGER (-16..15),
    gloZ             INTEGER (-67108864..67108863),
    gloZd            INTEGER (-8388608..8388607),
    gloZd            INTEGER (-16..15)
}

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

-- GANSS clock model for the GNSS satellite according to the choice
GANSSClockModel ::= CHOICE {
    standardClockModelList SeqOfStandardClockModelElement, -- Model-1
    ...,
    navClockModel          NAVclockModel, -- Model-2
    cnavClockModel         CNAVclockModel, -- Model-3
    glonassClockModel      GLONASSclockModel, -- Model-4
    sbasClockModel         SBASclockModel -- Model-5
}

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

StandardClockModelElement ::= SEQUENCE {
    stanClockToc        INTEGER (0 .. 16383),
    stanClockAF2        INTEGER (-2048 .. 2047),
    stanClockAF1        INTEGER (-131072 .. 131071),
    stanClockAF0        INTEGER (-134217728 .. 134217727),
    stanClockTgd        INTEGER (-512 .. 511) OPTIONAL,
    stanModelID         INTEGER (0 .. 1) OPTIONAL,
    ...
}

```

```

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

CNAVclockModel ::= SEQUENCE {
    cnavToc          INTEGER (0..2015),
    cnavTop          INTEGER (0..2015),
    cnavURA0        INTEGER (-16..15),
    cnavURA1        INTEGER (0..7),
    cnavURA2        INTEGER (0..7),
    cnavAf2          INTEGER (-512..511),
    cnavAf1          INTEGER (-524288..524287),
    cnavAf0          INTEGER (-33554432..33554431),
    cnavTgd          INTEGER (-4096..4095),
    cnavISCl1cp      INTEGER (-4096..4095)          OPTIONAL,
    cnavISCl1cd      INTEGER (-4096..4095)          OPTIONAL,
    cnavISCl1ca      INTEGER (-4096..4095)          OPTIONAL,
    cnavISCl2c       INTEGER (-4096..4095)          OPTIONAL,
    cnavISCl5i5      INTEGER (-4096..4095)          OPTIONAL,
    cnavISCl5q5      INTEGER (-4096..4095)          OPTIONAL
}

GLONASSclockModel ::= SEQUENCE {
    gloTau          INTEGER (-2097152..2097151),
    gloGamma        INTEGER (-1024..1023),
    gloDeltaTau     INTEGER (-16..15)              OPTIONAL
}

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

-- GANSS Real-Time Integrity IE
GANSSRealTimeIntegrity ::= SEQUENCE {
    -- list of satellites with bad signals
    -- NBS can be read from number of elements in SeqOf-BadSignalSet
    ganssBadSignalList      SeqOfBadSignalElement
}

SeqOfBadSignalElement ::= SEQUENCE (SIZE(1..16)) OF BadSignalElement

BadSignalElement ::= SEQUENCE {
    badSVID          SVID, -- Coding according to Annex
    badSignalID      GANSSSignals OPTIONAL -- Coding according to Annex
}

-- GANSS Data Bit Assistance IE
GANSSDataBitAssist ::= SEQUENCE {
    ganssTOD          INTEGER (0 .. 59),
    -- N_SAT can be read from number of elements in SeqOfGanssDataBitsElement
    ganssDataBitsSatList      SeqOfGanssDataBitsElement,
    ...
}

SeqOfGanssDataBitsElement ::= SEQUENCE (SIZE(1 .. 32)) OF GanssDataBitsElement

GanssDataBitsElement ::= SEQUENCE {
    svID             SVID,
    -- N_SGN can be read from number of elements in Seq-OfGANSSDataBitsSgn
    ganssDataBitsSgnList      Seq-OfGANSSDataBitsSgn,
    ...
}

```

```

SeqOfGANSSDataBitsSgn ::= SEQUENCE (SIZE(1..8)) OF GANSSDataBitsSgnElement

GANSSDataBitsSgnElement ::= SEQUENCE {
    ganssSignalType      GANSSSignalID,
    -- N_BIT can be read from number of elements in SeqOf-DataBits
    ganssDataBits        SeqOf-GANSSDataBits,
    ...
}

SeqOf-GANSSDataBits ::= SEQUENCE (SIZE(1 .. 1024)) OF GANSSDataBit
GANSSDataBit ::= INTEGER(0 .. 1)

-- GANSS Reference Measurement Assistance IE
-- Code and Doppler assistance from the network.
GANSSRefMeasurementAssist ::= SEQUENCE {
    ganssSignalID        GANSSSignalID, -- Coding according to Annex
    ganssRefMeasAssistList SeqOfGANSSRefMeasurementElement
}

SeqOfGANSSRefMeasurementElement ::= SEQUENCE (SIZE(1 .. 16)) OF GANSSRefMeasurementElement

GANSSRefMeasurementElement ::= SEQUENCE {
    svID                 SVID,
    -- Doppler 0th order term,
    -- -1024 m/s to 1023.5 m/s with 0.5 m/s resolution)
    doppler0             INTEGER (-2048 .. 2047), -- Coding according to Annex
    additionalDoppler    AdditionalDopplerFields OPTIONAL,
    codePhase            INTEGER (0 .. 1022), -- Code Phase in ms
    intCodePhase         INTEGER (0 .. 127), -- Integer Code Phase in ms
    codePhaseSearchWindow INTEGER (0 .. 31), -- Code Phase Search Window, see Annex
    additionalAngle      AdditionalAngleFields OPTIONAL,
    ...
}

AdditionalDopplerFields ::= SEQUENCE {
    -- Doppler 1st order term, -0.2 - +0.1 m/s2
    -- (= -42 + (0 to 63) with 1/210 m/s2 resolution)
    doppler1             INTEGER (0..63),
    dopplerUncertainty   INTEGER (0..4)
}

-- GANSS Almanac Model IE
GANSSAlmanacModel ::= SEQUENCE {
    weekNumber           INTEGER (0 .. 255),
    toa                  INTEGER (0 .. 255) OPTIONAL,
    ioda                 INTEGER (0 .. 3) OPTIONAL,
    ganssAlmanacList     SeqOfGANSSAlmanacElement
}

SeqOfGANSSAlmanacElement ::= SEQUENCE (SIZE(1 .. 36)) OF GANSSAlmanacElement

-- GANSS Almanac Model
GANSSAlmanacElement ::= CHOICE {
    keplerianAlmanacSet  Almanac-KeplerianSet, -- Model-1
    ...,
    keplerianNAVALmanac  Almanac-NAVKeplerianSet, -- Model-2
    keplerianReducedAlmanac Almanac-ReducedKeplerianSet, -- Model-3
    keplerianMidiAlmanac Almanac-MidiAlmanacSet, -- Model-4
    keplerianGLONASS     Almanac-GlonassAlmanacSet, -- Model-5
    ecefSBASAlmanac     Almanac-ECEFSbasAlmanacSet -- Model-6
}

-- Almanac parameters according to Keplerian parameters
Almanac-KeplerianSet ::= SEQUENCE {
    svID                 SVID,
    kepAlmanacE          INTEGER (0 .. 2047),
    kepAlmanacDeltaI     INTEGER (-1024 .. 1023),
    kepAlmanacOmegaDot   INTEGER (-1024 .. 1023),
    kepSVHealth          INTEGER (0 .. 15), -- Coding according to Annex
    kepAlmanacAPowerHalf INTEGER (-65536 .. 65535),
    kepAlmanacOmega0     INTEGER (-32768 .. 32767),
    kepAlmanacW          INTEGER (-32768 .. 32767),
    kepAlmanacM0         INTEGER (-32768 .. 32767),
    kepAlmanacAF0        INTEGER (-8192 .. 8191),
    kepAlmanacAF1        INTEGER (-1024..1023)
}

```

```

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

Almanac-ReducedKeplerianSet ::= SEQUENCE {
    svID                SVID,
    redAlmDeltaA       INTEGER (-128..127),
    redAlmOmega0       INTEGER (-64..63),
    redAlmPhi0         INTEGER (-64..63),
    redAlmL1Health    BOOLEAN,
    redAlmL2Health    BOOLEAN,
    redAlmL5Health    BOOLEAN
}

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

Almanac-GlonassAlmanacSet ::= SEQUENCE {
    gloAlmNA           INTEGER (1..1461),
    gloAlmNA           INTEGER (1..24),
    gloAlmHA           INTEGER (0..31),
    gloAlmLambdaA     INTEGER (-1048576..1048575),
    gloAlmLambdaA     INTEGER (0..2097151),
    gloAlmDeltaIa     INTEGER (-131072..131071),
    gloAlmDeltaTA     INTEGER (-2097152..2097151),
    gloAlmDeltaTdotA  INTEGER (-64..63),
    gloAlmEpsilonA    INTEGER (0..32767),
    gloAlmOmegaA      INTEGER (-32768..32767),
    gloAlmTauA        INTEGER (-512..511),
    gloAlmCA           INTEGER (0..1),
    gloAlmMA           BIT STRING (SIZE(2))
}
OPTIONAL

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

```



```

-- GANSS Universal Time Coordinate Model (Model-1)
GANSSUTCModel ::= SEQUENCE {
    ganssUtcA1      INTEGER (-8388608..8388607),
    ganssUtcA0      INTEGER (-2147483648..2147483647),
    ganssUtcTot     INTEGER (0..255),
    ganssUtcWnt     INTEGER (0..255),
    ganssUtcDeltaTls INTEGER (-128..127),
    ganssUtcWNlfsf  INTEGER (0..255),
    ganssUtcDN      INTEGER (-128..127),
    ganssUtcDeltaTlsf INTEGER (-128..127)
}

--GANSS Ephemeris Extension
GANSSEphemerisExtension ::= SEQUENCE {
    ganssEphemerisHeader      GANSSEphemerisExtensionHeader      OPTIONAL,
    ganssReferenceSet         SeqOfGANSSRefOrbit                 OPTIONAL,
    ganssephemerisDeltasMatrix GANSSEphemerisDeltaMatrix         OPTIONAL,
    ...
}

-- The ganssEphemerisHeader and the ganssReferenceSet are mandatory only once in the delivery of the
-- GANSS Ephemeris Extension. The ganssReferenceSet shall include all healthy satellite vehicles
-- at the time of message construction.

GANSSEphemerisExtensionHeader ::= SEQUENCE {
    timeAtEstimation      GANSSEphemerisExtensionTime,
    validityPeriod        INTEGER(1..8),
    -- The validity period, represented in hours, is the validity period of each individual ephemeris
    -- delta payload
    ephemerisExtensionDuration INTEGER(1..512),
    -- If the ephemerisExtensionDuration does not match the request duration made by the MS, the MS
    -- should regard the provided ephemerisExtensionDuration as the limit of the SMLC ephemeris
    -- extension capability at this time.
    ...
}

GANSSEphemerisExtensionTime ::= SEQUENCE {
    ganssEphExtDay      INTEGER(0..8191),
    ganssEphExtTOD      GANSSTOD,
    ...
}

-- Reference Nav Model for Ephepmeris Extension
ReferenceNavModel ::= SEQUENCE {
    keplerToe      INTEGER (0..37799),
    keplerW        INTEGER (-2147483648..2147483647),
    keplerDeltaN   INTEGER (-32768..32767),
    keplerM0       INTEGER (-2147483648..2147483647),
    keplerOmegaDot INTEGER (-8388608..8388607),
    keplerE        INTEGER (0..4294967295),
    keplerIDot     INTEGER (-8192..8191),
    keplerAPowerHalf INTEGER (0..4294967295),
    keplerI0       INTEGER (-2147483648..2147483647),
    keplerOmega0   INTEGER (-2147483648..2147483647),
    keplerCrns     INTEGER (-32768..32767),
    keplerCis      INTEGER (-32768..32767),
    keplerCus      INTEGER (-32768..32767),
    keplerCrc      INTEGER (-32768..32767),
    keplerCic      INTEGER (-32768..32767),
    keplerCuc      INTEGER (-32768..32767)
}

SeqOfGANSSRefOrbit ::= SEQUENCE (SIZE(1..32)) OF GANSSReferenceOrbit
--The number of reference orbits can be read from number of elements in this sequence

GANSSReferenceOrbit ::= SEQUENCE {
    svID      SVID,
    ganssOrbitModel ReferenceNavModel,
    ganssClockModel GANSSClockModel,
    ...
}

GANSSEphemerisDeltaMatrix ::= SEQUENCE (SIZE(1 .. 128)) OF GANSSEphemerisDeltaEpoch

```

```

GANSSEphemerisDeltaEpoch ::= SEQUENCE {
    ganssDeltaEpochHeader      GANSSDeltaEpochHeader      OPTIONAL,
    ganssDeltaElementList      GANSSDeltaElementList,
    ...
}
-- Each GANSSDeltaEpoch element contains a header and the delta values for a particular time window
-- for all PRN's.

GANSSDeltaEpochHeader ::= SEQUENCE {
    validityPeriod              INTEGER(1..8)                OPTIONAL,
    ephemerisDeltaSizes        GANSSEphemerisDeltaBitSizes    OPTIONAL,
    ephemerisDeltaScales      GANSSEphemerisDeltaScales        OPTIONAL,
    ...
}
-- In each of the GANSSDeltaEpochs, if the optional element, validityPeriod is not included, the
-- value in GANSSEphemerisExtensionHeader shall be used. If the optional elements
-- ephemerisDeltaSizes or ephemerisDeltaScales are not included, then the default ephemeris delta
-- sizes and scales shall be used. The default sizes and scales are found in the annex in the
-- table 55.11.

GANSSDeltaElementList ::= SEQUENCE (SIZE(1 .. 32)) OF OCTET STRING(SIZE (1..49))
-- Each octet string element in GANSSDeltaElementList corresponds to one PRN within one epoch

-- Table 55.11 of the annex shows the organization of the delta ephemeris octet string.
-- Decoding of each of the octet strings is accomplished by consulting the ephemerisDeltaSizes
-- table to learn the length and order of each of the parameters in the ephemerisDelta payload.

-- Post decode scaling is accomplished by consulting the ephemerisDeltaScales table to learn the
-- scale factors to apply to the terms in the delta ephemeris.

-- Ephemeris Delta Bit Sizes.

GANSSEphemerisDeltaBitSizes ::= SEQUENCE {

-- This structure defines the order and sizes of the fields in the GANSSDeltaEpoch octet string
-- seqNum and svID are the first two elements of each GANSS Ephemeris Delta Element Structure
-- seqNum is always 7 bits, and svID is always 6 bits long and are thus not included in
-- the GANSSEphemerisDeltaBitSizes table. The value of seqNum indicates the GANSSDeltaEpoch number

-- The Ephemeris delta element payload mimics the bitsize table, but also includes the svID and
-- seqNum as the first two elements (in that order), in each block.

    bitsize-delta-omega        INTEGER(1..32),
    bitsize-delta-deltaN       INTEGER(1..16),
    bitsize-delta-m0           INTEGER(1..32),
    bitsize-delta-omegadot     INTEGER(1..24),
    bitsize-delta-e            INTEGER(1..32),
    bitsize-delta-idot         INTEGER(1..14),
    bitsize-delta-sqrtA        INTEGER(1..32),
    bitsize-delta-i0           INTEGER(1..32),
    bitsize-delta-omega0       INTEGER(1..32),
    bitsize-delta-crs          INTEGER(1..16),
    bitsize-delta-cis          INTEGER(1..16),
    bitsize-delta-cus          INTEGER(1..16),
    bitsize-delta-crc          INTEGER(1..16),
    bitsize-delta-cic          INTEGER(1..16),
    bitsize-delta-cuc          INTEGER(1..16),
    bitsize-delta-tgd1         INTEGER(1..10),
    bitsize-delta-tgd2         INTEGER(1..10),
    ...
}

```

```

GANSSSEphemerisDeltaScales ::= SEQUENCE {
    scale-delta-omega          INTEGER(-16..15),
    scale-delta-deltaN         INTEGER(-16..15),
    scale-delta-m0             INTEGER(-16..15),
    scale-delta-omegadot       INTEGER(-16..15),
    scale-delta-e              INTEGER(-16..15),
    scale-delta-idot           INTEGER(-16..15),
    scale-delta-sqrtA          INTEGER(-16..15),
    scale-delta-i0             INTEGER(-16..15),
    scale-delta-omega0         INTEGER(-16..15),
    scale-delta-crs            INTEGER(-16..15),
    scale-delta-cis            INTEGER(-16..15),
    scale-delta-cus            INTEGER(-16..15),
    scale-delta-crc            INTEGER(-16..15),
    scale-delta-cic            INTEGER(-16..15),
    scale-delta-cuc            INTEGER(-16..15),
    scale-delta-tgd1           INTEGER(-16..15),
    scale-delta-tgd2           INTEGER(-16..15),
    ...
}

-- GANSS Ephemeris Extension Check
GANSSSEphemerisExtensionCheck ::= SEQUENCE {
    ganssBeginTime            GANSSSEphemerisExtensionTime,
    ganssEndTime              GANSSSEphemerisExtensionTime,
    ganssSatEventsInfo        GANSSSatEventsInfo,
    ...
}

GANSSSatEventsInfo ::= SEQUENCE {
    eventOccured              BIT STRING (SIZE (64)),
    futureEventNoted          BIT STRING (SIZE (64)),
    ...
}

-- If a bit is clear in the eventOccured field it indicates that no known errors have occurred
-- between the current time and the ganssBeginTime nor is a maneuver planned for the next sixty
-- minutes.
-- If a bit is set in the futureEventNoted field it indicates that a maneuver is planned during the
-- time period between current time plus sixty minutes and the ganssEndTime
-- GANSS Additional Universal Time Coordinate Model
GANSSAddUTCModel ::= CHOICE {
    utcModel2                  UTCmodelSet2,
    utcModel3                  UTCmodelSet3,
    utcModel4                  UTCmodelSet4,
    ...
}

UTCmodelSet2 ::= SEQUENCE {
    utcA0                      INTEGER (-32768..32767),
    utcA1                      INTEGER (-4096.. 4095),
    utcA2                      INTEGER (-64..63),
    utcDeltaTls                INTEGER (-128.. 127),
    utcTot                     INTEGER (0..65535),
    utcWNot                    INTEGER (0..8191),
    utcWNlsf                   INTEGER (0..255),
    utcDN                      BIT STRING (SIZE(4)),
    utcDeltaTlsf               INTEGER (-128..127)
}

UTCmodelSet3 ::= SEQUENCE {
    nA                        INTEGER (1..1461),
    tauC                      INTEGER (-2147483648..2147483647),
    b1                        INTEGER (-1024..1023)                OPTIONAL,
    b2                        INTEGER (-512..511)                  OPTIONAL,
    kp                        BIT STRING (SIZE(2))                OPTIONAL
}

```

```

UTCmodelSet4 ::= SEQUENCE {
    utcAlwnt          INTEGER (-8388608..8388607),
    utcA0wnt         INTEGER (-2147483648..2147483647),
    utcTot           INTEGER (0..255),
    utcWNT          INTEGER (0..255),
    utcDeltaTls     INTEGER (-128..127),
    utcWNlsf        INTEGER (0..255),
    utcDN           INTEGER (-128..127),
    utcDeltaTlsf    INTEGER (-128..127),
    utcStandardID   INTEGER (0..7)           -- coding according to annex
}

-- GANSS Auxiliary Information
GANSSAuxiliaryInformation ::= CHOICE{
    ganssID1    GANSS-ID1, -- This choice may only be present if GANSS ID indicates Modernized GPS
    ganssID3    GANSS-ID3, -- This choice may only be present if GANSS ID indicates GLONASS
    ...
}

GANSS-ID1 ::= SEQUENCE (SIZE(1..64)) OF GANSS-ID1-element

GANSS-ID1-element ::= SEQUENCE {
    svID          SVID,
    signalsAvailable  GANSSSignals,
    ...
}

GANSS-ID3 ::= SEQUENCE (SIZE(1..64)) OF GANSS-ID3-element

GANSS-ID3-element ::= SEQUENCE {
    svID          SVID,
    signalsAvailable  GANSSSignals,
    channelNumber  INTEGER (-7..13),
    ...
}

--Required Measurement Request Response Time, range is 1 to 128 seconds.
RequiredResponseTime ::= INTEGER (1..128)

-- Control header for additional GPS assistance data
Add-GPS-AssistData ::= SEQUENCE {
    add-GPS-controlHeader  Add-GPS-ControlHeader
}

Add-GPS-ControlHeader ::= SEQUENCE {
    gpsEphemerisExtension      GPSEphemerisExtension      OPTIONAL,
    gpsEphemerisExtensionCheck  GPSEphemerisExtensionCheck  OPTIONAL,
    ...
}

GPSClockModel ::= SEQUENCE {
    af2    INTEGER (-128..127),
    af1    INTEGER (-32768..32767),
    af0    INTEGER (-2097152..2097151),
    tgd    INTEGER (-128..127)
}

--GPS Ephemeris Extension
GPSEphemerisExtension ::= SEQUENCE {
    gpsEphemerisHeader      GPSEphemerisExtensionHeader      OPTIONAL,
    gpsReferenceSet         SeqOfGPSRefOrbit                  OPTIONAL,
    gpsephemerisDeltaMatrix  GPSEphemerisDeltaMatrix          OPTIONAL,
    ...
}

-- The gpsEphemerisHeader and the gpsReferenceSet are mandatory only once in the delivery of the
-- GPS Ephemeris Extension. The gpsReferenceSet shall include all healthy satellite vehicles at the
-- time of message construction

-- The SMLC is required to deliver the gpsReferenceSet for all healthy satellite vehicles
-- at the time of message construction.

```

```

GPSEphemerisExtensionHeader ::= SEQUENCE {
    timeofEstimation      GPSEphemerisExtensionTime,
    validityPeriod        INTEGER(1..8),
-- The validity period, represented in hours is the validity period of each individual ephemeris
-- delta payload
    ephemerisExtensionDuration  INTEGER(1..512),
-- If the ephemerisExtensionDuration does not match the request duration made by the MS, the MS
-- should regard the provided ephemerisExtensionDuration as the limit of the SMLC ephemeris
-- extension capability at this time.
    ...
}

GPSEphemerisExtensionTime ::= SEQUENCE {
    gpsWeek      GPSWeek,
    gpstOW       INTEGER (0..604799),
    ...
}

SeqOfGPSRefOrbit ::= SEQUENCE (SIZE(1..32)) OF GPSReferenceOrbit
--The number of reference orbits can be read from number of elements in this sequence

GPSReferenceOrbit ::= SEQUENCE {
    svID          SVID,
    gpsOrbitModel ReferenceNavModel,
    gpsClockModel GPSClockModel,
    ...
}

GPSEphemerisDeltaMatrix ::= SEQUENCE (SIZE(1 .. 128)) OF GPSEphemerisDeltaEpoch

GPSEphemerisDeltaEpoch ::= SEQUENCE {
    gpsDeltaEpochHeader  GPSDeltaEpochHeader          OPTIONAL,
    gpsDeltaElementList   GPSDeltaElementList,
    ...
}

-- Each GPSDeltaEpoch element contains a header and the delta values for a particular time window
-- for all PRN's.
GPSDeltaEpochHeader ::= SEQUENCE {
    validityPeriod        INTEGER(1..8)          OPTIONAL,
    ephemerisDeltaSizes   GPSEphemerisDeltaBitSizes  OPTIONAL,
    ephemerisDeltaScales  GPSEphemerisDeltaScales  OPTIONAL,
    ...
}

-- In each of the GPSDeltaEpochs, if the optional element validityPeriod is not included,
-- the value in GPSEphemerisExtensionHeader shall be used. if the optional elements
-- ephemerisDeltaSizes or ephemerisDeltaScales are not included, then the default ephemeris delta
-- sizes and scales shall be used. The default sizes and scales are found in the annex in section
-- A.29.m

GPSDeltaElementList ::= SEQUENCE (SIZE(1 .. 32)) OF OCTET STRING(SIZE (1..47))

-- Each octet string element in GPSDeltaElementList corresponds to one PRN within one epoch

-- Table A.29.m of the annex shows the organization of the delta ephemeris octet string.
-- Decoding of each of the octet strings is accomplished by consulting the ephemerisDeltaSizes
-- table to learn the length and order of each of the parameters in the ephemerisDelta payload

-- Post decode scaling is accomplished by consulting the ephemerisDeltaScales table to learn the.
-- scale factors to apply to the terms in the delta ephemeris

-- Ephemeris Delta Bit Sizes.

```

```

GPSEphemerisDeltaBitSizes ::= SEQUENCE {
-- This structure defines the order and sizes of the fields in the GPSsDeltaEpoch octet string
-- seqNum and svID are the first two elements of each GPS Ephemeris Delta Element Structure
-- seqNum is always 7 bits, and svID is always 5 bits long and are thus not included in
-- the GPSEphemerisDeltaBitSizes table. seqNum indicates the GPSDeltaEpoch number.

-- The Ephemeris delta element payload mimics the bitsize table, but also includes the svID and
-- seqNum as the first two elements (in that order),in each block.

    bitsize-delta-omega          INTEGER(1..32),
    bitsize-delta-deltaN         INTEGER(1..16),
    bitsize-delta-m0             INTEGER(1..32),
    bitsize-delta-omegadot       INTEGER(1..24),
    bitsize-delta-e              INTEGER(1..32),
    bitsize-delta-idot           INTEGER(1..14),
    bitsize-delta-sqrtA          INTEGER(1..32),
    bitsize-delta-i0             INTEGER(1..32),
    bitsize-delta-omega0         INTEGER(1..32),
    bitsize-delta-crs            INTEGER(1..16),
    bitsize-delta-cis            INTEGER(1..16),
    bitsize-delta-cus            INTEGER(1..16),
    bitsize-delta-crc            INTEGER(1..16),
    bitsize-delta-cic            INTEGER(1..16),
    bitsize-delta-cuc            INTEGER(1..16),
    bitsize-delta-tgd            INTEGER(1..10),
    ...
}

GPSEphemerisDeltaScales ::= SEQUENCE {
    scale-delta-omega            INTEGER(-16..15),
    scale-delta-deltaN           INTEGER(-16..15),
    scale-delta-m0               INTEGER(-16..15),
    scale-delta-omegadot         INTEGER(-16..15),
    scale-delta-e                 INTEGER(-16..15),
    scale-delta-idot             INTEGER(-16..15),
    scale-delta-sqrtA            INTEGER(-16..15),
    scale-delta-i0               INTEGER(-16..15),
    scale-delta-omega0           INTEGER(-16..15),
    scale-delta-crs              INTEGER(-16..15),
    scale-delta-cis              INTEGER(-16..15),
    scale-delta-cus              INTEGER(-16..15),
    scale-delta-crc              INTEGER(-16..15),
    scale-delta-cic              INTEGER(-16..15),
    scale-delta-cuc              INTEGER(-16..15),
    scale-delta-tgd              INTEGER(-16..15),
    ...
}

GPSEphemerisExtensionCheck ::= SEQUENCE {
    gpsBeginTime                 GPSEphemerisExtensionTime,
    gpsEndTime                   GPSEphemerisExtensionTime,
    gpsSatEventsInfo             GPSSatEventsInfo,
    ...
}

GPSSatEventsInfo ::= SEQUENCE {
    eventOccured                 BIT STRING (SIZE (32)),
    futureEventNoted             BIT STRING (SIZE (32)),
    ...
}
-- If a bit is clear in the eventOccured field it indicates that no known errors have occurred since
-- the gpsBeginTime nor is a maneuver planned for the next sixty minutes.
-- If a bit is set in the futureEventNoted field it indicates that a maneuver is planned during the
-- time period between current time plus sixty minutes and gpsEndTime

```

```

Rel-7-MsrPosition-Rsp-Extension ::= SEQUENCE {
    velEstimate      VelocityEstimate OPTIONAL,
-- Horizontal Velocity
-- Horizontal with Vertical Velocity
-- Horizontal Velocity with Uncertainty
-- Horizontal with Vertical Velocity and Uncertainty
ganssLocationInfo GANSSLocationInfo OPTIONAL,
ganssMeasureInfo  GANSSMeasureInfo OPTIONAL,
    ...
-- Further Release 7 extensions here
}

-- GANSS Location Information contains location estimate, time stamp with uncertainty
-- and optionally Reference Frame field
GANSSLocationInfo ::= SEQUENCE {
    referenceFrame      ReferenceFrame          OPTIONAL, -- Reference Frame Number
    ganssTODm           GANSSTODm              OPTIONAL, -- GNSS TOD modulo
    ganssTODFrac        INTEGER (0 .. 16384)    OPTIONAL, -- Coding according to Annex
-- a value of 16384 shall not be encoded by the sender
-- the receiver shall consider a value of 16384 to be invalid data
    ganssTODUncertainty GANSSTODUncertainty    OPTIONAL, -- Coding according to Annex
    ganssTimeID         INTEGER (0 .. 7)        OPTIONAL, -- Coding according to Annex
    fixType             FixType,
    posData             PositionData,
    stationaryIndication INTEGER(0 .. 1)        OPTIONAL, -- '0' if moving or motion not
-- known

-- Possible shapes carried in posEstimate are
-- ellipsoid point,
-- ellipsoid point with uncertainty circle
-- ellipsoid point with uncertainty ellipse
-- ellipsoid point with altitude and uncertainty ellipsoid
    posEstimate         Ext-GeographicalInformation,
    ...
}

PositionData ::= BIT STRING {
    e-otd      (0),
    gps        (1),
    galileo    (2),
    sbas       (3),
    modernizedGPS (4),
    qzss       (5),
    glonass    (6) } (SIZE (3..16))

-- GANSS TOD modulo 1 hour
GANSSTODm ::= INTEGER (0 .. 3599999)

ReferenceFrame ::= SEQUENCE {
    referenceFN INTEGER (0 .. 65535),
-- Note that applicable range for referenceFN is 0 - 42431
    referenceFNMSB INTEGER (0 .. 63) OPTIONAL -- MSB of Reference Frame Number
}

-- GANSS Measurement Information
GANSSMeasureInfo ::= SEQUENCE {
-- Measurement info elements
ganssMsrSetList SeqOfGANSS-MsrSetElement
}
SeqOfGANSS-MsrSetElement ::= SEQUENCE (SIZE(1..3)) OF GANSS-MsrSetElement

```

```

-- GANSS measurement information 1-3 times in a message
GANSS-MsrSetElement ::= SEQUENCE {
    referenceFrame          ReferenceFrame          OPTIONAL, -- Reference Frame Number
    -- if ganssTODm is included, it is the GNSS specific system time of the GANSS reported
    -- first in ganss-SgnTypeList. If GPS Measurement Information element is not included in
    -- a Measure Position Response component, this field shall be present.
    ganssTODm              GANSSTODm              OPTIONAL, -- GANSS TOD modulo 1 hour
    deltaGANSSTOD          INTEGER (0 .. 127)     OPTIONAL,
    ganssTODUncertainty    GANSSTODUncertainty    OPTIONAL, -- Coding according to Annex
    --N_GANSS can be read from number of elements of SeqOfGANSS-MsrElement
    ganss-MsrElementList   SeqOfGANSS-MsrElement
}

SeqOfGANSS-MsrElement ::= SEQUENCE (SIZE(1..8)) OF GANSS-MsrElement

GANSS-MsrElement ::= SEQUENCE {
    ganssID                INTEGER (0..7)         OPTIONAL, --Absence means Galileo
    ganss-SgnTypeList      SeqOfGANSS-SgnTypeElement
}

-- Measurements can be returned up to 8 different signal types
-- N_SGN_TYPE can be read from number of elements of SeqOfGANSS-SgnTypeElement
-- Reporting of multiple signal types as defined in A.2.2.4g
SeqOfGANSS-SgnTypeElement ::= SEQUENCE (SIZE(1..8)) OF GANSS-SgnTypeElement

GANSS-SgnTypeElement ::= SEQUENCE {
    ganssSignalID          GANSSSignalID, -- Coding according to Annex
    ganssCodePhaseAmbiguity INTEGER (0 .. 127)     OPTIONAL,
    --N_SGN can be read from number of elements of SeqOfGANSS-SgnElement
    ganss-SgnList          SeqOfGANSS-SgnElement,
    ...
}

-- Up to 16 Measurements can be returned per signal type
SeqOfGANSS-SgnElement ::= SEQUENCE (SIZE(1..16)) OF GANSS-SgnElement

GANSS-SgnElement ::= SEQUENCE {
    svID                   SVID,
    cNo                    INTEGER (0 .. 63),
    mpathDet               MpathIndic, -- Coding according to Annex
    carrierQualityInd      INTEGER (0 .. 3)     OPTIONAL, -- Coding according to Annex
    codePhase              INTEGER (0 .. 2097151),
    integerCodePhase       INTEGER (0 .. 127)   OPTIONAL,
    codePhaseRMSError      INTEGER (0..63), -- Coding according to Annex
    doppler                INTEGER (-32768 .. 32767) OPTIONAL,
    adr                    INTEGER (0 .. 33554431) OPTIONAL
}

Rel7-AssistanceData-Extension ::= SEQUENCE {
    ganss-AssistData       GANSS-AssistData     OPTIONAL,
    ganssCarrierPhaseMeasurementRequest NULL      OPTIONAL,
    ganssTODGSMTimeAssociationMeasurementRequest NULL  OPTIONAL,
    add-GPS-AssistData     Add-GPS-AssistData   OPTIONAL,
    ...
}
-- Possibly more extensions for Release 7 here
}

```



```

-- Rel-7 Positioning Capability parameters here

PosCapabilities ::= SEQUENCE {
    nonGANSSPositionMethods    NonGANSSPositionMethods OPTIONAL,
    gANSSPositionMethods       GANSSPositionMethods     OPTIONAL,
    multipleMeasurementSets     MultipleMeasurementSets  OPTIONAL,
    ...
}

NonGANSSPositionMethods ::= BIT STRING {
    msAssistedEOTD    (0),
    msBasedEOTD      (1),
    msAssistedGPS     (2),
    msBasedGPS        (3),
    standaloneGPS     (4) } (SIZE (1..16))

GANSSPositionMethods ::= SEQUENCE (SIZE(1..16)) OF GANSSPositionMethod

GANSSPositionMethod ::= SEQUENCE {
    ganssID                INTEGER (0..7)                OPTIONAL, --Absence means Galileo
-- gANSSPositioningMethodTypes may be present for PosCapability-Req
-- and shall be present for PosCapability-Rsp
    gANSSPositioningMethodTypes GANSSPositioningMethodTypes OPTIONAL,
    gANSSSignals            GANSSSignals,
    ... ,
-- sbasID shall be present if and only if ganssID indicates SBAS
    sbasID                  SBASID                        OPTIONAL
}

GANSSPositioningMethodTypes ::= BIT STRING {
    msAssisted (0),
    msBased    (1),
    standalone (2) } (SIZE (1..8))

-- indicates MS support for particular GANSS signals and frequencies
GANSSSignals ::= BIT STRING {
    signal1 (0),
    signal2 (1),
    signal3 (2),
    signal4 (3),
    signal5 (4),
    signal6 (5),
    signal7 (6),
    signal8 (7) } (SIZE (1..8))

SBASID ::= BIT STRING {
    waas    (0),
    egnos   (1),
    masas   (2),
    gagan   (3) } (SIZE (1..8))

-- indicates MS support of multiple measurement sets for MS assisted position methods
MultipleMeasurementSets ::= BIT STRING {
    eotd    (0),
    gps     (1),
    ganss   (2) } (SIZE (1..8))

-- indicates MS support of different types of assistance data
AssistanceSupported ::= SEQUENCE {
    gpsAssistance                GPSAssistance                OPTIONAL,
    gANSSAssistanceSet           GANSSAssistanceSet           OPTIONAL,
    ... ,
    gANSSAdditionalAssistanceChoices GANSSAdditionalAssistanceChoices OPTIONAL
}

```

```

-- GPS assistance data supported
GPSAssistance ::= BIT STRING {
    almanac                (0),
    uTCmodel                (1),
    ionosphericModel        (2),
    navigationmodel         (3),
    dGPScorrections         (4),
    referenceLocation        (5),
    referenceTime           (6),
    acquisitionAssistance   (7),
    realTimeIntegrity        (8),
    ephemerisExtension      (9),
    ephemerisExtensionCheck (10) } (SIZE (1..16))

-- GANSS assistance data supported
GANSSAssistanceSet ::= SEQUENCE {
    commonGANSSAssistance   CommonGANSSAssistance,
    specificGANSSAssistance SpecificGANSSAssistance,
    ...
}

-- Common GANSS assistance data supported
CommonGANSSAssistance ::= BIT STRING {
    referenceTime           (0),
    referenceLocation        (1),
    ionosphericModel        (3),
    addIonosphericModel     (4),
    earthOrientationParam    (5) } (SIZE (1..8))

SpecificGANSSAssistance ::= SEQUENCE (SIZE(1..16)) OF GANSSAssistanceForOneGANSS

-- assistance data supported for a particular GANSS system
GANSSAssistanceForOneGANSS ::= SEQUENCE {
    ganssID                  INTEGER (0..7) OPTIONAL, --Absence means Galileo
    gANSSAssistance          GANSSAssistance,
    ...
}

-- specific GANSS assistance data supported
GANSSAssistance ::= BIT STRING {
    realTimeIntegrity        (0),
    differentialCorrections  (1),
    almanac                  (2),
    referenceMeasurementInformation (3),
    navigationModel          (4),
    timeModelGNSS-UTC        (5),
    timeModelGNSS-GNSS       (6),
    databitassistance        (7),
    ephemerisExtension       (8),
    ephemerisExtensionCheck  (9),
    addUTCmodel              (10),
    auxiliaryInformation      (11) } (SIZE (1..16))

GANSSAdditionalAssistanceChoices ::= SEQUENCE (SIZE(1..16)) OF
GANSSAdditionalAssistanceChoicesForOneGANSS

GANSSAdditionalAssistanceChoicesForOneGANSS ::= SEQUENCE {
    ganssID                  INTEGER (0..7) OPTIONAL, --Absence means Galileo
    ganssClockModelChoice   GANSSModelID OPTIONAL,
    ganssOrbitModelChoice   GANSSModelID OPTIONAL,
    ganssAlmanacModelChoice GANSSModelID OPTIONAL,
    ganssAdditionalUTCModelChoice GANSSModelID OPTIONAL,
    ...
}

```

```

GANSSModelID ::= BIT STRING {
    model1 (0),
    model2 (1),
    model3 (2),
    model4 (3),
    model5 (4),
    model6 (5),
    model7 (6),
    model8 (7) } (SIZE (1..8))

-- indicates assistance data that may be needed by the MS
AssistanceNeeded ::= SEQUENCE {
    gpsAssistanceData      GPSAssistanceData      OPTIONAL,
    ganssAssistanceData    GANSSAssistanceData    OPTIONAL,
    ...
}
    
```

6 TOM Protocol Header for RRLP Transport

6.1 General

For the specification of the TOM protocol, see 3GPP TS 44.064.

6.2 Remaining Octets of TOM Protocol Header for RRLP

The number of remaining octet following the first octets of the TOM protocol header for RRLP is one. The encoding of this octet is defined in the figure 6.1 and the table 6.1.

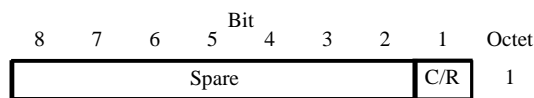


Figure 6.1: Remaining Octets of TOM Protocol Header for RRLP

Table 6.1: C/R bit content

C/R	UI frame information field
0	Command (SMLC to MS) or Final Response (MS to SMLC)
1	Not Command or Final Response

The setting of the C/R flag is provided by the sending RRLP entity, for further details see 3GPP TS 43.059.

The Spare bits shall be ignored by the receiver and set to 0 by the sender. If a protocol header with more than one remaining octet of the TOM protocol header is received, the additional octets after the first remaining octet shall be ignored by the receiver.

Annex A (informative): Description of Components

A.1 Introduction

This annex describes the contents of components.

A.2 Measure Position Request

A.2.1 General

The Measure Position Request is a RRLP component from the SMLC to the MS. This component is common to E-OTD, GPS and GANSS (Galileo and Additional Navigation Satellite Systems) location methods. As a response to this component, the MS performs E-OTD, GPS or GANSS measurements and possibly calculates its own position, if the MS and/or the network support these options. It contains the following elements.

Table A.1: Measure Position Request component content

Element	Type/Reference	Presence
Positioning Instructions	Positioning Instructions 2.2.1	M
E-OTD Reference BTS for Assistance Data	E-OTD Reference BTS for Assistance Data 2.2.2	O
E-OTD Measurement Assistance Data	E-OTD Measurement Assistance Data 2.2.3	O
E-OTD Measurement Assistance Data for System Information List	E-OTD Measurement Assistance Data for System Information List 2.2.4	O
GPS Assistance Data	GPS Assistance Data 4.2.4	O
Additional GPS Assistance Data	Additional GPS Assistance Data 4.2.4c	O
GPS Time Assistance Measurement Request	GPS Time Assistance Measurement Request 2.2.4a	O
GPS Reference Time Uncertainty	GPS Reference Time Uncertainty 2.2.4b	O
Velocity Request	Velocity Request 2.2.4c	O
Extended Reference	Extended Reference 2.2.5	O
GANSS Positioning Method Element	GANSS Positioning Method Element 2.2.1a	O
GANSS Carrier-Phase Measurement Request	GANSS Carrier-Phase Measurement Request 2.2.4d	O
GANSS TOD - GSM Time Association Request	GANSS TOD - GSM Time Association Request 2.2.4e	O
GANSS Multi-frequency Measurement Request	GANSS Multi-frequency Measurement Request 2.2.4g	O
GANSS Assistance Data	GANSS Assistance Data 4.2.6	O
Required Response Time	Required Response Time 2.2.4f	O

A.2.2 Elements

A.2.2.1 Positioning Instructions Element

The purpose of Positioning Instructions element is to express the allowed/required location method(s), and to provide information required QoS. This element is mandatory in the Measure Position Request message, and contains the following fields:

Method Type

This field indicates whether MS based or assisted version is allowed/requested. If the Positioning Methods field includes more than one method, the Method Type applies to all of them. This field is mandatory, and has the following values:

- '0': MS assisted;
- '1': MS based;
- '2': MS based is preferred, but MS assisted is allowed;
- '3': MS assisted is preferred, but MS based is allowed.

In GPS positioning methods, 'MS based' may indicate either MS Based Assisted GPS method or Conventional GPS method. If 'MS based is indicated with no GPS assistance data then the MS may interpret this as either Conventional GPS or MS based A-GPS without assistance data. The same interpretation applies also to the GANSS positioning method.

Positioning Methods

This field indicates which location method or methods should be used. This field is mandatory.

- '0': E-OTD;
- '1': GPS;
- '2': E-OTD or GPS (i.e. both can be reported).

NOTE: If the selected positioning method is 'GPS' or 'E-OTD or GPS', the field GANSS Positioning Method, if present in a Measure Position Request component, indicates request of GANSS method and indicates the allowed satellite systems.

Response Time

This field indicates the desired response time. However, when performing measurements, the desired response time may be exceeded. This field is mandatory.

The response time is 2^N seconds, where N is the value in this field. Thus the desired maximum response time can be 1, 2, 4, 8, 16, 32, 64, or 128 seconds.

Range: 0-7

Accuracy

This field indicates the required accuracy of the location estimate. This field is mandatory when Method Type is '1', '2', or '3' and optional when Method Type is '0'.

This field is 7 bit Uncertainty Code as defined in 3GPP TS 23.032.

Multiple Sets

This field indicates whether MS is requested to send multiple *E-OTD/GPS/GANSS Measurement Information Sets*. The maximum number of measurement sets is three. This field is mandatory. MS is expected to include the current measurement set. Additionally MS may include historical measurement sets, or measure new additional sets if the response time allows that.

- '0': multiple IEs can be send;
- '1': sending of multiple sets is not allowed.

Environment Characterization

Environment Characterization field provides the MS with information about expected multipath and NLOS in the current area. This field is optional.

- '0': possibly heavy multipath and NLOS conditions (e.g. bad urban or urban).
- '1': no or light multipath and usually LOS conditions (e.g. suburban or rural).

'2': not defined or mixed environment.

'3': reserved for future use.

A.2.2.1a GANSS Positioning Method Element

This bit map indicates the satellite systems allowed by the SMLC corresponding to allowance of 'GPS' in the Positioning Methods field. Each bit is of type Boolean, where TRUE ('1') means the particular satellite system is allowed. For example EOTD + Galileo method can be indicated by setting 'E-OTD or GPS' in Positioning Methods and setting only the 'bit 1' to TRUE value in the GANSS Positioning Method element. The MS shall not request assistance data or report measurements for the systems that are not indicated in the bit map.

NOTE: Bit 0 of this bit map shall not be the only one set to TRUE ('1').

'bit 0':	GPS;
'bit 1':	Galileo;
'bit 2':	SBAS (WAAS, EGNOS, MSAS, GAGAN);
'bit 3':	Modernized GPS (L1C, L2C, L5);
'bit 4':	QZSS;
'bit 5':	GLONASS;
'bit 6-15':	Reserved for future GNSSes.

A.2.2.2 E-OTD Reference BTS for Assistance Data Element

The RTD and 51 multiframe offset values in the E-OTD Measurement Assistance Data element and the E-OTD Measurement Assistance Data for System Information List element are calculated relative to the BTS indicated in this element. Also the E-OTD Measurement Assistance data for System Information List element, if present, refers to the System Information Neighbor List of this reference BTS.

Inclusion of this parameter is mandatory for E-OTD since it is not possible to reliably default to the current serving BTS for the target MS, as there is a small chance that the SMLC does not know this. If the E-OTD Measurement Assistance data for System Information List element is present, the current serving cell must be the same as reference BTS identified in this element.

BCCH Carrier

This field indicates the absolute RF channel number of BCCH of the reference BTS. This field is mandatory.

Range: 0 - 1023

BSIC

This field indicates the BSIC (Base Station Identity Code) of the reference BTS. This field is mandatory.

Range: 0 - 63

Time Slot Scheme

The Time Slot Scheme field indicates the type of transmission scheme the reference BTS is using. If the MS measures BTSs signals from time slots other than 0 or 4, and it is informed about the burst length schemes used by BTSs, then it can compensate for the possible error. (This is necessary if the MS averages bursts from different time slots, and the BTS uses varying lengths of bursts.) This field is mandatory.

'0' = all time slots are 156.25 bits long.

'1' = time slots 0 and 4 are 157 bits long and other time slots are 156 bits long.

BTS Position

This field contains the BTS position in the format defined in 3GPP TS 23.032. This field is optional, but should be present for MS based E-OTD positioning. The allowed shapes are:

- ellipsoid point;
- ellipsoid point with altitude and uncertainty ellipsoid.

A.2.2.3 E-OTD Measurement Assistance Data Element

This element identifies BTSs that are used for E-OTD measurements. This element helps the MS to make measurements from neighbor BTS (even below decoding level). This element is optional in the Measure Position Request component. The presence of this element means that the MS should try to measure the E-OTD values between the reference BTS and the BTSs identified in this element.

This element is used to deliver E-OTD measurement assistance data for those BTSs, that are not included in the System Information Neighbor List of the reference BTS, if necessary.

The RTD and 51 multiframe offset values are calculated relative to the BTS indicated in the E-OTD Reference BTS for Assistance Data element. This element contains the following fields.

Number of BTSs

This field indicates how many BTSs are included in this IE. This field is mandatory. The maximum number of BTSs in this message for whom the assistance data can be given is 16 (reference BTS and 15 neighbour BTSs). Thus the sum of **Number of BTSs** field in this IE and total amount of **E-OTD Neighbor present** bits with value '1' in **E-OTD Measurement Assistance Data for System Information List IE** can be at a maximum 15.

Range: 1 to 15.

The following fields are repeated for the number of BTSs included in the Number of BTSs field.

BCCH Carrier

This field indicates the absolute RF channel number of BCCH of the particular BTS. This field is mandatory.

Range: 0 - 1023

BSIC

This field indicates the BSIC (Base Station Identity Code) of the particular BTS. This field is mandatory.

Range: 0 - 63

Multiframe Offset

This field indicates the frame difference between the start of the 51 multiframe frames being transmitted from this BTS and the reference BTS. The multiframe offset is defined as $T_{\text{BTS}} - T_{\text{Ref}}$, where T_{BTS} is the time of the start of the 51 multiframe in the BTS in question, and T_{Ref} is the time of the start of the 51 multiframe in the reference BTS. This field is mandatory. Multiframe Offset may be used to calculate the Expected Multiframe Offset (the Multiframe Offset value that MS is expected to measure between this BTS and reference BTS in its current estimated location).

Expected Multiframe Offset = (Multiframe Offset + Adjustment) modulo 51

Adjustment = 1 if Rough RTD - Expected OTD \geq 850

Adjustment = -1 if Rough RTD - Expected OTD \leq -850

Adjustment = 0 if -400 \leq Rough RTD - Expected OTD \leq 400

If the Rough RTD - Expected OTD is not within any of the ranges above, an error has occurred and the Expected OTD should be ignored and no Expected Multiframe Offset can be calculated.

Range: 0 - 51

Usable range of Multiframe Offset value is 0 - 50. The Multiframe Offset value 51 shall not be encoded by the transmitting entity and shall be treated by the receiving entity as 0.

Time Slot Scheme

The Time Slot Scheme field indicates the type of transmission scheme the particular BTS is using. If the MS measures BTSs signals from time slots other than 0 or 4, and it is informed about the burst length schemes used by BTSs, then it can compensate for the possible error. (This is necessary if the MS averages bursts from different time slots, and the BTS uses varying lengths of bursts.) This field is mandatory.

'0' = all time slots are 156.25 bits long.

'1' = time slots 0 and 4 are 157 bits long and other time slots are 156 bits long.

Rough RTD

This field indicates the rough RTD value between this BTS and reference BTS. The used resolution is 1 bits. This RTD value is the RTD value of TS0s (i.e. the difference in starting of TS0), not only the RTD between starts of bursts. The RTD is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of TS0 in the BTS in question, and T_{Ref} is the time of the start of the TS0 in the reference BTS. This field is mandatory.

Range: 0 - 1250

Usable range of Rough RTD value is 0 - 1249. The Rough RTD value 1250 shall not be encoded by the transmitting entity and shall be treated by the receiving entity as 0.

Accurate RTD values are needed for MS based E-OTD, i.e. when the MS calculates its own position.

Expected OTD

This field indicates the OTD value that MS is expected to measure between this BTS and reference BTS in its current estimated location. SMLC can estimate MS's location roughly e.g. based on serving BTS coordinates, TA, and possibly some other information. The used resolution is 1 bits. This OTD value is the OTD value of TS0s (i.e. the difference in starting of TS0), not only the OTD between starts of bursts. The OTD is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of TS0 in the BTS in question, and T_{Ref} is the time of the start of the TS0 in the reference BTS. This is element is Release 98 extension and it is an optional element included in Release98-Ext IE. SMLC shall send this element to MS supporting MS Assisted or MS Based E-OTD.

Range: 0 - 1250

Usable range of Expected OTD value is 0 - 1249. The Expected OTD value 1250 shall not be encoded by the transmitting entity and shall be treated by the receiving entity as 0.

Uncertainty Of Expected OTD

This field indicates the uncertainty in Expected OTD value. The uncertainty is related to SMLC's estimation of MS's location. The uncertainty defines following search window for MS, that it can use to speed up the OTD measurements:

$$\text{Expected OTD} - \text{Uncertainty} < \text{measured OTD} < \text{Expected OTD} + \text{Uncertainty}.$$

This is element is Release 98 extension and it is an optional element included in Release98-Ext IE. SMLC shall send this element to MS supporting MS Assisted or MS Based E-OTD.

Range is 0 - 7 with following encoding:

'0'	0 < uncertainty <= 2 bit;
'1'	2 < uncertainty <= 4 bit;
'2'	4 < uncertainty <= 8 bit;
'3'	8 < uncertainty <= 12 bit;
'4'	12 < uncertainty <= 16 bit;
'5'	16 < uncertainty <= 22 bit;
'6'	22 < uncertainty <= 30 bit;
'7'	uncertainty > 30 bit.

NOTE: If uncertainty in MS's location is x bits, uncertainty in Expected OTD is 2*x (in the worst case). When the uncertainty is given with value '7' no upper bound exist for the uncertainty.

The following fields tell the coordinates of neighbor BTSs that are used for E-OTD measurements, and also fine RTD values. This information allows the MS to calculate its own location. These fields (Fine RTD, Relative north, Relative

east and Relative altitude) are optional. All of Fine RTD, Relative north, and Relative east fields must be present, if some of them is included.

Fine RTD

This field indicates the fine RTD value between this BTS and reference BTS. It provides the 1/256 bit duration resolution to the value expressed in the corresponding Rough RTD field. This RTD value is the RTD value of TS0s (i.e. the difference in starting of TS0), not only the RTD between starts of bursts. The RTD is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of TS0 in the BTS in question, and T_{Ref} is the time of the start of the TS0 in the reference BTS. This field is optional.

Range: 0 - 255

Relative North

This field indicates the distance of the neighbor BTS from the reference BTS in north- (negative values mean south) direction. This field is optional. The units are 0.03 seconds. The used reference ellipsoid is WGS 84 ellipsoid.

Range: -200000...200000

Relative East

This field indicates the distance of the neighbor BTS from the reference BTS in east (negative values mean west) direction. This field is optional. The units are 0.03 seconds. The used reference ellipsoid is WGS 84 ellipsoid.

Range: -200000 ... 200000

Relative Altitude

This field indicates the altitude of the neighbor BTS relative to the reference BTS in meters. This field is optional.

Range: -4000 .. 4000 meters

A.2.2.4 E-OTD Measurement Assistance Data for System Information List Element

This element identifies those BTSs in the System Information Neighbor List that are used for E-OTD measurements. The System Information Neighbor Lists, to which this assistance data is given, are System Information Neighbor Lists that are sent in the dedicated mode, packet idle mode, packet transfer mode, or dual transfer mode. This element helps the MS to make measurements from those neighbor BTS (even below decoding level). This element is optional in the Measure Position Request component. The presence of this element means that the MS should use the BTSs identified here to the E-OTD measurements.

The RTD and 51 multiframe offset values are calculated relative to the reference BTS. This element contains the following fields.

Number of Neighbors

This field indicates how many neighbors are included in this IE.

Range: 1-32

The following fields are repeated for the number indicated in the Number of Neighbors field.

E-OTD Neighbor present

This field indicates whether the information concerning a certain BTS in the Neighbor List is present. Altogether no more than 15 BTS can have the indication "Neighbor is included". The maximum number of BTSs in this message for whom the assistance data can be given is 16 (reference BTS and 15 neighbour BTSs). Thus the sum of total amount of **E-OTD Neighbor present** bits with value '1' in this IE and **Number of BTSs** field in **E-OTD Measurement Assistance Data IE** can be at a maximum 15.

'0' Neighbor not included;

'1' Neighbor is included.

The following fields (BSIC, Multiframe Offset, Time Slot Scheme and Rough RTD) are included if E-OTD neighbor present field is set to '1'.

BSIC

This field indicates the BSIC (Base Station Identity Code) of the particular BTS. This field is mandatory.

Range: 0 - 63

Multiframe Offset

This field indicates the frame difference between the start of the 51 multiframe frames being transmitted from this BTS and the reference BTS. The multiframe offset is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of the 51 multiframe in the BTS in question, and T_{Ref} is the time of the start of the 51 multiframe in the reference BTS. This field is mandatory. Multiframe Offset may be used to calculate the Expected Multiframe Offset (the Multiframe Offset value that MS is expected to measure between this BTS and reference BTS in its current estimated location).

$$\text{Expected Multiframe Offset} = (\text{Multiframe Offset} + \text{Adjustment}) \text{ modulo } 51$$

Adjustment = 1 if Rough RTD - Expected OTD \geq 850

Adjustment = -1 if Rough RTD - Expected OTD \leq -850

Adjustment = 0 if $-400 \leq$ Rough RTD - Expected OTD \leq 400

Range: 0 - 51

Usable range of Multiframe Offset value is 0 - 50. The Multiframe Offset value 51 shall not be encoded by the transmitting entity and shall be treated by the receiving entity as 0.

Time Slot Scheme

The Time Slot Scheme field indicates the type of transmission scheme the particular BTS is using. If the MS measures BTSs signals from time slots other than 0 or 4, and it is informed about the burst length schemes used by BTSs, then it can compensate for the possible error. (This is necessary if the MS averages bursts from different time slots, and the BTS uses varying lengths of bursts.) This field is mandatory.

'0' = all time slots are 156.25 bits long;

'1' = time slots 0 and 4 are 157 bits long and other time slots are 156 bits long.

Rough RTD

This field indicates the RTD value between this BTS and the reference BTS. The used resolution is 1 bit. This RTD value is the RTD value of TS0s (i.e. the difference in starting of TS0), not only the RTD between starts of bursts. The RTD is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of TS0 in the BTS in question, and T_{Ref} is the time of the start of the TS0 in the reference BTS. This field is mandatory.

Range: 0 - 1250

Usable range of Rough RTD value is 0 - 1249. The RoughRTD value 1250 shall not be encoded by the transmitting entity and shall be treated by the receiving entity as 0.

Expected OTD

This field indicates the OTD value that MS is expected to measure between this BTS and reference BTS in its current estimated location. SMLC can estimate MS's location roughly e.g. based on serving BTS coordinates, TA, and possibly some other information. The used resolution is 1 bits. This OTD value is the OTD value of TS0s (i.e. the difference in starting of TS0), not only the OTD between starts of bursts. The OTD is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of TS0 in the BTS in question, and T_{Ref} is the time of the start of the TS0 in the reference BTS. This element is Release 98 extension and it is an optional element included in Release98-Ext IE. SMLC shall send this element to MS supporting MS Assisted or MS Based E-OTD.

Range: 0 - 1250

Usable range of Expected OTD value is 0 - 1249. The Expected OTD value 1250 shall not be encoded by the transmitting entity and shall be treated by the receiving entity as 0.

Uncertainty Of Expected OTD

This field indicates the uncertainty in Expected OTD value. The uncertainty is related to SMLC's estimation of MS's location. The uncertainty defines following search window for MS, that it can use to speed up the OTD measurements:

$$\text{Expected OTD} - \text{Uncertainty} < \text{measured OTD} < \text{Expected OTD} + \text{Uncertainty}.$$

This element is Release 98 extension and it is an optional element included in Release98-Ext IE. SMLC shall send this element to MS supporting MS Assisted or MS Based E-OTD.

Range is 0 - 7 with following encoding:

'0'	0 < uncertainty <= 2 bit;
'1'	2 < uncertainty <= 4 bit;
'2'	4 < uncertainty <= 8 bit;
'3'	8 < uncertainty <= 12 bit;
'4'	12 < uncertainty <= 16 bit;
'5'	16 < uncertainty <= 22 bit;
'6'	22 < uncertainty <= 30 bit;
'7'	uncertainty > 30 bit.

NOTE: If uncertainty in MS's location is x bits, uncertainty in Expected OTD is 2*x (in the worst case). When the uncertainty is given with value '7' no upper bound exist for the uncertainty.

The following fields tell the coordinates of neighbor BTSs that are used for E-OTD measurements, and also fine RTD values. This information allows the MS to calculate its own location. These fields (Fine RTD, Relative north, Relative east and Relative altitude) are optional. All of Fine RTD, Relative north, and Relative east fields must be present, if some of them is included.

Fine RTD

This field indicates the fine RTD value between this BTS and reference BTS. It provides the 1/256 bit duration resolution to the value expressed in the corresponding Rough RTD field. This RTD value is the RTD value of TS0s (i.e. the difference in starting of TS0), not only the RTD between starts of bursts. The RTD is defined as $T_{\text{BTS}} - T_{\text{Ref}}$, where T_{BTS} is the time of the start of TS0 in the BTS in question, and T_{Ref} is the time of the start of the TS0 in the reference BTS. This field is optional.

Range: 0 - 255

Relative North

This field indicates the distance of the neighbor BTS from the reference BTS in north- (negative values mean south) direction. This field is optional. The units are 0.03 seconds. The used reference ellipsoid is WGS 84 ellipsoid.

Range: -200000...200000

Relative East

This field indicates the distance of the neighbor BTS from the reference BTS in east (negative values mean west) direction. This field is optional. The units are 0.03 seconds. The used reference ellipsoid is WGS 84 ellipsoid.

Range: -200000 ... 200000

Relative Altitude

This field indicates the altitude of the neighbor BTS relative to the reference BTS in meters. This field is optional.

Range: -4000 .. 4000 meters

A.2.2.4a GPS Time Assistance Measurement Request element

This component does not have any information contents. If this component is present, the MS is requested to return GPS time assistance measurements.

A.2.2.4b GPS Reference Time Uncertainty element

This element provides the accuracy of the relation GPS and GSM time in the Reference Time field in GPS Assistance Data IE. If GPS TOW is the given GPS time, then the true GPS time, corresponding to the provided GSM time as observed at the MS location, lies in the interval (GPS TOW - GPS Reference Time Uncertainty, GPS TOW + GPS Reference Time Uncertainty). An entity that supports this element shall always include it when appropriate. This means that when the element is expected but is not received, lack of support at the sender can be assumed and some implementation dependent default interpretation can then be applied.

The uncertainty r , expressed in microseconds, is mapped to a number K , with the following formula:

$$r = C * ((1+x)^K - 1)$$

with $C = 0.0022$ and $x = 0.18$. With $0 \leq K \leq 127$, a suitably useful range between 0 and 3 second is achieved for the uncertainty, while still being able to code down to values as small as 0.3 nanoseconds. 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 .

Table A.1a: Example values for the GPS Reference Time Uncertainty Parameter Format

Value of K	Value of uncertainty
0	0 nanoseconds
1	0.396 nanoseconds
2	0.863 nanoseconds
-	-
50	8.64 microseconds
-	-
127	≥ 2.96 seconds

A.2.2.4c Velocity Request element

If this element is present, the MS is requested to return a velocity estimate along with the location estimate. Requesting velocity does not guarantee its delivery, if conditions support its availability and it is requested it will be provided.

A.2.2.4d GANSS Carrier-Phase Measurement Request Element

This component does not have any information contents. If this component is present, the MS is requested to return carrier phase measurements in the GANSS Measurement Information IE.

A.2.2.4e GANSS TOD - GSM Time Association Request Element

This component does not have any information contents. If this component is present, the MS is requested to return GANSS TOD - GSM time association measurements. Only either GPS Timing Assistance Measurement Request Element or GANSS TOD - GSM Time Association Measurement Request should be present in Measure Position Request.

A.2.2.4f Required Response Time

This element indicates the maximum response time that shall be allowed for the positioning request in the MS. When this element is received, the MS shall send an RRLP Measure Position Response before the required response time has elapsed.

When this element is received, the MS shall ignore the Response Time field in the Positioning Instructions element.

The Required Response Time has a value from 1 to 128 seconds.

A.2.2.4g GANSS Multi-frequency Measurement Request Element

This component does not have any information contents.

If this component is present, the MS is requested to return measurements performed on multiple GANSS signal types if the MS supports this capability. If this component is not present, the MS shall report only one signal type for each GANSS.

If SMLC has indicated supported signal types in Positioning Capability Request, the MS shall only report signals that are supported by SMLC.

A.2.2.5 Extended Reference IE

This element is mandatory in any RRLP Measure Position Request component, any RRLP Assistance Data component, any RRLP Positioning Capability Request component and any RRLP Positioning Capability response component.

NOTE: For reasons of backward compatibility, the IE is not defined for a Release 4 or earlier SMLC and would be ignored, when received, by a Release 4 or earlier MS. Additionally, other requirements associated with this IE would not be supported by a Release 4 or earlier MS or SMLC.

The Extended Reference IE contains the following elements:

SMLC code: an integer in the range 0-63 distinguishing any SMLC from other neighbour SMLCs in the same Routing Area. Each SMLC is assigned a specific SMLC ID value. The values assigned to neighbour SMLCs in the same Routing Area between which inter-NSE cell change is possible should be different.

Transaction ID: an integer in the range 0-262143 distinguishing different RRLP transactions in different MSs currently being served by the same SMLC. An SMLC shall assign a different transaction ID to each currently open RRLP transaction for positioning and assistance data delivery among all target MSs. When any RRLP transaction for any MS is completed in the SMLC (e.g. the MS has sent a correctly formatted RRLP Measure Position Response or Assistance Data Ack.) or if the transaction is aborted (e.g. SMLC timeout on an RRLP response), the associated transaction ID value shall become free and may be later assigned to a new RRLP transaction by the SMLC. When any transaction ID value becomes free, an SMLC should attempt to wait for at least 128 seconds (the maximum defined RRLP response time from an MS) before reassigning the same value.

A.3 Measure Position Response

A.3.1 General

The Measure Position Response is a RRLP component from the MS to the network. It is the response to the Measure Position Request. It contains the following elements. One of the five elements containing measurement data or location estimate (*E-OTD Measurement Information*, *Location Information*, *GPS Measurement Information*, *GANSS Measurement Information* or *GANSS Location Information*) or *Location Information Error* element must be included.

Table A.2: Measure Position Response component content

Element	Type/Reference	Presence
Multiple Sets	Multiple Sets 3.2.1	O
Reference BTS Identity	Reference BTS Identity 3.2.2	O
E-OTD Measurement Information	E-OTD Measurement Information 3.2.3	O
Location Information	Location Information 3.2.4	O
GPS Measurement Information	GPS Measurement Information 3.2.5	O
Location Information Error	Location Information Error 3.2.6	C
GPS Time Assistance Measurements	GPS Time Assistance Measurements 3.2.6a	O
Velocity Estimate	Velocity Estimate 3.2.6b	O
Extended Reference	Extended Reference 3.2.7	C
Uplink RRLP Pseudo Segmentation Indication	Uplink RRLP Pseudo Segmentation Indication 3.2.8	C
GANSS Location Information	GANSS Location Information 3.2.9	O
GANSS Measurement Information	GANSS Measurement Information 3.2.10	O

A.3.2 Elements

A.3.2.1 Multiple Sets Element

This element indicates how many E-OTD Measurement Information sets, GPS Measurement Information sets or GANSS Measurement Information sets, and Reference BTS Identities are included to this element. This element is optional. If this element is absent, a single measurement set is included.

Number of E-OTD/GPS/GANSS Measurement Information Sets

This field indicates the number of *Number of E-OTD/GPS/GANSS Measurement Information* sets included to this component. This field is mandatory. If two or more types of measurement elements are present, then there are the equal number of them, and each pair has the same reference BTS.

Range: 2 - 3

Number of Reference BTS

This field indicates the number of reference BTSs used in this component. This field is mandatory.

Range: 1-3

Reference BTS relation to Measurement Elements

This field indicates how the reference BTSs listed in this element relate to measurement sets later in this component. This field is conditional and included only if Number of E-OTD/GPS/GANSS Measurement Information Sets is '3' and Number of Reference BTSs is '2'.

- '0' = First reference BTS is related to first and second E-OTD/GPS/GANSS Measurement Information Sets, and second reference BTS is related to third E-OTD/GPS Measurement Information Sets.
- '1' = First reference BTS is related to first and third E-OTD/GPS/GANSS Measurement Information Sets, and second reference BTS is related to second E-OTD/GPS/GANSS Measurement Information Sets.
- '2' = First reference BTS is related to first E-OTD/GPS/GANSS Measurement Information Sets, and second reference BTS is related to second and third E-OTD/GPS/GANSS Measurement Information Sets.

If this field is not included, the relation between reference BTS and Number of E-OTD/GPS/GANSS Measurement Information Sets is as follows:

- if there are three sets and three reference BTSs -> First reference BTS relates to first set, second reference BTS relates to second set, and third reference BTS relates to third set;
- if there are two sets and two reference BTS -> First reference BTS relates to first set, and second reference BTS relates to second set;
- if there is only one reference BTS and 1-3 sets -> this reference BTS relates to all sets.

A.3.2.2 Reference BTS Identity Element

This element identifies the reference BTS(s). This element is conditional to the number of reference BTSs. It is mandatory, if there is more than one reference BTS, and optional otherwise. If this element is not included, the Reference BTS, used in other elements, is the current serving BTS of MS. If this element is included, the BTSs defined here are used as Reference BTSs in all other elements.

The following fields are repeated for the number of reference BTSs included in the Number of Reference BTS field.

CellIdType

This field indicates is the identity method of the Reference BTS. This field is mandatory within this element.

- '0' = Cell identity is told using BSIC and BCCH carrier.
- '1' = Cell identity is told using CI, and the LAC is the same as the current serving BTS.

- '2' = Cell identity is told using an index referring to the BTS listed in the Measure Position Request component (the indicated reference BTS is 1)
- '3' = Cell identity is told using an index referring to the BTS listed in the BCCH allocation list (System Information Neighbor Lists) of the serving BTS. This type of reference identity shall not be used by the MS unless it has received the "E-OTD Measurement Assistance Data for System Information List Element" from the SMLC for this cell.
- '4' = Cell identity is told using CI, and the LAC.

Reference LAC

This field indicates the Location Area Code of the reference BTS. The purpose of the Location Area Code is to identify a location area. This field is conditional, and included, if CellIDType field is '4'.

Range: 0 - 65535

Reference CI

This field indicates the Cell Identity value of the reference BTS. The purpose of the Cell Identity value is to identify a cell within a location area. This field is conditional, and included, if CellIDType field is '1' or '4'.

Range: 0 - 65535

Reference BCCH Carrier

This field indicates the absolute RF channel number of the BCCH of the reference base station. BCCH carrier field is conditional and is included only if CellIDType is set '0'.

Range: 0 - 1023

Reference BSIC

This field indicates the BSIC (Base Station Identity Code of the base station).

BSIC field is conditional and is included only if CellIDType is set '0' or '3'.

Range: 0 - 63

Request Index

This field indicates an index identifying the reference BTS by referring to the BTSs listed in the Measure Position Request component (the indicated reference BTS in the Measure Position Request component has the index value 1, and possible next BTS '2', and so on)

This field is conditional and included only if CellIDType is set to '2'.

Range: 1-16

System Info Index

This field indicates an index identifying the reference BTS by referring to the BCCH allocation list (System Information Neighbor List) of the serving BTS .

This field is conditional and included only if CellIDType is set to '3'.

Range: 1-32

A.3.2.3 E-OTD Measurement Information Element

The purpose of the E-OTD Measurement Information element is to provide OTD measurements of signals sent from the reference and neighbor based stations. The length of this element depends on the number of neighbor cells for which OTD measurements have been collected. This element is optional in the Measure Position Response component. It is included in the Measure Position Response component, if the network has requested the mobile to perform the MS assisted E-OTD method. BTSs which cannot be measured or whose measurements are excessively inaccurate need not be reported. The MS may include measurements for other BTSs not given in the assistance data by the SMLC.

The E-OTD and 51 multiframe offset values are reported relative to the reference BTS as defined in the previous sub-clauses.

The following fields are repeated for each measurement set.

Reference Frame Number

This field indicates the frame number of the last measured burst from the reference BTS modulo 42432. This information can be used as a time stamp for the measurements. This field is mandatory.

Range: 0 - 42431

Reference Time Slot

Reference Time Slot indicates the time slot modulo 4 relative to which the MS reports the reference BTS measurements. This field is mandatory.

Range: 0 to 3

NOTE 1: If MS does not know timeslot scheme, the MS reports the used timeslot. MS can only report results based on one time slot (N) or two time slots (N and N+4). If the MS knows the timeslot scheme, it can make measurements from several timeslots and reports that the used timeslot is zero (and makes correction).

Reference Quality

Reference Quality field includes the standard deviation of the TOA measurements from the reference BTS with respect to T_{Ref} (where T_{Ref} is the time of arrival of signal from the reference BTS used to calculate the OTD values). This field is optional. The Reference Quality field can be used to evaluate the reliability of E-OTD measurements in the SMLC and in weighting of the E-OTD values in the location calculation.

Following linear 5 bit encoding is used:

'00000'	0 - (R*1-1) meters;
'00001'	R*1 - (R*2-1) meters;
'00010'	R*2 - (R*3-1) meters;
...	
'11111'	R*31 meters or more.

where R is the resolution defined by Std Resolution field. For example, if R=20 meters, corresponding values are 0 - 19 meters, 20 - 39 meters, 40 - 59 meters, ..., 620+ meters.

Number of Measurements

Number of Measurements for the Reference Quality field is used together with Reference Quality to define quality of the reference base site TOA. The field indicates how many measurements have been used in the MS to define the standard deviation of the measurements. Following 3 bit encoding is used:

'000':	2-4;
'001':	5-9;
'010':	10-14;
'011':	15-24;
'100':	25-34;
'101':	35-44;
'110':	45-54;
'111':	55 or more.

This field is optional.

Std Resolution

Std Resolution field includes the resolution used in Reference Quality field and Std of EOTD Measurements field. Encoding on 2 bits as follows:

'00'	10 meters;
'01'	20 meters;
'10'	30 meters;

'11' Reserved.

This field is mandatory.

TA Correction

This field indicates the estimate of the time difference between the moment that the MS uses to adjust its internal timing for reception and transmission (e.g. corresponding to maximum energy) and the estimate of the reception of the first arriving component from the serving BTS. This value can be used as a correction by the SMLC to the Timing Advance (TA) value when the distance between the MS and the serving BTS is estimated based on TA.

The value *TACor* in this field corresponds to the TA Correction in bit periods as follows:

- TA Correction in bit periods = $TACor/64 - 8$.

TA Correction has the resolution of 1/64 bit period, and the range - 8 ... +7 bit periods. Negative TA Correction in bits indicates that the first signal component from the serving BTS is estimated to arrive before the moment used for communication. This field is optional.

Range: 0-960

Number of Measured Neighbors

This field indicates the number of different neighbor BTSs. This field is mandatory.

Range: 0 - 10

NOTE 2: If the MS can not measure any neighbor BTSs, then this value is set to '0'.

The following fields are repeated for the number of BTSs included in the Number of Measured Neighbors field.

Neighbor Identity Present

The presence of this field is conditional, it shall not be present in the first set. It is mandatory for the other sets. This field indicates whether the identity information (i.e. CellIDType and possibly Neighbor CI / Neighbor BCCH Carrier / Neighbor BSIC / Neighbor Multiframe Offset / Request Index / System Info Index fields) concerning a certain BTS is present or whether the BTS identity is given as reference to the first measurement set.

'0' Identity information not included, and identity of this BTS is same as the identity of BTS in first set with same sequence number.

'1' Identity information is included.

CellIDType

This field indicates is the identity method of the cell. This field is conditional, and included if Neighbor Identity Present is '1'. If CellIDType field is not present, the following fields can not be present either: Neighbor CI, Neighbor BCCH Carrier, Neighbor BSIC, Neighbor Multiframe Offset, Request Index, System Info Index.

'0' = Cell identity is told using BSIC and BCCH carrier.

'1' = Cell identity is told using CI, and the LAC is the same as the current serving BTS.

'2' = Cell identity is told using 51 Multiframe offset and BCCH carrier.

'3' = Cell identity is told using an index referring to the BTS listed in the Measure Position Request component (the indicated reference BTS is 1).

'4' = Cell identity is told using an index referring to the BTS listed in the BCCH allocation list (System Information Neighbor Lists) of the serving BTS. This type of neighbor identity shall not be used by the MS unless it has received the "E-OTD Measurement Assistance Data for System Information List Element" from the SMLC for this cell.

'5' = Cell identity is told using CI and the LAC.

NOTE: The MS can decide which of these methods to use. The CellIDType '3' and '4' are preferred.

Neighbor LAC

This field indicates the Location Area Code of the neighbor BTS. The purpose of the Location Area Code is to identify a location area. This field is conditional, and included, if CellIDType field is '5'.

Range: 0 - 65535

Neighbor CI

This field indicates the Cell Identity of the particular neighbor cell. The purpose of the Cell Identity value is to identify a cell within a location area.

Neighbor CI field is conditional and is included only if CellIDType is set '1' or '5' and the CI value of the given cell is available.

Range: 0 - 65535

Neighbor BCCH Carrier

This field indicates the absolute RF channel number of the BCCH of the neighbor base station. BCCH carrier field is conditional and is included only if CellIDType is set '0' or '2'.

Range: 0 - 1023

Neighbor BSIC

This field indicates the BSIC (Base Station Identity Code of the base station).

BSIC field is conditional and is included only if CellIDType is set '0' or '4'.

Range: 0 - 63

Neighbor Multiframe Offset

This field indicates the frame difference between the start of the 51 multiframe frames arriving from this BTS and the reference BTS. The multiframe offset is defined as $T_{BTS} - T_{Ref}$, where T_{BTS} is the time of the start of the 51 multiframe in the BTS in question, and T_{Ref} is the time of the start of the 51 multiframe in the reference BTS. This field is conditional and included only if CellIDType is set to '2'.

Range: 0 - 51

Request Index

This field indicates an index identifying the reference BTS by referring to the BTSs listed in the Measure Position Request component (the indicated reference BTS in the Measure Position Request component has the index value 1, and possible next BTS '2', and so on).

This field is conditional and included only if CellIDType is set to '3'.

Range: 1-16

System Info Index

This field indicates an index identifying the reference BTS by referring to the BCCH allocation list (System Information Neighbor List) of the serving BTS.

This field is conditional and included only if CellIDType is set to '4'.

Range: 1-32

Neighbor Time Slot

Neighbor Time Slot indicates the time slot modulo 4 relative to which the MS reports the neighbor BTS measurements. This field is mandatory.

Range: 0 to 3

NOTE 3: If the MS does not know the timeslot scheme, the MS reports the used timeslot. MS can only report a result based on one time slot (N) or two time slots (N and N+4). If the MS knows the timeslot scheme, the MS can make measurements from several timeslots and reports that the used timeslot is zero (and makes correction).

Number of EOTD Measurements

Number of Measurements field is used together with Std of EOTD Measurements field to define quality of a reported EOTD measurement. The field indicates how many EOTD measurements have been used in the MS to define the standard deviation of these measurements. Following 3 bit encoding is used.

'000':	2-4;
'001':	5-9;
'010':	10-14;
'011':	15-24;
'100':	25-34;
'101':	35-44;
'110':	45-54;
'111':	55 or more.

This field is mandatory.

Std of EOTD Measurements

Std of EOTD Measurements field includes standard deviation of EOTD measurements. This field is mandatory. It can be used to evaluate the reliability of EOTD measurements in the SMLC and in weighting of the OTD values in location calculation.

Following linear 5 bit encoding is used:

'00000'	0 - (R*1-1) meters;
'00001'	R*1 - (R*2-1) meters;
'00010'	R*2 - (R*3-1) meters;
...	
'11111'	R*31 meters or more.

where R is the resolution defined by Std Resolution field. For example, if R=20 meters, corresponding values are 0 - 19 meters, 20 - 39 meters, 40 - 59 meters, ..., 620+ meters.

OTD

This field indicates the measured OTD value between the receptions of signals from the reference and the neighbor BTS. The OTD is defined as $T_{Nbor} - T_{Ref}$ (modulo burst length) where T_{Nbor} is the time of arrival of signal from the neighbor BTS, and T_{Ref} is the time of arrival of signal from the reference BTS. The reporting resolution of the OTD value is 1/256 bit. This field is mandatory.

Range: 0 - 39999

A.3.2.3a E-OTD Measurement Extended Information Element

The purpose of the E-OTD Measurement Ext Information element is to provide OTD measurements of signals sent from the reference and neighbour base stations. The length of this element depends on the number of neighbour cells for which OTD measurements have been collected. This element is optional in the Measure Position Response component. It is included in the Measure Position Response component, if E-OTD measurements didn't fit in the E-OTD Measurement Information Element.

The E-OTD and 51 multiframe offset values are reported relative to the reference BTS as defined in the previous sub-clauses.

The following fields are valid only for the first set of measurements

Number of Measured Neighbors

This field indicates the number of different neighbor BTSs. This field is mandatory.

Range: 0 - 5

NOTE: If the MS can not measure any neighbor BTSs, then this value is set to '0'.

The following fields are repeated for the number of BTSs included in the Number of Measured Neighbors field. They are defined in the previous sub-clause :

- CellIdType,
- Neighbor LAC,
- Neighbor CI,
- Neighbor BCCH Carrier,
- Neighbor BSIC,
- Neighbor Multiframe Offset,
- Request Index,
- System Info Index,
- Neighbor Time Slot,
- Number of EOTD Measurements,
- Std of EOTD Measurements,
- OTD

A.3.2.4 Location Information Element

The purpose of Location Information element is to provide the location estimate from the MS to the network, if the MS is capable of determining its own position. Optionally, the element may contain the velocity parameters computed by the MS.

This element is optional. This element contains the following fields.

Reference Frame

This field specifies the reference BTS Reference Frame number during which the location estimate was measured. The time of the Reference Frame boundary is as observed by the MS, ie without Timing Advance compensation. This field is mandatory. However, if the Reference Frame number is within (42432..65535), the value of this field shall be ignored and in that case the MS should provide GPS TOW if available.

Table A.3: Reference Frame field contents

Parameter	# of Bits	Resolution	Range	Units
Reference Frame	16	---	0 - 65535	frames

Note that expected values for Reference Frame are in range 0 - 42431.

GPS TOW

This field specifies the GPS TOW for which the location estimate is valid , rounded down to the nearest millisecond unit. This field is optional but shall be included if GPS Time Assistance Measurements are included. If GPS Time Assistance Measurements are included in the RRLP Measure Position Response, the MS shall align GPS System time (as defined by the GPS TOW and the GPS TOW Subms fields) with the reported GSM frame boundary observed by the MS at that time.

Table A.4: GPS TOW field contents

Parameter	# of Bits	Resolution	Range	Units
GPS TOW	24	1 ms	0 - 14399999	ms

The 24 bits of GPS TOW are the least significant bits. The most significant bits shall be derived by the Serving Mobile Location Center to unambiguously derive the GPS TOW.

Fix Type

This field contains an indication as to the type of measurements performed by the MS: 2D or 3D. This field is mandatory.

'0' = 2D fix.

'1' = 3D fix.

Position Estimate

This field contains the calculated position estimate in the format defined in 3GPP TS 23.032. The allowed shapes are:

- ellipsoid Point;
- ellipsoid point with uncertainty circle;
- ellipsoid point with uncertainty ellipse;
- ellipsoid point with altitude and uncertainty ellipsoid.

A.3.2.5 GPS Measurement Information Element

The purpose of the GPS Measurement Information element is to provide GPS measurement information from the MS to the SMLC. This information includes the measurements of code phase and Doppler, which enables the network-based GPS method where position is computed in the SMLC. The proposed contents are shown in table A.5, and the individual fields are described subsequently. See also Figure A.1 for an illustration of the relation between some of the fields.

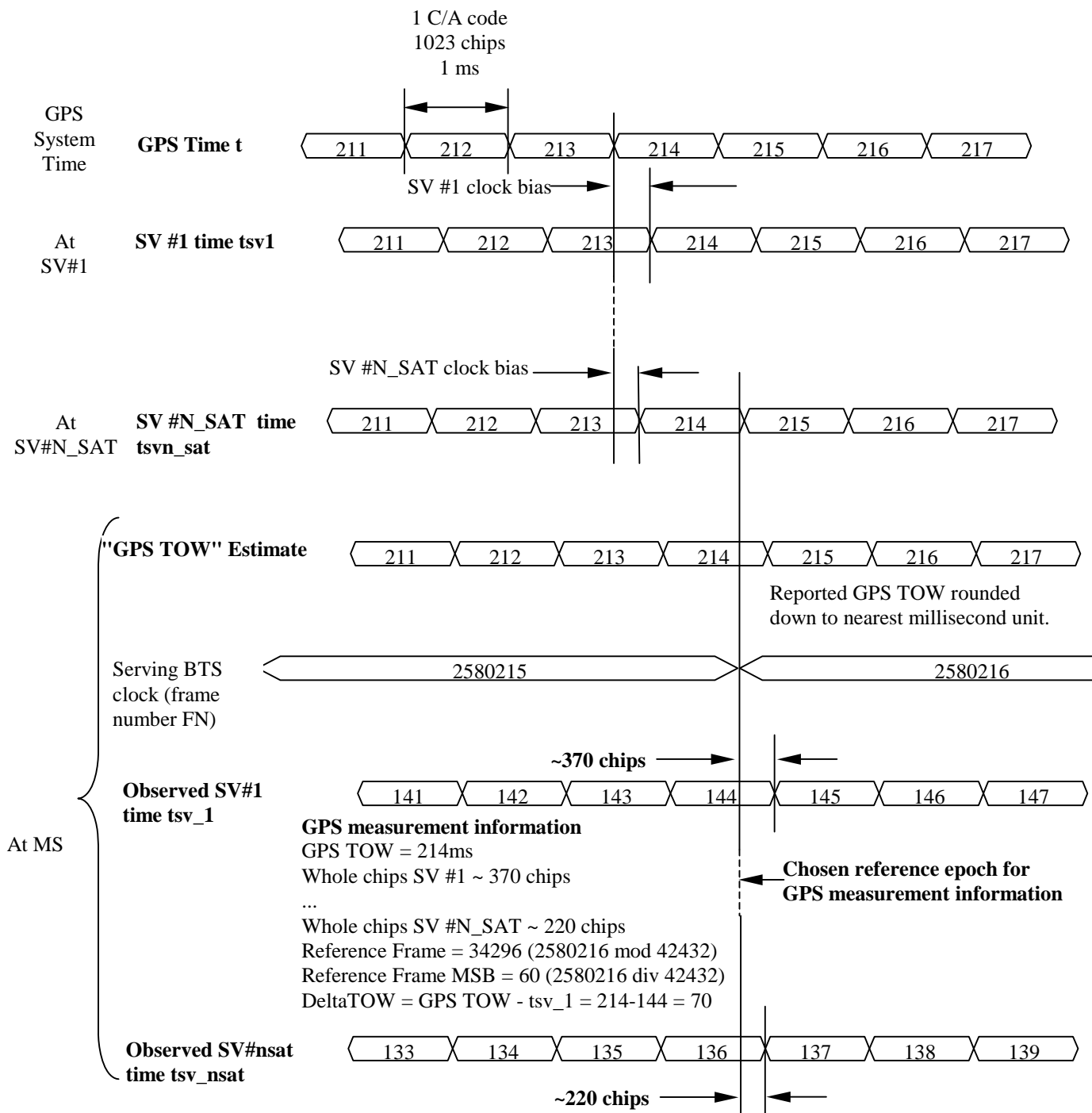


Figure A.1. Exemplary definitions of GPS measurement information fields.

This element is included in the Measure Position Response component if the network has requested the mobile to perform mobile-assisted location measurements using a GPS location method.

Following fields are repeated a number of times told in Number of E-OTD/GPS Measurement *Sets* field if Multiple Sets element is included. If Multiple Sets element is not included, the default value for sets is one (i.e. the following fields are present only once).

Table A.5: GPS Measurement Information element content

Element fields	Presence	Occurrences
Reference Frame	O	1
GPS TOW	M	1
# of Satellites (<i>N_SAT</i>)	M	1
Measurement Parameters	M	<i>N_SAT</i>

The following paragraphs describe the content of each information field of this element.

Reference Frame

This field is optional.

Table A.6: Reference Frame field contents

Parameter	# of Bits	Resolution	Range	Units
Reference Frame	16	---	0 - 65535	frames

Note that expected values for Reference Frame are in range 0 - 42431. If Reference Frame and GPS Time Assistance Measurements both are included in the RRLP Measure Position Response, the code phase measurements shall be aligned with the reported GSM frame boundary observed by the MS at that time, as indicated in Figure A.1. The time of the Reference Frame boundary is as observed by the MS, ie without Timing Advance compensation.

GPS TOW

This field specifies the GPS TOW for which the location estimate is valid, rounded down to the nearest millisecond unit. This field is mandatory.

Table A.7: GPS TOW field contents

Parameter	# of Bits	Resolution	Range	Units
GPS TOW	24	1 ms	0 - 14399999	ms

The 24 bits of GPS TOW are the least significant bits. The most significant bits shall be derived by the Serving Mobile Location Center to unambiguously derive the GPS TOW.

NOTE: The GPS Reference Time Uncertainty, if present, indicates the accuracy of GPSTOW, as described in sub-clause A.3.2.6.a.

of Satellites (*N_SAT*)

Number of Measurements

This field specifies the number of measurements for which measurements satellites are provided in the component. This value represents the number of satellites that were measured by the MS. This value of *N_SAT* determines the length of the payload portion of the component. Typical range for *N_SAT* is four to a maximum of 12. This field is mandatory and occurs once per set.

Table A.7a: # of Satellites field contents

Parameter	# of Bits	Resolution	Range	Units
<i>N_SAT</i>	4	---	1 - 16	---

Measurement Parameters

This field contains information about the measurements of code phase and Doppler, which enables the network-based method where position is computed in the SMLC. This field is mandatory and occurs N_{SAT} times per message.

Table A.8: Measurement Parameters field contents

Parameter	# of Bits	Resolution	Range	Units
Satellite ID	6	---	0 - 63	---
C/N ₀	6	1	0 - 63	dB-Hz
Doppler	16	0.2	±6553.6	Hz
Whole Chips	10	1	0 - 1022	chips
Fractional Chips	11	2 ⁻¹⁰	0 - (1-2 ⁻¹⁰)	chips
Multipath Indicator	2	see Table A.9	TBD	---
Pseudorange RMS Error	6	3 bit mantissa 3 bit exp	0.5 - 112	m

Satellite ID

This field identifies the particular satellite for which the measurement data is valid. This values 0 - 63 represent satellite PRNs 1 - 64, respectively.

C/N₀

This field contains the estimate of the carrier-to-noise ratio of the received signal from the particular satellite used in the measurement. It is given in whole dBs and has a range of 0 to 63. Typical levels observed by MS-based GPS units will be in the range of 20 dB to 50 dB.

Doppler

This field contains the Doppler measured by the MS for the particular satellite signal. This information can be used to compute the 3-D velocity of the MS. The Doppler range is sufficient to cover the potential range of values measured by the MS.

Whole Chips

This field contains the whole value of the code-phase measurement made by the MS for the particular satellite signal at the time of measurement, in units of 1 GPS chip in the range from 0 to 1022 chips, where increasing binary values of the field signify increasing measured pseudoranges. The code phase measurement is divided into two fields, "Whole Chips" and "Fractional Chips".

Fractional Chips

This field contains the fractional value of the code-phase measurement made by the MS for the particular satellite signal at the time of measurement. The resolution of the fractional portion is approximately 0,3 m.

NOTE: The actual ASN.1 coding of this field reserves 11 bits for legacy compatibility. Only the 10 least significant bits are actually required to code the values (0..1023)

Multipath Indicator

This field contains the Multipath Indicator value. This parameter is specified according to the representation described in table A.9.

Table A.9: Multipath Indicator values and associated indications

Value	Multipath Indication
00	Not measured
01	Low, MP error < 5m
10	Medium, 5m < MP error < 43m
11	High, MP error > 43m

Range: 0 - 3

Pseudorange RMS Error

This field contains a Pseudorange RMS Error value.

Range: 0,5 m to 112 m

NOTE: This parameter is specified according to a floating-point representation as described in Table A.10.

Table A.10: Pseudorange RMS Error 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	$0.5 \leq P < 0.5625$
l	x	y	$0.5 * (1 + x/8) * 2^y$	$x_{i-1} \leq P < x_i$
62	110	111	112	$104 \leq P < 112$
63	111	111	--	$112 \leq P$

A.3.2.6 Location Information Error Element

The purpose of Location Information Error element is to provide the indication of error and the reason for it, when the MS can not perform the required location or the network can not determine the position estimate. The element may also indicate what further assistance data may be needed by the target MS to produce a successful location estimate or location measurements. This element is optional. This element has the following fields.

Error Reason

This field indicates the reason for error. This field is mandatory.

'0':	Undefined error.
'1':	There were not enough BTSs to be received when performing mobile based E-OTD.
'2':	There were not enough GPS satellites to be received, when performing GPS location.
'3':	E-OTD location calculation assistance data missing.
'4':	E-OTD assistance data missing.
'5':	GPS location calculation assistance data missing.
'6':	GPS assistance data missing.
'7':	Requested method not supported.
'8':	Location request not processed.
'9':	Reference BTS for GPS is not the serving BTS.
'10':	Reference BTS for E-OTD is not the serving BTS.
'11':	There were not enough GANSS satellites received, when performing GANSS location.
'12':	GANSS assistance data missing.
'13':	Reference BTS for GANSS is not the serving BTS.

Additional Assistance Data

This field is optional. Its presence indicates that the target MS will retain assistance data already sent by the SMLC. The SMLC may send further assistance data for any new location attempt but need not resend previous assistance data. The field may contain the following:

GPS Assistance Data: Necessary additional GPS assistance data (structure and encoding as for the GPS Assistance Data IE in 3GPP TS 49.031 excluding the IEI and length octets)

GANSS Assistance Data: Necessary additional GANSS assistance data (structure and encoding as for the GANSS Assistance Data IE in 3GPP TS 49.031 excluding the IEI and length octets)

A.3.2.6a GPS Time Assistance Measurements Element

This IE contains measurements that are used to define an accurate relation between GSM and GPS time or to provide additional GPS TOW information for MS Assisted A-GPS. The contents are shown in Table A.10a, and the individual fields are described subsequently.

Table A.10a: GPS Time Assistance Measurements Information element content

Element fields	Presence
Reference Frame MSB	O
GPS TOW Subms	O
Delta TOW	O
GPS Reference Time Uncertainty	O

Reference Frame MSB

This field shall be included when GPS-GSM time association is provided for either MS Based A-GPS or MS Assisted A-GPS. It indicates the Most Significant Bits (MSBs) of the frame number of the reference BTS corresponding to the GPS measurement or location estimate. Starting from the complete GSM frame number denoted FN, the MS calculates Reference Frame MSB as

$$\text{Reference Frame MSB} = \text{floor}(\text{FN}/42432)$$

The complete GSM frame number FN can then be reconstructed in the SMLC by combining the fields Reference Frame with Reference Frame MSB in the following way

$$\text{FN} = \text{Reference Frame MSB} * 42432 + \text{Reference Frame}$$

Range: 0-63

GPS TOW Subms

This field is only applicable for MS-Based A-GPS. This field indicates in units of 100ns the submillisecond part of the GPS time of measurement. This field together with the GPS TOW field in the Location Information Element provides a more accurate time stamp of the location estimate for MS based AGPS Expressed in units of microseconds. The precise GPS time of measurements in milliseconds is thus equal to

$$\text{GPS TOW} + 0.0001 * \text{GPS TOW Subms}$$

The estimation of precise GPS time of measurement using AGPS is vulnerable to millisecond ambiguities. Therefore the MS shall only report this field when it is confident that any millisecond ambiguities have been avoided.

Range: 0-9999

Delta TOW

This field is only applicable for MS-Assisted A-GPS. This field specifies the difference in milliseconds between the GPS TOW reported in the GPS Measurement Information Element and the millisecond part of the SV time tsv_1 of the first SV in the list reported from the MS. Figure A.1 shows an example of Delta TOW calculation. The Delta TOW is defined as $\text{Delta TOW} = \text{GPS TOW} - \text{fix}(\text{tsv}_1)$

where fix() denotes rounding to the nearest integer towards zero. The estimation of tsv_1 which forms the basis for the calculation of Delta TOW is vulnerable to millisecond ambiguities. Therefore the MS shall only report this field when it is confident that the correct millisecond event has been recovered.

Range: 0-127

GPS Reference Time Uncertainty

This element is optional. It provides the accuracy of the relation GPS and GSM time in the Location Information or GPS Measurement Information Element when GPS-GSM time association is provided. For MS Assisted A-GPS when GPS-GSM time association is not provided, even if GPS Time Assistance Measurement Request is not included in the Measure Position Request, this element can be included to provide the accuracy of the reported GPS TOW. The interval, range and treatment is as described in sub-clause 2.2.4b.

A.3.2.6b Velocity Estimate Element

This field contains the calculated velocity estimate in the format defined in 3GPP TS 23.032. The allowed encodings are:

- Horizontal Velocity

- Horizontal with Vertical Velocity
- Horizontal Velocity with uncertainty
- Horizontal with Vertical Velocity and uncertainty

A.3.2.7 Extended Reference IE

This IE shall be included in any Measure Position Response if and only if an Extended Reference IE was received in the corresponding previous Measure Position Request message.

NOTE: For reasons of backward compatibility, a Release 4 or earlier MS will not include this IE.

The Extended Reference IE contains the following elements.

SMLC code: an integer in the range 0-63. The value returned by a target MS in a Measure Position Response shall equal the value received from the SMLC in the earlier Measure Position Request.

Transaction ID: an integer in the range 0-262143 distinguishing different RRLP transactions in different MSs currently being served by the same SMLC. The value returned by a target MS in a Measure Position Response shall equal the value received from the SMLC in the earlier Measure Position Request.

When an MS employs pseudo-segmentation to return an RRLP response, the same Extended Reference IE shall be included in each RRLP Measure Position Response component.

A.3.2.8 Uplink RRLP Pseudo Segmentation Indication

This element is included by the MS when up-link RRLP pseudo-segmentation is used. In the first segment, 'first of many' is indicated and in the second 'second of many' is indicated. It is not included when up-link pseudo-segmentation is not used.

A.3.2.9 GANSS Location Information Element

The purpose of GANSS Location Information element is to provide the GANSS location estimate from the MS to the SMLC, if the MS is capable of determining its own position. Optionally, the element may contain Reference Frame element for including accurate relation between the cellular frame and GANSS Time of Day (TOD) for the serving cell if requested by the SMLC.

If GANSS Positioning Method was included in a Measure Position Request component, this field shall be used to report the location estimate from the MS to the network.

The time reference of GANSS TOD in GANSS Location Information Element can be any GNSS specific system time. The time reference is indicated by GANSS_TIME_ID.

The contents of GANSS Location Information are shown in Table A.10.1, and the individual fields are described subsequently.

Table A.10.1: GANSS Location Information Element Content

Element fields	Presence
Reference Frame	O (note 1)
GANSS TOD	O (note 1)
GANSS TOD Frac	O
GANSS TOD Uncertainty	O
GANSS_TIME_ID	O (note 2)
Fix Type	M
Position Data	M
Stationary Indication	O
Location Estimate	M
NOTE 1: Either Reference Frame or GANSS Reference Time shall always be included.	
NOTE 2: Absence of this field means Galileo	

Reference Frame

This element contains Reference FN and Reference FN MSB fields. Reference FN field specifies the reference BTS reference frame number during which the location estimate was measured. The time of the reference frame boundary is as observed by the MS, i.e. without Timing Advance compensation.

Note that expected values for Reference FN are in range 0 - 42431.

Reference FN MSB field specifies the Most Significant Bits (MSB) of the frame number of the reference BTS corresponding to the GANSS Measurement Information or Location Estimate. Starting from the complete GSM frame number denoted FN, the MS calculates Reference FN MSB as

$$\text{Reference FN MSB} = \text{floor}(\text{FN}/42432)$$

The complete GSM frame number FN can then be reconstructed in the SMLC by combining the fields Reference Frame with Reference FN MSB in the following way

$$\text{FN} = \text{Reference FN MSB} * 42432 + \text{Reference FN}$$

Range: 0-63

Table A.10.2: Reference Frame field contents

Parameter	# of Bits	Resolution	Range	Unit	Incl.
Reference FN	16	---	0 - 65535	frame	M
Reference FN MSB	6	---	0 - 63	frame	O

GANSS TOD

This field specifies the time for which the location estimate is valid, rounded down to the nearest integer millisecond. This field is optional but shall be included if GANSS TOD - GSM time association is included in which case the MS shall align GANSS TOD with the reported GSM frame boundary observed by the MS at that time. The time reference of GANSS TOD is indicated by GANSS_TIME_ID.

Table A.10.3: GANSS TOD contents

Parameter	# of Bits	Resolution	Range	Unit
GANSS TOD	22	1	0 - 3599999	ms

The 22 bits of GANSS TOD are the least significant bits. The most significant bits shall be derived by the SMLC to unambiguously derive the GANSS TOD.

GANSS TOD Frac

This field is the submillisecond part of the GANSS time of day. This field together with the GANSS TOD field provides a more accurate time stamp of the Location Estimate having resolution of ~61 ns. This field is optional but shall be included if GANSS TOD - GSM time association is included.

Table A.10.4: GANSS TOD Frac contents

Parameter	# of Bits	Resolution	Range	Unit
GANSS_TOD_Frac	14	2^{-14}	0 - $(1-2^{-14})$	ms

GANSS TOD Uncertainty

This parameter provides the accuracy of the relation between GANSS TOD and GSM time if GANSS TOD- GSM time association is provided. When GANSS TOD-GSM time association is not provided, this element can be included to provide the accuracy of the reported GANSS TOD.

The uncertainty r , expressed in microseconds, is mapped to a number K , with the following formula:

$$r = C * (((1+x)^K) - 1)$$

with $C = 0.0022$ and $x = 0.18$. With $0 \leq K \leq 127$, a suitably useful range between 0 and 3 second is achieved for the uncertainty, while still being able to code down to values as small as 0.3 nanoseconds. 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 .

Table A.10.5: Example values for the GANSS TOD Uncertainty Parameter Format

Value of K	Value of uncertainty
0	0 nanoseconds
1	0.396 nanoseconds
2	0.863 nanoseconds
-	-
50	8.64 microseconds
-	-
127	≥ 2.96 seconds

GANSS_TIME_ID

This field indicates which GNSS has been used as the time reference for GANSS Location Information. This field is optional and absence of this field means that Galileo system time is used as time reference.

Table A.10.6: GANSS_TIME_ID

GANSS_TIME_ID	Indication
GPS	0
QZSS	1
GLONASS	2
Reserved for future use	3-7

Fix Type

This field contains an indication as to the type of measurements performed by the MS: 2D or 3D. This field is mandatory.

'0' = 2D fix.

'1' = 3D fix.

Position Data

This element provides a list of positioning methods and satellite systems used to calculate the Position Estimate. Each bit of this bitmap is of type Boolean, where TRUE ('1') means the particular positioning method or signal(s) from a satellite system has been used.

'bit 0': E-OTD;
 'bit 1': GPS;
 'bit 2': Galileo;
 'bit 3': SBAS;
 'bit 4': Modernized GPS;
 'bit 5': QZSS;
 'bit 6': GLONASS;
 'bit 7-15': Reserved.

Stationary Indication

This field indicates whether the MS is stationary (horizontal and vertical speeds less than the resolution of the Velocity Estimate parameters as defined in 3GPP TS 23.032).

If Velocity Estimate is requested and the MS is stationary, then the Stationary Indication is set to '1' and Velocity Estimate may not be included in Measure Position Response Element.

Position Estimate

This field contains the calculated position estimate in the format defined in 3GPP TS 23.032. The allowed shapes are:

- ellipsoid Point;
- ellipsoid point with uncertainty circle;
- ellipsoid point with uncertainty ellipse;
- ellipsoid point with altitude and uncertainty ellipsoid.

As defined in 3GPP TS 23.032, the position estimate is provided in WGS-84 reference system.

A.3.2.10 GANSS Measurement Information Element

The purpose of the GANSS Measurement Information element is to provide GANSS measurement information from the MS to the SMLC and GANSS TOD - GSM time association if requested by the SMLC. This information includes the measurements of code phase, Doppler, C/N_0 and optionally accumulated carrier phase, also called accumulated deltarange (ADR), which enable the network-based GANSS method where position is computed in the SMLC. The contents are shown in table A.10.7, and the individual fields are described subsequently. See also Figure A.1a for an illustration of the relation between some of the fields.

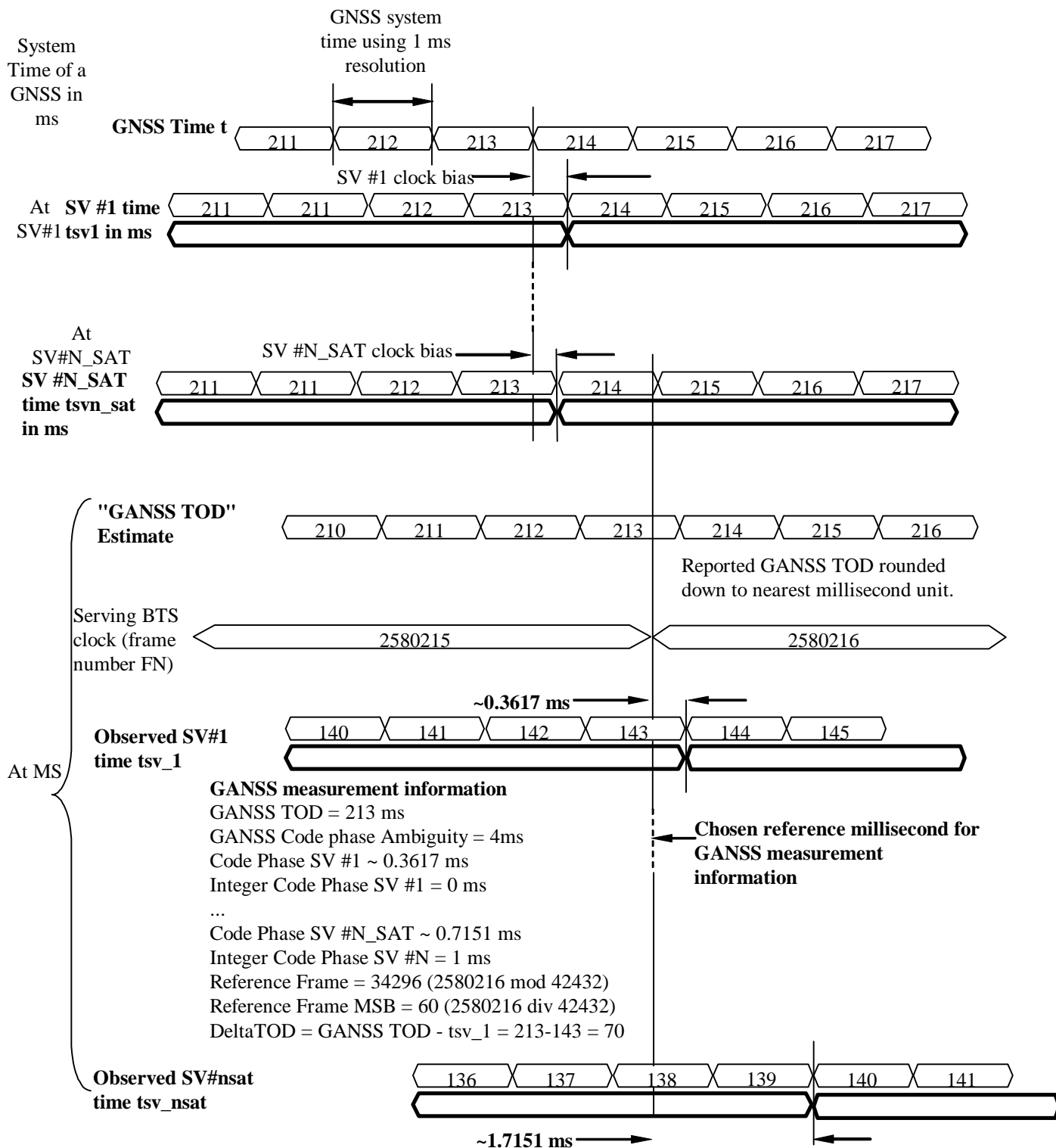


Figure A.1a. Exemplary definitions of GANSS measurement information fields.

GANSS Measurement Information element is included in the Measure Position Response component if the network has requested the mobile to perform mobile-assisted location measurements using GANSS Positioning Method. GANSS Measurement Information element will also optionally include carrier phase measurements if SMLC has requested the MS to perform carrier phase measurements.

The following fields are repeated the number of times indicated in Number of E-OTD/GPS/GANSS Measurement Sets field if Multiple Sets element is included. If Multiple Sets element is not included, the default value for sets is one (i.e. the following fields are present only once).

Table A.10.7: GANSS Measurement Information element content

Element fields	Presence	Occurrences
Reference Frame	O	1
GANSS TOD	O (note 1)	1
DeltaTOD	O	1
GANSS TOD Uncertainty	O	1
GANSS Generic Measurement Information	M	N_GANSS
NOTE 1: If GPS Measurement Information element is not included in a Measure Position Response component, this field shall be present.		

The following paragraphs describe the content of each information field of this element.

Reference Frame

These fields are shown in Table A.10.8 and are optional, but shall be included when GANSS TOD- GSM time association is provided.

Note that expected values for Reference FN are in range 0 - 42431. The time of the reference frame boundary is as observed by the MS, ie without Timing Advance compensation.

Reference FN MSB field indicates the Most Significant Bits (MSB) of the frame number of the reference BTS corresponding to the GANSS Measurement Information.

Starting from the complete GSM frame number denoted FN, the MS calculates Reference FN MSB as

$$\text{Reference FN MSB} = \text{floor}(\text{FN}/42432)$$

The complete GSM frame number FN can then be reconstructed in the SMLC by combining the fields Reference Frame with Reference FN MSB in the following way

$$\text{FN} = \text{Reference FN MSB} * 42432 + \text{Reference FN}$$

Table A.10.8: Reference Frame field contents

Parameter	# of Bits	Resolution	Range	Unit
Reference FN	16	---	0 - 65535	frame
Reference FN MSB	6	---	0 - 63	frame

GANSS TOD

This field specifies the GANSS TOD for which the GANSS Measurement Parameters in GANSS Generic Measurement Information Element are valid. This field shall be included when GANSS TOD-GSM time association is provided or if GPS Measurement Information element is not present in a Measure Position Response component. If GPS Measurement Information element is present in a Measure Position Response component, and GANSS TOD field is absent in the GANSS Measurement Information element, the GPS TOW included in the GPS Measurement Information element specifies the reference time for which the GANSS Measurement Parameters are valid.

The 22 bits of GANSS TOD are the least significant bits. The most significant bits shall be derived by the Serving Mobile Location Centre to unambiguously derive the GANSS TOD.

The value for GANSS TOD is derived from the GNSS specific system time of the GNSS reported first in the GANSS Measurement IE rounded down to the nearest millisecond unit.

Table A.10.9: GANSS TOD field contents

Parameter	# of Bits	Resolution	Range	Units
GANSS TOD	22	1 ms	0 - 3599999	ms

DeltaTOD

This field specifies the difference in milliseconds between GANSS TOD reported in the GANSS Measurement Information Element and the millisecond part of the SV time *tsv_1* of the first SV in the list reported from the MS. The DeltaTOD is defined as

$$\text{DeltaTOD} = \text{GANSS TOD} - \text{fix}(\text{tsv}_1)$$

where *fix()* denotes rounding to the nearest integer towards zero.

Range: 0-127

GANSS TOD Uncertainty

This element provides the accuracy of the relation GANSS TOD -GSM time when GANSS TOD-GSM time association is provided. When GANSS TOD-GSM time association is not provided, even if GANSS TOD - GSM Time Association Measurement Request is not included in the Measure Position Request, this element can be included to provide the accuracy of the reported GANSS TOD.

If GANSS TOD is the given GNSS time, then the true GNSS time, corresponding to the provided GSM time as observed at the MS location, lies in the interval (GANSS TOD – GANSS TOD Uncertainty, GANSS TOD + GANSS TOD Uncertainty).

The uncertainty *r*, expressed in microseconds, is mapped to a number K, with the following formula:

$$r = C * (((1+x)^K) - 1)$$

with *C* = 0.0022 and *x* = 0.18. With $0 \leq K \leq 127$, a suitably useful range between 0 and 3 second is achieved for the uncertainty, while still being able to code down to values as small as 0.3 nanoseconds. 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 GANSS TOD Uncertainty value are shown in Table A.10.10.

Table A.10.10: Example values for the GANSS TOD-GSM Time Uncertainty Parameter Format

Value of K	Value of uncertainty
0	0 nanoseconds
1	0.396 nanoseconds
2	0.863 nanoseconds
-	-
50	8.64 microseconds
-	-
127	≥ 2.96 seconds

N_GANSS, Number of GANSS Generic Measurement Information Elements

N_GANSS specifies the number of GANSS Generic Measurement Information Element occurrences in GANSS Measurement Information element, one occurrence for each reported GANSS. The range is from 1 to 8.

A.3.2.10.1 GANSS Generic Measurement Information Element

Table A.10.11: GANSS Generic Measurement Information

Element fields	Presence	Occurrences
GANSS ID	O (note 1)	1
GANSS Generic Measurement Element	M	N_SGN_TYPE
Note 1: Absence of this field means Galileo.		

GANSS ID

GANSS ID field identifies the GNSS constellation on which GANSS Measurement Parameters were measured according to Table A.40.

Range: 0 – 7

N_SGN_TYPE, Number of GANSS Generic Measurement Elements

N_SGN_TYPE specifies the number of GANSS Generic Measurement Element occurrences in GANSS Generic Measurement Information element. The range for N_SGN_TYPE is from 1 to 8.

Table A.10.12: GANSS Generic Measurement Element contents

Element fields	Presence	Occurrences
GANSS Signal ID	M	1
GANSS Code Phase Ambiguity	O	1
GANSS Measurement Parameters	M	N_SGN

This element contains measurement information for one GNSS signal type indicated by GANSS Signal ID.

GANSS Signal ID

GANSS Signal ID field identifies the signal on which GANSS Measurement Parameters were measured. The supported signals are listed in Table A.59.

Range: 0 - 7

GANSS Code Phase Ambiguity

The GANSS Code Phase Ambiguity field gives the ambiguity of the code phase measurement. It is given in ms and is an integer between 0 and 127.

The Total Code Phase for a satellite *k* (Satk) is given modulo this GANSS Code Phase Ambiguity and is reconstructed with :

$$\text{Code_Phase_Tot(Satk)} = \text{Code_Phase (Satk)} + \text{Integer Code Phase(Satk)} + n * \text{Code Phase Ambiguity}, n= 0,1,2,\dots$$

If there is no code phase ambiguity, the GANSS Code Phase Ambiguity shall be set to 0.

The field is optional. If GANSS Code Phase Ambiguity is absent, the default value is 0.

N_SGN, Number of Signal Measurements

N_SGN specifies the number of GANSS Measurement Parameters element occurrence in GANSS Generic Measurement Information element. Typical range for N_SGN is 4 to a maximum of 16.

GANSS Measurement Parameters

This field contains information about the measurements of code phase and Doppler, which enables the network-based method where position is computed in the SMLC. This field is mandatory and occurs N_SGN times in GANSS Generic Measurement Information element.

Table A.10.13: GANSS Measurement Parameters field contents

Parameter	# of Bits	Resolution	Range	Units	Incl.
Signal Quality Parameters					
SV ID	6	---	-	---	M
C/N ₀	6	1	0 - 63	dB-Hz	M
Multipath Indicator	2	---	See Table A.9	---	M
Carrier Quality Indication	2	---	---	---	O ⁽¹⁾
Code Phase Measurements					
Code Phase	21	2 ⁻²¹	0 - (1-2 ⁻²¹)	ms	M
Integer Code Phase	7	1	0 - 127	ms	O
Code Phase RMS Error	6	3 bit mantissa 3 bit exp	0.5 - 112	m	M
Doppler Frequency Measurements					
Doppler	16	0.04	±1310.7	m/s	O
ADR	25	2 ⁻¹⁰	0 - 32767.5	m	O ⁽¹⁾
NOTE 1: All of these fields shall be present together, or none of them shall be present.					

SV ID

The SV ID is an index number for a satellite within a satellite system. The SV ID value range starts from 0 for each satellite system. The interpretation of SV ID for each GANSS is defined in Table A.10.14.

Table A.10.14: Interpretation of SV ID

System	Value of SV ID	Interpretation of SV ID
Galileo	TBD	TBD
Modernized GPS	'0' – '62' '63'	Satellite PRN Signal No. 1 to 63 Reserved
SBAS	'0' – '38' '39' – '63'	Satellite PRN Signal No. 120 to 158 Reserved
QZSS	'0' – '4' '5' – '63'	Satellite PRN Signal No. 193 to 197 Reserved
GLONASS	'0' – '23' '24' – '63'	Slot Number 1 to 24 Reserved

C/N₀

This field contains the estimate of the carrier-to-noise ratio of the received signal from the particular satellite. It is given in whole dB-Hz and has a range of 0 to 63. Typical levels observed by GNSS receivers will be in the range of 16 dB-Hz to 50 dB-Hz.

Carrier Quality Indication

This field indicates the quality of a carrier phase measurement as a bit field. 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 and shall be included only when carrier phase measurements are requested.

Table A.10.16: Carrier Phase Quality Indication values and associated indications

Bit	Polarity Indication
'0'	Data Direct
'1'	Data Inverted
'0X'	Carrier phase not continuous
'1X'	Carrier phase continuous
X = do not care	

Code Phase

This field contains the whole and fractional value of the code-phase measurement made by the MS 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 (e.g. Galileo L1 OS measurement is divided by 1023.0 chip/ms).

Integer Code Phase

This field indicates the integer millisecond part of the code phase that is expressed modulo the GANSS Code PhaseAmbiguity.

The value of the ambiguity is given in the GANSS Ambiguity field of the GANSS Generic Measurement Information element.

The Integer code phase is optional. The default value is 0.

Code Phase RMS Error

This field contains Code Phase RMS Error value. This parameter has the same range as described in Table A.10.

Doppler

This field contains the Doppler measured by the MS for the particular satellite signal. This information can be used to compute the 3-D velocity of the MS.

The Doppler range is sufficient to cover the potential range of values measured by the MS. Doppler measurements are converted into unit of m/s by multiplying the Doppler measurement in Hz by the *nominal* wavelength of the measured signal.

ADR

This field contains the ADR measurement measured by the MS for the particular satellite signal. This information can be used to compute the 3-D velocity or high-accuracy position of the MS. ADR measurements are converted into units of m by multiplying the ADR measurement by the *nominal* wavelength of the measured signal.

This field is optional and shall be included only when carrier phase measurements are requested.

A.4 Assistance Data

A.4.1 General

The Assistance Data is a RRLP component from the network to the MS. It is used by the network to provide assistance data to enable MS-based E-OTD or MS-based Assisted GPS capabilities in the MS and may be used to help support MS-assisted E-OTD and MS-assisted Assisted GPS. It contains the following elements.

Table A.11: Assistance Data component content

Element	Type/Reference	Presence
E-OTD Reference BTS for Assistance Data	E-OTD Reference BTS for Assistance Data 2.2.3	C
E-OTD Measurement Assistance Data	E-OTD Measurement Assistance Data 2.2.4	C
E-OTD Measurement Assistance Data for System Information List	E-OTD Measurement Assistance Data for System Information List 2.2.5	C
GPS Assistance Data	GPS Assistance Data 4.2.4	C
Additional GPS Assistance Data	Additional GPS Assistance Data 4.2.4c	O
GPS Time Assistance Measurement Request	GPS Time Assistance Measurement Request 4.2.4a	O
GPS Reference Time Uncertainty	GPS Reference Time Uncertainty 4.2.4b	O
More Assistance Data To Be Sent	More Assistance Data To Be Sent 4.2.5	C
Extended Reference	Extended Reference 2.2.5	C
GANSS Assistance Data	GANSS Assistance Data 4.2.6	C
GANSS Carrier-Phase Measurement Request	GANSS Carrier-Phase Measurement Request 4.2.7	O
GANSS TOD - GSM Time Association Request	GANSS TOD - GSM Time Association Request 4.2.8	O

A.4.2 Elements

A.4.2.1 E-OTD Reference BTS for Assistance Data Element

This element is conditional. It is as described in sub-clause 2.2.3. If the network can provide assistance data, and data for E-OTD has been requested, this element is included.

A.4.2.2 E-OTD Measurement Assistance Data Element

This element is conditional. It is as described in sub-clause 2.2.4. If the network can provide assistance data, and data for E-OTD has been requested, this element is included.

A.4.2.3 E-OTD Measurement Assistance Data for System Information List Element

This element is conditional. It is as described in sub-clause 2.2.5. If the network can provide assistance data, and data for E-OTD has been requested, this element is included.

A.4.2.4 GPS Assistance Data Element

The GPS Assistance Data element contains a single GPS assistance message that supports both MS-assisted and MS-based GPS methods. This element can contain one or more of the fields listed in table A.12 below, which support both MS-assisted and MS-based GPS methods. As table A.12 shows, all fields are optional.

Note that certain types of GPS Assistance data may be derived, wholly or partially, from other types of GPS Assistance data.

In addition, an Integrity Monitor (IM) shall detect unhealthy (e.g., failed/failing) satellites and also shall inform users of measurement quality in DGPS modes when satellites are healthy. Excessively large pseudo range errors, as evidenced by the magnitude of the corresponding DGPS correction, shall be used to detect failed satellites. Unhealthy satellites should be detected within 10 seconds of the occurrence of the satellite failure. When unhealthy (e.g., failed/failing) satellites are detected, the assistance and/or DGPS correction data shall not be supplied for these satellites. When the error in the IM computed position is excessive for solutions based upon healthy satellites only, DGPS users shall be informed of measurement quality through the supplied UDRE values. After bad satellites have been indicated in the Real Time Integrity field, if the satellites return to healthy condition for some period of time, the indications for them shall be removed from this field.

Table A.12: Fields in the GPS Assistance Data element

Parameter	Presence	Repetition
Reference Time	O	Yes
Reference Location	O	No
DGPS Corrections	O	Yes
Navigation Model	O	Yes
Ionospheric Model	O	No
UTC Model	O	No
Almanac	O	Yes
Acquisition Assistance	O	Yes
Real-Time Integrity	O	Yes

When RRLP pseudo-segmentation is used, Table A.12 indicates which parameters may be repeated in more than one RRLP segment in order to provide data for multiple satellites. When any such parameter appears in more than one segment, the following rules shall apply.

1. There shall be no repetition of data for the same satellite.
2. Optional and conditional elements in the parameter not associated with a particular satellite shall each appear in at most one RRLP segment.
3. Any mandatory element not associated with a particular satellite shall assume consistent values in the case of an element related to current GPS time and the same value otherwise.
4. The maximum number of satellites defined in sub-clause 5.1 for which data can be included for any parameter in one RRLP segment shall apply also when counted over all RRLP segments.

Reference Time

These fields specify the relationship between GPS time and air-interface timing of the BTS transmission in the reference cell. These fields occur once per message; some are mandatory and some are conditional, as shown in table A.14. Note that Reference Time may also be present within the Acquisition Assistance parameter. In such a case, the SMLC shall ensure consistency.

Table A.14: Reference Time (Fields occurring once per message)

Parameter	# Bits	Scale Factor	Range	Units	Incl.
GPS Week	10	1	0 - 1023	weeks	M
GPS TOW	23	0.08	0-604799.92	sec	M
BCCH Carrier	10	1	0 - 1023	---	O (note 1)
BSIC	6	1	0 - 63	---	O (note 1)
FNm	21	1	0 - (2 ²¹ -1)	frames	O (note 1)
TN	3	1	0 - 7	timeslots	O (note 1)
BN	8	1	0 - 156	bits	O (note 1)
GPS TOW Assist	24*N_SAT	---	----	---	O

NOTE 1: All of these fields shall be present together, or none of them shall be present.

GPS Week

This field specifies the GPS week number of the assistance being provided. GPS Week eliminates one-week ambiguities from the time of the GPS assistance. This field is mandatory.

GPS TOW

The GPS TOW (time-of-week) is a mandatory field and is specified with 80 msec resolution. When GSM Time Present is "1", GPS TOW and BCCH/BSIC/FNm/TN/BN IEs provide a valid relationship between GPS and GSM time, as seen at the approximate location of the MS, ie the propagation delay from BTS to MS shall be compensated for by the SMLC. Depending on implementation, the relation between GPS and GSM time may have varying accuracy. Therefore, the uncertainty of the timing relation may be provided in the optional field GPS Reference Time Uncertainty. If the propagation delay from BTS to MS is not accurately known, the SMLC shall use the best available approximation of the propagation delay and take the corresponding delay uncertainty into account in the calculation of the field GPS Reference Time Uncertainty. When GSM Time Present is "0", GPS TOW is an estimate of current GPS time of week at

time of reception of the RRLP segment containing this data by the MS. The SMLC should achieve an accuracy of +/- 3 seconds for this estimate including allowing for the transmission delay between SMLC and MS of the RRLP segment containing GPS TOW. Note that the MS should further compensate GPS TOW for the time between the reception of the segment containing GPS TOW and the time when the GPS TOW field is used.

BCCH Carrier/BSIC/FNm/TN/BN

These fields specify the state of the GSM frame number, timeslot number, and bit number, respectively, of the reference BTS with the specified BCCH carrier and BSIC at the time that correspond to GPS TOW. The SMLC shall use the current serving BTS as the reference BTS. The frame number field is given modulo 2^{21} , i.e., the MSB of the GSM frame number is truncated. The MS shall interpret FNm as the most recent of the two possible frame numbers that FNm could represent. The target MS has the option of rejecting a GPS position request or GPS assistance data if the reference BTS is not the serving BTS.

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 MS to know the entire 1.2-second (60-bit) pattern of TLM and HOW that is transmitted at the start of each six-second subframe by the particular GPS satellite. This field contains information for each of N_SAT satellites, and optional. The individual fields for each satellite in the message are shown in table A.15a.

Table A.15a: GPS TOW Assist (Fields occurring N_SAT times per message)

Parameter	# Bits	Scale Factor	Range	Units	Incl.
SatID	6	---	0 - 63	---	M
TLM Message	14	---	0 - 16383	Bit field	M
Anti-Spoof	1	1	0 - 1	Bit field	M
Alert	1	1	0 - 1	Bit field	M
TLM Reserved	2	---	0 - 3	Bit field	M

SatID

This field identifies the satellite for which the corrections are applicable. The values ranging from 0 to 63 represent satellite PRNs ranging from 1 to 64, respectively.

TLM Message

This field contains a 14-bit value representing the Telemetry Message (TLM) being broadcast by the GPS satellite identified by the particular SatID, with the MSB occurring first in the satellite transmission.

Anti-Spoof/Alert

These fields contain the Anti-Spoof and Alert flags that are being broadcast by the GPS satellite identified by SatID.

TLM Reserved

These fields contain the two reserved bits in the TLM Word being broadcast by the GPS satellite identified by SatID, with the MSB occurring first in the satellite transmission.

Reference Location

The Reference Location field contains a 3-D location (with uncertainty) specified as per 3GPP TS 23.032. The purpose of this field is to provide the MS with a priori knowledge of its location in order to improve GPS receiver performance. The allowed shape is 3-D location with uncertainty (ellipsoid point with altitude and uncertainty ellipsoid).

DGPS Corrections

These fields specify the DGPS corrections to be used by the MS. All fields are mandatory when DGPS Corrections are present in the GPS Assistance Data.

Table A.15: DGPS Corrections

Parameter	# Bits	Scale Factor	Range	Units	Incl.
The following fields occur once per message					
GPS TOW	20	1	0 - 604799	sec	M
Status/Health	3	1	0-7	---	M
N_SAT	4	1	1-16	---	M
The following fields occur once per satellite (N_SAT times)					
SatID	6	---	0 - 63	---	M
IODE	8	---	0 - 255	---	M
UDRE	2	---	0 - 3	---	M
PRC	12	0.32	±655.04	meters	M
RRC	8	0.032	±4.064	meters/sec	M
Delta PRC2	8	---	---	---	M
Delta RRC2	4	---	---	---	M
Delta PRC3	8	---	---	---	M
Delta RRC3	4	---	---	---	M

GPS TOW

This field indicates the baseline time for which the corrections are valid.

Status/Health

This field indicates the status of the differential corrections contained in the broadcast message. The values of this field and their respective meanings are shown below in table A.16.

Table A.16: Values of Status/Health IE

Code	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

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 message. 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 DGPS network) is currently not being monitored. The value "111" indicates that the corrections provided by the source are invalid, as judged by the source. In the later case, the message shall contain no corrections for individual satellites. Any MS that receives DGPS Corrections in a GPS Assistance Data IE shall contain the appropriate logic to properly interpret this condition and look for the next IE.

N_SAT

This field indicates the number of satellites for which differential corrections are available. Corrections for up to 16 satellites.

SatID

This field identifies the satellite for which the corrections are applicable. The values ranging from 0 to 63 represent satellite PRNs ranging from 1 to 64, respectively.

IODE

This IE is the sequence number for the ephemeris for the particular satellite. The MS can use this IE to determine if new ephemeris is used for calculating the corrections that are provided in the broadcast message. This eight-bit IE identifies a particular set of ephemeris data for a GPS satellite and may occupy the numerical range of [0, 255]. The transmitted

IODE value will be different from any value transmitted by the GPS satellite during the preceding six hours. For more information about this field can be found from RTCM-SC104.

User Differential Range Error (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 common Corrections Status/Health field to determine the final UDRE estimate for the particular satellite. The meanings of the values for this field are described in table A.18.

Table A.18: Values of UDRE IE

Value	Indication
00	$UDRE \leq 1.0$ m
01	1.0 m < $UDRE \leq 4.0$ m
10	4.0 m < $UDRE \leq 8.0$ m
11	8.0 m < $UDRE$

Each UDRE value shall be adjusted based on the operation of an Integrity Monitor (IM) function which exists at the network (SMLC, GPS server, or reference GPS receiver itself). Positioning errors derived at the IM which are excessive relative to DGPS expected accuracy levels shall be used to scale the UDRE values to produce consistency.

Pseudo-Range Correction (PRC)

This field indicates the correction to the pseudorange for the particular satellite at the GPS Reference Time, t_0 . The value of this field is given in meters (m) and the resolution is 0.32, as shown in table A.15 above. The method of calculating this field is described in [9].

If the SMLC has received a request for GPS assistance data from an MS which included a request for the navigation models and DGPS (i.e., bit D and E are set to one in 'Requested GPS Assistance Data, see 3GPP TS 49.031), the SMLC shall determine, for each satellite, if the navigation model stored by the MS is still suitable for use with DGPS corrections (also see navigation model update conditions right before Table A.19) and if so and if DGPS corrections are supported the SMLC should send DGPS corrections without including the navigation model.

The IODE value sent for a satellite shall always be the IODE value that corresponds to the navigation model for which the pseudo-range corrections are applicable.

The pseudo-range correction shall correspond to the available navigation model (the one already stored in and identified by the MS or the one included in the same procedure as the pseudo-range correction). The MS shall only use the PRC value when the IODE value received matches its available navigation model.

Pseudo-Range Rate Correction (RRC)

This field indicates the rate-of-change of the pseudorange correction for the particular satellite, using the satellite ephemeris identified by the IODE IE. The value of this field is given in meters per second (m/sec) and the resolution is 0.032, as shown in table A.15 above. For some time $t_1 > t_0$, the corrections for IODE are estimated by

$$PRC(t_1, IODE) = PRC(t_0, IODE) + RRC(t_0, IODE) \cdot (t_1 - t_0) ,$$

and the MS uses this to correct the pseudorange it measures at t_1 , $PR_m(t_1, IODE)$, by

$$PR(t_1, IODE) = PR_m(t_1, IODE) + PRC(t_1, IODE) .$$

The SMLC shall always send the RRC value that corresponds to the PRC value that it sends (see above for details). The MS shall only use the RRC value when the IODE value received matches its available navigation model.

Delta Pseudo-Range Correction 2 (Delta PRC2)

This IE is not used. The sender shall set it to zero and the receiver shall ignore it.

Delta Pseudo-Range Rate Correction 2 (Delta RRC2)

This IE is not used. The sender shall set it to zero and the receiver shall ignore it.

Delta Pseudo-Range Correction 3 (Delta PRC3)

This IE is not used. The sender shall set it to zero and the receiver shall ignore it.

Delta Pseudo-Range Rate Correction 3 (Delta RRC3)

This IE is not used. The sender shall set it to zero and the receiver shall ignore it.

Navigation Model

This set of fields contains information required to manage the transfer of precise navigation data to the GPS-capable MS. In response to a request from an MS for GPS assistance data, the SMLC shall determine whether to send the navigation model for a particular satellite to an MS based upon factors like the T-Toe limit specified by the MS and any request from the MS for DGPS (also see above). This information includes control bit fields as well as satellite ephemeris and clock corrections. The individual fields are given in Table A.19 below, and the conditions for their presence is discussed below.

Table A.19: Navigation Model (per-satellite fields - ⁽¹⁾ = Positive range only)

Parameter	# Bits	Scale Factor	Units	Incl.
Navigation Model Flow Control (once per message)				
Num_Sats_Total	4 ⁽¹⁾	1	---	M
Satellite and Format Identification (once per satellite)				
SatID	6 ⁽¹⁾	---	---	M
Satellite Status	2	---	Boolean	M
Satellite Navigation Model and Associated Bits (once per satellite)				
C/A or P on L2	2	---	Boolean	C
URA Index	4	---	Boolean	C
SV Health	6	---	Boolean	C
IODC	10 ⁽¹⁾	---	---	C
L2 P Data Flag	1	---	Boolean	C
SF 1 Reserved	87	---	---	C
T _{GD}	8	2 ⁻³¹	sec	C
t _{oc}	16 ⁽¹⁾	2 ⁴	sec	C
af ₂	8	2 ⁻⁵⁵	sec/sec ²	C
af ₁	16	2 ⁻⁴³	sec/sec	C
af ₀	22	2 ⁻³¹	sec	C
C _{rs}	16	2 ⁻⁵	meters	C
Δn	16	2 ⁻⁴³	semi-circles/sec	C
M ₀	32	2 ⁻³¹	semi-circles	C
C _{uc}	16	2 ⁻²⁹	radians	C
e	32 ⁽¹⁾	2 ⁻³³	---	C
C _{us}	16	2 ⁻²⁹	radians	C
(A) ^{1/2}	32 ⁽¹⁾	2 ⁻¹⁹	meters ^{1/2}	C
t _{oe}	16 ⁽¹⁾	2 ⁴	sec	C
Fit Interval Flag	1	---	Boolean	C
AODO	5	900	sec	C
C _{ic}	16	2 ⁻²⁹	radians	C
OMEGA ₀	32	2 ⁻³¹	semi-circles	C
C _{is}	16	2 ⁻²⁹	radians	C
i ₀	32	2 ⁻³¹	semi-circles	C
C _{rc}	16	2 ⁻⁵	meters	C
ω	32	2 ⁻³¹	semi-circles	C
OMEGA _{dot}	24	2 ⁻⁴³	semi-circles/sec	C
ldot	14	2 ⁻⁴³	semi-circles/sec	C

Num_Sats_Total

This field specifies the number of satellites that are included in the provided Navigation Model. A range of 1-16 is available. This field is mandatory when the Navigation Model field is included in the message.

SatID

This field identifies the satellite for which the assistance is applicable. This value is the same as the PRN number provided in the navigation message transmitted by the particular satellite. The range is 0 to 63, with 0-31 indicating GPS satellites 1-32, respectively, and 32-63 indicating satellites in future augmentation systems (e.g., WAAS or EGNOS). This field is mandatory for each included satellite.

Satellite Status

This field is a two-bit value that indicates the status of the Navigation Model for the particular satellite specified by SatID. This field is mandatory for each included satellite. The MS shall interpret the combinations of the two bits as follows.

Table A.20: Satellite Status (per-satellite field)

MSB	LSB	Interpretation
0	0	New satellite, new Navigation Model
0	1	Existing satellite, same Navigation Model
1	0	Existing satellite, new Navigation Model
1	1	Reserved

This Satellite Navigation Model and associated bit fields include the parameters that accurately model the orbit and clock state of the particular satellite. For the particular satellite, these fields are conditional based on the value of Satellite Status for that satellite. The fields are absent when Satellite Status is "01", and present for all other values. The format for the ephemeris, clock corrections, and associate bits are specified in ICD-GPS-200.

Ionospheric Model

The Ionospheric Model contains fields needed to model the propagation delays of the GPS signals through the ionosphere. The information elements in this field are shown in table A.21. Proper use of these fields allows a single-frequency GPS receiver to remove approximately 50 % of the ionospheric delay from the range measurements. The Ionospheric Model is valid for the entire constellation and changes slowly relative to the Navigation Model. All of the fields must be included when Ionospheric Model is present.

Table A.21: Ionospheric Model (occurs once per message, when present)

Parameter	# Bits	Scale Factor	Units	Incl.
α_0	8	2^{-30}	seconds	C
α_1	8	2^{-27}	sec/semi-circle	C
α_2	8	2^{-24}	sec/(semi-circle) ²	C
α_3	8	2^{-24}	sec/(semi-circle) ³	C
β_0	8	2^{11}	seconds	C
β_1	8	2^{14}	sec/semi-circle	C
β_2	8	2^{16}	sec/(semi-circle) ²	C
β_3	8	2^{16}	sec/(semi-circle) ³	C

UTC Model

The UTC Model field contains a set of parameters needed to relate GPS time to Universal Time Coordinate (UTC). All of the fields in the UTC Model are mandatory when the field is present.

Table A.22: UTC Model (occurs once per message, when present per-satellite fields - ⁽¹⁾ = Positive range only)

Parameter	# Bits	Scale Factor	Units	Incl.
A_1	24	2^{-50}	sec/sec	C
A_0	32	2^{-30}	seconds	C
$t_{ot}^{(1)}$	8	2^{12}	seconds	C
$WN_t^{(1)}$	8	1	weeks	C
Δt_{LS}	8	1	seconds	C
$WN_{LSF}^{(1)}$	8	1	weeks	C
DN	8	1	days	C
Δt_{LSF}	8	1	seconds	C

Almanac

These fields specify the coarse, long-term model of the satellite positions and clocks. These fields are given in table A.23. With one exception (δi), these parameters are a subset of the ephemeris and clock correction parameters in the Navigation Model, although with reduced resolution and accuracy. The almanac model is useful for receiver tasks that require coarse accuracy, such as determining satellite visibility. The model is valid for up to one year, typically. Since it is a long-term model, the field should be provided for all satellites in the GPS constellation. All fields in the Almanac are mandatory when the Almanac is present. The fields t_{oa} and WN_a specify the GPS time-of-week and week number, respectively, that are the reference points for the Almanac parameters.

The Almanac also is useful as an acquisition aid for network-based GPS methods. Given a recent Almanac (< 3-4 weeks old), the MS only needs Reference Time and Reference Location information to quickly acquire the signals and return measurements to the network.

The Almanac also contains information about the health of that satellite as described in ICD-GPS-200. If this Almanac has been captured from the satellite signal, the SV Health field represents the predicted satellite health at the time the GPS control segment uploaded the Almanac to the satellite. According to ICD-GPS-200, this health information may differ from the SV Health field in the Navigation Model (table A.19) due to different upload times.

The parameters Num_Sats_Total and SatID shall be interpreted in the same manner as described under table A.19.

Table A.23: Almanac (per-satellite fields - ⁽¹⁾ = Positive range only)

Parameter	# Bits	Scale Factor	Units	Incl.
The following fields occur once per message				
Num_Sats_Total	$6^{(1)}$	1	---	M
WN_a	$8^{(1)}$	1	weeks	M
The following fields occur once per satellite				
SatID	$6^{(1)}$	---	---	M
$e^{(1)}$	16	2^{-21}	dimensionless	M
$t_{oa}^{(1)}$	8	2^{12}	sec	M
δi	16	2^{-19}	semi-circles	M
OMEGADOT	16	2^{-38}	semi-circles/sec	M
SV Health	8	---	Boolean	M
$A^{1/2(1)}$	24	2^{-11}	meters ^{1/2}	M
OMEGA ₀	24	2^{-23}	semi-circles	M
ω	24	2^{-23}	semi-circles	M
M_0	24	2^{-23}	semi-circles	M
af_0	11	2^{-20}	seconds	M
af_1	11	2^{-38}	sec/sec	M

Acquisition Assistance

The Acquisition Assistance field of the GPS Assistance Data Information Element contains parameters that enable fast acquisition of the GPS signals in network-based GPS positioning. Essentially, these parameters describe the range and derivatives from respective satellites to the Reference Location at the Reference Time. Table A.24 illustrates the assistance data occurring once per message and table A.25 illustrates the assistance data occurring per number of satellites for which acquisition assistance is being provided. Figure A.2 illustrates the relation between some of the fields.

This field is optional. The field would probably appear when the Method Type field of the Positioning Instructions IE is set to 0 (MS-Assisted) and the Positioning Methods field of the Position Instructions IE is set to 1 (GPS) or 2 (GPS or E-OTD).

Table A.24: GPS Acquisition Assist - Parameters appearing once per message

Parameter	Range	Bits	Resolution	Incl.	Notes
Number of Satellites	0 - 15	4		M	
Reference Time	GPS TOW	0 - 604799.92 sec	23	0.08 sec	M
	BCCH Carrier	0 - 1023	10		O ¹
	BSIC	0 - 63	6		O ¹
	Frame #	0 - 2097151	21		O ¹
	Timeslots #	0 - 7	3		O ¹
	Bit #	0 - 156	8		O ¹
NOTE: All of these field shall be present together, or none of them shall be present.					

Table A.25: GPS Acquisition Assist - Parameters appearing [number of satellites] times per message

Parameter	Range	Bits	Resolution	Incl.	Notes
SVID/PRNID	1 - 64 (0 - 63)	6		M	
Doppler (0 th order term)	-5,120 Hz to 5,117.5 Hz	12	2.5 Hz	M	
Doppler (1 st order term)	-1.0 - 0.5 Hz/sec.	6	1/42 Hz/sec.	O ¹	
Doppler Uncertainty	12.5 Hz - 200 Hz [2 ⁻ⁿ (200) Hz, n = 0 - 4]	3		O ¹	
Code Phase	0 - 1022 chips	10	1 chip	M	
Integer Code Phase	0-19	5	1 C/A period	M	
GPS Bit number	0 - 3	2		M	
Code Phase Search Window	1 - 192 chips	4		M	
Azimuth	0 - 348.75 deg	5	11.25 deg	O ²	
Elevation	0 - 78.75 deg	3	11.25 deg	O ²	
NOTE 1: Both of these fields shall be present together, or none of them shall be present.					
NOTE 2: Both of these fields shall be present together, or none of them shall be present.					

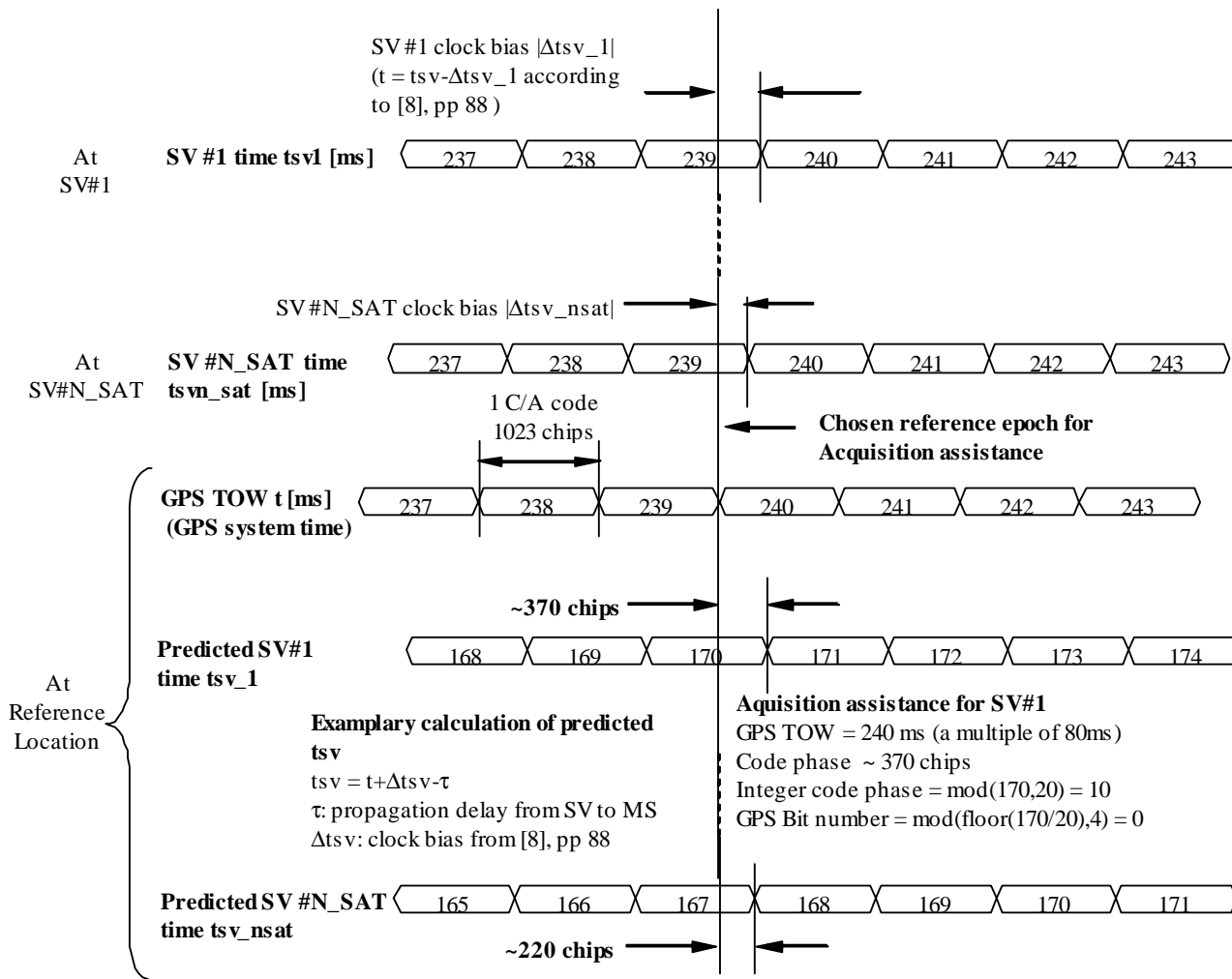


Figure A.2. Exemplary calculations of Acquisition Assistance fields.

This field indicates whether or not angle information is present in this message. The MS shall interpret a value of "1" to mean that angle (Azimuth and Elevation) information is present, and "0" to mean that it is not provided. This field is mandatory.

Number of Satellites

This field contains the number of satellites identified in this information element. This field is mandatory.

Range: 0 - 15

Reference Time

The Reference Time field of the GPS Acquisition Assistance Data IE specifies the relationship between GPS time and air-interface timing of the BTS transmission in the reference cell.

GPS TOW subfield specifies the GPS TOW for which the location estimate is valid. When the parameters BCCH Carrier/BSIC/Frame #/Timeslots #/Bit # are present, together with GPSTOW they provide a valid relationship between GPS and GSM time, as seen at the approximate location of the MS, ie the propagation delay from BTS to MS shall be compensated for by the SMLC. Depending on implementation, the relation between GPS and GSM time may have varying accuracy. The uncertainty of the timing relation may be provided in the optional field GPS Reference Time Uncertainty. If the propagation delay from BTS to MS is not accurately known, the SMLC shall use the best available approximation of the propagation delay and take the corresponding delay uncertainty into account in the calculation of the field GPS Reference Time Uncertainty. GPS TOW is mandatory when the GPS Acquisition Assistance Data

Information Element is included. When the GSM time parameters are not present the GPS TOW is an estimate of current GPS time of week at time of reception of the RRLP segment containing the GPS TOW by the MS. The SMLC should achieve an accuracy of +/- 3 seconds for this estimate including allowing for the transmission delay between SMLC and MS of the RRLP segment containing GPS TOW. Note that the MS should further compensate GPS TOW for the time between the reception of the segment containing GPS TOW and the time when the GPS TOW field is used.

Range: 0 - 604799.92 sec

The **BCCH Carrier #** and **BSIC** subfields specify the reference cell for which GSM timing is provided. These subfields are optional when the GPS Acquisition Assistance Data Information Element is included. If included, the SMLC shall set the reference cell to the current serving cell. A target MS has the option of rejecting a GPS position request or GPS assistance data if the reference cell is not the serving cell.

The **Frame #** subfield specifies the GSM frame number of the BTS transmissions for the reference cell that occur at the given GPS TOW. This subfield is optional when the GPS Acquisition Assistance Data Information Element is included.

Range: 0 - 2097151

The **Timeslots #** subfield specifies the GSM timeslot of the BTS transmissions for the reference cell that occur at the given GPS TOW. This subfield is optional when the GPS Acquisition Assistance Data Information Element is included.

Range: 0 - 7

The **Bit #** subfield specifies the GSM and bit number of the BTS transmissions for the reference cell that occur at the given GPS TOW. This subfield is optional when the GPS Acquisition Assistance Data Information Element is included.

Range: 0 - 156

SVID/PRNID

This field identifies the particular satellite for which the measurement data is supplied. This value is the same as the PRN number provided in the navigation message transmitted by the particular satellite.

The range is 0 to 63, where SVID = PRNID - 1

Doppler (0th order term)

This field contains the Doppler (0th order term) value. A positive value defines the increase in satellite signal frequency due to velocity towards the MS. A negative value defines the decrease in satellite signal frequency due to velocity away from the MS. This field is mandatory.

Range: 5,120 Hz to 5,117.5 Hz

Doppler (1st order term)

This field contains the Doppler (1st order term) value. A positive value defines the rate of increase in satellite signal frequency due to acceleration towards the MS. A negative value defines the rate of decrease in satellite signal frequency due to acceleration away from the MS. This field is optional.

Range: -1,0 Hz to 0,5 Hz / s

Doppler Uncertainty

This field contains the Doppler uncertainty value. It is defined such that the Doppler experienced by a stationary MS is in the range "Doppler - Doppler Uncertainty" to "Doppler + Doppler Uncertainty". This field is optional. If Doppler Uncertainty (together with Doppler 1st order term) is omitted, the terminal shall interpret Doppler Uncertainty as greater than +/-200 Hz.

Permitted Values: 12.5 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz as encoded by an integer n in the range 0-4 according to the formula in Table A.25

Code Phase

This field contains code phase, in units of 1 GPS chip, in the range from 0 to 1022 GPS chips, where increasing binary values of the field signify increasing predicted pseudoranges, as seen by a receiver at the Reference Location at the time GPS TOW. The Reference Location would typically be an a priori estimate of the MS location. This field is mandatory.

Range: 0-1022 chips

Integer Code Phase

This field contains integer code phase, i.e. the number of the code periods that have elapsed since the latest GPS bit boundary, in units of C/A code period, as seen by a receiver at the Reference Location at the time GPS TOW. This field is mandatory.

Range: 0-19

GPS Bit Number

This field contains GPS bit number (expressed modulo 4) currently being transmitted at the time GPS TOW, as seen by a receiver at the Reference Location. This field is mandatory.

Range: 0-3

Code Phase Search Window

This field contains the code phase search window. The code phase search window accounts for the uncertainty in the estimated MS location but not any uncertainty in GPS TOW. 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". This field is mandatory.

Range: 0-15 (i.e. 1-512 chips according to following table)

Table A.26: Code Phase Search Window Parameter Format

CODE_PHASE_WIN	Code Phase Search Window (GPS chips)
'0000'	512
'0001'	1
'0010'	2
'0011'	3
'0100'	4
'0101'	6
'0110'	8
'0111'	12
'1000'	16
'1001'	24
'1010'	32
'1011'	48
'1100'	64
'1101'	96
'1110'	128
'1111'	192

Azimuth

This field contains the azimuth angle. An angle of x degrees means the satellite azimuth a is in the range $(x \leq a < x+11.25)$ degrees. This field is optional.

Range: 0 - 348.75 degrees.

Elevation

This field contains the elevation angle. An angle of y degrees means the satellite elevation e is in the range $(y \leq e < y+11.25)$ degrees except for $y = 78.75$ where the range is extended to include 90 degrees. This field is optional.

Range: 0 - 78.75 degrees

Real-Time Integrity

The Real-Time Integrity field of the GPS Assistance Data Information Element contains parameters that describe the real-time status of the L1C/A signal in GPS constellation. Primarily intended for non-differential applications, the real-

time integrity of the satellite constellation is of importance as there is no differential correction data by which the mobile can determine the soundness of each satellite signal. The Real-Time GPS Satellite Integrity data communicates the health of the L1C/A signal to the mobile in real-time. The format is shown in table A.29. The SMLC shall always transmit the Real Time Integrity field with the current list of satellites with unhealthy L1C/A signal, for any A-GPS positioning attempt and whenever A-GPS assistance data is sent. The same applies for GANSS positioning attempt and assistance data when modernized GPS is involved. If the number of bad satellites (NBS) is zero, then the Real Time Integrity field shall be omitted. When the Extended Reference IE is included in the RRLP Measure Position Request message or in the RRLP Assistance Data message, then the MS shall interpret the absence of a Real Time Integrity field in the assistance data provided by the SMLC to mean that NBS is zero. If the Extended Reference IE is not present, this interpretation applies when the assistance data is provided by the SMLC following a previous request of the MS for Real Time Integrity data.

Table A.29: Real-Time Integrity - Parameters appearing NBS times

Parameter	# Bits	Scale Factor	Range	Units	Incl.
Bad_SVID	6	1	0-63	---	C

NBS (Number of Bad Satellites)

The NBS value indicates the number of satellite ID's that follow. The user should not use the L1C/A signal of those satellites at this time in a fix. This NBS value is determined from the Bad_SVID list.

Bad_SVID

This six bit field appears NBS times, and indicates the SVID of satellites which L1C/A signal should not be used for fix by the user at this time. The values ranging from 0 to 63 represent satellite PRNs ranging from 1 to 64, respectively.

A.4.2.4a GPS Time Assistance Measurement Request Element

This element is optional and controls if the MS should return GPS time assistance measurements or not to the SMLC. The inclusion of this parameter implies use of measure Position Request. The description is found in sub-chapter 2.2.4a.

A.4.2.4b GPS Reference Time Uncertainty Element

This element is conditional and provides the accuracy of the relation GPS and GSM time in the Acquisition Assistance in GPS Assistance Data Element. The interval, range and treatment is as described in sub-clause 2.2.4b.

A.4.2.4c Additional GPS Assistance Data

The Additional GPS Assistance Data Element contains additional GPS assistance data which are not included in the GPS Assistance Data Element. This element can contain one or more of the fields listed in Table A.29a below.

Table A.29a: Fields in the Additional GPS Assistance Data element

Parameter	Presence	Repetition
GPS Ephemeris Extension	O	Yes
GPS Ephemeris Extension Check	O	Yes

When RRLP pseudo-segmentation is used, Table A.29a indicates which parameters may be repeated in more than one RRLP segment in order to provide data for multiple satellites. When any such parameter appears in more than one segment, the following rules shall apply.

1. There shall be no repetition of the same data for the same satellite, even though there might be multiple realizations of the IEs for the same satellite. For example, GPS Ephemeris Extension may occur multiple times for the same satellite, but with different data content.
2. Optional and conditional elements in the parameter not associated with a particular satellite shall each appear in at most one RRLP segment.
3. Any mandatory element not associated with a particular satellite shall assume consistent values in the case of an element related to current GPS time and the same value otherwise.

4. The maximum number of satellites defined in sub-clause 5.1 for which data can be included for any parameter in one RRLP segment shall apply also when counted over all RRLP segments.

GPS Ephemeris Extension

The GPS Ephemeris extension contains parameters designed to extend the time of applicability of the Ephemeris terms by the continuous addition of the delta ephemeris terms to the respective terms of the referenced ephemeris.

This message can provide extension information for every satellite for many days into the future; doing so may create a large message, thus care must be taken to consider the transport bandwidth. The SMLC can limit the duration of the extension to decrease the message size. For example if the extension duration is limited to twelve hours the payload will be approximately 2,000 octets, for a typical 27 satellite constellation.

Table A.29.b: GPS Ephemeris Extension

Parameter	# Bits	Scale Factor	Units	Incl.
gpsEphemerisHeader	See Table A.29.c		---	O
gpsReferenceSet	See Table A.29.e		---	O
ephemerisDeltaMatrix	List of GPSEphemerisDeltaEpochs			O

Table A.29.c: GPS Ephemeris Header

Parameter	# Bits	Scale Factor	Units	Incl.
GPS Ephemeris Extension (Once per message)				
timeOfEstimation	See Table A.29.d		---	M
validityPeriod	3	1	Hours	M
ephemerisExtensionDuration	9	1	Hours	M

Time of Estimation

The GPS Time at Estimation provides the GPS time at which the ephemeris extensions were created.

Table A.29.d: Time of Estimation

Parameter	# Bits	Scale Factor	Units	Incl.
GPS Week of Estimation	10	1	Week	M
GPS TOW of Estimation	20	1	Seconds	M

GPS Week of Estimation

This field specifies the week of the time that the estimation was determined.

Range: 0 - 1023 weeks

GPS TOW of Estimation

Integer number of GPS TOW seconds within the current week of the time that the estimation was determined.

Range: 0 - 604800 s.

Validity Period

The validityPeriod indicates the validity period of each individual delta ephemeris packet. It is the length of time that the ephemeris constructed by application of the delta is intended to last.

Range: 1 – 8 hours.

Ephemeris Extension Duration

The Ephemeris Extension duration indicates the total block of time measured in units of hours that the extended ephemeris covers.

Range: 1 – 512 hours.

The gpsEphemeris header is mandatory only once in the delivery of the GPS Ephemeris Extension message.

GPS Reference Set

Table A.29.e: GPS Reference Set

Parameter	Presence	Note
GPS Reference Orbit	M	See Table A.29.f

The GPS Reference Set is a list of GPS Reference Orbits, one for each healthy satellite vehicle at the time of construction.

GPSReference Orbit

Table A.29.f: GPS Reference Orbit

Parameter	# Bits	Scale Factor	Units	Incl.
svID	5	1	---	M
gpsOrbitModel	See Table A.29.g		--	M
gpsClockModel	See Table A.29.h		--	M

SvID

The satellite vehicle ID identifying to which satellite the following orbital and clock model apply

GPSOrbitModel

This field is a structure that contains the satellite orbit information upon which all subsequent delta information will be applied to create the next ephemeris for use in navigation.

GPSClockModel

This field is a structure that contains the satellite clock model upon which all subsequent clock information will be applied to create the next clock model for use in navigation.

GPS Orbit Model

Table A.29.g: Reference Nav Model

Parameter	# Bits	Scale Factor	Units	Incl.
keplerToe	16	24	seconds	M
keplerW	32	2-31	hours	M
keplerDeltaN	16	2-43	semi-circles/sec	M
keplerM0	32	2 ⁻³¹	semi-circles	M
keplerOmegaDot	27	2 ⁻⁴³	semi-circles/sec	M
keplerE	32	2 ⁻³³	---	M
keplerIDot	14	2 ⁻⁴³	semi-circles/sec	M
keplerAPowerHalf	32	2 ⁻¹⁹	Meters ^{1/2}	M
keplerIO	32	2 ⁻³¹	semi-circles	M
kelerOmega0	32	2 ⁻³¹	semi-circles	M
keplerCrs	16	2 ⁻⁵	meters	M
keplerCis	16	2 ⁻²⁹	radians	M
keplerCus	16	2 ⁻²⁹	radians	M
keplerCrc	16	2 ⁻⁵	meters	M
keplerCic	16	2 ⁻²⁹	radians	M
KeplerCuc	16	2 ⁻²⁹	radians	M

GPS Clock Model

Table A.29.h: GPS Clock Model

Parameter	# Bits	Scale Factor	Units	Incl.
aF2	8	2^{-55}	seconds/seconds ²	M
aF1	16	2^{-43}	seconds/seconds	M
aF0	22	2^{-31}	seconds	M
tgd	8	2^{-31}	seconds	M

GPS Ephemeris Delta Matrix

GPS Ephemeris Delta Matrix is a list of GPS Ephemeris Delta Epochs. Each epoch is indicated by a unique seqNum. Each epoch corresponds to a specific update interval and contains a delta epoch header and ephemeris delta elements for all PRNs for that epoch.

GPS Ephemeris Delta Epoch**Table A.29.i: GPS Ephemeris Delta Epoch**

Parameter	Note	Incl.
gpsDeltaEpochHeader	See Table A.29.j	O
gpsDeltaElementList	List of GPS Ephemeris Delta Elements	M

GPS Delta Epoch Header**Table A.29.j: GPS Delta Epoch Header**

Parameter	# Bits	Scale Factor	Units	Incl.
validityPeriod	3	1	Hours	O
ephemerisDeltaSizes	See Table A.29.k			O
ephemerisDeltaScales	See Table A.29.l			O

Validity Period

The validityPeriod indicates the validity period of each individual delta ephemeris packet. It is the length of time that the ephemeris constructed by application of the delta is intended to last.

Range: 1 – 8 hours.

Ephemeris Delta Sizes

This field is a structure that indicates the bit sizes for all the fields in the GPS Ephemeris Delta structure.

Table A.29.k: GPS Ephemeris Delta Sizes

Parameter	# Bits	Scale Factor	Units	Incl.
bitSize_delta_ω	5	1	---	M
bitSize_delta_Δn	4	1	---	M
bitSize_delta_M0	5	1	---	M
bitSize_delta_ΩEGA _{dot}	5	1	---	M
bitSize_delta_e	5	1	---	M
bitSize_delta_Δdot	4	1	---	M
bitSize_delta_sqrtA	5	1	---	M
bitSize_delta_i0	5	1	---	M
bitSize_delta_ΩEGA0	5	1	---	M
bitSize_delta_Crs	4	1	---	M
bitSize_delta_Cis	4	1	---	M
bitSize_delta_Cus	4	1	---	M
bitSize_delta_Crc	4	1	---	M
bitSize_delta_Cic	4	1	---	M
bitSize_delta_Cuc	4	1	---	M
bitSize_delta_tgd	4	1	---	M

Ephemeris Delta Scales

This field is a structure that indicates the scale factor modifiers for all the fields in the GPS Ephemeris Delta structure.

Table A.29.I: GPS Ephemeris Delta Scales

Parameter	# Bits	Scale Factor	Units	Incl.
scale_delta_ω	5	1	---	M
scale_delta_Δn	5	1	---	M
scale_delta_M0	5	1	---	M
scale_delta_OMEGAdot	5	1	---	M
scale_delta_e	5	1	---	M
scale_delta_lidot	5	1	---	M
scale_delta_sqrtA	5	1	---	M
scale_delta_i0	5	1	---	M
scale_delta_OMEGA0	5	1	---	M
scale_delta_Crs	5	1	---	M
scale_delta_Cis	5	1	---	M
scale_delta_Cus	5	1	---	M
scale_delta_Crc	5	1	---	M
scale_delta_Cic	5	1	---	M
scale_delta_Cuc	5	1	---	M
scale_delta_tgd	5	1	---	M

GPS Delta Element List

GPS Delta Element List is a list of GPS Ephemeris Delta Elements

GPS Ephemeris Delta Element

Each GPS Ephemeris Delta Element is encoded as an octet string of up to 47 octets. Each element is uniquely identified by the pair (seqNum, sv_ID) and it is defined as a structure as shown in table A.29.m. The MS should parse the octet string according to the fields specified in table A.29.m. Each element in table A.29.m but for seqNum and sv_ID should be treated as a signed integer. The actual number of octets is determined by the size of the bit fields in the GPS_Ephemeris_Delta_Sizes table (table A.29.k). Each set of up to 47 octets represents a single extension for a single satellite vehicle. Each element encodes the satellite vehicle ID and the sequence number. The sequence number specifies the order in which the individual ephemeris extension elements are assembled as time marches forward to create the next ephemeris. The sequence number is the same for all satellite vehicle IDs for a particular update period.

Table A.29.m: GPS Ephemeris Delta Element

Parameter	# Bits	Default # Bits	Scale Factor	Default Scale	Units	Incl.
sequenceNum	7		1	1	---	M
svID	5		1	1	---	M
delta_ω	1..32 (1)	21	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31}$ (2)	2^{-31}	semi-circles	M
delta_Δn	1..16 (1)	12	$2^{-16} \cdot 2^{-43} \dots 2^{15} \cdot 2^{-43}$ (2)	2^{-43}	semi-circles/sec	M
delta_M0	1..32 (1)	21	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31}$ (2)	2^{-31}	semi-circles	M
delta_OMEGAdot	1..24 (1)	13	$2^{-16} \cdot 2^{-43} \dots 2^{15} \cdot 2^{-43}$ (2)	2^{-43}	semi-circles/sec	M
delta_e	1..32 (1)	18	$2^{-16} \cdot 2^{-33} \dots 2^{15} \cdot 2^{-33}$ (2)	2^{-33}	---	M
delta_lidot	1..14 (1)	11	$2^{-16} \cdot 2^{-43} \dots 2^{15} \cdot 2^{-43}$ (2)	2^{-43}	semi-circles/sec	M
delta_sqrtA	1..32 (1)	14	$2^{-16} \cdot 2^{-19} \dots 2^{15} \cdot 2^{-19}$ (2)	2^{-19}	meters ^{1/2}	M
delta_i0	1..32 (1)	14	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31}$ (2)	2^{-31}	semi-circles	M
delta_OMEGA0	1..32 (1)	14	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31}$ (2)	2^{-31}	semi-circles	M
delta_Crs	1..16 (1)	12	$2^{-16} \cdot 2^{-5} \dots 2^{15} \cdot 2^{-5}$ (2)	2^{-5}	meters	M
delta_Cis	1..16 (1)	11	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29}$ (2)	2^{-29}	radians	M
delta_Cus	1..16 (1)	12	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29}$ (2)	2^{-29}	radians	M
delta_Crc	1..16 (1)	12	$2^{-16} \cdot 2^{-5} \dots 2^{15} \cdot 2^{-5}$ (2)	2^{-5}	meters	M
delta_Cic	1..16 (1)	11	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29}$ (2)	2^{-29}	radians	M
delta_Cuc	1..16 (1)	12	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29}$ (2)	2^{-29}	radians	M
delta_tgd	1..16 (1)	2	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31}$ (2)	2^{-31}	seconds	M

- (1) The number of bits of each signed integer field is variable and it is indicated once for all numEphemerisDeltas by the structure ephemerisDeltasSizes. When the ephemerisDeltaSizes field is not present, the values found in the columns "Default # Bits" shall be used.
- (2) The scale factor of each parameter is variable around the default scale factor. The variation for each field is indicated once for all numEphemerisDeltas by the structure ephemerisDeltasScales. For example, if the scale factor modifier for delta_omega has a value of 4, the scale factor for delta_omega is $2^4 * 2^{-31}$. When the ephemerisDeltaScales is not used, the values found in the column "Default Scale" shall be used.

sequenceNum

This field indicates the order of the Ephemeris delta terms. The ephemeris constructed for use in satellite positioning is built by adding the delta terms to the referenced GPS_Navigation Model in the order dictated by this sequence number. The sequence number shall remain the same for each svID in an epoch of Ephemeris Deltas corresponding to a particular update interval.

svID

This field identifies the satellite ID within a particular sequenceNum or epoch.

These fields, with the exception of sequenceNum and svID, specify the deltas to be added to the existing Ephemeris to create a new Ephemeris suite that is extended from its predecessor by the time provided in the "validityPeriod" parameter. To compute the time of ephemeris for the newly constructed ephemeris, validityPeriod is added to the preceding toe. The ephemeris time of clock (toc) is set equal to the toe.

For each of the other ephemeris terms the corresponding delta ephemeris term is added in order to create the updated ephemeris. The terms delta_M0, delta_i0, and delta_OMEGA0 of the delta ephemeris must be extrapolated prior to the addition of the delta terms as follows:

$$\text{delta_}M_{0(i+1)} = \text{delta_}M_{0(i)} + \left(\sqrt{\frac{\mu}{A_i^3}} + \Delta n_i \right) * dt$$

Where μ is the WGS 84 value of the earth's gravitational constant for GPS user and is equal to $3.986005 * 10^{14}$ m³/sec², and A(i) is the semi-major axis associated with this satellite's update. The extrapolation of delta_M0, uses the prior set's sqrtA term to compute A(i) as the square of sqrtA(i).

$$\text{delta_OMEGA0}_{(i+1)} = \text{delta_OMEGA0}_{(i)} + \text{delta_OMEGAdot}_{(i)} * dt$$

$$i0_{(i+1)} = i0_{(i)} + \text{Idot}_{(i)} * dt$$

Where dt is equal to the validity period * 3600. The terms af0, and af1 from the GPS clock model must be extrapolated as follows:

$$\text{af0}_{(i+1)} = \text{af0}_{(i)} + \text{af1}_{(i)} * dt + \text{af2} * dt^2$$

$$\text{af1}_{(i+1)} = \text{af1}_{(i)} + 2 * \text{af2}_{(i)} * dt$$

$$\text{af2}_{(i+1)} = \text{af2}_{(i)}$$

Where af0, af1, and af2 are the clock model terms as shown in table A.29.c

dt is equal to the validity period represented in seconds (validityPeriod * 3600)

The following demonstrates the application of the ephemeris extension technique. Assume the validityPeriod = 5, representing: (5+1) hours = 6 hours, and the GPS Navigation model for a particular satellite, identified by the reference IOD has a toe = 0 seconds.

The toe for sequenceNumber 1 is computed by adding the validityPeriod to the initial toe of 0 as 0 + 6 hours = 0 + 21600 seconds. The new ephemeris is constructed by adding the delta ephemeris terms from set 1 to the reference ephemeris creating the new ephemeris, which will be used for the next six hours. For the five terms listed above (delta_M0, delta_i0, delta_OMEGA0, af0, and af1) the extrapolation described must occur prior to the addition of the delta term.

The next ephemeris computation will occur by adding the validityPeriod to the current toe of 21600 as: $21600 + 6 \text{ hours} = 21600 + 21600 = 43200$. The ephemeris delta terms from set two are added to the ephemeris resulting from the prior addition to create the next ephemeris. This is done for each satellite vehicle ID.

GPS Ephemeris Extension check

The GPS Ephemeris Extension check provides information about non foreseen events that occurred during the period starting at the gpsBeginTime to the current time. An event is signified through a bit string . Each bits refers to one PRN. If a bit is set to one, this means that the ephemeris extension is no longer valid for this specific PRN. In order to indicate planned future maneuvers an end time is provided. The SMLC can indicate that a future event is planned between the current time and the end time of this ephemeris extension.

Table A.29.n: Ephemeris Extension check

Parameter	Presence	Note
gpsBeginTime	M	See Table A.29o
gpsEndTime	M	See Table A.29p
gpsSatEventsInfo	M	See Table A.29q

GPS Begin Time

The GPS begin time corresponds to the GPS Week and GPS Seconds of Estimation of the ephemeris extensions block.

Table A.29.o: GPS Begin Time

Parameter	# Bits	Scale Factor	Units	Incl.
GPS Week	10	1	Weeks	M
GPS TOW	20	1	Seconds	M

GPS End Time

The GPS end time represents the final time the Ephemeris extension is valid.

Table A.29.p: GPS End Time

Parameter	# Bits	Scale Factor	Units	Incl.
GPS Week	10	1	Weeks	M
GPS TOW	20	1	Seconds	M

GPS Sat Event Information

This IE is designed to indicate events that have or may occur between the gpsBeginTime and the gpsEndTime.

Table A.29.q: GPS Sat Event Information

Parameter	# Bits	Scale Factor	Units	Incl.
EventOccurred	32	-	-	M
FutureEventNoted	32	-	-	M

EventOccurred

If a bit is clear in the eventOccured field it indicates that a satellite maneuver has not occurred since the ganssBeginTime nor is a maneuver planned for the next sixty minutes.

FutureEventNoted

If a bit is set in the futureEventNoted field it indicates that a maneuver is planned during the time period between current time plus sixty minutes and gpsEndTime

A.4.2.5 More Assistance Data To Be Sent Element

This element is set by the SMLC to indicate to the MS if more Assistance Data components or a the final RRLP Measure Position Request component will be sent in the current procedure in order to deliver the entire set of assistance data.

A.4.2.6 GANSS Assistance Data

The GANSS Assistance Data consists of two or more data elements depending on the number of GNSS constellations included in the GANSS Assistance Data. GANSS Assistance Data elements are of two different types: GANSS Common Assistance Data and GANSS Generic Assistance Data. GANSS Common Assistance Data element is included at most only once and it contains Information Elements that can be used with any GNSS constellation. GANSS Generic Assistance data element can be included multiple times depending on the number of GNSS constellations supported in the GANSS Assistance Data. One GANSS Generic Assistance Data element contains Information Elements dedicated only for one specific GNSS constellation at a time. If two or more constellations are supported, GANSS Generic Assistance Data is given for each constellation separately.

The fields in GANSS Assistance Data are listed in Table A.30 below. As table A.30 shows, all fields are optional.

Table A.30: Fields in the GANSS Assistance Data element

Element	Presence	Repetition
GANSS Common Assistance Data	O	No
GANSS Generic Assistance Data	O	Yes

When RRLP pseudo-segmentation is used, Tables A.30, A.31 and A.39 indicate which elements may be repeated in more than one RRLP segment in order to provide data for multiple constellations, satellites or signals. When any such element - with the exception of the GANSS ID and SBAS ID element - appears in more than one segment, the following rules shall apply.

1. There shall be no repetition of the same data for the same constellation, satellite or signal even though there might be multiple realizations of the IEs for the same constellation, satellite or signal. For example, DGANSS corrections may occur multiple times for the same satellite.
2. Optional and conditional fields in the element not associated with a particular satellite or signal shall each appear in at most one RRLP segment.
3. Any mandatory field not associated with a particular satellite or signal shall assume consistent values in the case of a field related to current reference time and the same value otherwise.
4. The maximum number of constellations, satellites or signals defined in sub-clause 5.1 for which data can be included for any parameter in one RRLP segment shall apply also when counted over all RRLP segments.

A.4.2.6.1 GANSS Common Assistance Data

GANSS Common Assistance Data element contains GNSS constellation independent information elements that can be applied on any specific GNSS or on a combination of GNSS. GANSS Common Assistance Data fields are included in GANSS Assistance Data only once. This element can contain one or more of the fields listed in table A.31 below. As Table A.31 shows, all fields are optional.

Table A.31: GANSS Common Assistance Data content

Element	Presence	Repetition
GANSS Reference Time	O	No
GANSS Reference Location	O	No
GANSS Ionospheric Model	O	No
GANSS Additional Ionospheric Model	O	No
GANSS Earth Orientation Parameters	O	No

GANSS Reference Time

This field specifies the GANSS Time Of Day (TOD) with uncertainty and relationship between GANSS Reference Time and air-interface timing of the BTS transmission in the reference cell. These fields occur once per message; some are mandatory and some are optional, as shown in Table A.33.

When GANSS TOD -GSM Time association is present, GANSS TOD and BCCH/BSIC/FN_m/TN/BN IEs provide a valid relationship between GANSS TOD and GSM time, as seen at the approximate location of the MS, i.e. the propagation delay from BTS to MS shall be compensated for by the SMLC. Depending on implementation, the relation between GANSS TOD and GSM time may have varying accuracy. Therefore, the uncertainty of the timing relation is provided in GANSS TOD Uncertainty. If the propagation delay from BTS to MS is not accurately known, the SMLC shall use the best available approximation of the propagation delay and take the corresponding delay uncertainty into account in the calculation of the field GANSS TOD Uncertainty. When GANSS TOD -GSM Time association is not present, GANSS TOD is an estimate of current GANSS TOD at time of reception of the RRLP segment containing this data by the MS. The SMLC should achieve an accuracy of +/- 3 seconds for this estimate including allowing for the transmission delay between SMLC and MS of the RRLP segment containing GANSS TOD. Note that the MS should further compensate GANSS TOD for the time between the reception of the segment containing GANSS TOD and the time when the GANSS TOD field is used.

Table A.33: GANSS Reference Time

Parameter	# Bits	Scale Factor	Range	Units	Incl.
GANSS Reference Time Information (once per message)					
GANSS Day	13	1	0 - 8191	day	O
GANSS TOD	17	1	0 - 86399	sec	M
GANSS TOD Uncertainty	7	-	0...127	-	O
GANSS_TIME_ID	3	---	---	---	O (note 3)
GANSS TOD - GSM Time Association (once per message)					
BCCH Carrier	10	1	0 - 1023	---	O (note 1)
BSIC	6	1	0 - 63	---	O (note 1)
FN _m	21	1	0 - (2 ²¹ -1)	frames	O (note 1)
TN	3	1	0 - 7	timeslots	O (note 1)
BN	8	1	0 - 156	bits	O (note 1)
FN ₁	7	2 ⁻³⁰	-5.9605e-8 - +5.8673e-8	sec/sec	O (note 2)
NOTE 1: All of these fields shall be present together, or none of them shall be present.					
NOTE 2: This field can be optionally included if GANSS TOD - GSM Time association is present.					
NOTE 3: Absence of this field means Galileo system time.					

GANSS Day

This field specifies the sequential number of days from the origin of the GNSS system time indicated by GANSS_TIME_ID modulo 8192 days (about 22 years). The GNSS system time origin is defined in Table A.34 for each GANSS. This field is optional.

Range: 0 - 8191 days

GANSS TOD

Integer number of GANSS TOD seconds within the current day.

Range: 0 - 86399 s.

GANSS TOD Uncertainty

GANSS TOD uncertainty value as described in 3.2.9. This field is optional.

GANSS_TIME_ID

This field specifies the GNSS system time used in GANSS Reference Time. The SMLC shall set the GANSS_TIME_ID only to system times for corresponding GANSSs supported by the MS.

Table A.34: GANSS_TIME_ID

GANSS_TIME_ID	Indication	GNSS System Time Origin
Galileo System Time	(default)	August 22, 1999; 00:00:00 UTC (BIPM)
GPS System Time	0	January 6, 1980; 00:00:00 UTC(USNO)
QZSS System Time	1	January 6, 1980; 00:00:00 UTC(USNO)
GLONASS System Time	2	January 1, 1996; 03:00:00 UTC(RU)
Reserved for future use	3 - 7	–

BCCH Carrier/BSIC/FN_m/TN/BN/FN₁

These fields specify the state of the GSM frame number, respectively, of the reference BTS with the specified BCCH carrier and BSIC at the time that correspond to GANSS TOD. Also, the drift rate of the frame timing, FN₁, with respect to the GANSS TOD is optionally given. The SMLC shall use the current serving BTS as the reference BTS. The target MS has the option of rejecting a GANSS position request or GANSS assistance data if the reference BTS is not the serving BTS. If FN_m field is present in the assistance, cellular time parameters FN_m/TN/BN shall be aligned with the integer GANSS TOD second given in GANSS TOD field.

GANSS Reference Location

The Reference Location field contains a 3-D location (with uncertainty) specified as per 3GPP TS 23.032. The purpose of this field is to provide the MS with a priori knowledge of its location in order to improve GNSS receiver performance. The allowed shape is 3-D location with uncertainty (ellipsoid point with altitude and uncertainty ellipsoid). As defined in 3GPP TS 23.032, the GANSS Reference Location is provided in WGS-84 reference system.

NOTE: If GPS Assistance Data component is present as well, the SMLC should include the Reference Location either in the GPS Assistance Data or GANSS Common Assistance Data element.

GANSS Ionospheric Model

GANSS Ionospheric Model contains parameters to model the propagation delay of the GNSS signals through the ionosphere. The information elements in this field are shown in Table A.35. Proper use of these fields as defined in [11] allows a single-frequency GNSS receiver to remove the ionospheric delay from the pseudorange measurements.

Table A.35: GANSS Ionospheric Model

Parameter	# Bits	Scale Factor	Units	Incl.
GANSS Ionosphere Model Parameters				
a _{i0}	12	---	---	M
a _{i1}	12	---	---	M
a _{i2}	12	---	---	M
GANSS Ionosphere Regional Storm Flags				
Storm Flag 1	1	---	---	O (note 1)
Storm Flag 2	1	---	---	O (note 1)
Storm Flag 3	1	---	---	O (note 1)
Storm Flag 4	1	---	---	O (note 1)
Storm Flag 5	1	---	---	O (note 1)
NOTE 1: All of these fields shall be present together, or none of them shall be present.				

GANSS Ionosphere Parameters

The ionosphere model parameters are used to estimate the ionospheric distortions on pseudoranges as described in [11] on page 71.

GANSS Ionosphere Regional Storm Flags

Ionosphere storm flags (1,...,5) are optionally provided separately for five different regions as described in [11] on page 71.

GANSS Additional Ionospheric Model

The GANSS Additional Ionospheric Model contains parameters to model the propagation delays of the GANSS signals through the ionosphere. The information elements in this field are shown in table A.35.a.

When Data ID 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 [16]. When Data ID has the value '00' it indicates the parameters are applicable worldwide [16]. All other values for Data ID are reserved.

Table A.35.a: GANSS Additional Ionospheric Model

Parameter	# Bits	Scale Factor	Units	Incl.
Data ID	2	--	See text	M
α_0	8	2^{-30}	seconds	M
α_1	8	2^{-27}	sec/semi-circle	M
α_2	8	2^{-24}	sec/(semi-circle) ²	M
α_3	8	2^{-24}	sec/(semi-circle) ³	M
β_0	8	2^{11}	seconds	M
β_1	8	2^{14}	sec/semi-circle	M
β_2	8	2^{16}	sec/(semi-circle) ²	M
β_3	8	2^{16}	sec/(semi-circle) ³	M

GANSS Earth Orientation Parameters

The GANSS Earth Orientation Parameters provides parameters to construct the ECEF and ECI coordinate transformation as defined in [12] and are shown in Table A.35.b. GANSS Earth Orientation Parameters indicate the relationship between the Earth's rotational axis and WGS-84 reference system.

Table A.35.b: GANSS Earth Orientation Parameters

Parameter	# Bits	Scale Factor	Units	Incl.
t_{EOP}	16	2^4	seconds	M
PM_X	21	2^{-20}	arc-seconds	M
PM_X_dot	15	2^{-21}	arc-seconds/day	M
PM_Y	21	2^{-20}	arc-seconds	M
PM_Y_dot	15	2^{-21}	arc-seconds/day	M
$\Delta UT1$	31	2^{-24}	seconds	M
$\Delta UT1_dot$	19	2^{-25}	seconds/day	M

A.4.2.6.2 GANSS Generic Assistance Data

GANSS Generic Assistance data elements contain Information Elements that are applied on one specific GNSS at a time indicated by GANSS_ID. The format of the IE's remains the same regardless of the GANSS; only the values of the parameters and inclusion of certain optional fields will vary.

GANSS Generic Assistance Data is repeated for each GNSS included in GANSS Assistance Data. GANSS Generic Assistance Data can contain one or more of the elements listed in Table A.39 below. As Table A.39 shows, all fields are optional.

Table A.39: GANSS Generic Assistance Data content

Element	Presence	Repetition
GANSS ID	O (note 1)	Yes
GANSS Time Model	O	Yes
DGANSS Corrections	O	Yes
GANSS Navigation Model	O	Yes
GANSS Real-Time Integrity	O	Yes
GANSS Data Bit Assistance	O	Yes
GANSS Reference Measurement Information	O	Yes
GANSS Almanac Model	O	Yes
GANSS UTC Model	O	Yes
GANSS Ephemeris Extension	O	Yes
GANSS Ephemeris Ext Check	O	Yes
SBAS ID	O	Yes
GANSS Additional UTC Model	O	Yes
GANSS Auxiliary Information	O	Yes
NOTE 1: Absence of this field means Galileo.		

GANSS_ID

This field indicates the GNSS for which the following assistance data IE's in GANSS Generic Assistance Data element are dedicated. The supported GANSS are listed in Table A.40. Absence of this field indicates Galileo. If GANSS ID indicates SBAS, the SBAS ID shall be included to indicate the specific SBAS addressed.

Range: 0 - 7

Table A.40: GANSS_ID

GANSS_ID	Indication
SBAS	0
Modernized GPS	1
QZSS	2
GLONASS	3
Reserved for future use	4-7

GANSS Time Model

This field specifies a model to relate GNSS system time to a selected time reference. GNSS Time Offset ID (GNSS_TO_ID) identifies the GNSS for which the relation is provided.

The SMLC may send multiple GANSS Time Models (up to 7) for a specific GNSS depending on the number of the allowed satellite systems in GANSS Positioning Method. For example, the SMLC may send two GANSS Time Models for Galileo to give the relations between Galileo and two GNSS system times.

Table A.41: GANSS Time Model

Parameter	# Bits	Scale Factor	Range	Units	Incl.
GANSS Time Model Reference Time	16	2^4	0 - 604784	s	M
T_{A0}	32	2^{-35}		sec	M
T_{A1}	24	2^{-51}		sec/sec	O
T_{A2}	7	2^{-68}		sec/sec ²	O
GNSS_TO_ID	3	---	---	---	M
Week Number	13	1	0 - 8191	week	O

GANSS Time Model Reference Time

This field specifies the reference time of week for GANSS Time Model and it is given in GNSS specific system time.

Range: 0 604784 seconds

$T_{A0}/T_{A1}/T_{A2}$

These fields specify the GANSS Time Model for a specific GNSS system by constant and first and second order terms of polynomial. The first and second order terms are optional.

GNSS_TO_ID

This field specifies GNSS Time Offset ID. GANSS Time Model contains parameters to convert GNSS System Time from the system indicated by GANSS_ID to GNSS System Time indicated by GNSS_TO_ID. The conversion is defined in [12,13,14].

Table A.42: GNSS_TO_ID

GNSS_TO_ID	Indication
GPS	0
GALILEO	1
QZSS	2
GLONASS	3
Reserved for future use	4-7

Week Number

This field specifies the reference week of GANSS Time Model given in GNSS specific system time. This field is optional.

DGANSS Corrections

These fields specify the DGANSS corrections to be used by the MS.

Table A.43: DGANSS Corrections

Parameter	# Bits	Scale Factor	Range	Units	Incl.
The following fields occur once per message					
DGANSS Reference Time	7	30	0 - 3570	seconds	M
N_SGN_TYPE	2	1	1 - 3	---	M
The following fields occur once per GNSS signal type (N_SGN_TYPE times)					
GANSS_Signal_ID	3	---	---	---	M
Status/Health	3	1	0 - 7	---	M
N_SAT	4	1	1 - 16	---	M
The following fields occur once per satellite (N_SAT times)					
SV_ID	6	---	0...63	---	M
IOD	10	---	---	---	M
UDRE	2	---	0 - 3	---	M
PRC	12	0.32	±655.04	meters	M
RRC	8	0.032	±4.064	meters/sec	M

DGANSS Reference Time

This field indicates the baseline time for which the DGANSS corrections are valid as modulo 3600 s. DGANSS Reference Time is given in GNSS system time.

Range: 0 - 3600 s

N_SGN_TYPE

This field indicates the number of GNSS signal types included in DGANSS Corrections IE.

Range: 1 - 3

GANSS_Signal_ID

DGANSS corrections are provided per GNSS signal type identified by GANSS_Signal_ID. The supported signals are listed in Table A.59.

Status/Health

This field indicates the status of the differential corrections contained in the broadcast message. The values of this field and their respective meanings are shown below in Table A.44.

Table A.44: Values of Status/Health IE

Code	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

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 message. 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. In the later case, the message shall contain no corrections for individual satellites. Any MS that receives DGNSS Corrections in a GANSS Assistance Data IE shall contain the appropriate logic to properly interpret this condition and look for the next IE.

N_SAT

This field indicates the number of satellites (per specified GANSS_Signal_ID) for which differential corrections are included in this element.

Range: 1 - 16

SV_ID

The SV ID is an index number for a satellite. The interpretation of SV ID is defined in Table A.10.14.

Issue Of Data

Issue of Data field contains the identity for the GANSS Navigation Model, as defined in Table A.48.2 (i.e., excluding the IOD_MSB, if applicable for the particular GANSS or signal).

User Differential Range Error (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 common Corrections Status/Health field to determine the final UDRE estimate for the particular satellite. The meanings of the values for this field are described in Table A.45.

Table A.45: Values of UDRE IE

Value	Indication
00	$UDRE \leq 1.0 \text{ m}$
01	$1.0 \text{ m} < UDRE \leq 4.0 \text{ m}$
10	$4.0 \text{ m} < UDRE \leq 8.0 \text{ m}$
11	$8.0 \text{ m} < UDRE$

Each UDRE value shall be adjusted based on the operation of an Integrity Monitor (IM) function which exists at the network (SMLC, GPS server, or reference GPS receiver itself). Positioning errors derived at the IM which are excessive relative to DGPS expected accuracy levels shall be used to scale the UDRE values to produce consistency.

Pseudo-Range Correction (PRC)

This field indicates the correction to the pseudorange for the particular satellite at DGANSS Reference Time, t_0 . The value of this field is given in meters (m) and the resolution is 0.32, as shown in Table A.43 above. The method of calculating this field is described in [9].

If the SMLC has received a request for GANSS assistance data from an MS which included a request for the navigation models and DGANSS (i.e., bit J and M are set to one in 'Requested GANSS Assistance Data, see 3GPP TS 49.031), the SMLC shall determine, for each satellite, if the navigation model stored by the MS is still suitable for use with DGANSS corrections (also see navigation model update conditions right before Table A.46) and if so and if DGANSS corrections are supported the SMLC should send DGANSS corrections without including the 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 pseudo-range correction shall correspond to the available navigation model (the one already stored in and identified by the MS or the one included in the same procedure as the pseudo-range correction). The MS shall only use the PRC 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 GANSS ID indicates GLONASS).

Pseudo-Range Rate Correction (RRC)

This field indicates the rate-of-change of the pseudorange correction for the particular satellite, using the satellite ephemeris and clock corrections identified by the IOD IE. The value of this field is given in meters per second (m/sec) and the resolution is 0.032, as shown in table A.43 above. For some time $t_1 > t_0$, the corrections for IOD are estimated by

$$\text{PRC}(t_1, \text{IOD}) = \text{PRC}(t_0, \text{IOD}) + \text{RRC}(t_0, \text{IOD}) \cdot (t_1 - t_0) ,$$

and the MS uses this to correct the pseudorange it measures at t_1 , $\text{PR}_m(t_1, \text{IOD})$, by

$$\text{PR}(t_1, \text{IOD}) = \text{PR}_m(t_1, \text{IOD}) + \text{PRC}(t_1, \text{IOD}) .$$

The SMLC shall always send the RRC value that corresponds to the PRC value that it sends (see above for details). The MS shall only use the RRC value when the IOD value received matches its available navigation model.

GANSS Navigation Model

This set of fields contains information required to manage the transfer of precise navigation data to the GANSS-capable MS. In response to a request from a MS for GANSS Assistance Data, the SMLC shall determine whether to send the navigation model for a particular satellite to an MS based upon factors like the T-Toe limit specified by the MS and any request from the MS for DGANSS (also see above). This information includes control bit fields as well as satellite ephemeris and clock corrections and clock and orbit accuracy models. GANSS Orbit Model can be given in Keplerian parameters or as state vector in Earth-Centered Earth-Fixed coordinates, dependent on the GANSS-ID and the MS capabilities. The meaning of these parameters is defined in relevant ICDs of the particular GANSS and GNSS specific interpretations apply. For example, Modernized GPS and QZSS use the same model parameters but some parameters have a different interpretation [16].

GANSS Navigation Model element can contain data up to at most 32 satellites. The individual fields are given in Table A.46 and the conditions for their presence is discussed below.

Table A.46: GANSS Navigation Model contents

Parameter	# Bits	Scale Factor	Units	Incl.
Navigation Model Flow Control (once per message)				
Num_Sat	5	1	---	M
Non-Broadcast Indication	1	---	---	M
The following fields occur once per satellite (Num_Sat times)				
SV ID	6	---	---	M
SV Health	5	---	---	M
IOD	10	---	---	M
GANSS Clock Model	See Table A.49.1	---	---	M
GANSS Orbit Model	See Table A.49.2	---	---	M
SV Health_MSB	1	---	---	O
IOD_MSB	1	---	---	O

Num_Sat

This field specifies the number of satellites that are included in the provided GANSS Navigation Model element. A range of 1-32 is available. This field is mandatory when the GANSS Navigation Model field is included in the GANSS Assistance Data message.

Non-Broadcast Indication

This field indicates if the GANSS Navigation Model Elements are not derived from satellite broadcast data or are given in a format not native to the GANSS.

Table A.47: Values of Non-Broadcast Indication Flag

Value	Non-Broadcast Indication
0	GANSS Navigation Data elements corresponding with broadcasted data
1	GANSS Navigation Data element not derived from satellite broadcast

SV_ID

The field specifies the SV/Slot ID for which the GANSS Navigation Model Elements is given. The interpretation of SV ID is defined in Table A.10.14.

Range: 0 - 63

SV Health and SV Health_MSB

This parameter gives information about the satellite's current health. The health values are GNSS system specific. The SV Health bits have the encoding as in Table A.48.1 for a particular GANSS. The SV Health_MSB may be present for some GANSS or signals as defined in Table A.48.1. If SV Health_MSB is present, the total SV Health information is created by appending the SV Health field to the SV Health_MSB field.

Table A.48.1: Interpretation SV Health Bits

GANSS	SV Health_MSB	SV Health Bit String(5)				
		Bit 1 (MSB)	Bit 2	Bit 3	Bit 4	Bit 5 (LSB)
Galileo [11, pages 75-76]	--- ⁽¹⁾	E5a Data Validity Status	E5b Data Validity Status	E1-B Data Validity Status	E5a Signal Health Status See [11], Table 67	
Modernized GPS ⁽²⁾	--- ⁽¹⁾	L1C Health [14]	L1 Health [12,13]	L2 Health [12,13]	L5 Health [12,13]	'0' (reserved)
SBAS ⁽³⁾	--- ⁽¹⁾	Ranging On (0), Off(1)	Corrections On (0), Off (1)	Integrity On (0), Off(1)	'0' (reserved)	'0' (reserved)
QZSS QZS-L1 ⁽⁴⁾	MSB of SV Health [16]	5 LSBs of SV Health [16]				
QZSS QZS- L1C/L2C/L5 ⁽⁵⁾	--- ⁽¹⁾	L1C Health [16]	L1 Health [16]	L2 Health [16]	L5 Health [16]	'0' (reserved)
GLONASS	--- ⁽¹⁾	B _n (MSB) [17, page 23]	F _T [17, Table 4.4]			

Note 1: The SV Health_MSB field shall not be present in GANSS Navigation Model for these GANSS or GANSS signals.
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: SV Health in case of GANSS ID indicates SBAS includes the 5 LSBs of the Health included in GEO Almanac Message Parameters (Type 17) [15].
Note 4: If GANSS ID indicates 'QZSS', and GANSS Orbit Model-2 is included, this interpretation of SV Health applies.
Note 5: If GANSS ID indicates 'QZSS', and GANSS Orbit Model-3 is included, this interpretation of SV Health applies.

Issue Of Data

Issue of Data field contains the identity for GANSS Navigation Model. The IOD_MSB may be present for some GANSS or signals as defined in Table A.48.2a. If IOD_MSB is present, the total IOD information is constructed as defined in Table A.48.2a.

In the case of broadcasted Galileo ephemeris, the IOD contains the IOD index as described in [11].

In case of broadcasted Modernized GPS ephemeris, the IOD contains the 11-bit parameter t_{oe} as defined in [12, Table 30-I] [14, Table 3.5-1] and is constructed using IOD and IOD_MSB fields.

In case of broadcasted SBAS ephemeris, the IOD contains the 8 bits Issue of Data as defined in [15] Message Type 9.

In case of broadcasted QZSS QZS-L1 ephemeris, the IOD contains the IODC as described in [16].

In case of broadcasted QZSS QZS-L1C/L2C/L5 ephemeris, the IOD contains the 11-bit parameter t_{oe} as defined in [16] and is constructed using IOD and IOD_MSB fields.

In case of broadcasted GLONASS ephemeris, the IOD contains the parameter t_b as defined in [17].

Table A.48.2: Interpretation of Issue Of Data

GANSS	Parameter	# Bits	Scale Factor	Range	Units
Galileo	IOD	10	--	0-1023	--
Modernized GPS ⁽¹⁾	LSBs of t_{oe}	10	300	0-306900	seconds
SBAS	IOD	8	--	0-255	--
QZSS – QZS-L1 ⁽²⁾	IODC	10	--	0-1023	--
QZSS – QZS- L1C/L2C/L5 ⁽¹⁾⁽³⁾	LSBs of t_{oe}	10	300	0-306900	seconds
GLONASS	t_b	7	15	15-1425	minutes

Note 1: The MSB of t_{oe} is provided in IOD_MSB field.
Note 2: If GANSS ID indicates 'QZSS', and GANSS Clock and Orbit Model-2 are included, this interpretation of IOD applies.
Note 3: If GANSS ID indicates 'QZSS', and GANSS Clock and Orbit Model-3 are included, this interpretation of IOD applies

Table A.48.2a: Interpretation of IOD_MSB

GNSS⁽¹⁾	IOD_MSB	Scale Factor	Units	Comment
Modernized GPS	MSB of t_{oe}	307200	seconds	The full t_{oe} is constructed as "MSB of t_{oe} " x 307200 + "LSBs of t_{oe} " x 300 (Effective range of full t_{oe} is 0-604500 seconds)
QZSS – QZS-L1C/L2C/L5	MSB of t_{oe}	307200	seconds	The full t_{oe} is constructed as "MSB of t_{oe} " x 307200 + "LSBs of t_{oe} " x 300 (Effective range of full t_{oe} is 0-604500 seconds)
Note 1: The IOD_MSB field shall not be present in GNSS Navigation Model for GNSS or GNSS signals not defined in this Table.				

GNSS Clock Model

GNSS clock model (Model-1) contains one or two clock model elements depending on the GNSS. Clock Model-1 shall be included once or twice depending on the MS capability.

If the MS is supporting multiple Galileo signals, SMLC shall include both F/Nav and I/Nav clock models in GNSS Clock Model IE if the SMLC assumes the MS to perform Location Information calculation using multiple signals. The MS capabilities to support multiple GNSS frequencies are indicated in the Positioning Capability Response element (clause A.8). Otherwise, SMLC shall include only the model suitable for the GNSS.

Table A.49.1: GANSS Clock Model

Parameter	# Bits	Scale Factor	Units	Incl.
One of the following models can be included:				
Model-1:				
Standard Satellite Clock Model (can occur multiple times per model, N_CLOCK, if selected)				
t_{oc}	14 ⁽¹⁾	60	sec	C ⁽¹⁾
af_2	12	2 ⁻⁶⁵ , if GANSS_ID indicates Galileo	sec/sec ²	C ⁽¹⁾
af_1	18	2 ⁻⁴⁵	sec/sec	C ⁽¹⁾
af_0	28	2 ⁻³³	sec	C ⁽¹⁾
T_{GD}	10	2 ⁻³² , if GANSS_ID indicates Galileo	sec	O ⁽¹⁾
Model ID	1	---	---	O
Model-2:				
NAV Clock Model				
t_{oc}	16	2 ⁴	seconds	C ⁽¹⁾
af_2	8	2 ⁻⁵⁵	sec/sec ²	C ⁽¹⁾
af_1	16	2 ⁻⁴³	sec/sec	C ⁽¹⁾
af_0	22	2 ⁻³¹	seconds	C ⁽¹⁾
T_{GD}	8	2 ⁻³¹	seconds	C ⁽¹⁾
Model-3:				
CNAV/CNAV-2 Clock Model				
t_{oc}	11	300	seconds	C ⁽¹⁾
t_{op}	11	300	seconds	C ⁽¹⁾
URA _{oc} Index	5	---	---	C ⁽¹⁾
URA _{oc1} Index	3	---	---	C ⁽¹⁾
URA _{oc2} Index	3	---	---	C ⁽¹⁾
a_{f2-n}	10	2 ⁻⁶⁰	sec/sec ²	C ⁽¹⁾
a_{f1-n}	20	2 ⁻⁴⁸	sec/sec	C ⁽¹⁾
a_{f0-n}	26	2 ⁻³⁵	seconds	C ⁽¹⁾
T_{GD}	13	2 ⁻³⁵	seconds	C ⁽¹⁾
ISC _{L1CP}	13	2 ⁻³⁵	seconds	O ⁽²⁾
ISC _{L1CD}	13	2 ⁻³⁵	seconds	O ⁽²⁾
ISC _{L1C/A}	13	2 ⁻³⁵	seconds	O ⁽³⁾
ISC _{L2C}	13	2 ⁻³⁵	seconds	O ⁽³⁾
ISC _{L5I5}	13	2 ⁻³⁵	seconds	O ⁽⁴⁾
ISC _{L5Q5}	13	2 ⁻³⁵	seconds	O ⁽⁴⁾
Model-4:				
GLONASS Satellite Clock Model				
$\tau_n(t_b)$	22	2 ⁻³⁰	seconds	C ⁽¹⁾
$\gamma_n(t_b)$	11	2 ⁻⁴⁰	---	C ⁽¹⁾
$\Delta\tau_n$	5	2 ⁻³⁰	seconds	O
Model-5:				
SBAS Satellite Clock Model				
t_0	13	16	seconds	C ⁽¹⁾
a_{Gfo}	12	2 ⁻³¹	seconds	C ⁽¹⁾
a_{Gf1}	8	2 ⁻⁴⁰	Seconds/sec	C ⁽¹⁾
NOTE 2: Both of these fields shall be present together, or none of them shall be present.				
NOTE 3: Both of these fields shall be present together, or none of them shall be present.				
NOTE 4: Both of these fields shall be present together, or none of them shall be present.				

Model ID

This field specifies the identity of the clock model according to Table A.49.1a. This field is optional.

Table A.49.1a: Galileo Clock Model Identity

Value	Identity
0	I/Nav
1	F/Nav

GANSS Orbit Model

GANSS Orbit Model IE contains the following presentation: Satellite Navigation Model Using Keplerian Parameters or Satellite Navigation Model Using Earth-Centered, Earth-fixed Parameters as described in Table A.49.2.

Table A.49.2: GANSS Orbit Model

Parameter	# Bits	Scale Factor	Units	Incl.
One of the following models can be included:				
Model-1:				
Satellite Navigation Model Using Keplerian Parameters				
t_{oe}	14 ^(u)	60	sec	C
ω	32	2^{-31}	semi-circles	C
Δn	16	2^{-43}	semi-circles/sec	C
M_0	32	2^{-31}	semi-circles	C
OMEGAdot	24	2^{-43}	semi-circles/sec	C
e	32 ^(u)	2^{-33}	---	C
ldot	14	2^{-43}	semi-circles/sec	C
sqrtA	32 ^(u)	2^{-19}	meters ^{1/2}	C
i_0	32	2^{-31}	semi-circles	C
OMEGA ₀	32	2^{-31}	semi-circles	C
C _{rs}	16	2^{-5}	meters	C
C _{is}	16	2^{-29}	radians	C
C _{us}	16	2^{-29}	radians	C
C _{rc}	16	2^{-5}	meters	C
C _{ic}	16	2^{-29}	radians	C
C _{uc}	16	2^{-29}	radians	C
Model-2:				
Satellite Navigation Model Using NAV Keplerian Parameters				
URA Index	4	--	--	C
Fit Interval Flag	1	--	Boolean	C
t_{oe}	16	2^4	sec	C
ω	32	2^{-31}	semi-circles	C
Δn	16	2^{-43}	semi-circles/sec	C
M_0	32	2^{-31}	semi-circles	C
OMEGAdot	24	2^{-43}	semi-circles/sec	C
e	32 ^(u)	2^{-33}	---	C
ldot	14	2^{-43}	semi-circles/sec	C
sqrtA	32 ^(u)	2^{-19}	meters ^{1/2}	C
i_0	32	2^{-31}	semi-circles	C
OMEGA ₀	32	2^{-31}	semi-circles	C
C _{rs}	16	2^{-5}	meters	C
C _{is}	16	2^{-29}	radians	C
C _{us}	16	2^{-29}	radians	C
C _{rc}	16	2^{-5}	meters	C
C _{ic}	16	2^{-29}	radians	C
C _{uc}	16	2^{-29}	radians	C
Model-3:				
Satellite Navigation Model Using CNAV/CNAV-2 Keplerian Parameters				
t_{op}	11	300	seconds	C
URA _{oe} Index	5	---	---	C
ΔA	26	2^{-9}	meters	C
A_dot	25	2^{-21}	meters/sec	C
Δn_0	17	2^{-44}	semi-circles/sec	C
Δn_0_dot	23	2^{-57}	semi-circles/sec ²	C
M_{0-n}	33	2^{-32}	semi-circles	C
e_n	33	2^{-34}	---	C
ω_n	33	2^{-32}	semi-circles	C
Ω_{0-n}	33	2^{-32}	semi-circles	C
$\Delta \Omega_dot$	17	2^{-44}	semi-circles/sec	C
i_{0-n}	33	2^{-32}	semi-circles	C
i_{0-n_dot}	15	2^{-44}	semi-circles/sec	C
C _{is-n}	16	2^{-30}	radians	C
C _{ic-n}	16	2^{-30}	radians	C
C _{rs-n}	24	2^{-8}	meters	C
C _{rc-n}	24	2^{-8}	meters	C
C _{us-n}	21	2^{-30}	radians	C
C _{uc-n}	21	2^{-30}	radians	C
Model-4:				
Satellite Navigation Model Using GLONASS Earth-Centered, Earth-fixed Parameters				

E_n	$5^{(u)}$	1	days	C
P1	$2^{(u)}$	--	---	C
P2	$1^{(u)}$	1	---	C
M	$2^{(u)}$	1	---	O
$x_n(t_b)$	27	2^{-11}	kilometers	C
$\dot{x}_n(t_b)$	24	2^{-20}	kilometres/second	C
$\ddot{x}_n(t_b)$	5	2^{-30}	kilometres/second ²	C
$y_n(t_b)$	27	2^{-11}	kilometers	C
$\dot{y}_n(t_b)$	24	2^{-20}	kilometres/second	C
$\ddot{y}_n(t_b)$	5	2^{-30}	kilometres/second ²	C
$z_n(t_b)$	27	2^{-11}	kilometers	C
$\dot{z}_n(t_b)$	24	2^{-20}	kilometres/second	C
$\ddot{z}_n(t_b)$	5	2^{-30}	kilometres/second ²	C
Model-5:				
Satellite Navigation Model Using SBAS Earth-Centered, Earth-fixed Parameters				
t_0	13	16	seconds	O ⁽¹⁾
Accuracy	4	--	--	C
X_G	30	0.08	meters	C
Y_G	30	0.08	meters	C
Z_G	25	0.4	meters	C
X_G Rate-of-Change	17	0.000625	meters/sec	C
Y_G Rate-of-Change	17	0.000625	meters/sec	C
Z_G Rate-of-Change	18	0.004	meters/sec	C
X_G Acceleration	10	0.0000125	meters/sec ²	C
Y_G Acceleration	10	0.0000125	meters/sec ²	C
Z_G Acceleration	10	0.0000625	meters/sec ²	C
Note 1: If GANSS Clock Model-5 is not included, this field shall be present.				
NOTE u: unsigned parameter				

GANSS Real-Time Integrity

Integrity Monitor (IM) shall detect unhealthy (e.g., failed/failing) satellite signals and also shall inform users of measurement quality in DGNSS modes when satellite signals are healthy. Excessively large pseudo range errors, as evidenced by the magnitude of the corresponding DGNSS correction, shall be used to detect failed satellite signals. Unhealthy satellite signals should be detected within 10 seconds of the occurrence of the satellite signal failure. When unhealthy (e.g., failed/failing) satellite signals are detected, the assistance and/or DGNSS correction data shall not be supplied for these satellite signals. When the error in the IM computed position is excessive for solutions based upon healthy satellite signals only, DGNSS users shall be informed of measurement quality through the supplied UDRE values. After bad satellite signals have been indicated in the Real Time Integrity field, if the satellite signals return to healthy condition for some period of time, the indications for them shall be removed from this field.

GANSS Real-Time Integrity field of the GANSS Assistance Data Information Element contains parameters that describe the real-time status of the GANSS constellations. Primarily intended for non-differential applications, the real-time integrity of the satellite constellation is of importance as there is no differential correction data by which the mobile can determine the soundness of each satellite signal. GANSS Real-Time Integrity data communicates the health of the GNSS signals to the mobile in real-time. The format is shown in Table A.50. The SMLC shall always transmit the GANSS Real Time Integrity field with the current list of unhealthy signals, for any GANSS positioning attempt and whenever GANSS Assistance Data is sent. If the number of bad signals (NBS) is zero, then the GANSS Real Time Integrity field shall be omitted.

Table A.50: GANSS Real-Time Integrity

Parameter	# Bits	Scale Factor	Range	Units	Incl.
The following fields occur once per SV with bad signal (NBS times)					
Bad_GNSS_SV_ID	6	1	---	---	M
Bad_GNSS_Signal_ID	8	1	---	---	O

NBS (Number of satellites with bad signal)

The NBS value indicates the number of satellites with bad signal.

Bad_GNSS_SV_ID

This field specifies the SV ID of the satellite with bad signal or signals. The interpretation of SV ID is defined in Table A.10.14.

Bad_GNSS_Signal_ID

This field identifies the bad signal of a satellite. Absence of this field means that all signals on the specific SV are bad. The interpretation of Bad_GNSS_Signal_ID is listed in Table A.59. If the satellite in question belongs to the modernized GPS constellation and has some healthy signals but bad L1C/A signal, Bad_GNSS_Signal_ID shall be present but may have all the bits set to '0'. Status of L1C/A signal shall be indicated with Real-Time Integrity IE in GPS Assistance Data Element.

GANSS Data Bit Assistance

This element provides data bit assistance data for specific satellite signals for data wipe-off. The data bits included in the assistance data depends on the GANSS and its signal.

Table A.51: GANSS Data Bit Assistance

Parameter	Bits	Resolution	Range	Incl.
GANSS TOD	6	1	0 – 59	M
The following fields occur once per satellite (N_SAT times)				
SV ID	6	1	---	M
The following fields occur once per signal (N_SGN times)				
GANSS_Signal_ID	3	1	0 - 7	M
N_BIT	10	1	1 – 1024	M
Data Bits	N_BIT	---	---	M

GANSS TOD

This field indicates the reference time of the first bit of the data in GANSS Data Bit Assistance in integer seconds in GNSS specific system time.

Data Bit Reference Time is given as modulo 60 s from GANSS TOD.

N_SAT

This field specifies the number of satellites in GANSS Data Bit Assistance element.

SV_ID

The field specifies the SV for which the GANSS Data Bit Assistance is given. The interpretation of SV ID is defined in Table A.10.14.

Range: 0 – 63

N_SGN

This field specifies the number of signals for which GANSS Data Bit Assistance is provided.

Range: 1 – 8

GANSS_Signal_ID

This field specifies the GANSS signal type of the GANSS Data Bit Assistance as listed in Table A.59.

N_BIT

This field indicates the number of bits (or symbols) included in the IE.

Data Bits

Data bits are contained in GNSS system and data type specific format.

In case of Galileo, it contains the FEC encoded and interleaved modulation symbols. The logical levels 1 and 0 correspond to signal levels -1 and +1, respectively. In case of Modernized GPS L1C, it contains the encoded and interleaved modulation symbols as defined in [14] section 3.2.3.1.

In case of Modernized GPS L2C, it contains either the NAV data modulation bits, the FEC encoded NAV data modulation symbols, or the FEC encoded CNAV data modulation symbols, dependent on the current signal configuration of this satellite as defined in [12, Table 3-III].

In case of Modernized GPS L5, it contains the FEC encoded CNAV data modulation symbols as defined in [13].

In case of SBAS, it contains the FEC encoded data modulation symbols as defined in [15].

In case of QZSS QZS-L1, it contains the NAV data modulation bits as defined in [16] section 5.2. In case of QZSS QZS-L1C, it contains the encoded and interleaved modulation symbols as defined in [16] section 5.3. In case of QZSS QZS-L2C, it contains the encoded modulation symbols as defined in [16] section 5.5. In case of QZSS QZS-L5, it contains the encoded modulation symbols as defined in [16] section 5.6.

In case of GLONASS, it contains the 100 sps differentially Manchester encoded modulation symbols as defined in [17] section 3.3.2.2.

GANSS Reference Measurement Information

This field provides reference code and Doppler measurement information of visible satellites of a GANSS constellation. The information can be used as acquisition assistance to improve the sensitivity of the receiver.

These parameters describe the range and optionally the derivatives from respective satellites to the GANSS Reference Location at the GANSS Reference Time. The code phase and Doppler fields are aligned with the time provided in GANSS Reference Time. Figure A.4a illustrates the relation between some of the fields with respect to the GANSS TOD.

If GPS Acquisition Assistance is included the Reference Time included in the GPS Acquisition Assistance is also valid for the GANSS Reference Measurement fields and the parameters are referenced to GPS TOW. Figure A.4b illustrates the relation between some of the fields with respect to GPS TOW.

The parameters are given in units of ms and m/s which makes it possible to convert the values to any nominal frequency and chipping and code rate.

Table A.52: GANSS Reference Measurement Information Contents

Parameter	Range	Bits	Resolution	Incl.
GANSS_Signal_ID	0 - 7	3	---	M
The following fields occur once per satellite (Num_Sat times)				
SV_ID	0 - 63	6		M
Doppler (0 th order term)	-1024 m/s to 1023.5 m/s	12	0.5 m/s	M
Doppler (1 st order term)	-0.2 - 0.1 m/s ² .	6	1/210 m/s ² .	O ⁽¹⁾
Doppler Uncertainty	2.5 m/s - 40 m/s [2 ⁻ⁿ (40) m/s, n = 0 - 4]	3	---	O ⁽¹⁾
Code Phase	0 - (1-2 ⁻¹⁰) ms	10	2 ⁻¹⁰ ms	M
Integer Code Phase	0 - 127 ms	7	1 ms	M
Code Phase Search Window	See Table A.53	5	---	M
Azimuth	0 - 348.75 deg	5	11.25 deg	O ⁽²⁾
Elevation	0 - 78.75 deg	3	11.25 deg	O ⁽²⁾
NOTE 1,2: All of these fields shall be present together, or none of them shall be present.				

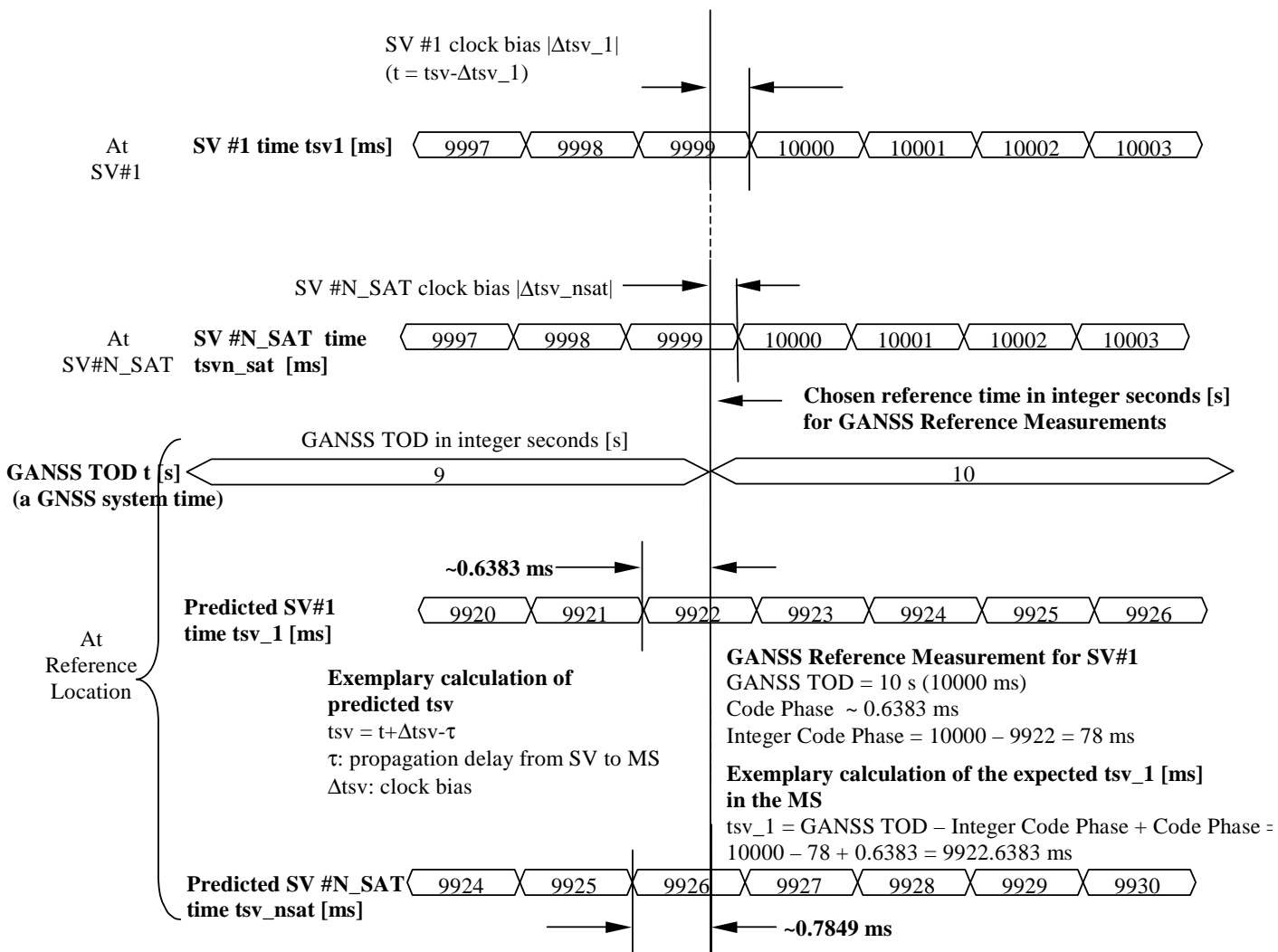


Figure A.4a. Exemplary calculations of some GANSS Reference Measurement fields with respect to GANSS TOD.

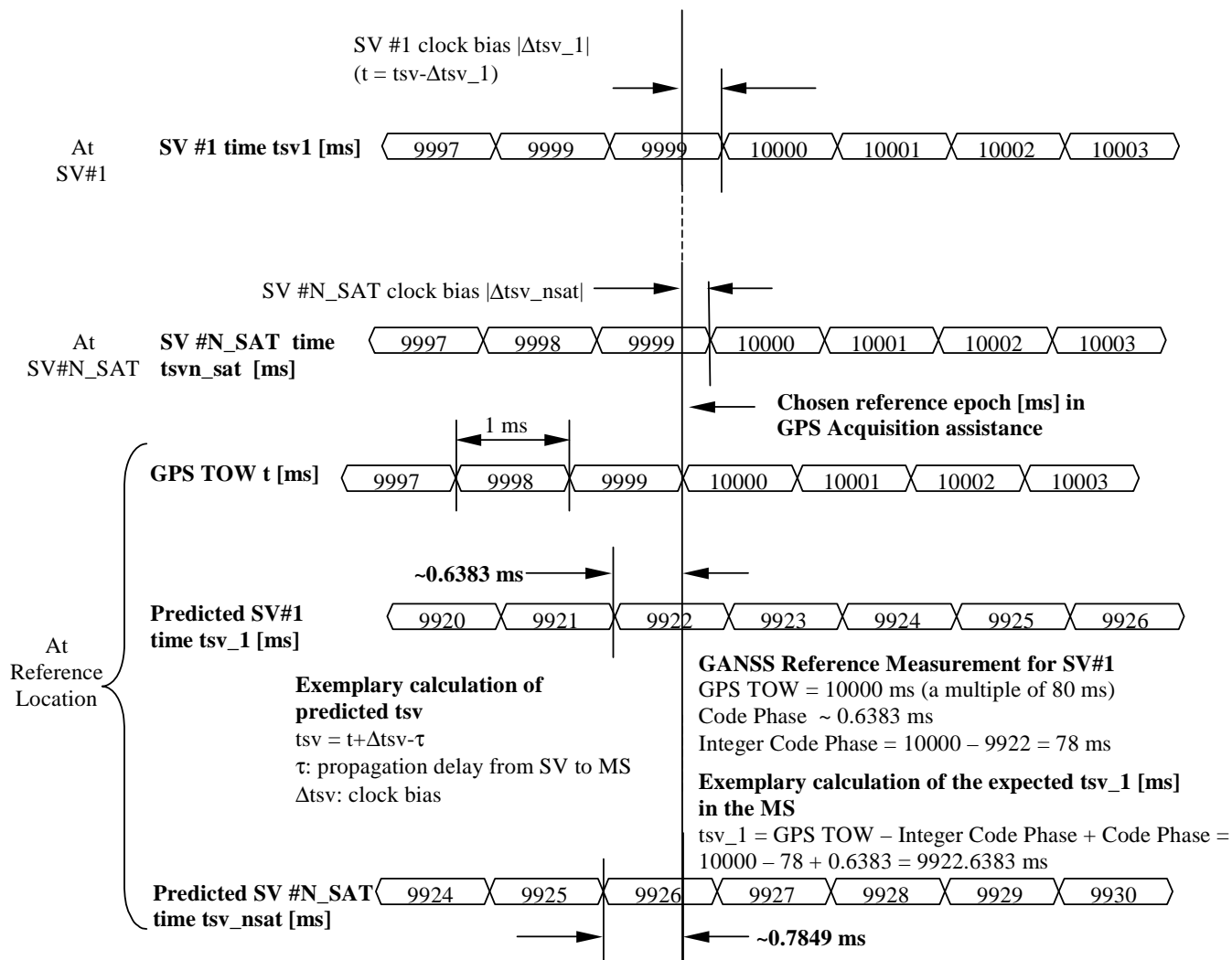


Figure A.4b. Exemplary calculations of some GANSS Reference Measurement fields with respect to GPS TOW.

GANSS_Signal_ID

This field specifies the GNSS signal type. The supported signals are listed in Table A.59.

Num_Sat

This field specifies the number of satellites in GANSS Reference Measurement Information element.

SV_ID

This field specifies the SV for which the GANSS Reference Measurement Assistance is given. The interpretation of SV ID is defined in Table A.10.14.

Range: 0 – 63

Doppler (0th order term)

This field contains the Doppler (0th order term) value. A positive value in Doppler defines the increase in satellite signal frequency due to velocity towards the MS. A negative value in Doppler defines the decrease in satellite signal frequency due to velocity away from the MS.

Doppler is given in unit of m/s by multiplying the Doppler value in Hz by the *nominal* wavelength of the assisted signal.

This field is mandatory.

Doppler (1st order term)

This field contains the Doppler (1st order term) value. A positive value defines the rate of increase in satellite signal frequency due to acceleration towards the MS. A negative value defines the rate of decrease in satellite signal frequency due to acceleration away from the MS.

Doppler (1st order term) is given in unit of m/s by multiplying the Doppler value in Hz by the *nominal* wavelength of the assisted signal.

This field is optional.

Doppler Uncertainty

This field contains the Doppler uncertainty value. It is defined such that the Doppler experienced by a stationary MS is in the range "Doppler – Doppler Uncertainty" to "Doppler + Doppler Uncertainty". This field is optional. If Doppler Uncertainty (together with Doppler 1st order term) is omitted, the terminal shall interpret Doppler Uncertainty as greater than +/-40 m/s.

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.

Permitted 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 the formula in Table A.52.

Code Phase

This field contains code phase, in units of milliseconds, 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 GANSS Reference Time. The Reference Location would typically be an a priori estimate of the MS location. This field is mandatory.

Range: 0 - $(1-2^{-10})$ ms

Integer Code Phase

This field contains integer code phase (expressed modulo 128 ms) currently being transmitted at the GANSS Reference Time, as seen by a receiver at the Reference Location. This field is mandatory.

Range: 0-127 ms

Code Phase Search Window

This field contains the code phase search window. The code phase search window accounts for the uncertainty in the estimated MS location but not any uncertainty in GANSS 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 milliseconds. This field is mandatory.

Range: 0-31 (i.e. 0.002 - 2,000 ms according to following table)

Table A.53: Code Phase Search Window Parameter Format

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

Azimuth

This field contains the azimuth angle. An angle of x degrees means the satellite azimuth a is in the range $(x \leq a < x+11.25)$ degrees. This field is optional.

Range: 0 - 348.75 degrees.

Elevation

This field contains the elevation angle. An angle of y degrees means the satellite elevation e is in the range $(y \leq e < y+11.25)$ degrees except for $y = 78.75$ where the range is extended to include 90 degrees. This field is optional.

Range: 0 - 78.75 degrees

GANSS Almanac Model

These fields specify the coarse, long-term model of the satellite positions and clocks. These fields are given in Table A.54. The meaning of these parameters is defined in relevant ICDs of the particular GANSS and GNSS specific interpretations apply. For example, Modernized GPS and QZSS use the same model parameters but some parameters have a different interpretation [16].

GANSS Almanac Model is useful for receiver tasks that require coarse accuracy, such as determining satellite visibility. The model is valid for up to few weeks, typically. Since it is a long-term model, the field should be provided for all satellites in the GNSS constellation.

Table A.54: GANSS Almanac Model (per-satellite fields - ⁽¹⁾ = Positive range only)

Parameter	# Bits	Scale Factor	Units	Incl.
The following fields occur once per message				
Num_Sats_Total	6	1	---	M
Week Number	8	1	weeks	M
T _{oa}	8	2 ¹²	s	O (note 1)
IOD _a	2	---	---	O (note 1)
One of the following models can be included:				
Model-1:				
This model occurs once per satellite (Num_Sats_Total times)				
GANSS Almanac Model Using Keplerian Parameters				
SV_ID	6	---	---	M
e	11	2 ⁻¹⁶	dimensionless	M
δi	11	2 ⁻¹⁴	semi-circles	M
OMEGADOT	11	2 ⁻³³	semi-circles/sec	M
SV Health_KP	4	---	dimensionless	M
delta_A ^{1/2}	17	2 ⁻⁹	meters ^{1/2}	M
OMEGA ₀	16	2 ⁻¹⁵	semi-circles	M
ω	16	2 ⁻¹⁵	semi-circles	M
M ₀	16	2 ⁻¹⁵	semi-circles	M
af ₀	14	2 ⁻¹⁹	seconds	M
af ₁	11	2 ⁻³⁸	sec/sec	M
NOTE 1: All of these field shall be present together, or none of them shall be present, if GANSS ID indicates Galileo.				
Model-2:				
This model occurs once per satellite (Num_Sats_Total times)				
GANSS Almanac Model Using NAV Keplerian Parameters				
SV_ID	6	---	---	M
e	16	2 ⁻²¹	dimensionless	M
δi	16	2 ⁻¹⁹	semi-circles	M
OMEGADOT	16	2 ⁻³⁸	semi-circles/sec	M
SV Health	8	---	Boolean	M
A ^{1/2}	24	2 ⁻¹¹	meters ^{1/2}	M
OMEGA ₀	24	2 ⁻²³	semi-circles	M
ω	24	2 ⁻²³	semi-circles	M
M ₀	24	2 ⁻²³	semi-circles	M
af ₀	11	2 ⁻²⁰	seconds	M
af ₁	11	2 ⁻³⁸	sec/sec	M
Model-3:				
This model occurs once per satellite (Num_Sats_Total times)				
GANSS Almanac Model Using Reduced Keplerian Parameters				
SV_ID	6	---	---	M
δ _A	8	2 ⁺⁹	meters	M
Ω ₀	7	2 ⁻⁶	semi-cicles	M
Φ ₀	7	2 ⁻⁶	semi-circles	M
L1 Health	1	---	---	M
L2 Health	1	---	---	M
L5 Health	1	---	---	M

Model-4:				
This model occurs once per satellite (Num_Sats_Total times)				
GANSS Almanac Model Using Midi Keplerian Parameters				
SV_ID	6	---	---	M
e	11	2^{-16}	---	M
δ_i	11	2^{-14}	semi-circles	M
Ω_dot	11	2^{-33}	semi-circles/sec	M
sqrtA	17	2^{-4}	meters ^{1/2}	M
Ω_0	16	2^{-15}	semi-circles	M
ω	16	2^{-15}	semi-circles	M
M_0	16	2^{-15}	semi-circles	M
a_{fo}	11	2^{-20}	seconds	M
a_{fl}	10	2^{-37}	sec/sec	M
L1 Health	1	---	---	M
L2 Health	1	---	---	M
L5 Health	1	---	---	M
Model-5:				
This model occurs once per satellite (Num_Sats_Total times)				
GANSS Almanac Model Using GLONASS Keplerian Parameters				
N^A	11	1	days	M
n^A	5	1	---	M
H_n^A	5	1	---	M
λ_n^A	21	2^{-20}	semi-circles	M
$t_{\lambda n}^A$	21	2^{-5}	seconds	M
Δi_n^A	18	2^{-20}	semi-circles	M
ΔT_n^A	22	2^{-9}	seconds/orbit period	M
$\Delta T_DOT_n^A$	7	2^{-14}	seconds/orbit period ²	M
ϵ_n^A	15	2^{-20}	---	M
ω_n^A	16	2^{-15}	semi-circles	M
τ_n^A	10	2^{-18}	seconds	M
C_n^A	1	1	---	M
M_n^A	2	1	---	O
Model-6:				
This model occurs once per satellite (Num_Sats_Total times)				
GANSS Almanac Model Using SBAS ECEF Parameters				
Data ID	2	1	--	M
SV_ID	6	--	--	M
Health	8	--	--	M
X_G	15	2600	meters	M
Y_G	15	2600	meters	M
Z_G	9	26000	meters	M
X_G Rate-of-Change	3	10	meters/sec	M
Y_G Rate-of-Change	3	10	meters/sec	M
Z_G Rate-of-Change	4	40.96	meters/sec	M
t_0	11	64	seconds	M

Num_Sats_Total

This field specifies the total number of satellites in GANSS Almanac Model.

Range: 1 - 36

Week Number

This field specifies the Almanac reference week number in GNSS specific system time to which the Almanac Reference Time T_{oa} is referenced, modulo 256 weeks. If T_{oa} is not included in GANSS Almanac Model, the MS shall ignore the Week Number.

Range: 0 - 255

T_{oa}

This field specifies the Almanac Reference Time common to all satellites in GANSS Almanac Model Using Keplerian Parameters given in GNSS specific system time.

IOD_a

This field specifies the Issue-Of-Data common to all satellites in GANSS Almanac Model Using Keplerian Parameters.

SV_ID

This field identifies the satellite for which the GANSS Almanac Model is given. The interpretation of SV ID is defined in Table A.10.14.

Range: 0 - 63

SV Health_KP

This field specifies the SV Health status in GANSS Almanac Model Using Keplerian Parameters. In Galileo case this field shall contain the I/NAV health status bits.

GANSS UTC Model

The GANSS UTC Model field contains a set of parameters needed to relate GNSS system time to Universal Time Coordinate (UTC). All of the fields in the GANSS UTC Model are mandatory when the field is present. The UTC time standard, UTC(k), is GNSS specific. E.g., if GANSS ID indicates QZSS, GANSS UTC Model field contains a set of parameters needed to relate QZST to UTC(NICT).

Table A.55: GANSS UTC Model (Model-1)

Parameter	# Bits	Scale Factor	Units	Incl.
A ₁	24	2 ⁻⁵⁰	sec/sec	C
A ₀	32	2 ⁻³⁰	seconds	C
t _{ot}	8	2 ¹²	seconds	C
WN _t	8	1	weeks	C
Δt _{LS}	8	1	seconds	C
WN _{LSF}	8	1	weeks	C
DN	8	1	days	C
Δt _{LSF}	8	1	seconds	C

Reference Nav Model

Table A.55.1: Reference Nav Model

Parameter	# Bits	Scale Factor	Units	Incl.
keplerToe	16	2 ⁴	seconds	M
keplerω	32	2 ⁻³¹	semi-circles	M
keplerDeltaN	16	2 ⁻⁴³	semi-circles/sec	M
keplerM0	32	2 ⁻³¹	semi-circles	M
keplerOmegaDot	27	2 ⁻⁴³	semi-circles/sec	M
keplerE	32	2 ⁻³³	---	M
keplerIDot	14	2 ⁻⁴³	semi-circles/sec	M
keplerAPowerHalf	32	2 ⁻¹⁹	Meters ^{1/2}	M
keplerI0	32	2 ⁻³¹	semi-circles	M
kelerOmega0	32	2 ⁻³¹	semi-circles	M
keplerCrs	16	2 ⁻⁵	meters	M
keplerCis	16	2 ⁻²⁹	radians	M
keplerCus	16	2 ⁻²⁹	radians	M
keplerCrc	16	2 ⁻⁵	meters	M
keplerCic	16	2 ⁻²⁹	radians	M
KeplerCuc	16	2 ⁻²⁹	radians	M

GANSS Ephemeris Extension

The GANSS Ephemeris extension contains parameters designed to extend the time of applicability of the Ephemeris terms by the continuous addition of the delta ephemeris terms to the respective terms of the referenced ephemeris.

This message can provide extension information for every satellite for many days into the future; doing so may create a large message, thus care must be taken to consider the transport bandwidth. The SMLC can limit the duration of the extension to decrease the message size. For example if the extension duration is limited to twelve hours the payload will be approximately 2,000 octets, for a typical 27 satellite constellation.

Table A.55.2: GANSS Ephemeris Extension

Parameter	# Bits	Scale Factor	Units	Incl.
ganssEphemerisHeader	See Table A.55.3		---	O
ganssReferenceSet	See Table A.55.5		---	O
ganssEphemerisDeltaMatrix	List of GANSSEphemerisDeltaEpochs			O

Table A.55.3: GANSS Ephemeris Header

Parameter	# Bits	Scale Factor	Units	Incl.
GANSS Ephemeris Extension (Once per message)				
timeAtEstimation	See Table A.55.4		---	M
validityPeriod	3	1	Hours	M
ephemerisExtensionDuration	9	1	Hours	M

Time at Estimation

The Time at Estimation provides the GANSS time at which the ephemeris extensions were created.

Table A.55.4: Time at Estimation

Parameter	# Bits	Scale Factor	Units	Incl.
GANSS Day of Estimation	13	1	Day	M
GANSS TOD of Estimation	17	1	Seconds	M

GANSS Day of Estimation

This field specifies the sequential number of days from the origin of the GNSS system time indicated by GANSS_TIME_ID modulo 8192 days (about 22 years) of the time that the estimation was determined.

Range: 0 - 8191 days

GANSS TOD of Estimation

Integer number of GANSS TOD seconds within the current day of the time that the estimation was determined.

Range: 0 - 86399 s.

Validity Period

The validityPeriod indicates the validity period of each individual delta ephemeris packet. It is the length of time that ephemeris constructed by application of the delta is intended to last.

Range: 1 – 8 hours.

Ephemeris Extension Duration

The Ephemeris Extension duration indicates the total block of time measured in units of hours that the extended ephemeris covers.

Range: 1 - 512 Hours.

The ganssEphemeris header is mandatory only once in the delivery of the GANSS Ephemeris Extension message

GANSS Reference Set

Table A.55.5: GANSS Reference Set

Parameter	Presence	Note
GANSS Reference Orbit	M	See Table A.55.6

GANSS Reference Orbit**Table A.55.6: GANSS Reference Orbit**

Parameter	# Bits	Scale Factor	Units	Incl.
svID	6	1	---	M
ganssOrbitModel	See Table 55.1		--	M
ganssClockModel	See Table 49.1		--	M

SvID

The satellite vehicle ID identifying to which satellite the following orbital and clock model apply. The interpretation of SV ID is defined in Table A.10.14.

GANSS OrbitModel

This field is a structure that contains the satellite orbit information upon which all subsequent delta information will be applied to create the next ephemeris for use in navigation.

GANSS ClockModel

This field is a structure that contains the satellite clock model upon which all subsequent clock information will be applied to create the next clock model for use in navigation.

GANSA Ephemeris Delta Matrix

GANSS Ephemeris Delta Matrix is a list of GANSS Ephemeris Delta Epochs. Each epoch is indicated by a unique seqNum. Each epoch corresponds to a specific update interval and contains a delta epoch header and ephemeris delta elements for all PRNs for that epoch.

GANSS Ephemeris Delta Epoch**Table A.55.7: GANSS Ephemeris Delta Epoch**

Parameter	Note	Incl.
ganssDeltaEpochHeader	See Table A.55.8	O
ganssDeltaElementList	List of GANSS Ephemeris Delta Elements	M

GANSS Delta Epoch Header**Table A.55.8: GANSS Delta Epoch Header**

Parameter	# Bits	Scale Factor	Units	Incl.
validityPeriod	3	1	Hours	O
ephemerisDeltaSizes	See Table A.55.9			O
ephemerisDeltaScales	See Table A.55.10			O

Validity Period

The validityPeriod indicates the validity period of each individual delta ephemeris packet. It is the length of time that the ephemeris constructed by application of the delta is intended to last.

Range: 1 – 8 hours.

Ephemeris Delta Sizes

This field is a structure that indicates the bit sizes for all the fields in the GANSS Ephemeris Delta structure

Table A.55.9: GANSS Ephemeris Delta Sizes

Parameter	# Bits	Scale Factor	Units	Incl.
bitSize_delta_ω	5	1	---	M
bitSize_delta_Δn	4	1	---	M
bitSize_delta_M0	5	1	---	M
bitSize_delta_ΩEGAdot	5	1	---	M
bitSize_delta_e	5	1	---	M
bitSize_delta_λdot	4	1	---	M
bitSize_delta_sqrtA	5	1	---	M
bitSize_delta_i0	5	1	---	M
bitSize_delta_ΩEGA0	5	1	---	M
bitSize_delta_Crs	4	1	---	M
bitSize_delta_Cis	4	1	---	M
bitSize_delta_Cus	4	1	---	M
bitSize_delta_Crc	4	1	---	M
bitSize_delta_Cic	4	1	---	M
bitSize_delta_Cuc	4	1	---	M
bitSize_delta_tgd1	4	1	---	M
bitSize_delta_tgd2	4	1	---	M

Ephemeris Delta Scales

This field is a structure that indicates the scale factor modifiers for all the fields in the GANSS Ephemeris Delta structure.

Table A.55.10: GANSS Ephemeris Delta Scales

Parameter	# Bits	Scale Factor	Units	Incl.
scale_delta_ω	5	1	---	M
scale_delta_Δn	5	1	---	M
scale_delta_M0	5	1	---	M
scale_delta_ΩEGAdot	5	1	---	M
scale_delta_e	5	1	---	M
scale_delta_λdot	5	1	---	M
scale_delta_sqrtA	5	1	---	M
scale_delta_i0	5	1	---	M
scale_delta_ΩEGA0	5	1	---	M
scale_delta_Crs	5	1	---	M
scale_delta_Cis	5	1	---	M
scale_delta_Cus	5	1	---	M
scale_delta_Crc	5	1	---	M
scale_delta_Cic	5	1	---	M
scale_delta_Cuc	5	1	---	M
scale_delta_tgd1	5	1	---	M
scale_delta_tgd2	5	1	---	M

GANSS Delta Element List

GANSS Delta Element List is a list of GANSS Ephemeris Delta Elements

Ephemeris Delta Element

Each GANSS Ephemeris Delta element is uniquely identified by the pair (seqNum, sv_ID) and it is defined as a structure as shown in table A.55.11. The MS should parse the octet string according to the fields specified in table A.55.4. Each element in table A.55.4 but for seqNum and sv_ID should be treated as a signed integer. Each Ephemeris delta is transmitted as an octet string of up to 49 octets. The actual number of octets is determined by the size of the bit fields in the GPS_Ephemeris_Delta_Sizes table (table A.55.9). Each set of up to 49 octets represents a single extension for a single satellite vehicle. Each set encodes the satellite vehicle ID and the sequence number. The sequence number specifies the order in which the individual ephemeris extension elements are assembled as time marches forward to create the next ephemeris. The sequence number is the same for all satellite vehicle IDs for a particular update period.

Table A.55.11: GANSS Ephemeris Delta Element

Parameter	# Bits	Default # Bits	Scale Factor	Default Scale	Units	Incl.
sequenceNum	7		1	1	---	M
svID	6		1	1	---	M
delta_omega	1..32 (1)	21	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31} (2)$	2^{-31}	semi-circles	M
delta_Delta_n	1..16 (1)	12	$2^{-16} \cdot 2^{-43} \dots 2^{15} \cdot 2^{-43} (2)$	2^{-43}	semi-circles/sec	M
delta_M0	1..32 (1)	21	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31} (2)$	2^{-31}	semi-circles	M
delta_OMEGAdot	1..24 (1)	13	$2^{-16} \cdot 2^{-43} \dots 2^{15} \cdot 2^{-43} (2)$	2^{-43}	semi-circles/sec	M
delta_e	1..32 (1)	18	$2^{-16} \cdot 2^{-33} \dots 2^{15} \cdot 2^{-33} (2)$	2^{-33}	---	M
delta_Idot	1..14 (1)	11	$2^{-16} \cdot 2^{-43} \dots 2^{15} \cdot 2^{-43} (2)$	2^{-43}	semi-circles/sec	M
delta_sqrtA	1..32 (1)	14	$2^{-16} \cdot 2^{-19} \dots 2^{15} \cdot 2^{-19} (2)$	2^{-19}	meters ^{1/2}	M
delta_i0	1..32 (1)	14	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31} (2)$	2^{-31}	semi-circles	M
delta_OMEGA0	1..32 (1)	14	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31} (2)$	2^{-31}	semi-circles	M
delta_Crs	1..16 (1)	12	$2^{-16} \cdot 2^{-5} \dots 2^{15} \cdot 2^{-5} (2)$	2^{-5}	meters	M
delta_Cis	1..16 (1)	11	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29} (2)$	2^{-29}	radians	M
delta_Cus	1..16 (1)	12	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29} (2)$	2^{-29}	radians	M
delta_Crc	1..16 (1)	12	$2^{-16} \cdot 2^{-5} \dots 2^{15} \cdot 2^{-5} (2)$	2^{-5}	meters	M
delta_Cic	1..16 (1)	11	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29} (2)$	2^{-29}	radians	M
delta_Cuc	1..16 (1)	12	$2^{-16} \cdot 2^{-29} \dots 2^{15} \cdot 2^{-29} (2)$	2^{-29}	radians	M
delta_tgd1	1..16 (1)	2	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31} (2)$	2^{-31}	seconds	M
delta_tgd2	1..16 (1)	2	$2^{-16} \cdot 2^{-31} \dots 2^{15} \cdot 2^{-31} (2)$	2^{-31}	seconds	M

- (1) The number of bits of each signed integer field is variable and it is indicated once for all numEphemerisDeltas by the structure ephemerisDeltasSizes. When the ephemerisDeltaSizes field is not present, the values found in the columns “Default # Bits” shall be used.
- (2) The scale factor of each parameter is variable around the default scale factor. The variation for each field is indicated once for all numEphemerisDeltas by the structure ephemerisDeltasScales. For example, if the scale factor modifier for delta_omega has a value of 4, the scale factor for delta_omega is $2^4 * 2^{-31}$. When the ephemerisDeltaScales is not used, the values found in the column “Default Scale” shall be used.

sequenceNum

This field indicates the order of the Ephemeris delta terms. The ephemeris constructed for use in satellite positioning is built by adding the delta terms to the referenced GANSS_Navigation Model in the order dictated by this sequence number. The sequence number shall remain the same for each svID in a group of Ephemeris Deltas corresponding to a particular update epoch.

svID

This field identifies the satellite ID within a particular sequenceNum.

These fields, with the exception of sequenceNum and svID, specify the deltas to be added to the existing Ephemeris to create a new Ephemeris suite that is extended from its predecessor by the time provided in the “validityPeriod” parameter. To compute the time of ephemeris for the newly constructed ephemeris, validityPeriod is added to the preceding toe. The ephemeris time of clock (toc) is set equal to the toe.

For each of the other ephemeris terms the corresponding delta ephemeris term is added in order to create the updated ephemeris. The terms delta_M0, delta_i0, and delta_OMEGA0 of the delta ephemeris must be extrapolated prior to the addition of the delta terms as follows:

$$M_{0(i+1)} = M_{0(i)} + \text{delta_} M_{0(i)} + \left(\sqrt{\frac{\mu}{A_{(i)}}} + \Delta n_{(i)} \right) \cdot dt$$

Where μ is the WGS 84 value of the earth’s gravitational constant for GANSS user, and $A_{(i)}$ is the semi-major axis associated with this satellite’s update. The extrapolation of delta_M0, uses the prior set’s sqrtA term to compute $A_{(i)}$.

$$\text{OMEGA0}_{(i+1)} = \text{OMEGA0}_{(i)} + \text{deltaOMEGA0}_{(i)} + \text{OMEGAdot}_{(i)} * dt$$

$$i0_{(i+1)} = i0_{(i)} + \text{delta_}i0_{(i)} + \text{Idot}_{(i)} * dt$$

Where dt is equal to $validityPeriod * 3600$. The terms $af0$, and $af1$ from the GANSS clock model must be extrapolated as follows:

$$af0_{(i+1)} = af0_{(i)} + af1_{(i)} * dt + af2_{(i)} * dt^2$$

$$af1_{(i+1)} = af1_{(i)} + 2 * af2_{(i)} * dt$$

$$af2_{(i+1)} = af2_{(i)}$$

Where $af0$, $af1$, and $af2$ are the clock model terms as shown in table A.49.1.

The following demonstrates the application of the ephemeris extension technique. Assume the $validityPeriod = 5$, representing: $(5+1)hours = 6$ hours, and the GANSS Navigation model for a particular satellite, identified by the reference IOD has a $toe = 0$ seconds.

The toe for sequenceNumber 1 is computed by adding the $validityPeriod$ to the initial toe of 0 as $0 + 6$ hours $= 0 + 21600$ seconds. The new ephemeris is constructed by adding the delta ephemeris terms from set 1 to the reference ephemeris creating the new ephemeris, which will be used for the next six hours. For the five terms listed above ($delta_M0$, $delta_i0$, $delta_OMEGA0$, $af0$, and $af1$) the extrapolation described must occur prior to the addition of the delta term. Of course if one of these three delta ephemeris terms was provided in full via the exception table then the extrapolation is unnecessary and the exception term combined with the $delta_ephemeris$ term is used directly.

The next ephemeris computation will occur by adding the $validityPeriod$ to the current toe of 21600 as: $21600 + 6$ hours $= 21600 + 21600 = 43200$. The ephemeris delta terms from set two are added to the ephemeris resulting from the prior addition to create the next ephemeris. This is done for each satellite vehicle ID listed in the provided satellite list indicated in the $ganssSatRef$ field.

GANSS Ephemeris Extension check

The GANSS Ephemeris Extension check provides information about non foreseen events that occurred during the period starting at the $ganssBeginTime$ to the current time. An event is signified through a bit string. Each bit refers to one PRN. If a bit is set to one, this means that the ephemeris extension is no longer valid for this specific PRN. In order to indicate planned future maneuvers an end time is provided. The SMLC can indicate that a future event is planned between the current time and the end time of this ephemeris extension.

Table A.55.12: Ephemeris Extension check

Parameter	Presence	Note
$ganssBeginTime$	M	See Table A.55.13
$ganssEndTime$	M	See Table A.55.14
$ganssSatEventsInfo$	M	See Table A.55.15

GANSS Begin Time

The GANSS begin time corresponds to the GANSS Day and GANSS Seconds of Estimation of the ephemeris extensions block.

Table A.55.13: GANSS Begin Time

Parameter	# Bits	Scale Factor	Units	Incl.
GANSS Day	13	1	Day	M
GANSS TOD	17	1	Seconds	M

GANSS End Time

The GANSS end time represents the final time the Ephemeris extension is valid.

Table A.55.14: GANSS End Time

Parameter	# Bits	Scale Factor	Units	Incl.
GANSS Day	13	1	Day	M
GANSS TOD	17	1	Seconds	M

GANSS Sat Event Information

If a bit is clear in the eventOccurred field it indicates that a satellite maneuver has not occurred since the ganssBeginTime nor is This IE is designed to indicate events that have or may occur between the ganssBeginTime and the ganssEndTime.

Table A.55.15: GANSS Sat Event Information

Parameter	# Bits	Scale Factor	Units	Incl.
EventOccurred	64	-	-	M
FutureEventNoted	64	-	-	M

EventOccurred

FutureEventNoted

If a bit is set in the futureEventNoted field it indicates that a maneuver is planned during the time period between current time plus sixty minutes and ganssEndTime

SBAS ID

If GANSS ID indicates SBAS, this field defines the specific SBAS for which the GANSS specific assistance data are provided according to Table A.55.16.

Table A.55.16: SBAS ID

SBAS	Value of SBAS ID
WAAS	0
EGNOS	1
MSAS	2
GAGAN	3
Reserved	4-7

GANSS Additional UTC Model

The GANSS Additional UTC Model field contains several sets of parameters needed to relate GNSS system time to Universal Time Coordinate (UTC), as defined in [12, 13, 14, 15, 16, 17]. Only one parameter set can be included in one GANSS Additional UTC Model and which set of parameters to include depends on the GANSS-ID and MS capabilities.

The UTC time standard, UTC(k), is GNSS specific. E.g., if GANSS ID indicates QZSS, GANSS Additional UTC Model field contains a set of parameters needed to relate QZST to UTC(NICT). If GANSS ID indicates Modernized GPS, GANSS Additional UTC Model field contains a set of parameters needed to relate GPS system time to UTC(USNO). If GANSS ID indicates GLONASS, GANSS Additional UTC Model field contains a set of parameters needed to relate GLONASS system time to UTC(RU). If GANSS ID indicates SBAS, GANSS Additional UTC Model field 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.

Table A.55.17: GANSS Additional UTC Model

Parameter	# Bits	Scale Factor	Units	Incl.
One of the following models can be included:				
Model-2 (as defined in [12,13,14,16])				
A _{0-n}	16	2 ⁻³⁵	seconds	C ⁽¹⁾
A _{1-n}	13	2 ⁻⁵¹	sec/sec	C ⁽¹⁾
A _{2-n}	7	2 ⁻⁶⁸	sec/sec ²	C ⁽¹⁾
Δt _{LS}	8	1	seconds	C ⁽¹⁾
t _{ot}	16	2 ⁴	seconds	C ⁽¹⁾
WN _{ot}	13	1	weeks	C ⁽¹⁾
WN _{LSF}	8	1	weeks	C ⁽¹⁾
DN	4	1	days	C ⁽¹⁾
Δt _{LSF}	8	1	seconds	C ⁽¹⁾
Model-3 (as defined in [17])				
N ^A	11	1	days	C ⁽¹⁾
τ _c	32	2 ⁻³¹	seconds	C ⁽¹⁾
B1	11	2 ⁻¹⁰	seconds	O ⁽²⁾
B2	10	2 ⁻¹⁶	sec/msd	O ⁽²⁾
KP	2	1	---	O
Model-4 (as defined in [15], Message Type 12)				
A _{1WNT}	24	2 ⁻⁵⁰	sec/sec	C ⁽¹⁾
A _{0WNT}	32	2 ⁻³⁰	seconds	C ⁽¹⁾
t _{ot}	8	2 ¹²	seconds	C ⁽¹⁾
WN _t	8	1	weeks	C ⁽¹⁾
Δt _{LS}	8	1	seconds	C ⁽¹⁾
WN _{LSF}	8	1	weeks	C ⁽¹⁾
DN	8	1	days	C ⁽¹⁾
Δt _{LSF}	8	1	seconds	C ⁽¹⁾
UTC Standard ID	3	1	---	C ⁽¹⁾
Note 1: All of these fields shall be present together, or none of them shall be present.				
Note 2: If the optional elements are included, both elements shall be included.				

UTC Standard ID

If GANSS 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 Table A.55.18 ([15], Message Type 12).

Table A.55.18: UTC Standard ID

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

GANSS Auxiliary Information

This field contains additional information dependent on the GANSS ID and is shown in Table A.55.19. If GANSS Auxiliary Information is provided together with other satellite dependent GANSS assistance data (i.e., any of DGANSS Corrections, GANSS Navigation Model, GANSS Data Bit Assistance, or GANSS Reference Measurement Information IEs) and RRLP pseudo-segmentation is used, the GANSS Auxiliary Information should be provided for the same satellites and in the same RRLP segment as the other satellite dependent GANSS assistance data.

Table A.55.19: GANSS Auxiliary Information Parameter Format

Parameter	Range	Bits	Resolution	Incl.
One of the following group of elements can be included, dependent on the GANSS ID				
The following fields may only be present if GANSS ID indicates Modernized GPS and occur once per satellite (N_SAT times):				
SV ID	0-63	6	---	M
Signals Available	Table A.59	8	---	M
The following fields may only be present if GANSS ID indicates GLONASS and occur once per satellite (N_SAT times):				
SV ID	0-63	6	---	M
Channel number	-7 – 13	5	---	M
Signals Available	Table A.59	8	---	M

SV_ID

This field specifies the SV for which the GANSS Auxiliary Information is given. The interpretation of SV ID is defined in Table A.10.14.

Range: 0 – 63

Signals Available

This field indicates the ranging signals supported by the satellite indicated by SV ID. This field is given as a bit string as shown in Table A.59 for a particular GANSS. If a bit is set to '1' it indicates that the satellite identified by SV ID transmits ranging signals according to the signal correspondence in Table A.59. If a bit is set to '0' it indicates that the corresponding signal is not supported on the satellite identified by SV ID.

Channel number

This field indicates the GLONASS carrier frequency number of the satellite identified by SV ID, as defined in [17].

A.4.2.7 GANSS Carrier-Phase Measurement Request Element

This element is optional and controls if the MS should return carrier-phase measurements in GANSS Measurement Information IE or not to the SMLC. The inclusion of this parameter implies use of measure Position Request. The description is found in sub-chapter 2.2.4d.

A.4.2.8 GANSS TOD - GSM Time Association Request Element

This element is optional and controls if the MS should return GANSS TOD - GSM Time Association Measurements or not to the SMLC. The inclusion of this parameter implies use of measure Position Request. The description is found in sub-chapter 2.2.4e.

A.5 Assistance Data Acknowledgement**A.5.1 General**

The MS sends the Assistance Data Acknowledgement component to the SMLC to indicate that it has received the whole Assistance Data component.

A.6 Protocol Error**A.6.1 General**

This component is used by the receiving entity (SMLC or MS) to indicate to the sending entity, that there is a problem that prevents the receiving entity to receive a complete and understandable component.

This component has the following values:

'0':	Undefined;
'1':	Missing Component;
'2':	Incorrect Data;
'3':	Missing Information Element or Component Element;
'4':	Message Too Short;
'5':	Unknown Reference Number.

A.6.2 Extended Reference IE

This IE shall be included in any Protocol Error message if and only if an Extended Reference IE was received in the corresponding previous Measure Position Request or Assistance Data message.

NOTE: For reasons of backward compatibility, a Release 4 or earlier MS will not include this IE.

The Extended Reference IE contains the following elements.

SMLC code: an integer in the range 0-63. The value returned by a target MS in a Protocol Error message shall equal the value received from the SMLC in the earlier Measure Position Request or Assistance Data message.

Transaction ID: an integer in the range 0-262143 distinguishing different RRLP transactions in different MSs currently being served by the same SMLC. The value returned by a target MS in a Protocol Error message shall equal the value received from the SMLC in the earlier Measure Position Request or Assistance Data message.

A.7 Positioning Capability Request

A.7.1 General

The SMLC sends the Positioning Capability Request component to the MS to request the MS positioning capabilities, types of assistance data supported and any assistance data that may be needed. It contains the following elements.

Table A.56: Positioning Capability Request component content

Element	Type/Reference	Presence
Extended Reference	Extended Reference 2.2.5	M
GNSS Position Method Parameters	GNSS Position Method Parameters, Table A.58	O

A.8 Positioning Capability Response

A.8.1 General

The Positioning Capability Response is a RRLP component from the MS to the network. It is the response to the Positioning Capability Request. It contains the following elements.

Table A.57: Positioning Capability Response component content

Element	Type/Reference	Presence
Extended Reference	Extended Reference 2.2.5	M
Positioning Capabilities	Positioning Capabilities 8.2.1	M
Assistance Data Supported	Assistance Data Supported 8.2.2	O
Assistance Data Needed	Assistance Data Needed 8.2.3	O

A.8.2 Elements

A.8.2.1 Positioning Capabilities

This element indicates the positioning methods and other positioning capabilities supported by the MS. The inclusion of this element is mandatory.

The MS may indicate support for non-GANSS position methods and/or GANSS position methods. The MS indicates its support for non-GANSS position methods using a bit string with one bit representing each method, set to one if the method is supported and zero if it is not. The following Non-GANSS Position Methods can be identified:

- MS Assisted E-OTD;
- MS Based E-OTD;
- MS Assisted GPS;
- MS Based GPS;
- Standalone GPS.

The MS indicates its support for GANSS position methods by providing the parameters shown in Table A.58 for each GANSS system supported.

Table A.58: GANSS Position Method Support

GANSS Position Method Parameters
GANSS_ID
GANSS Position Method Types
GANSS Signals
SBAS ID

GANSS_ID

Range: 0 - 7

This field indicates the GANSS. The supported GANSS are defined in sub-clause A.4.2.6.2 (Table A.40). Absence of this field indicates Galileo.

GANSS Position Method Types

For each supported GANSS system, the MS shall and SMLC may indicate which method types are supported. This is represented using a bit string with one bit per method type where a one value indicates support and a zero value no support. The following GANSS Method Types can be identified:

- MS Assisted;
- MS Based;
- Standalone.

GANSS Signals

For each supported GANSS system, the MS shall and SMLC may indicate which signals are supported. This is represented using a bit string with one bit per signal where a one value indicates support and a zero value no support. The individual signals are denoted generically as signal1, signal2 etc. in the ASN.1 in clause 5.1. Table A.59 shows the signal correspondence for each defined GANSS system. Unfilled table entries indicate no assignment and shall either not be included or set to zero if included.

The GANSS Signal Correspondence in Table A.59 is also used when a single signal is addressed (e.g., when reporting GANSS measurements or providing GANSS assistance data). In this case, an Integer value is used to indicate the signal, and the values 0 to 7 correspond to GANSS Signal 1 to 8, respectively.

Table A.59: GANSS Signal Correspondence

GANSS System	Signal 1	Signal 2	Signal 3	Signal 4	Signal 5	Signal 6	Signal 7	Signal 8
Galileo	E1	E5a	E5b	E6	E5a+E5b			
Modernized GPS	L1C	L2C	L5					
SBAS	L1							
QZSS	QZS-L1	QZS-L1C	QZS-L2C	QZS-L5				
GLONASS	G1	G2	G3					

SBAS_ID

If GANSS ID in Table A.58 indicates support for SBAS, this field shall be present to indicate support of specific SBAS using a bit map with one bit per SBAS where a one value indicates support and a zero value no support.

Table A.59.a: SBAS ID Correspondence

Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
WAAS	EGNOS	MSAS	GAGAN	reserved	reserved	reserved	reserved

The MS shall also indicate whether it supports multiple measurement sets for the MS Assisted position methods listed below. This is represented using a bit string with one bit representing each position method which is set to a one if multiple measurement sets are supported for that method and to a zero if not. The following MS Assisted Position Methods associated with Multiple Measurement Sets can be identified:

- E-OTD;
- GPS;
- GANSS.

A.8.2.2 Assistance Data Supported

This element indicates the types of assistance data that the MS supports for GPS and GANSS and is shown in Table A.59.b.

Table A.59.b: Assistance Data Supported

GANSS Position Method Parameters
GPS Assistance Data
GANSS Assistance Data
GANSS Additional Assistance Data Choices

GPS Assistance Data

In the case of GPS, support for each of the following types of assistance data can be individually indicated using a bit string in which a one value indicates support and a zero no support. The following GPS Assistance Indications can be identified:

- Almanac;
- UTC model;
- Ionospheric Model;
- Navigation Model;
- DGPS Corrections;
- Reference Location;

- Reference Time;
- Acquisition Assistance;
- Real Time Integrity;
- Ephemeris Extension;
- Ephemeris Extension Check.

GANSS Assistance Data

In the case of GANSS, support for each of the following types of common assistance data is indicated using a bit string in which each bit represents one type of assistance data and is set to a one to indicate support and a zero to indicate no support. The following Common GANSS Assistance Indications can be identified:

- GANSS Reference Time;
- GANSS Reference Location;
- GANSS Ionospheric Model;
- GANSS Additional Ionospheric Model;
- GANSS Earth Orientation Parameters.

The MS indicates its support for assistance data specific to each GANSS system by providing the parameters shown in Table A.60 for each GANSS system supported.

Table A.60: GANSS Assistance Support

GANSS Assistance Parameters
GANSS_ID
GANSS Assistance

GANSS_ID

Range: 0 - 7

This field indicates the GANSS. The supported GANSS are defined in sub-clause A.4.2.6.2 (Table A.40). Absence of this field indicates Galileo.

GANSS Assistance

Supported GANSS Assistance data is indicated using a bit string in which each bit represents one type of assistance data and is set to a one to indicate support and a zero to indicate no support. The following types of Specific GANSS Assistance Indications can be identified.

- GANSS Real Time Integrity;
- GANSS Differential Corrections;
- GANSS Almanac;
- GANSS Reference Measurement Information;
- GANSS Navigation Model;
- GANSS Time Model GNSS-UTC;
- GANSS Time Model GNSS-GNSS;
- GANSS Data Bit Assistance;
- GANSS Ephemeris Extension;

- GANSS Ephemeris Extension Check;
- GANSS Additional UTC Model;
- GANSS Auxiliary Information.

GANSS Additional Assistance Data Choices

For GANSS Assistance Data elements for which multiple choices exist (GANSS Clock Model (Table A.49.1), GANSS Orbit Model (Table A.49.2), GANSS Almanac Model (Table A.54), and GANSS UTC Model/Additional UTC Model (Table A.55/A.55.17)) the MS and SMLC shall support the native formats choice as defined in the relevant ICDs for each GANSS signal. The MS can indicate which additional non-native choice(s) is(are) supported for a particular GANSS using a bit map with one bit per model where a one value indicates support and a zero value no support. Note that native support need not be indicated in this bit map.

Table A.61: GANSS Additional Assistance Data Choices

Parameter	#Bits	Type/Reference	Prsesence
The following fields occur once per GANSS (Num_GANSS times)			
GANSS ID	3	Table A.40	O ⁽¹⁾
GANSS Clock Model Choice	8	Bit String –Table A.62	C ⁽²⁾
GANSS Orbit Model Choice	8	Bit String –Table A.62	C ⁽²⁾
GANSS Almanac Model Choice	8	Bit String –Table A.62	C ⁽³⁾
GANSS UTC Model Choice	8	Bit String –Table A.62	C ⁽⁴⁾
Note 1: Absence of this field indicates Galileo. Note 2: These elements may only be present if GANSS Navigation Model support is indicated in GANSS Assistance. Note 3: This element may only be present if GANSS Almanac support is indicated in GANSS Assistance. Note 4: This element may only be present if GANSS Additional UTC Model support is indicated in GANSS Assistance.			

Table A.62: Bit String of GANSS Additional Assistance Data Choices

Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
The individual Models 1-8 are identified in Tables A.49.1, A.49.2, A.54, and A.55/A.55.17. Non defined Models in Assistance Data Choices shall have the value '0' at the corresponding bit position.							

A.8.2.3 Assistance Data Needed

This element indicates the types of assistance data that the MS may need to obtain a location estimate or positioning measurements. The MS shall use this IE to indicate to the SMLC all the supported assistance data types for which the MS does not have current versions using the assistance data request IEs defined in 3GPP TS 49.031. The SMLC can then decide which subset of these assistance data types if any to download. The IE is encoded using the request for assistance data IEs defined for GPS and GANSS in 3GPP TS 49.031.

Annex B (informative): Change History

Meeting#	Tdoc	CR	Rev	Subject/Comment	New Version
GP-39	-	-	-	Rel-8 version based on 7.9.0.	8.0.0
GP-39	GP-081324	0187	1	Support for additional navigation satellite systems in RRLP	8.0.0
GP-40	GP-081818	0189	1	Various GANSS Corrections	8.1.0
GP-40	GP-081819	0190	1	Definition of GNSS system time origins	8.1.0
GP-40	GP-081814	0192	1	Correction to Extended Ephemeris Duration	8.1.0
GP-40	GP-081820	0193	1	GANSS UTC model renaming	8.1.0
GP-41	GP-090075	0194		Clarifications for GPS real-time integrity	8.2.0
GP-41	GP-090353	0198	1	Corrections to Ephemeris Extension	8.2.0
GP-41	GP-090370	0200	1	Correction to GANSS Positioning Method Element	8.2.0
GP-41	GP-090359	0196	1	Correction to MAP imports (implementation of change regarding table formatting was done in an editorially preferred manner)	8.2.0
GP-42	GP-090657	0201		Correction to allowed settings of GANSS Positioning Method element	8.3.0
GP-43	GP-091171	0202		Correction to pseudo-segmentation rules for GANSS Assistance Data	8.4.0
GP-44	GP-092236	0205	2	Extended Reference Number clarification	8.5.0

History

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V8.1.0	January 2009	Publication
V8.2.0	April 2009	Publication
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