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1 Scope

The present document specifies the stage 3 protocol and data model for the Nlmf Service Based Interface. It provides stage 3 protocol definitions and message flows, and specifies the API for each service offered by the LMF.

The 5G System stage 2 architecture and procedures are specified in 3GPP TS 23.501 [2] and 3GPP TS 23.502 [3].

The Technical Realization of the Service Based Architecture and the Principles and Guidelines for Services Definition are specified in 3GPP TS 29.500 [4] and 3GPP TS 29.501 [5].

2 References

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

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

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".
- [3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".
- [4] 3GPP TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3".
- [5] 3GPP TS 29.501: "5G System; Principles and Guidelines for Services Definition; Stage 3".
- [6] IETF RFC 4776: "Dynamic Host Configuration Protocol (DHCPv4 and DHCPv6) Option for Civic Addresses Configuration Information".
- [7] IETF RFC 5139: "Revised Civic Location Format for Presence Information Data Format Location Object (PIDF-LO)".
- [8] 3GPP TS 29.571: "5G System; Common Data Types for Service Based Interfaces; Stage 3".
- [9] 3GPP TS 33.501: "Security architecture and procedures for 5G system".
- [10] IETF RFC 6749: "The OAuth 2.0 Authorization Framework".
- [11] 3GPP TS 29.510: "Network Function Repository Services; Stage 3".
- [12] IETF RFC 7540: "Hypertext Transfer Protocol Version 2 (HTTP/2)". [13] IETF RFC 8259: "The JavaScript Object Notation (JSON) Data Interchange Format".
- [14] OpenAPI Initiative, "OpenAPI 3.0.0 Specification", <https://github.com/OAI/OpenAPI-Specification/blob/master/versions/3.0.0.md>.
- [15] IETF RFC 7807: "Problem Details for HTTP APIs".
- [16] 3GPP TR 21.900: "Technical Specification Group working methods".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

LMF Location Management Function

4 Overview

The Location Management Function (LMF) is the network entity in the 5G Core Network (5GC) supporting the following functionality:

- Supports location determination for a UE.
- Obtains downlink location measurements or a location estimate from the UE.
- Obtains uplink location measurements from the NG RAN.
- Obtains non-UE associated assistance data from the NG RAN.

Figure 4-1 provides the reference model (in service based interface representation and in reference point representation), with focus on the LMF:

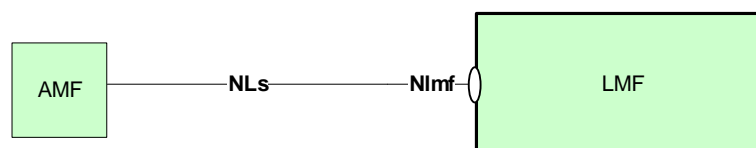


Figure 4-1: Reference model – LMF

5 Services Offered by the LMF

5.1 Introduction

The LMF offers to other NFs the following services:

- Nlmf_Location

5.2 Nlmf_Location Service

5.2.1 Service Description

The Nlmf_Location service enables an NF to request location determination (current geodetic and optionally civic location) for a target UE.

5.2.2 Service Operations

5.2.2.1 Introduction

The service operations defined for the Nlmf_Location service are as follows:

- DetermineLocation: It provides UE location information to the consumer NF.

5.2.2.2 DetermineLocation

5.2.2.2.1 General

The following procedures are defined, using the "DetermineLocation" service operation:

- Retrieve UE Location

5.2.2.2.2 Retrieve UE Location

This procedure allows a consumer NF to request the location information (geodetic location and, optionally, civic location).

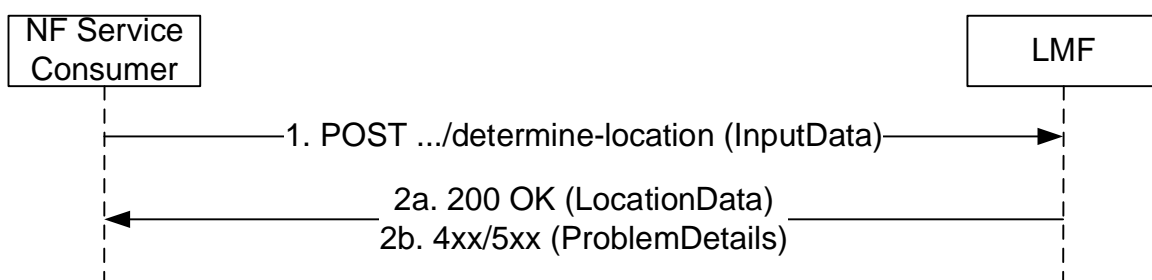


Figure 5.2.2.2.2-1: DetermineLocation Request

1. The NF Service Consumer shall send an HTTP POST request to the resource URI associated with the "determine-location" custom operation. The input parameters for the request (external client type, LCS correlation identifier, serving cell identifier, location QoS, supported GAD shapes....) shall be included in the HTTP POST request body.

If UE LCS Capability is received in the request indicating LPP is not supported by the UE, the LMF shall not send LPP messages to the UE in subsequent positioning procedures.

- 2a. On success, "200 OK" shall be returned. The response body shall contain the parameters related to the determined position of the UE (geodetic position, civic location, positioning methods...).
- 2b. On failure, one of the HTTP status code listed in Table 6.1.4.2.2-2 shall be returned. For a 4xx/5xx response, the message body shall contain a ProblemDetails structure with the "cause" attribute set to one of the application error listed in Table 6.1.4.2.2-2.

6 API Definitions

6.1 Nlmf_Location Service API

6.1.1 API URI

The Nlmf_Location service shall use the Nlmf_Location API.

The request URI used in HTTP request from the NF service consumer towards the NF service producer shall have the structure defined in clause 4.4.1 of 3GPP TS 29.501 [5], i.e.:

{apiRoot}/<apiName>/<apiVersion>/<apiSpecificResourceUriPart>

with the following components:

- The {apiRoot} shall be set as described in 3GPP TS 29.501 [5].
- The <apiName> shall be "nlmf-loc".
- The <apiVersion> shall be "v1".
- The <apiSpecificResourceUriPart> shall be set as described in clause 6.1.3.

6.1.2 Usage of HTTP

6.1.2.1 General

HTTP/2, as defined in IETF RFC 7540 [12], shall be used as specified in clause 5 of 3GPP TS 29.500 [4].

HTTP/2 shall be transported as specified in clause 5.3 of 3GPP TS 29.500 [4].

HTTP messages and bodies for the Nlmf_Location service shall comply with the OpenAPI [14] specification contained in Annex A.

6.1.2.2 HTTP Standard Headers

6.1.2.2.1 General

6.1.2.2.2 Content type

The following content types shall be supported:

- JSON, as defined in IETF RFC 8259 [13], shall be used as content type of the HTTP bodies specified in the present specification as indicated in clause 5.4 of 3GPP TS 29.500 [4].
- The Problem Details JSON Object (IETF RFC 7807 [15]). The use of the Problem Details JSON object in a HTTP response body shall be signalled by the content type "application/problem+json".

6.1.2.3 HTTP custom headers

6.1.2.3.1 General

The following HTTP custom headers shall be supported:

- 3gpp-Sbi-Message-Priority: See 3GPP TS 29.500 [4], clause 5.2.3.2.2.

This API does not define any new HTTP custom headers.

6.1.3 Resources

6.1.3.1 Overview

The structure of the Resource URIs of the Nlmf_Location service is shown in figure 6.1.3.1-1.

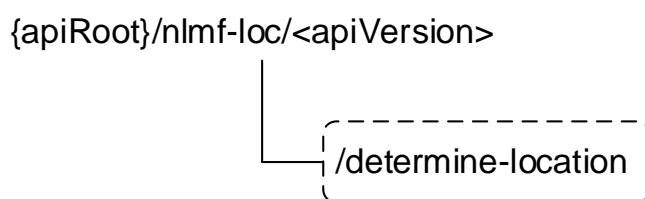


Figure 6.1.3.1-1: Resource URI structure of the Nlmf_Location API

Table 6.1.3.1-1 provides an overview of the resources and applicable HTTP methods.

Table 6.1.3.1-1: Resources and methods overview

| Resource name | Resource URI | HTTP method or custom operation | Description |
|---|--|---------------------------------|-------------|
| DetermineLocation (Custom operation) | {apiRoot}/nlmf-loc/<apiVersion>/determine-location | determine-location (POST) | |

6.1.4 Custom Operations without associated resources

6.1.4.1 Overview

Table 6.1.4.1-1: Custom operations without associated resources

| Custom operation URI | Mapped HTTP method | Description |
|--|--------------------|-------------|
| {apiRoot}/nlmf-loc/<apiVersion>/determine-location | POST | |

6.1.4.2 Operation: determine-location

6.1.4.2.1 Description

This subclause will describe the custom operation and what it is used for, and the custom operation's URI.

6.1.4.2.2 Operation Definition

This operation shall support the response data structures and response codes specified in tables 6.1.4.2.2-1 and 6.1.4.2.2-2.

Table 6.1.4.2.2-1: Data structures supported by the POST Request Body on this resource

| Data type | P | Cardinality | Description |
|-----------|---|-------------|--|
| InputData | M | 1 | Input parameters to the "Determine Location" operation |

Table 6.1.4.2.2-2: Data structures supported by the POST Response Body on this resource

| Data type | P | Cardinality | Response codes | Description |
|----------------|---|-------------|---------------------------|--|
| LocationData | M | 1 | 200 OK | This case represents the successful retrieval of the location of the UE. Upon success, a response body is returned containing the different parameters of the location data, such as: - Geographic Area - Civic Location - Positioning methods |
| ProblemDetails | M | 1 | 403 Forbidden | The "cause" attribute shall be set to one of the following application errors: - POSITIONING_DENIED - UNSPECIFIED See table 6.1.7.3-1 for the description of these errors. |
| ProblemDetails | M | 1 | 500 Internal Server Error | The "cause" attribute shall be set to the following application error: - POSITIONING_FAILED See table 6.1.7.3-1 for the description of these errors. |
| ProblemDetails | M | 1 | 504 Gateway Timeout | The "cause" attribute shall be set to the following application error: - UNREACHABLE_USER See table 6.1.7.3-1 for the description of this error. |

6.1.5 Notifications

There are no notifications defined for the Nlmf_Location service in this release of the specification.

6.1.6 Data Model

6.1.6.1 General

This clause specifies the application data model supported by the API.

Table 6.1.6.1-1 specifies the data types defined for the Nlmf service based interface protocol.

Table 6.1.6.1-1: Nlmf specific Data Types

| Data type | Clause defined | Description |
|--|----------------|---|
| InputData | 6.1.6.2.2 | |
| LocationData | 6.1.6.2.3 | |
| GeographicalCoordinates | 6.1.6.2.4 | |
| GeographicArea | 6.1.6.2.5 | |
| Point | 6.1.6.2.6 | |
| PointUncertaintyCircle | 6.1.6.2.7 | |
| PointUncertaintyEllipse | 6.1.6.2.8 | |
| Polygon | 6.1.6.2.9 | |
| PointAltitude | 6.1.6.2.10 | |
| PointAltitudeUncertainty | 6.1.6.2.11 | |
| EllipsoidArc | 6.1.6.2.12 | |
| LocationQoS | 6.1.6.2.13 | |
| CivicAddress | 6.1.6.2.14 | |
| PositioningMethodAndUsage | 6.1.6.2.15 | |
| GnssPositioningMethodAndUsage | 6.1.6.2.16 | |
| VelocityEstimate | 6.1.6.2.17 | |
| HorizontalVelocity | 6.1.6.2.18 | |
| HorizontalWithVerticalVelocity | 6.1.6.2.19 | |
| HorizontalVelocityWithUncertainty | 6.1.6.2.20 | |
| HorizontalWithVerticalVelocityAndUncertainty | 6.1.6.2.21 | |
| UncertaintyEllipse | 6.1.6.2.22 | |
| UeLcsCapability | 6.1.6.2.23 | Indicates the LCS capability supported by the UE. |
| Altitude | 6.1.6.3.2 | |
| Angle | 6.1.6.3.2 | |
| Uncertainty | 6.1.6.3.2 | |
| Orientation | 6.1.6.3.2 | |
| Confidence | 6.1.6.3.2 | |
| Accuracy | 6.1.6.3.2 | |
| InnerRadius | 6.1.6.3.2 | |
| CorrelationID | 6.1.6.3.2 | |
| AgeOfLocationEstimate | 6.1.6.3.2 | |
| HorizontalSpeed | 6.1.6.3.2 | |
| VerticalSpeed | 6.1.6.3.2 | |
| SpeedUncertainty | 6.1.6.3.2 | |
| BarometricPressure | 6.1.6.3.2 | |
| ExternalClientType | 6.1.6.3.3 | |
| SupportedGADShapes | 6.1.6.3.4 | |
| ResponseTime | 6.1.6.3.5 | |
| PositioningMethod | 6.1.6.3.6 | |
| GnssMethod | 6.1.6.3.7 | |
| GnssId | 6.1.6.3.8 | |
| Usage | 6.1.6.3.9 | |
| LcsPriority | 6.1.6.3.10 | |
| VelocityRequested | 6.1.6.3.11 | |
| AccuracyFulfilmentIndicator | 6.1.6.3.12 | |
| VerticalDirection | 6.1.6.3.13 | |

Table 6.1.6.1-2 specifies data types re-used by the Nlmf service based interface protocol from other specifications, including a reference to their respective specifications and when needed, a short description of their use within the Nlmf service based interface.

Table 6.1.6.1-2: Nlmf re-used Data Types

| Data type | Reference | Comments |
|---------------|--------------------|----------|
| Supi | 3GPP TS 29.571 [8] | |
| Pei | 3GPP TS 29.571 [8] | |
| Gpsi | 3GPP TS 29.571 [8] | |
| Ecgi | 3GPP TS 29.571 [8] | |
| Ncgi | 3GPP TS 29.571 [8] | |
| NfnInstanceid | 3GPP TS 29.571 [8] | |

6.1.6.2 Structured data types

6.1.6.2.1 Introduction

This clause defines the structures to be used in resource representations.

6.1.6.2.2 Type: InputData

Table 6.1.6.2.2-1: Definition of type InputData

| Attribute name | Data type | P | Cardinality | Description |
|---|---------------------------|---|-------------|--|
| externalClientType | ExternalClientType | O | 0..1 | |
| correlationID | CorrelationID | O | 0..1 | |
| amfId | NfnInstanceid | O | 0..1 | Indicates the AMF Instance serving the UE. LMF shall use the AMF Instance to forward LCS related N1/N2 messages to the UE/RAN. |
| locationQoS | LocationQoS | O | 0..1 | |
| supportedGADShapes | array(SupportedGADShapes) | O | 1..N | |
| supi | Supi | O | 0..1 | |
| pei | Pei | O | 0..1 | |
| gpsi | Gpsi | O | 0..1 | |
| ecgi | Ecgi | O | 0..1 | When present, this IE shall indicate the identifier of the E-UTRAN cell serving the UE. (NOTE 2) |
| ncgi | Ncgi | O | 0..1 | When present, this IE shall indicate the identifier of the NR cell serving the UE. (NOTE 2) |
| priority | LcsPriority | O | 0..1 | |
| velocityRequested | VelocityRequested | O | 0..1 | |
| ueLcsCap | UeLcsCapability | O | 0..1 | When present, this IE shall indicate the LCS capability supported by the UE. |
| NOTE 1: At least one of the attributes defined in this table shall be present in the InputData structure. | | | | |
| NOTE 2: Attribute "ecgi" and "ncgi" shall not be present at the same time. | | | | |

6.1.6.2.3 Type: LocationData

Table 6.1.6.2.3-1: Definition of type LocationData

| Attribute name | Data type | P | Cardinality | Description |
|-----------------------------|--------------------------------------|---|-------------|---|
| locationEstimate | GeographicArea | M | 1 | |
| accuracyFulfilmentIndicator | AccuracyFulfilmentIndicator | O | 0..1 | |
| ageOfLocationEstimate | AgeOfLocationEstimate | O | 0..1 | |
| velocityEstimate | VelocityEstimate | O | 0..1 | |
| civicAddress | CivicAddress | O | 0..1 | |
| positioningDataList | array(PositioningMethodAndUsage) | O | 1..N | |
| gnssPositioningDataList | array(GnssPositioningMethodAndUsage) | O | 1..N | |
| ecgi | Ecgi | O | 0..1 | |
| ncgi | Ncgi | O | 0..1 | |
| altitude | Altitude | O | 0..1 | Altitude of the positioning estimate. When the shape used in "locationEstimate" supports conveying the altitude parameter, this IE shall be absent. |
| barometricPressure | BarometricPressure | O | 0..1 | If present, this IE contains the barometric pressure measurement as reported by the target UE. |

6.1.6.2.4 Type: GeographicalCoordinates

Table 6.1.6.2.4-1: Definition of type GeographicalCoordinates

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-----------|---|-------------|---|
| lon | number | M | 1 | Longitude (float value): Minimum: -180 Maximum: 180 |
| lat | number | M | 1 | Latitude (float value): Minimum: -90 Maximum: 90 |

6.1.6.2.5 Type: GeographicArea

Table 6.1.6.2.5-1: Definition of type GeographicArea as a list of mutually exclusive alternatives

| Data type | Cardinality | Description |
|--------------------------|-------------|--|
| Point | 1 | Geographical area consisting of a single point, represented by its longitude and latitude. |
| PointUncertaintyCircle | 1 | Geographical area consisting of a point and an uncertainty value. |
| PointUncertaintyEllipse | 1 | Geographical area consisting of a point, plus an uncertainty ellipse and a confidence value. |
| Polygon | 1 | Geographical area consisting of a list of points (between 3 to 15 points). |
| PointAltitude | 1 | Geographical area consisting of a point and an altitude value. |
| PointAltitudeUncertainty | 1 | Geographical area consisting of a point, an altitude value and an uncertainty value. |
| EllipsoidArc | 1 | Geographical area consisting of an ellipsoid arc. |

6.1.6.2.6 Type: Point

Table 6.1.6.2.6-1: Definition of type Point

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-------------------------|---|-------------|----------------------------------|
| shape | SupportedGADShapes | M | 1 | It shall take the value "POINT". |
| point | GeographicalCoordinates | M | 1 | |

6.1.6.2.7 Type: PointUncertaintyCircle

Table 6.1.6.2.7-1: Definition of type PointUncertaintyCircle

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-------------------------|---|-------------|---|
| shape | SupportedGADShapes | M | 1 | It shall take the value "POINT_UNCERTAINTY_CIRCLE". |
| point | GeographicalCoordinates | M | 1 | |
| uncertainty | Uncertainty | M | 1 | |

6.1.6.2.8 Type: PointUncertaintyEllipse

Table 6.1.6.2.8-1: Definition of type PointUncertaintyEllipse

| Attribute name | Data type | P | Cardinality | Description |
|--------------------|-------------------------|---|-------------|--|
| shape | SupportedGADShapes | M | 1 | It shall take the value "POINT_UNCERTAINTY_ELLIPSE". |
| point | GeographicalCoordinates | M | 1 | |
| uncertaintyEllipse | UncertaintyEllipse | M | 1 | |
| confidence | Confidence | M | 1 | |

6.1.6.2.9 Type: Polygon

Table 6.1.6.2.9-1: Definition of type Polygon

| Attribute name | Data type | P | Cardinality | Description |
|----------------|--------------------------------|---|-------------|--|
| shape | SupportedGADShapes | M | 1 | It shall take the value "POLYGON". |
| pointList | array(GeographicalCoordinates) | M | 3..15 | Array with up to 15 items, where each item is a "point". |

6.1.6.2.10 Type: PointAltitude

Table 6.1.6.2.10-1: Definition of type PointAltitude

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-------------------------|---|-------------|---|
| shape | SupportedGADShapes | M | 1 | It shall take the value "POINT_ALTITUDE". |
| point | GeographicalCoordinates | M | 1 | |
| altitude | Altitude | M | 1 | |

6.1.6.2.11 Type: PointAltitudeUncertainty

Table 6.1.6.2.11-1: Definition of type PointAltitudeUncertainty

| Attribute name | Data type | P | Cardinality | Description |
|---------------------|-------------------------|---|-------------|---|
| shape | SupportedGADShapes | M | 1 | It shall take the value "POINT_ALTITUDE_UNCERTAINTY". |
| point | GeographicalCoordinates | M | 1 | |
| altitude | Altitude | M | 1 | |
| uncertaintyEllipse | UncertaintyEllipse | M | 1 | |
| uncertaintyAltitude | Uncertainty | M | 1 | |
| confidence | Confidence | M | 1 | |

6.1.6.2.12 Type: EllipsoidArc

Table 6.1.6.2.12-1: Definition of type EllipsoidArc

| Attribute name | Data type | P | Cardinality | Description |
|-------------------|-------------------------|---|-------------|--|
| shape | SupportedGADShapes | M | 1 | It shall take the value "ELLIPSOID_ARC". |
| point | GeographicalCoordinates | M | 1 | |
| innerRadius | InnerRadius | M | 1 | |
| uncertaintyRadius | Uncertainty | M | 1 | |
| offsetAngle | Angle | M | 1 | |
| includedAngle | Angle | M | 1 | |
| confidence | Confidence | M | 1 | |

6.1.6.2.13 Type: LocationQoS

Table 6.1.6.2.13-1: Definition of type LocationQoS

| Attribute name | Data type | P | Cardinality | Description |
|----------------|--------------|---|-------------|--------------------------------------|
| hAccuracy | Accuracy | O | 0..1 | Horizontal accuracy |
| vAccuracy | Accuracy | O | 0..1 | Vertical accuracy |
| vertRequested | boolean | O | 0..1 | Vertical accuracy requested (yes/no) |
| responseTime | ResponseTime | O | 0..1 | Low delay vs. Delay tolerant |

6.1.6.2.14 Type: CivicAddress

Table 6.1.6.2.14-1: Definition of type CivicAddress

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-----------|---|-------------|--|
| country | string | M | 1 | The two-letter ISO 3166 country code in capital ASCII letters, e.g., DE or US IETF RFC 4776 [6] |
| A1 | string | O | 0..1 | National subdivisions (state, canton, region, province, prefecture) IETF RFC 4776 [6] |
| A2 | string | O | 0..1 | County, parish, gun (JP), district (IN) IETF RFC 4776 [6] |
| A3 | string | O | 0..1 | City, township, shi (JP) IETF RFC 4776 [6] |
| A4 | string | O | 0..1 | City division, borough, city district, ward, chou (JP) IETF RFC 4776 [6] |
| A5 | string | O | 0..1 | Neighbourhood, block IETF RFC 4776 [6] |
| A6 | string | O | 0..1 | Group of streets below the neighbourhood level IETF RFC 4776 [6] |
| PRD | string | O | 0..1 | Leading street direction IETF RFC 4776 [6] |
| POD | string | O | 0..1 | Trailing street suffix IETF RFC 4776 [6] |
| STS | string | O | 0..1 | Street suffix or type IETF RFC 4776 [6] |
| HNO | string | O | 0..1 | House number IETF RFC 4776 [6] |
| HNS | string | O | 0..1 | House number suffix IETF RFC 4776 [6] |
| LMK | string | O | 0..1 | Landmark or vanity address IETF RFC 4776 [6] |
| LOC | string | O | 0..1 | Additional location information IETF RFC 4776 [6] |
| NAM | string | O | 0..1 | Name (residence and office occupant) IETF RFC 4776 [6] |
| PC | string | O | 0..1 | Postal/zip code IETF RFC 4776 [6] |
| BLD | string | O | 0..1 | Building (structure) IETF RFC 5139 [7] |
| UNIT | string | O | 0..1 | Unit (apartment, suite) IETF RFC 5139 [7] |
| FLR | string | O | 0..1 | Floor IETF RFC 4776 [6] |
| ROOM | string | O | 0..1 | Room IETF RFC 5139 [7] |
| PLC | string | O | 0..1 | Place-type IETF RFC 5139 [7] |
| PCN | string | O | 0..1 | Postal community name IETF RFC 5139 [7] |
| POBOX | string | O | 0..1 | Post office box (P.O. box) IETF RFC 5139 [7] |
| ADDCODE | string | O | 0..1 | Additional code IETF RFC 5139 [7] |
| SEAT | string | O | 0..1 | Seat (desk, cubicle, workstation) IETF RFC 5139 [7] |
| RD | string | O | 0..1 | Primary road or street IETF RFC 5139 [7] |
| RDSEC | string | O | 0..1 | Road clause IETF RFC 5139 [7] |
| RDBR | string | O | 0..1 | Road branch IETF RFC 5139 [7] |
| RDSUBBR | string | O | 0..1 | Road sub-branch IETF RFC 5139 [7] |
| PRM | string | O | 0..1 | Road pre-modifier IETF RFC 5139 [7] |
| POM | string | O | 0..1 | Road post-modifier IETF RFC 5139 [7] |

EXAMPLE: The above structure follows the same label naming as in the XML schema shown in IETF RFC 5139 [7]. The same example shown in XML in that RFC, in chapter 5, would be equivalent to the following JSON document:

```
{
  "country": "AU",
  "A1": "NSW",
  "A3": "Wollongong",
  "A4": "North Wollongong",
  "RD": "Flinders",
  "STS": "Street",
  "RDBR": "Campbell Street",
  "LMK": "Gilligan's Island",
  "LOC": "Corner",
  "NAM": "Video Rental Store",
  "PC": "2500",
  "ROOM": "Westerns and Classics",
  "PLC": "store",
  "POBOX": "Private Box 15"
}
```

6.1.6.2.15 Type: PositioningMethodAndUsage

Table 6.1.6.2.15-1: Definition of type PositioningMethodAndUsage

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-------------------|---|-------------|-------------|
| method | PositioningMethod | M | 1 | |
| mode | PositioningMode | M | 1 | |
| usage | Usage | M | 1 | |

6.1.6.2.16 Type: GnssPositioningMethodAndUsage

Table 6.1.6.2.16-1: Definition of type GnssPositioningMethodAndUsage

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-----------------|---|-------------|-------------|
| mode | PositioningMode | M | 1 | |
| gnss | GnssId | M | 1 | |
| usage | Usage | M | 1 | |

6.1.6.2.17 Type: VelocityEstimate

Table 6.1.6.2.17-1: Definition of type VelocityEstimate as a list of mutually exclusive alternatives

| Data type | Cardinality | Description |
|--|-------------|--|
| HorizontalVelocity | 1 | Velocity estimate including horizontal speed and bearing. |
| HorizontalWithVerticalVelocity | 1 | Velocity estimate including horizontal speed and bearing, and also vertical speed and vertical direction. |
| HorizontalVelocityWithUncertainty | 1 | Velocity estimate including horizontal speed and bearing; it also includes an uncertainty value. |
| HorizontalWithVerticalVelocityAndUncertainty | 1 | Velocity estimate including horizontal speed and bearing, and also vertical speed and vertical direction; it also includes uncertainty value for horizontal and vertical speeds. |

6.1.6.2.18 Type: HorizontalVelocity

Table 6.1.6.2.18-1: Definition of type HorizontalVelocity

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-----------------|---|-------------|--|
| hSpeed | HorizontalSpeed | M | 1 | Horizontal speed in kilometres per hour. |
| bearing | Angle | M | 1 | Bearing angle in degrees, measured clockwise from North. |

6.1.6.2.19 Type: HorizontalWithVerticalVelocity

Table 6.1.6.2.19-1: Definition of type HorizontalWithVerticalVelocity

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-------------------|---|-------------|--|
| hSpeed | HorizontalSpeed | M | 1 | Horizontal speed in kilometres per hour. |
| bearing | Angle | M | 1 | Bearing angel in degrees, measured clockwise from North. |
| vSpeed | VerticalSpeed | M | 1 | Vertical Seed in kilometres per hour. |
| vDirection | VerticalDirection | M | 1 | Vertical Direction: upward or downward. |

6.1.6.2.20 Type: HorizontalVelocityWithUncertainty

Table 6.1.6.2.20-1: Definition of type HorizontalVelocityWithUncertainty

| Attribute name | Data type | P | Cardinality | Description |
|----------------|------------------|---|-------------|--|
| hSpeed | HorizontalSpeed | M | 1 | Speed in kilometres per hour. |
| bearing | Angle | M | 1 | Bearing angel in degrees, measured clockwise from North. |
| uncertainty | SpeedUncertainty | M | 1 | Uncertainty of horizontal speed in kilometres per hour. |

6.1.6.2.21 Type: HorizontalWithVerticalVelocityAndUncertainty

Table 6.1.6.2.21-1: Definition of type HorizontalWithVerticalVelocityAndUncertainty

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-------------------|---|-------------|--|
| hspeed | HorizontalSpeed | M | 1 | Speed in kilometres per hour. |
| bearing | Angle | M | 1 | Bearing angel in degrees, measured clockwise from North. |
| vSpeed | VerticalSpeed | M | 1 | Vertical Seed in kilometres per hour. |
| vDirection | VerticalDirection | M | 1 | Vertical Direction: upwards or downwards. |
| hUncertainty | SpeedUncertainty | M | 1 | Uncertainty of horizontal speed in kilometres per hour. |
| vUncertainty | SpeedUncertainty | M | 1 | Uncertainty of vertical speed in kilometres per hour. |

6.1.6.2.22 Type: UncertaintyEllipse

Table 6.1.6.2.22-1: Definition of type UncertaintyEllipse

| Attribute name | Data type | P | Cardinality | Description |
|------------------|-------------|---|-------------|-------------|
| semiMajor | Uncertainty | M | 1 | |
| semiMinor | Uncertainty | M | 1 | |
| orientationMajor | Orientation | M | 1 | |

6.1.6.2.23 Type: UeLcsCapability

Table 6.1.6.2.x-1: Definition of type UeLcsCapability

| Attribute name | Data type | P | Cardinality | Description |
|----------------|-----------|---|-------------|--|
| lppSupport | boolean | O | 0..1 | Indicates whether the UE supports LPP or not. - true (default): LPP supported by the UE - false: LPP not supported by the UE |

6.1.6.3 Simple data types and enumerations

6.1.6.3.1 Introduction

This clause defines simple data types and enumerations that can be referenced from data structures defined in the previous clauses.

6.1.6.3.2 Simple data types

The simple data types defined in table 6.1.6.3.2-1 shall be supported.

Table 6.1.6.3.2-1: Simple data types

| Type Name | Type Definition | Description |
|-----------------------|-----------------|--|
| Altitude | number | Float value of the altitude, expressed in meters. Minimum = -32767. Maximum = 32767. |
| Angle | integer | Integer value of the angle, expressed in degrees. Minimum = 0. Maximum = 360. |
| Uncertainty | number | Float value of uncertainty, expressed in meters. Minimum = 0 |
| Orientation | integer | Integer value of the orientation angle, expressed in degrees. Minimum = 0. Maximum = 180. |
| Confidence | integer | Integer value of the confidence, expressed in percentage value. Minimum = 0. Maximum = 100. |
| Accuracy | number | Float value of accuracy, expressed in meters. Minimum = 0 |
| InnerRadius | integer | Integer value of the inner radius, expressed in meters. Minimum = 0. Maximum = 327675. |
| CorrelationID | string | LCS Correlation ID. The correlation ID shall be of a minimum length of 1 character and maximum length of 255 characters. |
| AgeOfLocationEstimate | integer | Integer value of the age of the location estimate, expressed in minutes. Minimum: 0. Maximum: 32767. |
| HorizontalSpeed | number | Float value of horizontal speed, expressed in kilometres per hour. Minimum = 0. Maximum = 2047. |
| VerticalSpeed | number | Float value of horizontal speed, expressed in kilometres per hour. Minimum = 0. Maximum = 255. |
| SpeedUncertainty | number | Float value of speed uncertainty, expressed in kilometres per hour. Minimum = 0. Maximum = 255. |
| BarometricPressure | integer | This IE specifies the measured uncompensated atmospheric pressure in units of Pascal (Pa). Minimum = 30000. Maximum = 115000. |

6.1.6.3.3 Enumeration: ExternalClientType

The enumeration ExternalClientType represents the different types of clients of the location service.

Table 6.1.6.3.3-1: Enumeration ExternalClientType

| Enumeration value | Description |
|---|-------------|
| "EMERGENCY_SERVICES" | |
| "VALUE_ADDED_SERVICES" | |
| "PLMN_OPERATOR_SERVICES" | |
| "LAWFUL_INTERCEPT_SERVICES" | |
| "PLMN_OPERATOR_BROADCAST_SERVICES" | |
| "PLMN_OPERATOR_OM" | |
| "PLMN_OPERATOR_ANONYMOUS_STATISTICS" | |
| "PLMN_OPERATOR_TARGET_MS_SERVICE_SUPPORT" | |

6.1.6.3.4 Enumeration: SupportedGADShapes

The enumeration SupportedGADShapes represents the different types, or shapes, of geographic areas supported by the system.

Table 6.1.6.3.4-1: Enumeration SupportedGADShapes

| Enumeration value | Description |
|------------------------------|-------------|
| "POINT" | |
| "POINT_UNCERTAINTY_CIRCLE" | |
| "POINT_UNCERTAINTY_ELLIPSE" | |
| "POLYGON" | |
| "POINT_ALTITUDE" | |
| "POINT_ALTITUDE_UNCERTAINTY" | |
| "ELLIPSOID_ARC" | |

6.1.6.3.5 Enumeration: ResponseTime

The enumeration ResponseTime represents the acceptable delay in the determination of the location of the UE.

Table 6.1.6.3.5-1: Enumeration ResponseTime

| Enumeration value | Description |
|-------------------|-------------|
| "LOW_DELAY" | |
| "DELAY_TOLERANT" | |

6.1.6.3.6 Enumeration: PositioningMethod

The enumeration PositioningMethod represents the method used to determine the location of the UE.

Table 6.1.6.3.6-1: Enumeration PositioningMethod

| Enumeration value | Description |
|-----------------------|-------------|
| "CELLID" | |
| "ECID" | |
| "OTDOA" | |
| "BAROMETRIC_PRESSURE" | |
| "WLAN" | |
| "BLUETOOTH" | |
| "MBS" | |
| "MOTION_SENSOR" | |

6.1.6.3.7 Enumeration: PositioningMode

The enumeration PositioningMode represents the mode used to determine the location of the UE when a certain positioning method is used.

Table 6.1.6.3.7-1: Enumeration PositioningMode

| Enumeration value | Description |
|-------------------|-------------|
| "UE_BASED" | |
| "UE_ASSISTED" | |
| "CONVENTIONAL" | |

6.1.6.3.8 Enumeration: GnssId

The enumeration GnssId represents the different GNSS systems.

Table 6.1.6.3.8-1: Enumeration GnssId

| Enumeration value | Description |
|-------------------|-------------|
| "GPS" | |
| "GALILEO" | |
| "SBAS" | |
| "MODERNIZED_GPS" | |
| "QZSS" | |
| "GLONASS" | |

6.1.6.3.9 Enumeration: Usage

The enumeration Usage represents the type of usage made of the location measurement from the UE.

Table 6.1.6.3.9-1: Enumeration Usage

| Enumeration value | Description |
|---|-------------|
| "UNSUCCESS" | |
| "SUCCESS_RESULTS_NOT_USED" | |
| "SUCCESS_RESULTS_USED_TO_VERIFY_LOCATION" | |
| "SUCCESS_RESULTS_USED_TO_GENERATE_LOCATION" | |
| "SUCCESS_METHOD_NOT_DETERMINED" | |

6.1.6.3.10 Enumeration: LcsPriority

The enumeration LcsPriority represents the priority of the LCS client.

Table 6.1.6.3.10-1: Enumeration LcsPriority

| Enumeration value | Description |
|--------------------|-------------|
| "HIGHEST_PRIORITY" | |
| "NORMAL_PRIORITY" | |

6.1.6.3.11 Enumeration: VelocityRequested

The enumeration VelocityRequested represents the indication of velocity requirement.

Table 6.1.6.3.11-1: Enumeration VelocityRequested

| Enumeration value | Description |
|-----------------------------|-------------|
| "VELOCITY_IS_NOT_REQUESTED" | |
| "VELOCITY_IS_REQUESTED" | |

6.1.6.3.12 Enumeration: AccuracyFulfilmentIndicator

The enumeration AccuracyFulfilmentIndicator represents whether the requested accuracy was fulfilled or not.

Table 6.1.6.3.12-1: Enumeration AccuracyFulfilmentIndicator

| Enumeration value | Description |
|------------------------------------|-------------|
| "REQUESTED_ACCURACY_FULFILLED" | |
| "REQUESTED_ACCURACY_NOT_FULFILLED" | |

6.1.6.3.13 Enumeration: VerticalDirection

The enumeration VerticalDirection represents the direction (upward/downward) of the vertical speed.

Table 6.1.6.3.13-1: Enumeration VerticalDirection

| Enumeration value | Description |
|-------------------|-------------|
| "UPWARD" | |
| "DOWNWARD" | |

6.1.7 Error Handling

6.1.7.1 General

HTTP error handling shall be supported as specified in clause 5.2.4 of 3GPP TS 29.500 [4].

6.1.7.2 Protocol Errors

Protocol errors handling shall be supported as specified in clause 5.2.7 of 3GPP TS 29.500 [4].

6.1.7.3 Application Errors

The application errors defined for the Nlmf_Location service are listed in Table 6.1.7.3-1.

Table 6.1.7.3-1: Application errors

| Application Error | HTTP status code | Description |
|--------------------|---------------------------|--|
| POSITIONING_DENIED | 403 Forbidden | The positioning procedure was denied. |
| UNSPECIFIED | 403 Forbidden | The request is rejected due to unspecified reasons. |
| POSITIONING_FAILED | 500 Internal Server Error | The positioning procedure failed. |
| UNREACHABLE_USER | 504 Gateway Timeout | The user could not be reached in order to perform positioning procedure. |

6.1.8 Security

As indicated in 3GPP TS 33.501 [9], the access to the Nlmf_Location API may be authorized by means of the OAuth2 protocol (see IETF RFC 6749 [10]), using the "Client Credentials" authorization grant, where the NRF (see 3GPP TS 29.510 [11]) plays the role of the authorization server.

If OAuth2 authorization is used, an NF Service Consumer, prior to consuming services offered by the Nlmf_Location API, shall obtain a "token" from the authorization server, by invoking the Access Token Request service, as described in 3GPP TS 29.510 [11], clause 5.4.2.2.

NOTE: When multiple NRFs are deployed in a network, the NRF used as authorization server is the same NRF that the NF Service Consumer used for discovering the Nlmf_Location service.

The Nlmf_Location API defines scopes for OAuth2 authorization as specified in 3GPP TS 33.501 [9]; it defines a single scope consisting on the name of the service (i.e., "nlmf-loc"), and it does not define any additional scopes at resource or operation level.

Annex A (normative): OpenAPI specification

A.1 General

This Annex specifies the formal definition of the Nlmf Service API. It consists of an OpenAPI 3.0.0 specification, in YAML format.

This Annex takes precedence when being discrepant to other parts of the specification with respect to the encoding of information elements and methods within the API(s).

NOTE 1: The semantics and procedures, as well as conditions, e.g. for the applicability and allowed combinations of attributes or values, not expressed in the OpenAPI definitions but defined in other parts of the specification also apply.

Informative copies of the OpenAPI specification files contained in this 3GPP Technical Specification are available on the public 3GPP file server in the following locations (see clause 5B of the 3GPP TR 21.900 [16] for further information):

- <https://www.3gpp.org/ftp/Specs/archive/OpenAPI/<Release>/>, and
- <https://www.3gpp.org/ftp/Specs/<Plenary>/<Release>/OpenAPI/>.

NOTE 2: To fetch the OpenAPI specification file after CT#83 plenary meeting for Release 15 in the above links <Plenary> must be replaced with the date the CT Plenary occurs, in the form of year-month (yyyy-mm), e.g. for CT#83 meeting <Plenary> must be replaced with value "2019-03" and <Release> must be replaced with value "Rel-15".

A.2 Nlmf_Location API

```

openapi: 3.0.0
info:
  version: '1.0.4'
  title: 'LMF Location'
  description: |
    LMF Location Service.
    © 2019, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).
    All rights reserved.
servers:
  - url: '{apiRoot}/nlmf-loc/v1'
    variables:
      apiRoot:
        default: https://example.com
        description: apiRoot as defined in clause 4.4 of 3GPP TS 29.501
security:
  - {}
  - oAuth2ClientCredentials:
    - nlmf-loc
paths:
  /determine-location:
    post:
      summary: Determine Location of an UE
      operationId: DetermineLocation
      tags:
        - Determine Location
      requestBody:
        content:
          application/json:
            schema:
              $ref: '#/components/schemas/InputData'
            required: true
      responses:
        '200':
          description: Expected response to a valid request
          content:
            application/json:
              schema:
                $ref: '#/components/schemas/LocationData'
        '400':

```

```

    $ref: 'TS29571_CommonData.yaml#/components/responses/400'
  '401':
    $ref: 'TS29571_CommonData.yaml#/components/responses/401'
  '403':
    $ref: 'TS29571_CommonData.yaml#/components/responses/403'
  '404':
    $ref: 'TS29571_CommonData.yaml#/components/responses/404'
  '411':
    $ref: 'TS29571_CommonData.yaml#/components/responses/411'
  '413':
    $ref: 'TS29571_CommonData.yaml#/components/responses/413'
  '415':
    $ref: 'TS29571_CommonData.yaml#/components/responses/415'
  '429':
    $ref: 'TS29571_CommonData.yaml#/components/responses/429'
  '500':
    $ref: 'TS29571_CommonData.yaml#/components/responses/500'
  '503':
    $ref: 'TS29571_CommonData.yaml#/components/responses/503'
  '504':
    $ref: 'TS29571_CommonData.yaml#/components/responses/504'
  default:
    $ref: 'TS29571_CommonData.yaml#/components/responses/default'
components:
  securitySchemes:
    oAuth2ClientCredentials:
      type: oauth2
      flows:
        clientCredentials:
          tokenUrl: '{nrfApiRoot}/oauth2/token'
          scopes:
            nlmf-loc: Access to the Nlmf_Location API
  schemas:
#
# COMPLEX TYPES
#
  InputData:
    type: object
    not:
      required: [ ecgi, ncgi ]
    properties:
      externalClientType:
        $ref: '#/components/schemas/ExternalClientType'
      correlationID:
        $ref: '#/components/schemas/CorrelationID'
      amfId:
        $ref: 'TS29571_CommonData.yaml#/components/schemas/NfInstanceId'
      locationQoS:
        $ref: '#/components/schemas/LocationQoS'
      supportedGADShapes:
        type: array
        items:
          $ref: '#/components/schemas/SupportedGADShapes'
        minItems: 1
      supi:
        $ref: 'TS29571_CommonData.yaml#/components/schemas/Supi'
      pei:
        $ref: 'TS29571_CommonData.yaml#/components/schemas/Pei'
      gpsi:
        $ref: 'TS29571_CommonData.yaml#/components/schemas/Gpsi'
      ecgi:
        $ref: 'TS29571_CommonData.yaml#/components/schemas/Ecgi'
      ncgi:
        $ref: 'TS29571_CommonData.yaml#/components/schemas/Ncgi'
      priority:
        $ref: '#/components/schemas/LcsPriority'
      velocityRequested:
        $ref: '#/components/schemas/VelocityRequested'
      ueLcsCap:
        $ref: '#/components/schemas/UeLcsCapability'
  LocationData:
    type: object
    required:
      - locationEstimate
    properties:
      locationEstimate:
        $ref: '#/components/schemas/GeographicArea'
      accuracyFulfilmentIndicator:

```

```

    $ref: '#/components/schemas/AccuracyFulfilmentIndicator'
  ageOfLocationEstimate:
    $ref: '#/components/schemas/AgeOfLocationEstimate'
  velocityEstimate:
    $ref: '#/components/schemas/VelocityEstimate'
  civicAddress:
    $ref: '#/components/schemas/CivicAddress'
  positioningDataList:
    type: array
    items:
      $ref: '#/components/schemas/PositioningMethodAndUsage'
    minItems: 1
  gnssPositioningDataList:
    type: array
    items:
      $ref: '#/components/schemas/GnssPositioningMethodAndUsage'
    minItems: 1
  ecgi:
    $ref: 'TS29571_CommonData.yaml#/components/schemas/Ecgi'
  ncgi:
    $ref: 'TS29571_CommonData.yaml#/components/schemas/Ncgi'
  altitude:
    $ref: '#/components/schemas/Altitude'
  barometricPressure:
    $ref: '#/components/schemas/BarometricPressure'
GeographicArea:
  anyOf:
    - $ref: '#/components/schemas/Point'
    - $ref: '#/components/schemas/PointUncertaintyCircle'
    - $ref: '#/components/schemas/PointUncertaintyEllipse'
    - $ref: '#/components/schemas/Polygon'
    - $ref: '#/components/schemas/PointAltitude'
    - $ref: '#/components/schemas/PointAltitudeUncertainty'
    - $ref: '#/components/schemas/EllipsoidArc'
GADShape:
  type: object
  required:
    - shape
  properties:
    shape:
      $ref: '#/components/schemas/SupportedGADShapes'
  discriminator:
    propertyName: shape
    mapping:
      POINT: '#/components/schemas/Point'
      POINT_UNCERTAINTY_CIRCLE: '#/components/schemas/PointUncertaintyCircle'
      POINT_UNCERTAINTY_ELLIPSE: '#/components/schemas/PointUncertaintyEllipse'
      POLYGON: '#/components/schemas/Polygon'
      POINT_ALTITUDE: '#/components/schemas/PointAltitude'
      POINT_ALTITUDE_UNCERTAINTY: '#/components/schemas/PointAltitudeUncertainty'
      ELLIPSOID_ARC: '#/components/schemas/EllipsoidArc'
Point:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - point
      properties:
        point:
          $ref: '#/components/schemas/GeographicalCoordinates'
PointUncertaintyCircle:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - point
        - uncertainty
      properties:
        point:
          $ref: '#/components/schemas/GeographicalCoordinates'
        uncertainty:
          $ref: '#/components/schemas/Uncertainty'
PointUncertaintyEllipse:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - point

```

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    - uncertaintyEllipse
    - confidence
  properties:
    point:
      $ref: '#/components/schemas/GeographicalCoordinates'
    uncertaintyEllipse:
      $ref: '#/components/schemas/UncertaintyEllipse'
    confidence:
      $ref: '#/components/schemas/Confidence'
Polygon:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - pointList
      properties:
        pointList:
          $ref: '#/components/schemas/PointList'
PointAltitude:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - point
        - altitude
      properties:
        point:
          $ref: '#/components/schemas/GeographicalCoordinates'
        altitude:
          $ref: '#/components/schemas/Altitude'
PointAltitudeUncertainty:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - point
        - altitude
        - uncertaintyEllipse
        - uncertaintyAltitude
        - confidence
      properties:
        point:
          $ref: '#/components/schemas/GeographicalCoordinates'
        altitude:
          $ref: '#/components/schemas/Altitude'
        uncertaintyEllipse:
          $ref: '#/components/schemas/UncertaintyEllipse'
        uncertaintyAltitude:
          $ref: '#/components/schemas/Uncertainty'
        confidence:
          $ref: '#/components/schemas/Confidence'
EllipsoidArc:
  allOf:
    - $ref: '#/components/schemas/GADShape'
    - type: object
      required:
        - point
        - innerRadius
        - uncertaintyRadius
        - offsetAngle
        - includedAngle
        - confidence
      properties:
        point:
          $ref: '#/components/schemas/GeographicalCoordinates'
        innerRadius:
          $ref: '#/components/schemas/InnerRadius'
        uncertaintyRadius:
          $ref: '#/components/schemas/Uncertainty'
        offsetAngle:
          $ref: '#/components/schemas/Angle'
        includedAngle:
          $ref: '#/components/schemas/Angle'
        confidence:
          $ref: '#/components/schemas/Confidence'
GeographicalCoordinates:
  type: object
  required:

```

```

    - lon
    - lat
  properties:
    lon:
      type: number
      format: float
      minimum: -180
      maximum: 180
    lat:
      type: number
      format: float
      minimum: -90
      maximum: 90
  UncertaintyEllipse:
    type: object
    required:
      - semiMajor
      - semiMinor
      - orientationMajor
    properties:
      semiMajor:
        $ref: '#/components/schemas/Uncertainty'
      semiMinor:
        $ref: '#/components/schemas/Uncertainty'
      orientationMajor:
        $ref: '#/components/schemas/Orientation'
  PointList:
    type: array
    items:
      $ref: '#/components/schemas/GeographicalCoordinates'
    minItems: 3
    maxItems: 15
  LocationQoS:
    type: object
    properties:
      hAccuracy:
        $ref: '#/components/schemas/Accuracy'
      vAccuracy:
        $ref: '#/components/schemas/Accuracy'
      verticalRequested:
        type: boolean
      responseTime:
        $ref: '#/components/schemas/ResponseTime'
  PositioningMethodAndUsage:
    type: object
    required:
      - method
      - mode
      - usage
    properties:
      method:
        $ref: '#/components/schemas/PositioningMethod'
      mode:
        $ref: '#/components/schemas/PositioningMode'
      usage:
        $ref: '#/components/schemas/Usage'
  GnssPositioningMethodAndUsage:
    type: object
    required:
      - mode
      - gnss
      - usage
    properties:
      mode:
        $ref: '#/components/schemas/PositioningMode'
      gnss:
        $ref: '#/components/schemas/GnssId'
      usage:
        $ref: '#/components/schemas/Usage'
  CivicAddress:
    type: object
    properties:
      country:
        type: string
      A1:
        type: string
      A2:
        type: string

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A3:
  type: string
A4:
  type: string
A5:
  type: string
A6:
  type: string
PRD:
  type: string
POD:
  type: string
STS:
  type: string
HNO:
  type: string
HNS:
  type: string
LMK:
  type: string
LOC:
  type: string
NAM:
  type: string
PC:
  type: string
BLD:
  type: string
UNIT:
  type: string
FLR:
  type: string
ROOM:
  type: string
PLC:
  type: string
PCN:
  type: string
POBOX:
  type: string
ADDCODE:
  type: string
SEAT:
  type: string
RD:
  type: string
RDSEC:
  type: string
RDBR:
  type: string
RDSUBBR:
  type: string
PRM:
  type: string
POM:
  type: string
VelocityEstimate:
  oneOf:
    - $ref: '#/components/schemas/HorizontalVelocity'
    - $ref: '#/components/schemas/HorizontalWithVerticalVelocity'
    - $ref: '#/components/schemas/HorizontalVelocityWithUncertainty'
    - $ref: '#/components/schemas/HorizontalWithVerticalVelocityAndUncertainty'
HorizontalVelocity:
  type: object
  required:
    - hSpeed
    - bearing
  properties:
    hSpeed:
      $ref: '#/components/schemas/HorizontalSpeed'
    bearing:
      $ref: '#/components/schemas/Angle'
HorizontalWithVerticalVelocity:
  type: object
  required:
    - hSpeed
    - bearing
    - vSpeed

```



```

    - vDirection
  properties:
    hSpeed:
      $ref: '#/components/schemas/HorizontalSpeed'
    bearing:
      $ref: '#/components/schemas/Angle'
    vSpeed:
      $ref: '#/components/schemas/VerticalSpeed'
    vDirection:
      $ref: '#/components/schemas/VerticalDirection'
HorizontalVelocityWithUncertainty:
  type: object
  required:
    - hSpeed
    - bearing
    - hUncertainty
  properties:
    hSpeed:
      $ref: '#/components/schemas/HorizontalSpeed'
    bearing:
      $ref: '#/components/schemas/Angle'
    hUncertainty:
      $ref: '#/components/schemas/SpeedUncertainty'
HorizontalWithVerticalVelocityAndUncertainty:
  type: object
  required:
    - hSpeed
    - bearing
    - vSpeed
    - vDirection
    - hUncertainty
    - vUncertainty
  properties:
    hSpeed:
      $ref: '#/components/schemas/HorizontalSpeed'
    bearing:
      $ref: '#/components/schemas/Angle'
    vSpeed:
      $ref: '#/components/schemas/VerticalSpeed'
    vDirection:
      $ref: '#/components/schemas/VerticalDirection'
    hUncertainty:
      $ref: '#/components/schemas/SpeedUncertainty'
    vUncertainty:
      $ref: '#/components/schemas/SpeedUncertainty'
UeLcsCapability:
  type: object
  properties:
    lppSupport:
      type: boolean
      default: true
#
# SIMPLE TYPES
#
Altitude:
  type: number
  format: float
  minimum: -32767
  maximum: 32767
Angle:
  type: integer
  minimum: 0
  maximum: 360
Uncertainty:
  type: number
  format: float
  minimum: 0
Orientation:
  type: integer
  minimum: 0
  maximum: 180
Confidence:
  type: integer
  minimum: 0
  maximum: 100
Accuracy:
  type: number
  format: float

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    minimum: 0
  InnerRadius:
    type: integer
    format: int32
    minimum: 0
    maximum: 327675
  CorrelationID:
    type: string
    minLength: 1
    maxLength: 255
  AgeOfLocationEstimate:
    type: integer
    minimum: 0
    maximum: 32767
  HorizontalSpeed:
    type: number
    format: float
    minimum: 0
    maximum: 2047
  VerticalSpeed:
    type: number
    format: float
    minimum: 0
    maximum: 255
  SpeedUncertainty:
    type: number
    format: float
    minimum: 0
    maximum: 255
  BarometricPressure:
    type: integer
    minimum: 30000
    maximum: 115000
#
# ENUMS
#
  ExternalClientType:
    anyOf:
      - type: string
        enum:
          - EMERGENCY_SERVICES
          - VALUE_ADDED_SERVICES
          - PLMN_OPERATOR_SERVICES
          - LAWFUL_INTERCEPT_SERVICES
          - PLMN_OPERATOR_BROADCAST_SERVICES
          - PLMN_OPERATOR_OM
          - PLMN_OPERATOR_ANONYMOUS_STATISTICS
          - PLMN_OPERATOR_TARGET_MS_SERVICE_SUPPORT
      - type: string
  SupportedGADShapes:
    anyOf:
      - type: string
        enum:
          - POINT
          - POINT_UNCERTAINTY_CIRCLE
          - POINT_UNCERTAINTY_ELLIPSE
          - POLYGON
          - POINT_ALTITUDE
          - POINT_ALTITUDE_UNCERTAINTY
          - ELLIPSOID_ARC
      - type: string
  ResponseTime:
    anyOf:
      - type: string
        enum:
          - LOW_DELAY
          - DELAY_TOLERANT
      - type: string
  PositioningMethod:
    anyOf:
      - type: string
        enum:
          - CELLID
          - ECID
          - OTDOA
          - BAROMETRIC_PRESSURE
          - WLAN
          - BLUETOOTH

```

```
- MBS
- MOTION_SENSOR
- type: string
PositioningMode:
  anyOf:
    - type: string
      enum:
        - UE_BASED
        - UE_ASSISTED
        - CONVENTIONAL
    - type: string
GnssId:
  anyOf:
    - type: string
      enum:
        - GPS
        - GALILEO
        - SBAS
        - MODERNIZED_GPS
        - QZSS
        - GLONASS
    - type: string
Usage:
  anyOf:
    - type: string
      enum:
        - UNSUCCESS
        - SUCCESS_RESULTS_NOT_USED
        - SUCCESS_RESULTS_USED_TO_VERIFY_LOCATION
        - SUCCESS_RESULTS_USED_TO_GENERATE_LOCATION
        - SUCCESS_METHOD_NOT_DETERMINED
    - type: string
LcsPriority:
  anyOf:
    - type: string
      enum:
        - HIGHEST_PRIORITY
        - NORMAL_PRIORITY
    - type: string
VelocityRequested:
  anyOf:
    - type: string
      enum:
        - VELOCITY_IS_NOT_REQUESTED
        - VELOCITY_IS_REQUESTED
    - type: string
AccuracyFulfilmentIndicator:
  anyOf:
    - type: string
      enum:
        - REQUESTED_ACCURACY_FULFILLED
        - REQUESTED_ACCURACY_NOT_FULFILLED
    - type: string
VerticalDirection:
  type: string
  enum:
    - UPWARD
    - DOWNWARD
externalDocs:
  description: 3GPP TS 29.572 V15.6.0; 5G System; Location Management Services; Stage 3
  url: 'http://www.3gpp.org/ftp/Specs/archive/29_series/29.572/'
```

Annex B (informative): Change history

| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
|---------|---------|-----------|------|-----|-----|--|-------------|
| 2018-01 | CT4#82 | | | | | TS Skeleton agreed in CT4#82 | 0.0.0 |
| 2018-01 | CT4#82 | C4-181398 | | | | Initial draft (C4-181119) Incorporation of agreed pCRs from CT4#82: C4-181121, C4-181233, C4-181234 | 0.1.0 |
| 2018-03 | CT4#83 | C4-182444 | | | | Incorporation of agreed pCRs from CT4#83: C4-182181, C4-182427 | 0.2.0 |
| 2018-03 | CT#79 | CP-180034 | | | | Presented for information | 1.0.0 |
| 2018-04 | CT4#84 | C4-183524 | | | | Incorporation of agreed pCRs from CT4#84: C4-183184, C4-183363, C4-183510 | 1.1.0 |
| 2018-05 | CT4#85 | C4-184640 | | | | Incorporation of agreed pCRs from CT4#85: C4-184195, C4-184197, C4-184198, C4-184199, C4-184202, C4-184443, C4-184446, C4-184547 | 1.2.0 |
| 2018-06 | CT#80 | CP-181111 | | | | Presented for approval | 2.0.0 |
| 2018-06 | CT#80 | | | | | Approved in CT#80 | 15.0.0 |
| 2018-09 | CT#81 | CP-182066 | 0002 | 2 | | Error Cases | 15.1.0 |
| 2018-09 | CT#81 | CP-182066 | 0003 | - | | Custom Headers | 15.1.0 |
| 2018-09 | CT#81 | CP-182066 | 0004 | - | | Overall Clean-up | 15.1.0 |
| 2018-09 | CT#81 | CP-182066 | 0005 | - | | Description of Structured data types | 15.1.0 |
| 2018-09 | CT#81 | CP-182066 | 0006 | 1 | | Resource structure presentation | 15.1.0 |
| 2018-09 | CT#81 | CP-182066 | 0007 | 1 | | LMF servers clause in OpenAPI | 15.1.0 |
| 2018-09 | CT#81 | CP-182066 | 0008 | - | | API Version Update | 15.1.0 |
| 2018-12 | CT#82 | CP-183025 | 0010 | 1 | F | Cardinality | 15.2.0 |
| 2018-12 | CT#82 | CP-183025 | 0011 | - | F | APIRoot Clarification | 15.2.0 |
| 2018-12 | CT#82 | CP-183025 | 0012 | - | F | AMF Id | 15.2.0 |
| 2018-12 | CT#82 | CP-183025 | 0013 | - | F | Barometric Pressure in Location Data | 15.2.0 |
| 2018-12 | CT#82 | CP-183025 | 0014 | 1 | F | Clarify Serving Cell in Input Data | 15.2.0 |
| 2018-12 | CT#82 | CP-183025 | 0015 | 1 | F | Oauth2 Corrections | 15.2.0 |
| 2018-12 | CT#82 | CP-183025 | 0016 | - | F | API Version | 15.2.0 |
| 2018-12 | CT#82 | CP-183179 | 0017 | - | F | ExternalDocs Update | 15.2.0 |
| 2019-03 | CT#83 | CP-190030 | 0018 | 1 | F | OpenAPI Corrections | 15.3.0 |
| 2019-03 | CT#83 | CP-190030 | 0019 | 1 | F | Application Errors | 15.3.0 |
| 2019-03 | CT#83 | CP-190030 | 0020 | 1 | F | Essential Correction to InnerRadius | 15.3.0 |
| 2019-03 | CT#83 | CP-190030 | 0021 | 1 | F | Mandatory Response Codes | 15.3.0 |
| 2019-03 | CT#83 | CP-190030 | 0022 | 1 | F | Essential correction to OpenAPI definition of GeographicArea | 15.3.0 |
| 2019-03 | CT#83 | CP-190030 | 0023 | - | F | API version update | 15.3.0 |
| 2019-06 | CT#84 | CP-191042 | 0024 | 2 | F | UE Capabilities | 15.4.0 |
| 2019-06 | CT#84 | CP-191042 | 0025 | 2 | F | Storage of OpenAPI specification files | 15.4.0 |
| 2019-06 | CT#84 | CP-191042 | 0027 | 1 | F | Copyright Note in OpenAPI Spec | 15.4.0 |
| 2019-06 | CT#84 | CP-192113 | 0028 | 1 | F | Major API version | 15.4.0 |
| 2019-06 | CT#84 | CP-192113 | 0030 | - | F | Open API Version | 15.4.0 |
| 2019-09 | CT#85 | CP-192119 | 0031 | 1 | F | Missing attribute FLR in Civic Address | 15.5.0 |
| 2019-09 | CT#85 | CP-192113 | 0037 | 1 | D | Correct type Polygon | 15.5.0 |
| 2019-09 | CT#85 | CP-192113 | 0038 | - | F | 3GPP TS 29.572 API version update | 15.5.0 |
| 2019-12 | CT#86 | CP-193033 | 0040 | 1 | F | Motion Sensor Position Method | 15.6.0 |
| 2019-12 | CT#86 | CP-193043 | 0047 | - | F | 3GPP TS 29.572 API version update | 15.6.0 |

History

| Document history | | |
|-------------------------|----------------|-------------|
| V15.0.0 | September 2018 | Publication |
| V15.1.0 | October 2018 | Publication |
| V15.2.0 | April 2019 | Publication |
| V15.3.0 | April 2019 | Publication |
| V15.4.0 | July 2019 | Publication |
| V15.5.0 | October 2019 | Publication |
| V15.6.0 | January 2020 | Publication |