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Contents

Foreword

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

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where:

x the first digit:

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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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:
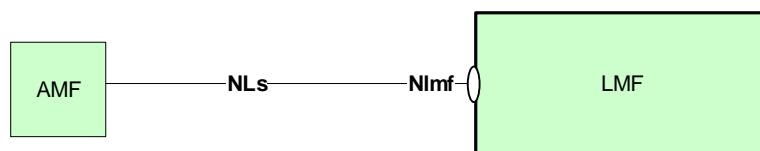
Figure 4-1: Reference model – LMF

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).
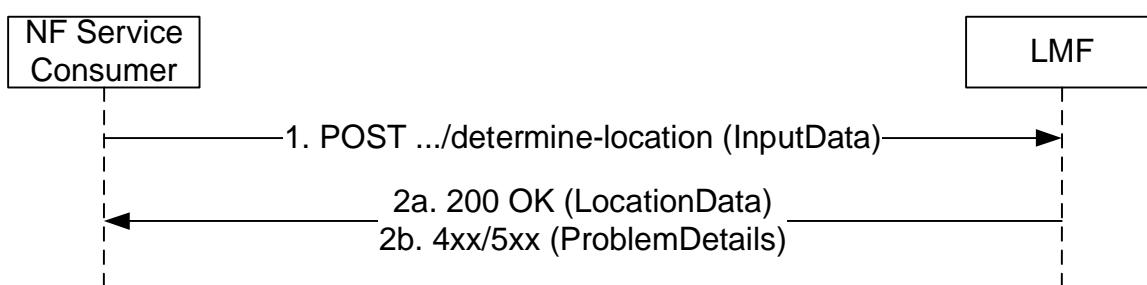
Figure 5.2.2.2.2-1: DetermineLocation Request

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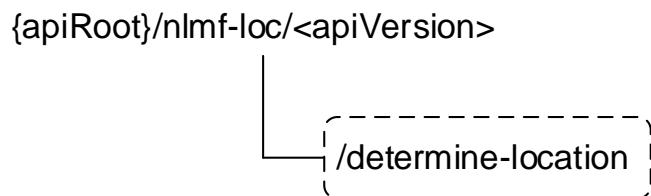
Figure 6.1.3.1-1: Resource URI structure of the Nlmf_Location API

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 sublause 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 "Deterrmine 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]	
NfInstanceId	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	NfInstanceId	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 are 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 to15 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"	

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: '1.0.3'
  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
```

```
            - 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
```

```
        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
```

```
        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
              - 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 V15.5.0; 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

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