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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".

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:

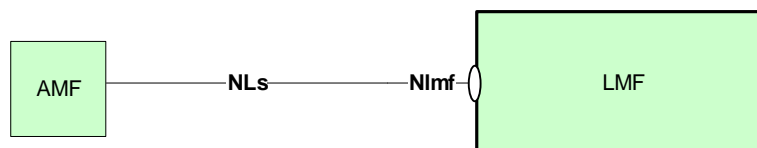


Figure 4-1: Reference model – LMF

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).

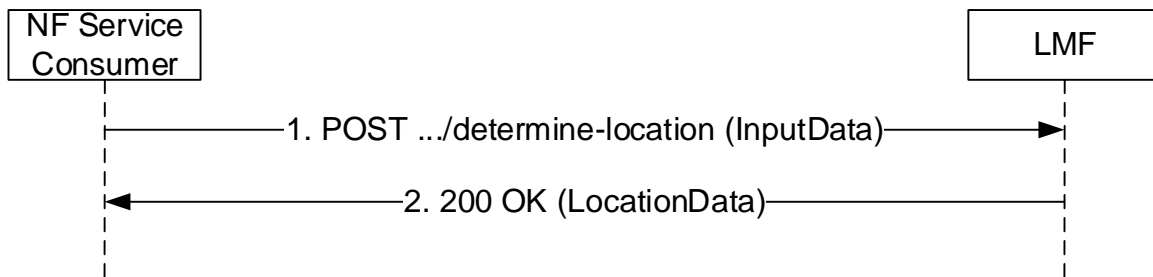


Figure 5.2.2.2-1: DetermineLocation Request

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.
2. 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...).

Editor's Note: the description of failure cases is FFS.

6 API Definitions

6.1 Nlmf_Location Service API

6.1.1 API URI

URIs of this API shall have the following root:

```
{apiRoot}/{apiName}/{apiVersion}/
```

where the "apiName" shall be set to "nlmf-loc" and the "apiVersion" shall be set to "v1" for the current version of this specification.

6.1.2 Usage of HTTP

6.1.2.1 General

This subclause will include a reference to TS 29.500 for the description of the Transport and HTTP/2 protocol requirements and for the security requirements.

6.1.2.2 HTTP Standard Headers

6.1.2.2.1 General

6.1.2.2.2 Content type

This subclause will indicate the encoding of HTTP requests/responses and the applicable MIME media type for the related Content-Type header.

6.1.2.3 HTTP custom headers

6.1.2.3.1 General

This clause will list, if applicable, the possible reused HTTP custom headers and the definition of new HTTP custom headers introduced by this specification.

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.

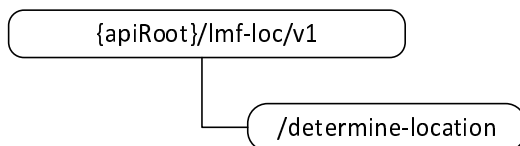


Figure 6.1.3.1-1: Resource URI structure of the <xyz> API

Editor's Note: The URI component "determine-location" is a custom operation without any associated resource; it is FFS how to represent this in the resource URI structure figures (e.g., as a box framed by a dotted-line).

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/v1/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/v1/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
NOTE: In addition, common data structures as listed in table 6.1.7-1 are supported.				

6.1.5 Notifications

6.1.5.1 General

This subclause will specify the use of notifications and corresponding protocol details if required for the specific service. When notifications are supported by the API, it will include a reference to the general description of notifications support over the 5G SBIs specified in TS 29.500 / TS 29.501.

6.1.5.2 <notification 1>

6.1.5.3 <notification 2>

6.1.6 Data Model

6.1.6.1 General

This subclause 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	Section 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	
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	
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]	

6.1.6.2 Structured data types

6.1.6.2.1 Introduction

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

Allowed structures are: array, object.

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	
locationQoS	LocationQoS	O	0..1	
supportedGADShapes	SupportedGADShapes	O	0..1	
supi	Supi	O	0..1	
pei	Pei	O	0..1	
gpsi	Gpsi	O	0..1	
ecgi	Ecgi	O	0..1	
ncgi	Ncgi	O	0..1	
priority	LcsPriority	O	0..1	
velocityRequested	VelocityRequested	O	0..1	

NOTE: At least one of the attributes defined in this table shall be present in the InputData structure.

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	0..N	
gnssPositioningDataList	array(GnssPositioningMethodAndUsage)	O	0..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.

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	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 section 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	

6.1.6.3 Simple data types and enumerations

6.1.6.3.1 Introduction

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

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 = 65535.
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.

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

This subclause will include a reference to the general error handling principles specified in TS 29.501, and further specify any general error handling aspect specific to the API, if any Error handling specific to each method (and resource) is specified in subclauses 6.1.3. and 6.1.4.

6.1.8 Security

As indicated in 3GPP TS 33.501 [9], the access to the Nlmf_Location API shall 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.

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], subclause 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 does not define any scopes for OAuth2 authorization.

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.

A.2 Nlmf_Location API

```

openapi: 3.0.0
info:
  version: '1.PreR15.0.0'
  title: 'LMF Location'
  description: 'LMF Location Service'
security:
  - oAuth2ClientCredentials: []
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'
        default:
          description: Unexpected error
          content:
            application/problem+json:
              schema:
                $ref: 'TS29571_CommonData.yaml#/components/schemas/ProblemDetails'
components:
  securitySchemes:
    oAuth2ClientCredentials:
      type: oauth2
      flows:
        clientCredentials:
          tokenUrl: '{nrfApiRoot}/oauth2/token'
          scopes: {}
  schemas:
    #
    # COMPLEX TYPES
    #
    InputData:
      type: object
      properties:
        externalClientType:
          $ref: '#/components/schemas/ExternalClientType'
        correlationID:
          $ref: '#/components/schemas/CorrelationID'
        locationQoS:
          $ref: '#/components/schemas/LocationQoS'
        supportedGADShapes:
          type: array
          items:
            $ref: '#/components/schemas/SupportedGADShapes'
        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'
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'
    gnssPositioningDataList:
      type: array
      items:
        $ref: '#/components/schemas/GnssPositioningMethodAndUsage'
  ecgi:
    $ref: 'TS29571_CommonData.yaml#/components/schemas/Ecgi'
  ncgi:
    $ref: 'TS29571_CommonData.yaml#/components/schemas/Ncgi'
  altitude:
    $ref: '#/components/schemas/Altitude'
GeographicArea:
  oneOf:
  - $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
      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'

```

#

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
  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
#
# 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: Documentation
  url: 'http://www.3gpp.org/ftp/Specs/archive/29_series/29.572/29572-120.zip'
```

Annex B (informative): Change history

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

History

Document history		
V15.0.0	September 2018	Publication