



Location Services

Table 1: Feature History

Feature Name	Release Information	Description
MT-LR Location Services	2024.02.0	AMF supports the MT-LR location services using the Location Management Function (LMF) to determine the accurate position and location of the UE. AMF uses the MT-LR location services for regulatory requirements. Default Setting: Disabled – Configuration Required

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Feature Description

Architecture

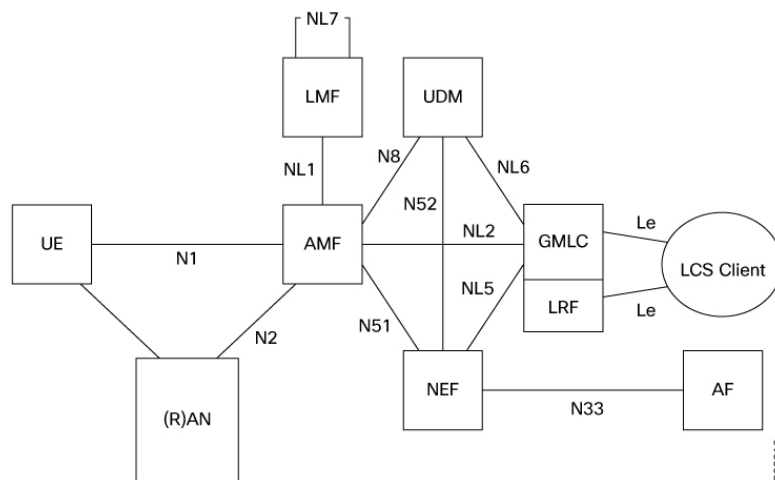
Location Service consists of the following layers as part of the non-roaming location services architecture:

- **UE:** The UE represents end-user devices, such as smart phones, tablets, or IoT devices. These devices interact with the network.
- **GMLC:** GMLC provides the location information services related to mobile devices.
- **LCS Client:** The LCS client is an external entity or application that requests location information for a specific mobile device.
- **LRF:** The LRF is a component within the Location Services (LCS) architecture in cellular networks. LRF retrieves and provides the location information for mobile devices or user equipment (UE).

- LMF: The LMF determines the geographical location of the UE.
- AMF: The AMF is a key component in 5G networks. It manages mobility, session management, and security for user devices.
- UDM: The UDM handles user-related data, including authentication, authorization, and subscription information.
- RAN: The RAN connects user devices to the core network. It includes base stations and antennas.
- N1 Interface: The N1 interface connects the UE and the RAN. It carries user data and control signaling.
- N2 Interface: The N2 interface connects the AMF and the RAN. It handles signaling and data transfer between the core network and the RAN.
- NL1 Interface: NL1 interface connects the LMF to the UE.
- NL2 Interface: NL2 interface connects the AMF to the GMLC.

The following diagram describes the high level architecture for location services.

Figure 1: Non-roaming Location Services



How it Works

Once an emergency session is active, it starts a location service by contacting a GMLC. The GMLC then discovers the AMF that is responsible for the call. The GMLC sends a provide positioning info request to AMF. If the UE is IDLE, the AMF pages the UE.

When the UE is active, the AMF selects an LMF using local configuration. AMF sends a location request to the LMF. AMF generates a correlation identifier and uses it for various communications between the AMF and LMF.

Multiple message exchange happens between the following nodes and the UE to determine the location.

- LMF
- AMF

- gNB
- UE

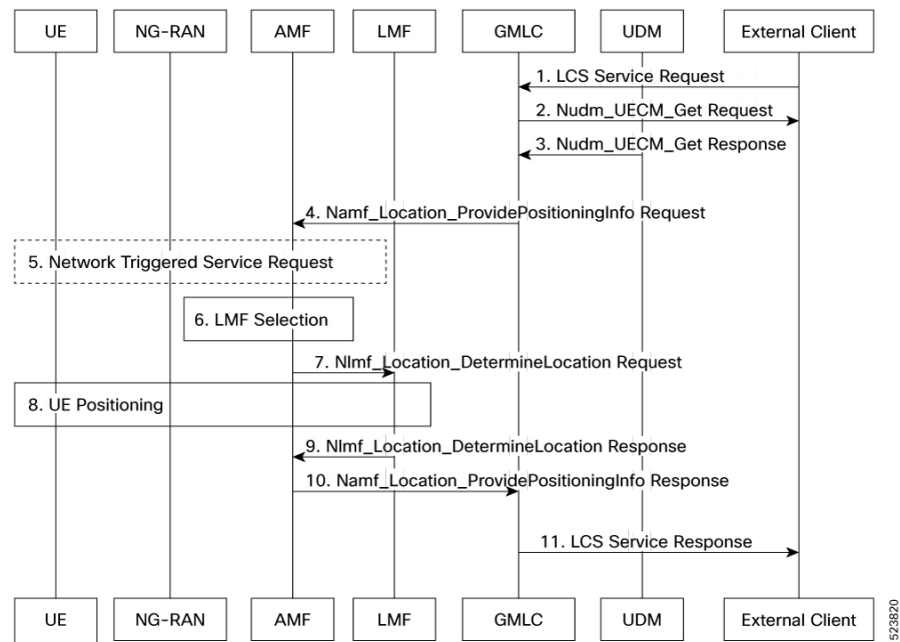
LMF responds to the request from AMF with the location of the UE. AMF sends this location to the GMLC that requested the information.

Call Flows

This section describes the key call flows for this feature.

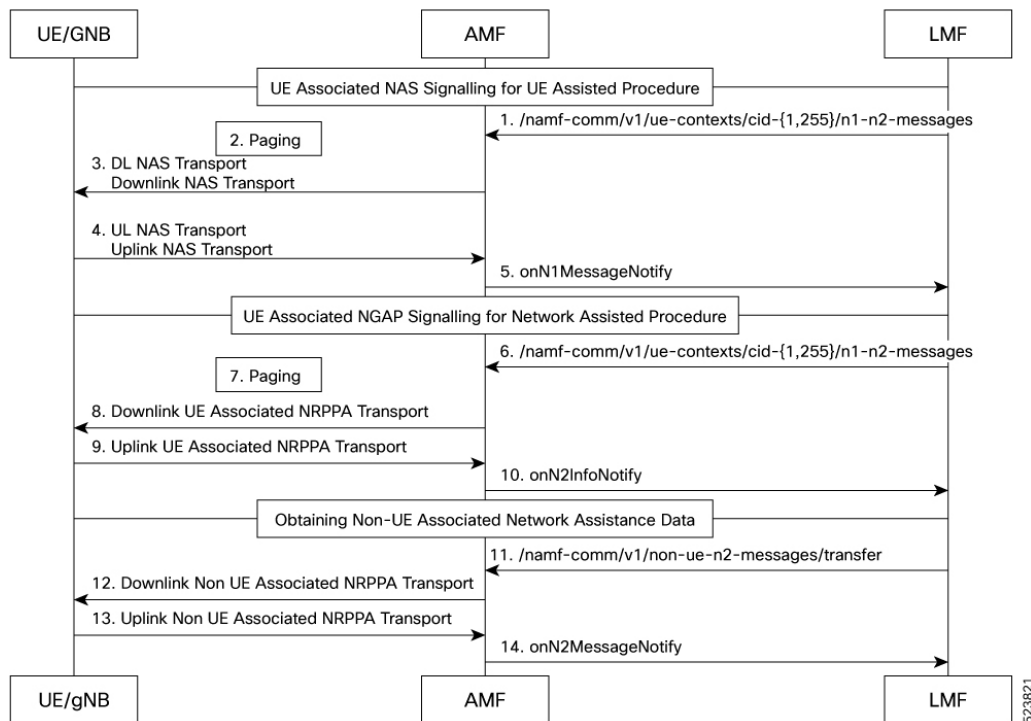
MT-LR Location Service Call Flow

The following call flow and messages between the various nodes complies with the 3GPP TS 123.273.



UE Positioning Call Flow

The following call flow and messages between the various nodes complies with the 3GPP TS 123.273.



Standard Compliance

This feature complies with the following standards specifications:

- 3GPP TS 23.271 “*Description of Location Services (LCS)*”
- 3GPP 23.273 v16.4 “*5G System (5GS) Location Services (LCS)*”
- 3GPP TS 29.572 “*5G System; Location Management Services*”
- 3GPP TS 29.515 “*5G System; Gateway Mobile Location Services*”

LMF Configuration

To enable LMF, use the following configuration.

```
config
  amf-global
    location
    positioning
    use-lmf
  end
```

NOTES:

- **location**—Specify the location services or settings within the AMF’s global configuration. By default, this feature is disabled.

- **positioning**—Specify the positioning methods or protocols for determining the location of UE.
- **use-lmf**—Specify the LMF for positioning services. The LMF is responsible for providing positioning information of UEs in the network.

Configuration Verification

Following is the CLI to verify the configuration:

```
show running-config amf-global location
location positioning use-lmf
exit
```

Configuring LMF in Network Element Profile List

To configure LMF in the network element profile list, use the following configuration:

```
config
  amf-global
    operator-policy policy_name
    ccp-name ccp_name
    network-element-profile-list lmf lmf_name
  end
```

NOTES:

- **ccp-name** *ccp_name*—Specify the Configuration Control Point (CCP) name. The CCP is used for managing and controlling configuration settings.
- **network-element-profile-list lmf** *lmf_name*—Specify the name of LMF with the network element profile.

Configuring the Profile NF Client

To configure the profile NF-client, use the following configuration:

```
config
  profile nf-client nf-type nf_client_name
    lmf-profile lmf_profile_name
    locality locality_name
    priority priority_value
    service name type nlmf-loc
    endpoint-profile profile_name
    capacity capacity_value
    default-notification-subscriptions subscriptions_name
    n1-message-class n1_message_class_type
    notification-type notification_message_type
    callback-uri callback_uri_url
    uri-scheme uri_scheme_name
    version
    uri-version uri_version
    endpoint-name end_point_name
    priority priority_value
```

```

primary ip-address ipv4 ipv4_address
primary ip-address port ipv4_port_number
end

```

NOTES:

- **profile nf-client nf-type** *nf_client_name*—Specify the profile name of the NF client.
- **lmf-profile** *profile_name*—Specify the profile name for the NSSF.
- **locality** *locality_name*—Specify the locality name within the NSSF profile.
- **priority** *priority_value*—Specify the priority value of the locality name within the NSSF profile.
- **endpoint-profile** *profile_name*—Specify the associated end point profile name.
- **capacity** *capacity_value*—Specify the capacity of the endpoint.
- **default-notification-subscriptions** *default_notification_subscriptions_name* —Specify the name of the default notification subscriptions.
- **n1-message-class** *n1_message_class_type* —Specify the n1 message class.
- **notification-type** *notification_message_type* —Specify the type of notification message.
- **callback-uri** *callback_uri_url* —Specify the URL for the callback uri.
- **uri-scheme** *uri_scheme_name*—Specify the uri scheme associated with the endpoint.
- **uri-version** *uri_version*—Specify the uri version associated with the endpoint.

Configuration Example

Following is an example configuration.

```

profile nf-client nf-type lmf
lmf-profile LMF1
locality LOC1
priority 30
service name type nlmf-loc
endpoint-profile EP1
capacity 30
uri-scheme http
endpoint-name EP1
priority 56
capacity 100
default-notification-subscriptions <name>
n1-message-class LCS/LPP
notification-type N1_MESSAGES
callback-uri <URL>
exit
primary ip-address ipv4 172.16.186.13
primary ip-address port 8047
exit
exit

```

Configuring the Profile Network Element

To configure the profile network element, use the following configuration:

```

config
  profile network-element lmf lmf_name
    nf-client-profile nf_client_name
    failure-handling-profile failure_handling_profile_name
  end

```

NOTES:

- **profile network-element lmf** *lmf_name*—Specify the profile name for the network element.
- **nf-client-profile** *nf_client_name*—Specify the network function client profile name.
- **failure-handling-profile** *failure_handling_profile_name*—Specify the failure handling profile name.

Configuring Failure Handling Profile

To configure the profile NF-client-failure, use the following configuration:

```

config
  profile nf-client-failure nf-type nssf lmf_name
    profile failure-handling failure_handling_profile_name
    service name type nlmf-loc
    responsetimeout timeout_value
    message type LmfDetermineLocation
      status-code httpv2 503
      retry retry_count
      action retry-and-ignore
    end

```

NOTES:

- **profile nf-client-failure nf-type lmf** *nssf_name*—Specify NF client failure profile.
- **profile failure-handling** *failure_handling_profile_name*—Specify failure-handling profile name.
- **responsetimeout** *timeout_value*—Specify the response timeout for the specified services.
- **retry** *retry_count*—Specify the retry count for the status code.

The following is an example configuration.

```

profile nf-client-failure nf-type lmf
profile failure-handling FH1
  service name type nlmf-loc
  responsetimeout 10
  message type LmfDetermineLocation
    status-code httpv2 403
    retry 3
    action retry-and-continue
  exit
  message type LmfN1MessageNotify
    status-code httpv2 403
    retransmit 3
    retransmit-interval 2000
    action retry-and-continue
  exit
  message type LmfN2InfoNotify
    status-code httpv2 403
    retransmit 3

```

```

    retransmit-interval 2000
    action retry-and-continue
  exit
exit
exit
exit
exit
exit

```

Configuring the Profile NF-pair NF-type

To configure the profile NF-pair NF-type, use the following configuration:

```

config
  profile nf-pair nf-type nf_type_name
    locality client client_name
    locality preferred-server server_name
    locality geo-server server_name
  end

```

NOTES:

- **profile nf-pair nf-type** *nf_type_name*—Specify NF (Network Function) type name.
- **locality client** *client_name*—Specify the locality name for the client.
- **locality preferred-server** *server_name*—Specify the server name as the preferred server locality.
- **locality geo-server** *server_name*—Specify the geographical location for the geo-server.



Note Each endpoint-profile can contain multiple endpoints. Each endpoint contains defaultNotificationCallback under endpoint-name. So, instead of configuring primary and secondary within one endpoint, it is advisable to configure them under different endpoint names in an endpoint profile to ensure separate defaultNotificationCallback for each endpoint.

OAM Support

This section describes operations, administration, and maintenance support for this feature.

Bulk Statistics Support

The following statistics are supported for the MTLR Location Services feature.

LMF STATS Under nl1_service_stats

Following are the LMF STATS records under nl1_service_stats.

Messages	Metrics Message Type
Determine Req & Rsp	NlmfDetermineLocReq
	NlmfDetermineLocRsp

Messages	Metrics Message Type
N1N2MessageTransfer	NlmfN1N2MessageTransferReq NlmfN1N2MessageTransferRsp NlmfNonUEN2MessageTransferRequest NlmfNonUEN2MessageTransferResponse
N1 Message Notify	NlmfN1MessageNotifyRequest NlmfN1MessageNotifyResponse
N2 Message Notify	NlmfN2InfoNotifyRequest NlmfN2InfoNotifyResponse NlmfNonUEN2InfoNotifyRequest NlmfNonUEN2InfoNotifyResponse
N1N2 Failure Notification	NlmfN1N2MessageTransferfailurenotifyReq NlmfN1N2MessageTransferfailurenotifyRsp

Following are the examples of stats output:

- n11_service_stats{app_name="AMF",cluster="clu1",data_center="dc1",instance_id="0",message_type="NlmfN1N2MessageTransferReq",reason="",roaming_status="HOMER",service_name="amf-service",slice_data="_2-333333",status="success"} 2
- n11_service_stats{app_name="AMF",cluster="clu1",data_center="dc1",instance_id="2",message_type="NlmfN1N2MessageTransferReq",reason="Invalid Input",roaming_status="HOMER",service_name="amf-service",slice_data="_2-333333",status="failures"} 2
- n11_service_stats{app_name="AMF",cluster="clu1",data_center="dc1",instance_id="2",message_type="NlmfN1N2MessageTransferReq",reason="Invalid LCS Correlation ID",roaming_status="HOMER",service_name="amf-service",slice_data="_2-333333",status="failures"} 3
- n11_service_stats{app_name="AMF",cluster="clu1",data_center="dc1",instance_id="2",message_type="NlmfN1N2MessageTransferfailurenotifyReq",reason="",roaming_status="HOMER",service_name="amf-service",slice_data="_2-333333",status="success"} 3
- n11_service_stats{app_name="AMF",cluster="clu1",data_center="dc1",instance_id="2",message_type="NlmfN1N2MessageTransferfailurenotifyRsp",reason="",roaming_status="HOMER",service_name="amf-service",slice_data="_2-333333",status="success"} 3
- n11_service_stats{app_name="AMF",cluster="clu1",data_center="dc1",instance_id="0",message_type="NlmfNonUEN2MessageTransferRequest",reason="",roaming_status="HOMER",service_name="amf-service",slice_data="",status="success"} 1

GMLC STATS Under n12_service_stats

Following are the GMLC STATS records under n12_service_stats.

Messages	Metrics Message Type
Provide position Req & Rsp	NgmlcRequestPositioningInfo NgmlcProvidePositioningInfoRsp

Following is the example of stats output:

```
n12_service_stats{app_name="AMF",cluster="cl1",data_center="dc1",instance_id="0",
message_type="NgmlcProvidePositioningInfoRsp",reason="",roaming_status="HOMER",
service_name="amf-service",slice_data="_2-333333",status="success"} 1
```

NGAP Service Stats Under n2_service_stats

Following are the NGAP service stats records under n2_service_stats

Messages	Metrics Message Type
NRRPA based messages	DIUeAssociatedNRPPaTransport UIUeAssociatedNRPPaTransport DINonUeAssociatedNRPPaTransport UINonUeAssociatedNRPPaTransport

Following is the example of stats output:

```
n2_service_stats{app_name="AMF",cluster="cl1",data_center="dc1",instance_id="0",
message_type="DIUeAssociatedNRPPaTransport",reason="",roaming_status="HOMER",
service_name="amf-service",slice_data="_2-333333",status="success"} 1
```

```
n2_service_stats{app_name="AMF",cluster="cl1",data_center="dc1",instance_id="0",
message_type=" DINonUeAssociatedNRPPaTransport ",reason="", roaming_status="",
service_name="amf-service",
slice_data="",status="success"} 1
```

Nas Message Total

Location service based UplinkNasTransport and DownlinkNasTransport is recorded under message type N1DINasTransport_LPP, N1UINasTransport_LPP.

Following is the example of stats output:

```
amf_nas_message_total{app_name="AMF",cluster="cl1",data_center="dc1",instance_id="0",
message_direction="outbound",message_type="N1DINasTransport_LPP",
service_name="amf-service",slice_data="_2-333333"} 2
```