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- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can indicates that something is possible

cannot indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

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1 Scope

The present document specifies the operations and information coding for the Non-Access Stratum (NAS) layer protocol for supporting the Location Services (LCS) in the NG-RAN.

The present document is applicable to the User Equipment (UE) and to the Access and Mobility Management Function (AMF) or Location Management Function (LMF) in the 5G System (5GS).

The present document is developed in accordance to the general principles stated in 3GPP TS 23.273 [2].

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 23.273: "5G System (5GS) Location Services (LCS); Stage 2".
 - [3] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".
 - [4] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)".
 - [4a] 3GPP TS 38.355: "Sidelink Positioning Protocol (SLPP); Protocol specification".
 - [5] 3GPP TS 24.080: "Mobile radio interface layer 3 supplementary services specification; Formats and coding".
 - [6] 3GPP TS 29.572: "5G System; Location Management Services; Stage 3".
 - [7] 3GPP TS 38.305: "Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".
 - [8] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1".
 - [9] 3GPP TS 24.572: "User Plane Location Services (LCS) Protocols And Procedures; Stage 3".
 - [10] 3GPP TS 23.586: "Architectural Enhancements to support; Ranging based services and Sidelink Positioning".
 - [11] 3GPP TS 38.455: "NG-RAN; NR Positioning Protocol A (NRPPa)".
-

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms 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].

ExtendedFacility IE for 5G LCS: Usage of ExtendedFacility information element in the LCS operations as specified in clause 5.

For the purposes of the present document, the following terms and definitions given in 3GPP TS 22.261 [8] apply:

satellite NG-RAN

PRU ON/OFF state: This state is defined for a UE associated as a PRU with an LMF (i.e. after the successful completion of PRU association procedure). This state indicates whether the PRU functionality of the UE is activated (i.e. ON state) or deactivated (i.e. OFF state) while it is associated with an LMF.

UE operating as PRU: From the UE perspective, a UE which supports PRU functionality and operates as PRU. From the network perspective, the UE allowed to operate as a PRU based on the UE subscription data and the PRU state is ON.

3.2 Symbols

3.3 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].

5GCN	5G Core Network
5GS	5G System
AMF	Access and Mobility Management Function
DL	Downlink
IE	Information Element
GMLC	Gateway Mobile Location Centre
LCS	Location Services
LDR	Location Deferred Request
LMF	Location Management Function
LPP	LTE Positioning Protocol
MO-LR	Mobile Originated Location Request
MT-LR	Mobile Terminated Location Request
NAS	Non-access Stratum
PRU	Positioning Reference Unit
RSPP	Ranging and sidelink positioning protocol
SLPP	SideLink Positioning Protocol
SNPN	Stand-alone Non-Public Network
UE	User Equipment
UL	Uplink

4 General

4.1 Overview

4.1.1 NAS aspect

To enable transfer of Location Services (LCS) signaling messages between the 5G core network (5GCN) and the UE, two Payload container types are defined in the downlink (DL NAS TRANSPORT message) and the uplink (UL NAS TRANSPORT message or CONTROL PLANE SERVICE REQUEST message). The message protocol and procedures are described in 3GPP TS 24.501 [3].

4.1.2 LCS aspect

LCS uses the defined payload container to transfer LCS signalling messages between the UE and the network.

The corresponding LCS signaling messages include:

a) LTE Positioning Protocol (LPP) messages (see 3GPP TS 37.355 [4]):

- Both downlink and uplink LPP messages are supported.
- Routing information is transported as the Additional information IE in UL NAS TRANSPORT message or DL NAS TRANSPORT message for LPP messages (see 3GPP TS 24.501 [3]).

a1) SideLink Positioning Protocol (SLPP) messages (see 3GPP TS 38.355 [4a]):

- Both downlink and uplink SLPP messages are supported.
- Routing information is transported as the Additional information IE in UL NAS TRANSPORT message or DL NAS TRANSPORT message for SLPP messages (see 3GPP TS 24.501 [3]).

b) Location services messages:

- Messages for lcs-MOLR operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-LocationNotification operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-EventReport operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-PeriodicTriggeredInvoke operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-CancelDeferredLocation operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-MSCancelDeferredLocation operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-LocationPrivacySetting operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-PruAssociation operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-PruDisassociation operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-SLMOLR operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-SLMTLR operations (see 3GPP TS 24.080 [5]).
- Routing information associated with the LMF is transported as the Additional information IE in UL NAS TRANSPORT message or DL NAS TRANSPORT message or CONTROL PLANE SERVICE REQUEST message (see clause 5.2.2.6.1) for Location services messages that are transported between the UE and the LMF (see 3GPP TS 24.501 [3]).

c) RSPP transport messages:

- Messages for lcs-ULRSPPTransport operations (see 3GPP TS 24.080 [5]).
- Messages for lcs-DLRSPPTransport operations (see 3GPP TS 24.080 [5]).

The Routing information transported as the Additional information IE can be Routing identifier in the current specification, which includes immediate routing identifier and deferred routing identifier, which have LCS session level granularity (i.e. these identifiers are allocated per each LCS session). The immediate routing identifier transported as the Additional information IE is the LCS correlation identifier, which is allocated by the AMF and can be used in the UL NAS TRANSPORT message or DL NAS TRANSPORT message (see clause 5.2 and clause 5.3). The deferred routing identifier transported as the Additional information IE can be used in the UL NAS TRANSPORT and CONTROL PLANE SERVICE REQUEST message for the AMF routing the LCS messages to the particular LMF (see clause 5.2.2).

The messages for lcs-PeriodicTriggeredInvoke operations can be used to enable the location events reporting over user plane connection, and the messages for lcs-EventReport operations can be used for the cumulative event report, as described in clause 6.16.1 of 3GPP TS 23.273 [2]. The location events reporting over user plane connection is defined in 3GPP TS 24.572 [9]).

4.2 LCS Support capabilities

4.2.1 UE support of LCS

The UE announces to the network its ability to support:

- a) LCS notification mechanism;
- b) LPP messages;
- c) ExtendedFacility IE for 5G LCS; or
- d) any combination of a, b and c;

using the 5GMM capability IE defined in 3GPP TS 24.501 [3].

The UE supporting LCS notification mechanism and LPP messages may support PRU (defined in 3GPP TS 38.305 [7]). The UE's ability to support PRU is stored in the UDM (see 3GPP TS 23.273 [2]) without any indication in 5GMM capability IE defined in 3GPP TS 24.501 [3].

A UE accessing 5G network via satellite NG-RAN shall not operate as a PRU.

4.2.2 Network support of LCS

The network announces to the UE its ability to support LCS in 5GC using the 5GS network feature support IE defined in 3GPP TS 24.501 [3]. The information is taken into account by the UE, in addition to UE's LCS capabilities, for the UE to determine whether to initiate MO-LR procedure in NG-RAN as specified in 3GPP TS 23.273 [3], clause 6.2.

If the ExtendedFacility IE for 5G LCS is supported homogeneously across all LMFs and is supported by the AMF, the network announces to the UE its ability to support ExtendedFacility IE for 5G LCS using the 5GS network feature support IE defined in 3GPP TS 24.501 [3].

NOTE: An SNPN can provide Location Services except for the cases of interworking with EPC, and roaming, which are not supported in an SNPN.

5 Support of LCS signalling

5.1 General

This clause defines the NG-RAN LCS operations (clause 5.2) and the format and coding of the messages (clause 5.3).

The messages defined in this clause can be transported in the UL NAS TRANSPORT message or DL NAS TRANSPORT message defined in 3GPP TS 24.501 [3].

5.2 LCS operations

5.2.1 Network initiated location services operations

5.2.1.1 Supplementary Services Location Notification

5.2.1.1.1 General

The supplementary services Location Notification operation enables the AMF to trigger the end-user notification verification process on the UE using NAS signalling. The supplementary services messages are transported using the DL NAS TRANSPORT message and the UL NAS TRANSPORT message defined in 3GPP TS 24.501 [3]. UE Location Privacy Indication information may be included in Location Notification Return Result to indicate whether subsequent LCS requests or ranging and sidelink positioning requests will be allowed or disallowed by the UE.

Figure 5.2.1.1.1.1 illustrates an example of the NAS signalling transport applicable to a 5GC-MT-LR procedure for immediate or deferred location or to an SL-MT-LR procedure for immediate or deferred location.

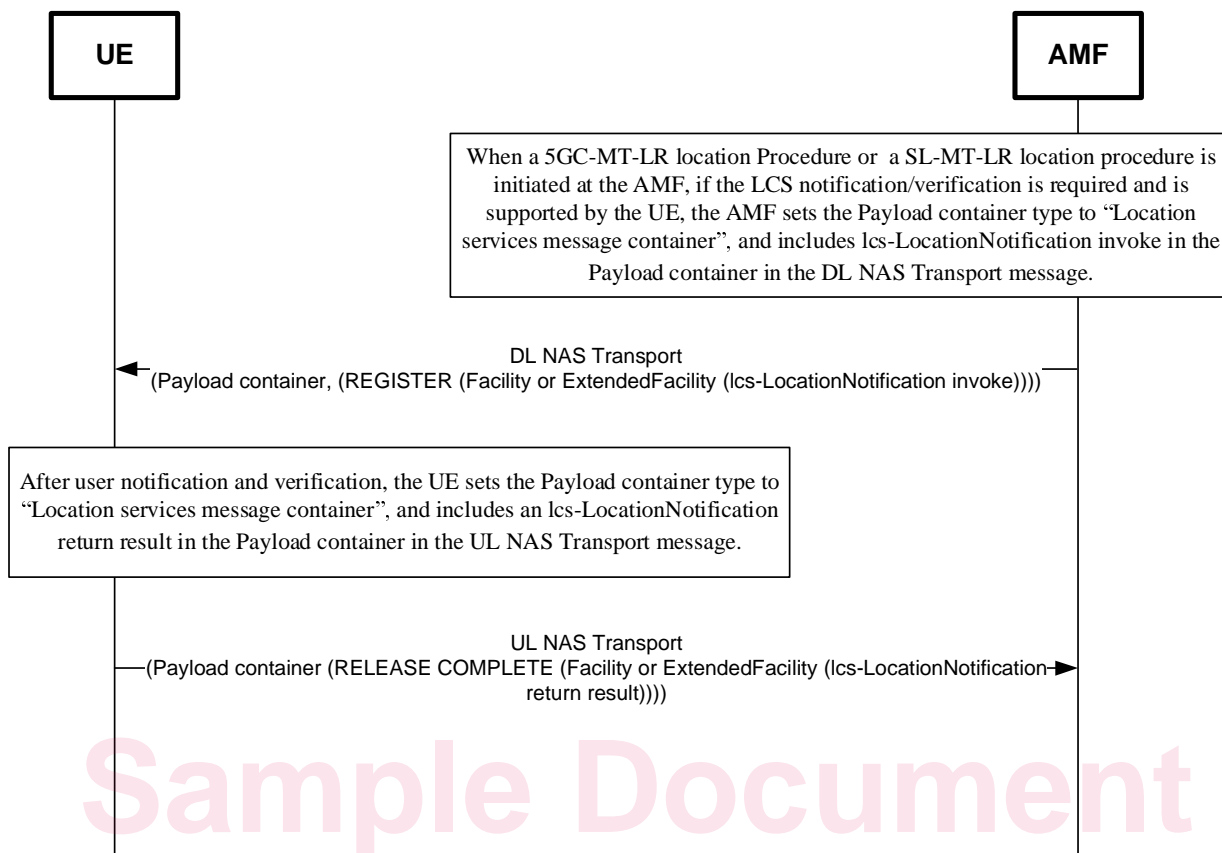


Figure 5.2.1.1.1.1: NAS signalling transport for Supplementary Services Location Notification

NOTE: The optional Additional information IE of the DL NAS TRANSPORT message or UL NAS TRANSPORT message is not included when the LCS Location Notification signalling is transported in the Payload container.

5.2.1.1.2 Normal operation

The network invokes a location notification procedure by sending a REGISTER message containing an lcs-LocationNotification invoke component to the UE as defined in 3GPP TS 24.080 [5]. This may be sent either to request verification for a 5GC-MT-LR or to notify the UE about an already authorized 5GC-MT-LR.

In case of privacy verification for LCS or ranging and sidelink positioning, the UE shall respond to the request by sending a RELEASE COMPLETE message containing the user's response and optionally UE Location Privacy Indication information in a lcs-LocationNotification return result component (see figure 5.2.1.1.2.1). If rangingSIEExt is included, the privacy verification is for ranging and sidelink positioning and the corresponding verification result for ranging and sidelink positioning is included in UE Location Privacy Indication information.

During the supplementary services Location Notification operation, the network shall run the timer T(LCSN) defined in 3GPP TS 24.080 [5]. This timer is started when the operation is sent, and stopped when a response is received from the UE. If the timer T(LCSN) expires in the network before any response from the UE (e.g. due to no response from the user), the network shall interpret this by applying the default treatment defined in 3GPP TS 23.273 [2] (i.e. disallow location if barred by subscription or allow location if allowed by subscription). The network may also terminate the dialogue by sending a RELEASE COMPLETE message.

In the case of location notification, the UE shall terminate the dialogue immediately by sending a RELEASE COMPLETE message containing a lcs-LocationNotification return result.

If the UE is unable to process the request received from the network, it shall return an error indication by sending a RELEASE COMPLETE message containing a return error component. Error values are specified in 3GPP TS 24.080 [5].

The use of Facility or ExtendedFacility IE in figure 5.2.1.1.2.1 is specified in clause 5.3.1.

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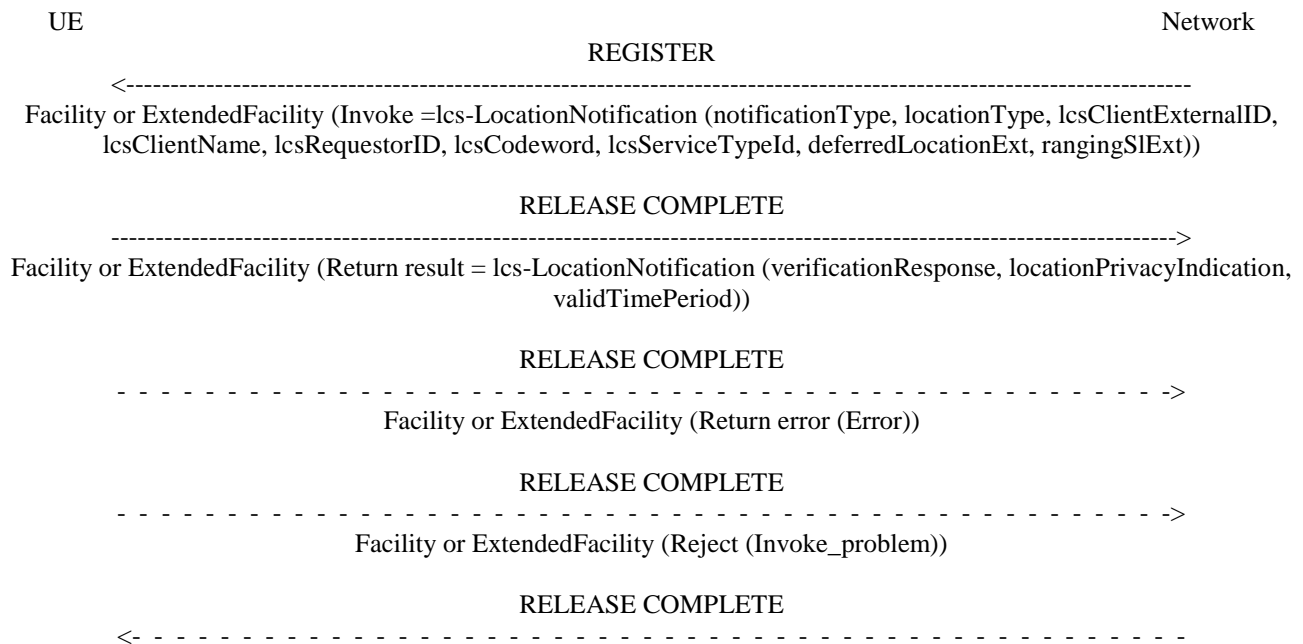


Figure 5.2.1.1.2.1: Location Notification

5.2.1.2 Positioning Information Transport

The AMF sends an LPP message and a Routing identifier which is the associated LCS correlation identifier in the DL NAS TRANSPORT message (refer to 3GPP TS 24.501 [3] and 3GPP TS 23.273 [2] clause 6.11.1) to a UE, or a UE operating as PRU, or both. Figure 5.2.1.2.1 illustrates an example of the NAS signalling transport for downlink LPP messages.

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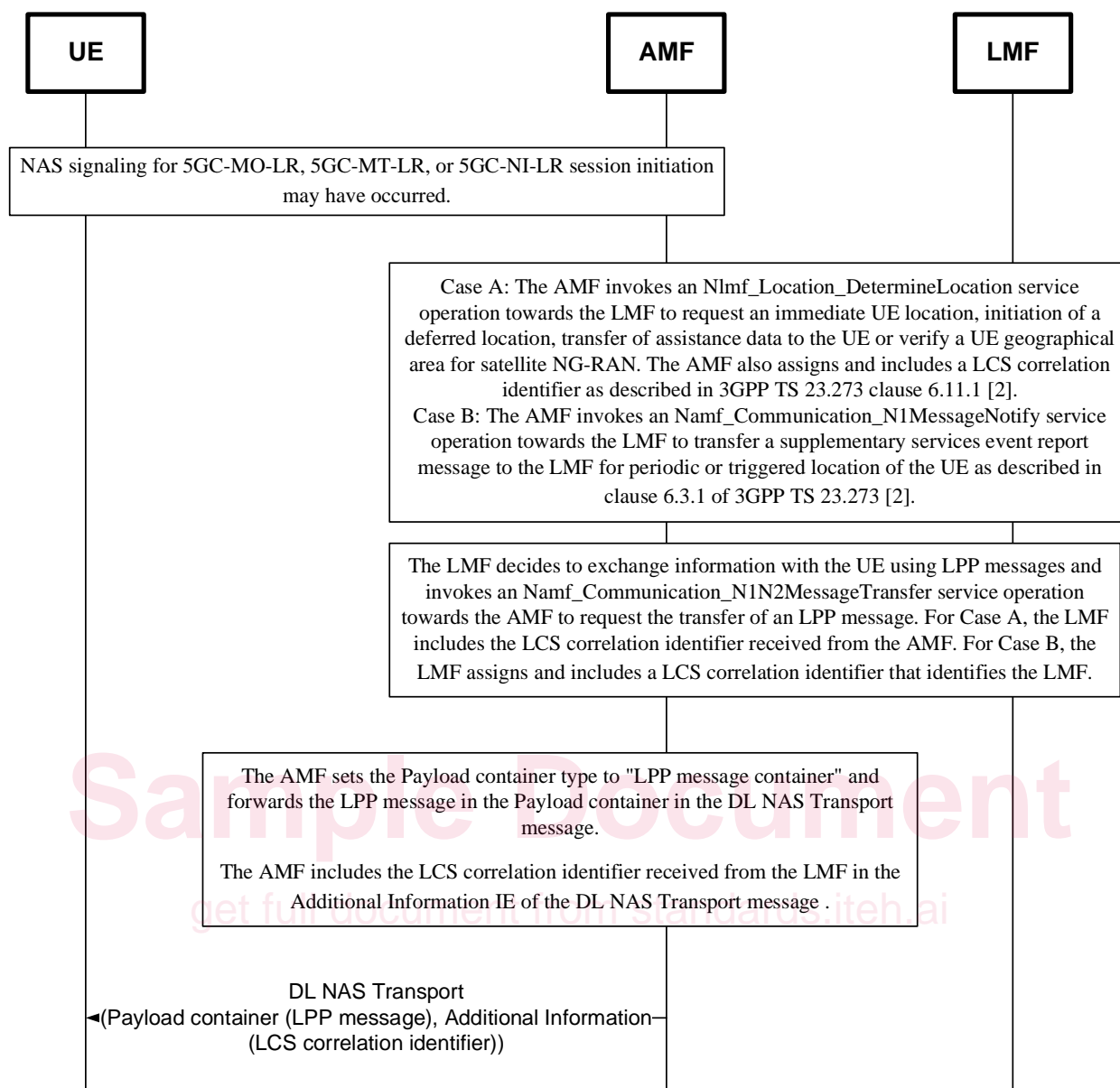


Figure 5.2.1.2.1: NAS signalling transport for downlink LPP messages

NOTE 1: If a scheduled location time is received in the LPP message, the UE in 5GMM-IDLE mode can initiate a service request procedure shortly before the scheduled location time.

NOTE 2: If the LMF determines that simultaneous measurements for UE and PRU(s) are needed, the LMF may send the time window(s) rather than the scheduled location time in the LPP messages to the UE, PRU(s) and NG-RAN. Definition of the time window and the associated configuration parameters are specified in TS 37.355 [4] and TS 38.455 [11].

5.2.1.3 Supplementary Services Periodic or Triggered Location

5.2.1.3.1 General

The supplementary services LCS PeriodicTriggered Invoke operation enables the LMF to initiate periodic or triggered location event reporting by a target UE as described in clause 6.3.1 of 3GPP TS 23.273 [2]. `lcs-PeriodicTriggeredInvoke` invoke component is transferred to the target UE via the serving AMF in a DL NAS TRANSPORT message. A response from the target UE is similarly returned to the LMF via the serving AMF and is transferred to the AMF in an UL NAS TRANSPORT message. If the `lcs-PeriodicTriggeredInvoke` invoke component in the Payload container IE of a DL NAS TRANSPORT message includes the deferred routing identifier, the UE shall