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Contents

Foreword

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1 Scope

The present document specifies the Sidelink Positioning Protocol (SLPP) for the interface between UEs and between UE and LMF.

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 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[3] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[4] ITU-T Recommendation X.691 (07/2002) "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)" (Same as the ISO/IEC International Standard 8825-2).

[5] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[6] 3GPP TS 38.211: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; Physical channels and modulation".

[7] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

[8] 3GPP TR 38.901: "Technical Specification Group Radio Access Network; Study on channel model for frequencies from 0.5 to 100 GHz".

[9] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[10] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[11] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[12] 3GPP TS 23.586: "Technical Specification Group Services and System Aspects; Architectural Enhancements to support Ranging based services and Sidelink Positioning".

[13] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[14] 3GPP TS 23.304: "Technical Specification Group Services and System Aspects; Proximity based Services (ProSe) in the 5G System (5GS)".

[15] 3GPP TS 38.321: "NR; Medium Access Control (MAC); Protocol specification".

[16] 3GPP TS 38.215: "NR; Physical layer measurements".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 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 TR 21.905 [1].

Field: The individual contents of an information element are referred to as fields.

Ranging: Refers to the determination of the distance between two UEs or more UEs and/or the direction of one UE (i.e. Target UE) from another UE via PC5 interface.

Ranging/Sidelink Positioning: AS functionality enabling ranging-based services and sidelink positioning as specified in TS 23.586 [12].

SL Anchor UE: A UE, supporting positioning of target UE, e.g. by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc. over the Sidelink interface.

SL Server UE: A UE offering position method determination, assistance data distribution and/or location calculation functionalities for sidelink positioning and ranging based services. It interacts with other UEs over PC5 as necessary in order to determine a ranging/SL position method, distribute assistance data and calculate the location of the target UE. A Target UE or SL Anchor UE can act as SL Server UE if any of the functionalities is supported.

SL Target UE: A UE whose distance, direction and/or position is measured with the support from one or multiple SL Anchor UEs using Sidelink in the Ranging based service and Sidelink positioning.

UE-only Operation: Operation of Ranging/Sidelink Positioning in which the service request handling and result calculation are performed by UE.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 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 TR 21.905 [1].

DFN	Direct Frame Number
GCS	Global Coordinate System (as defined in TR 38.901 [8])
LCS	LoCation Services
	Local Coordinate System (as defined in TR 38.901 [8])
LMF	Location Management Function
LOS	Line-of-Sight
NLOS	Non-Line-of-Sight
RTD	Relative Time Difference
SL	Sidelink
SL-AoA	Sidelink Angle-of-Arrival
SL-MO-LR	Sidelink Mobile Originating Location Request
SL-MT-LR	Sidelink Mobile Terminating Location Request
SLPP	Sidelink Positioning Protocol
SL-PRS	Sidelink Positioning Reference Signals
SL-PRS-RSRP	Sidelink Positioning Reference Signals based Reference Signal Received Power
SL-PRS-RSRPP	Sidelink Positioning Reference Signals based Reference Signal Received Path Power
SL-PRS-RSTD	Sidelink Positioning Reference Signals based Reference Signal Time Difference
SL-PRS-RTOA	Sidelink Positioning Reference Signals based Relative Time of Arrival
SL-RTT	Sidelink Round Trip Time
SL-TDOA	Sidelink Time Difference Of Arrival
SL-TOA	Sidelink Time Of Arrival
UE	User Equipment

4 Functionality of Protocol

4.1 General

4.1.1 SLPP Configuration

SLPP is used point-to-point between Endpoints, e.g. Location Server (SL Server UE or LMF) and target in order to obtain absolute position, relative position, or ranging information of target UE using sidelink measurements obtained by one or more reference sources.

Figure 4.1.1-1: Void

4.1.2 SLPP Sessions and Transactions

An SLPP session is used between UEs or a Location Server and a UE in order to obtain location related measurements based on NR PC5 radio signals, a location estimate or to transfer assistance data. A single SLPP session is used to support a single location request (e.g., for a single SL-MT-LR, or SL-MO-LR). Multiple SLPP sessions can be used between the same endpoints to support multiple location requests (as required by TS 23.273 [5]). For UE-only Operation, the instigator of an SLPP session which is the Endpoint who receives the LCS request, initiates an SLPP session by sending an SLPP message containing an assigned session ID (session identifier) to the other endpoint(s). All constituent messages within a session shall contain the same session ID. For LMF involved Operation, the session ID is assigned by target UE and contained in the SLPP messages used for communication between UEs. The session ID may be included in the SLPP message for the communication between a UE and the LMF.

Each SLPP session comprises one or more SLPP transactions, with each SLPP transaction performing a single operation (capability exchange, assistance data transfer, or location information transfer). The SLPP transactions are realized as SLPP procedures. The instigator of an SLPP session will always instigate the first SLPP transaction, but subsequent transactions may be instigated by either end. SLPP transactions within a session may occur serially or in parallel. SLPP transactions are indicated at the SLPP protocol level with a transaction ID in order to associate messages with one another (e.g., request and response).

Messages within a transaction are linked by a common transaction identifier.

4.1.3 SLPP Positioning Methods

This version of the specification defines SL-TDOA, SL-TOA, SL-AoA and SL-RTT positioning methods based on NR PC5 radio signals.

4.1.4 SLPP Messages

Each SLPP transaction involves the exchange of one or more SLPP messages between Endpoint A and Endpoint B. The general format of an SLPP message consists of a set of common fields followed by a body. The body (which may be empty) contains information specific to a particular message type. Each message type contains information specific to one or more positioning methods and/or information common to all positioning methods.

The common fields are as follows:

Field	Role
sessionID	Identify messages belonging to the same session
transactionID	Identify messages belonging to the same transaction
endTransaction	Indicate when a transaction (e.g. one with periodic responses) has ended
sequenceNumber	Enable detection of a duplicate SLPP message at a receiver
acknowledgement	Enable an acknowledgement to be requested and/or returned for any SLPP message

The following message types are defined:

- Request Capabilities;
- Provide Capabilities;
- Request Assistance Data;
- Provide Assistance Data;
- Request Location Information;
- Provide Location Information;
- Abort;
- Error.

4.2 Common SLPP Session Procedure

The purpose of this procedure is to support an SLPP session comprising a sequence of SLPP transactions. The procedure is described in Figure 4.2-1.

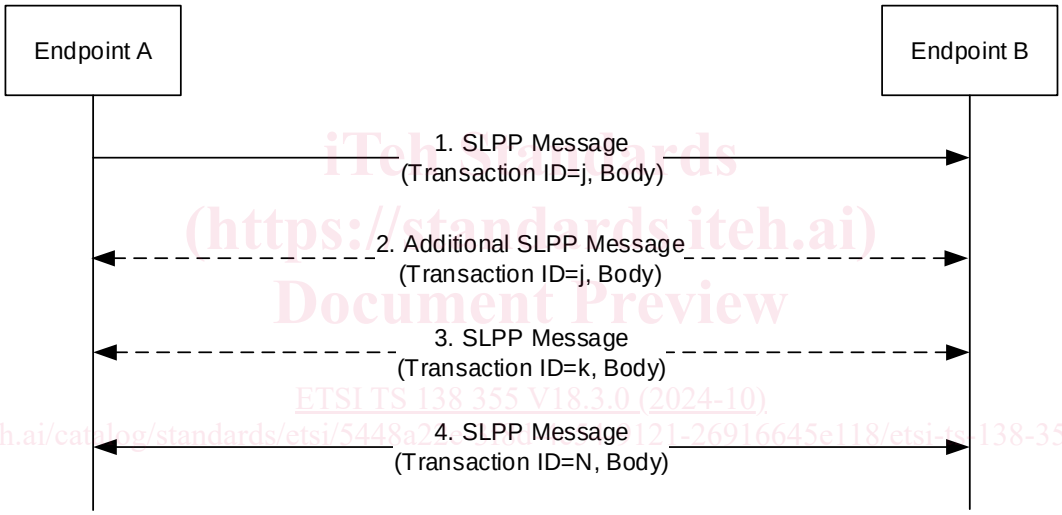

Figure 4.2-1 SLPP Session Procedure

1. Endpoint A, which is the Endpoint who receives the LCS request, initiates an SLPP session by sending an SLPP message containing an assigned session ID for an initial SLPP transaction *j* to the other endpoint B.
2. Endpoints A and B may exchange further messages to continue the transaction started in step 1.
3. Either endpoint may instigate further transactions by sending additional SLPP messages.
4. A session is terminated by a final transaction *N* in which SLPP messages will be exchanged between the two endpoints.

Within the same session, all constituent messages shall contain the same session ID and within each transaction, all constituent messages shall contain the same transaction ID. The last message sent in each transaction shall have the field *endTransaction* set to TRUE. Transactions that occur in parallel shall use different transaction IDs; transaction IDs for completed transactions may be reused at any time after the final message of the previous transaction with the same ID is known to have been received.

4.3 SLPP Transport

4.3.1 Transport Layer Requirements

SLPP requires reliable, in-sequence delivery of SLPP messages from the underlying transport layers. This clause describes the transport capabilities that are available within SLPP. A UE implementing SLPP shall support SLPP reliable transport (including all three of duplicate detection, acknowledgement, and retransmission).

4.3.2 SLPP Duplicate Detection

A sender shall include a sequence number in all SLPP messages sent for a particular location session. The sequence number shall be distinct for different SLPP messages sent by the same endpoint for the same endpoint in the same location session (e.g., may start at zero in the first SLPP message and increase monotonically in each succeeding SLPP message). Sequence numbers used in the messages transmitted from different endpoints or for different endpoints are independent (e.g., can be the same).

A receiver shall record the most recent received sequence number for each pair of endpoints of each location session. If a message is received carrying the same sequence number as that last received for the same pair of endpoints and the associated location session, it shall be discarded. Otherwise (i.e., if the sequence number is different or the sequence number is same but for different pair of endpoints), the message shall be processed.

Sending and receiving sequence numbers shall be deleted in a server when the associated location session is terminated and shall be deleted in the UE(s) when there has been no activity for a particular location session for 10 minutes.

4.3.3 SLPP Acknowledgement

4.3.3.1 General

Each SLPP message may carry an acknowledgement request and/or an acknowledgement indicator. An SLPP message including an acknowledgement request (i.e., that include the field *ackRequested* set to TRUE) shall also include a sequence number. Upon reception of an SLPP message which includes the field *ackRequested* set to TRUE, a receiver returns an SLPP message with an acknowledgement response (i.e., that includes the field *ackIndicator* set to the same sequence number of the message being acknowledged). An acknowledgement response may contain no SLPP message body (in which case only the sequence number being acknowledged is significant); alternatively, the acknowledgement may be sent in an SLPP message along with an SLPP message body. An acknowledgement is returned for each received SLPP message that requested an acknowledgement including any duplicate(s). Once a sender receives an acknowledgement for an SLPP message, and provided any included sequence number is matching, it is permitted to send the next SLPP message. No message reordering is needed at the receiver since this stop-and-wait method of sending ensures that messages normally arrive in the correct order.

When an SLPP message is transported via a NAS SL-MO-LR request, the message does not request an acknowledgement.

4.3.3.2 Procedure related to Acknowledgement

Figure 4.3.3.2-1 shows the procedure related to acknowledgement.

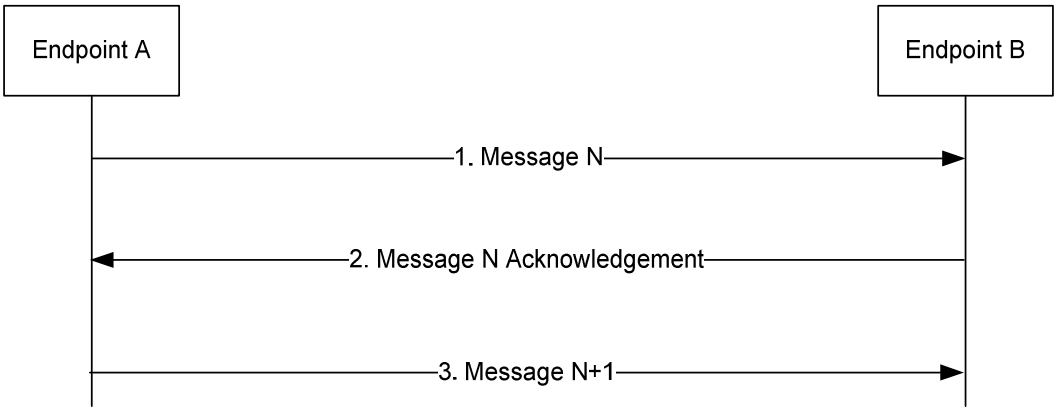

Figure 4.3.3.2-1: SLPP Acknowledgement procedure

1. Endpoint A sends an SLPP message *N* to Endpoint B which includes the field *ackRequested* set to TRUE and a sequence number.
2. If SLPP message *N* is received and Endpoint B is able to decode the *ackRequested* value and sequence number, Endpoint B shall return an acknowledgement for message *N*. The acknowledgement shall contain the field *ackIndicator* set to the same sequence number as that in message *N*.
3. When the acknowledgement for SLPP message *N* is received and provided the included field *ackIndicator* matches the sequence number sent in message *N*, Endpoint A sends the next SLPP message *N+1* to Endpoint B when this message is available.

4.3.4 SLPP Retransmission

4.3.4.1 General

This capability builds on the acknowledgement and duplicate detection capabilities. When an SLPP message which requires acknowledgement is sent and not acknowledged, it is resent by the sender following a timeout period up to three times. If still unacknowledged after that, the sender aborts all SLPP activity for this Endpoint. The timeout period is determined by the sender implementation but shall not be less than a minimum value of 250 ms.

4.3.4.2 Procedure related to Retransmission

Figure 4.3.4.2-1 shows the procedure related to retransmission when combined with acknowledgement and duplicate detection.

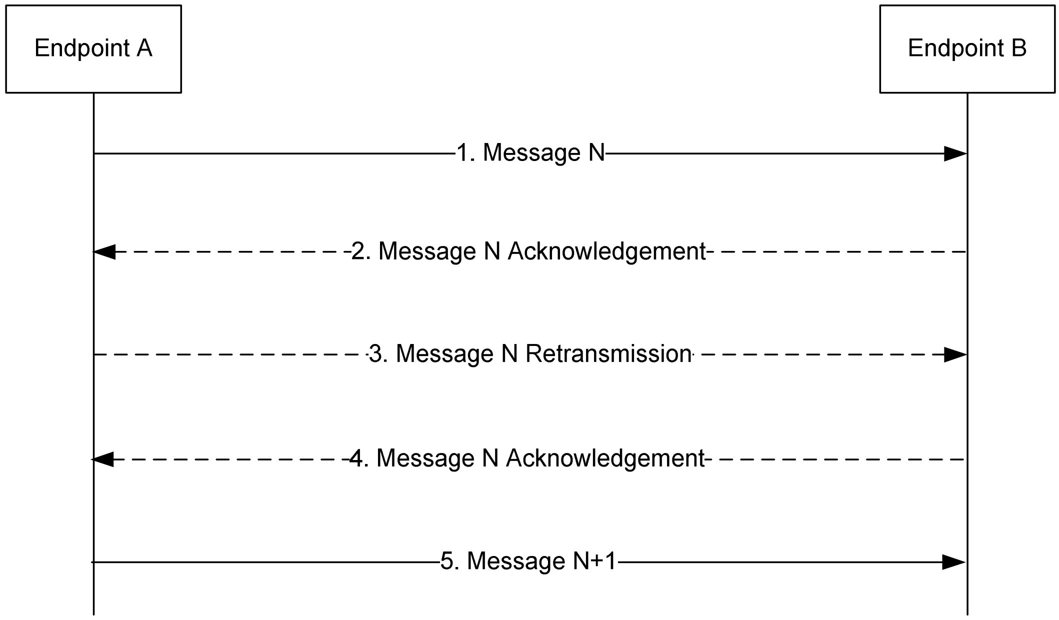

Figure 4.3.4.2-1: SLPP Retransmission procedure

1. Endpoint A sends an SLPP message *N* to Endpoint B for a particular location session and includes a request for acknowledgement along with a sequence number.

2. If SLPP message *N* is received and Endpoint B is able to decode the *ackRequested* value and sequence number (regardless of whether the message body can be correctly decoded), Endpoint B shall return an acknowledgement for message *N*. If the acknowledgement is received by Endpoint A (such that the acknowledged message can be identified and sequence numbers are matching), Endpoint A skips steps 3 and 4.

3. If the acknowledgement in step 2 is not received after a timeout period, Endpoint A shall retransmit SLPP message *N* and shall include the same sequence number as in step 1.

4. If SLPP message *N* in step 3 is received and Endpoint B is able to decode the *ackRequested* value and sequence number (regardless of whether the message body can be correctly decoded and whether or not the message is considered a duplicate), Endpoint B shall return an acknowledgement. Steps 3 may be repeated one or more times if the acknowledgement in step 4 is not received after a timeout period by Endpoint A. If the acknowledgement in step 4 is still not received after sending three retransmissions, Endpoint A shall abort all procedures and activity associated with SLPP support for this Endpoint B.

5. Once an acknowledgement in step 2 or step 4 is received, Endpoint A sends the next SLPP message *N+1* for the location session to Endpoint B when this message is available.

5 SLPP Procedures

5.1 Procedures related to capability transfer

5.1.1 General

The purpose of the procedures that are grouped together in this clause is to enable the transfer of capabilities from Endpoint A to Endpoint B. Capabilities in this context refer to positioning and protocol capabilities related to SLPP and the positioning methods supported by SLPP. These procedures instantiate the Capability Transfer procedure from TS 38.305 [3].

5.1.2 Capability Transfer procedure

The Capability Transfer procedure is shown in Figure 5.1.2-1.