|  |  |
| --- | --- |
| 3GPP TS 33.533 V18.1.0 (2023-12) | |
| Technical Specification | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Security aspects of ranging based services and  sidelink positioning  (Release 18) | |
|  | |
|  | 3GPP-logo_web |
|  | |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification. Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. | |

|  |
| --- |
|  |
| ***3GPP***  Postal address  3GPP support office address  650 Route des Lucioles - Sophia Antipolis  Valbonne - FRANCE  Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  Internet  http://www.3gpp.org |
| ***Copyright Notification***  No part may be reproduced except as authorized by written permission. The copyright and the foregoing restriction extend to reproduction in all media.  © 2023, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).  All rights reserved.  UMTS™ is a Trade Mark of ETSI registered for the benefit of its members  3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners LTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners  GSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 5

1 Scope 7

2 References 7

3 Definitions of terms, symbols and abbreviations 8

3.1 Terms 8

3.2 Symbols 8

3.3 Abbreviations 8

4 Overview of security architecture 9

4.1 General 9

4.2 Functional entities and reference points 9

4.2.1 Functional entities 9

4.2.1.1 SideLink Positioning Key Management Function 9

4.2.2 Reference points 9

5 Common security 10

5.1 General 10

5.2 Security for PC8\* interface 10

5.2.1 General 10

5.2.2 Security requirements 10

5.2.3 Security procedures for PC8\* using GBA 10

5.2.4 Security procedures for PC8\* using AKMA 10

5.3 Security of service-based interfaces used in Ranging/SL Positioning 10

6 Security for Ranging/SL positioning features 11

6.1 Void 11

6.2 Security for Ranging/SL positioning UE discovery 11

6.2.1 General 11

6.2.2 Security requirements 11

6.2.3 Security procedures for ProSe capable UEs 11

6.2.4 Security procedures for V2X capable UEs 11

6.3 Authorization for Ranging/SL positioning service 11

6.3.1 General 11

6.3.2 Authorization requirements 12

6.3.3 Procedures of UE role authorization during discovery 12

6.3.4 Procedures of UE authorization for Ranging/SL positioning communication 12

6.3.5 Procedures for authorization of AF/5GC NF/LCS Client for Ranging/SL positioning service exposure 12

6.3.6 Procedures for authorization of UE for Ranging/SL positioning service exposure 13

6.3.6.1 General 13

6.3.6.2 Authorization procedure for Ranging/SL positioning service exposure through 5GC control plane 13

6.3.6.3 Authorization procedure for Ranging/SL positioning service exposure through PC5 13

6.3.7 Procedure of UE privacy verification for UE-only operation 13

6.4 Security for communication of Ranging/SL positioning control 14

6.4.1 General 14

6.4.2 Security requirements 14

6.4.3 Security procedures for unicast direct communication over RSPP between the UEs 14

6.4.3.1 General 14

6.4.3.2 Unicast direct communication for Ranging/SL Positioning services provided application 14

6.4.3.3 Unicast direct communication for Ranging/SL Positioning services provided by network 15

6.4.4 Security procedure for broadcast/groupcast communication over RSPP 15

6.4.4.1 General 15

6.4.4.2 Security flows for broadcast/groupcast communication 16

6.4.4.3 Protection of messages between UEs 17

6.4.4.3.1 Message processing in the sending UE 17

6.4.4.3.2 Protected message processing in the receiving UE 17

6.4.4.4 Key hierarchy for broadcast/groupcast protection communication over RSPP 18

6.4.5 Security procedure for communication between the UE and LMF 18

7 Security related services 18

7.1 General 18

7.2 SLPKMF services 19

7.2.1 General 19

7.2.2 Nslpkmf\_Discovery service 19

7.2.2.1 Nslpkmf\_Discovery\_AnnounceAuthorize service operation 19

7.2.2.2 Nslpkmf\_Discovery\_MonitorAuthorize service operation 19

7.2.2.3 Nslpkmf\_Discovery\_DiscoveryAuthorize service operation 19

7.2.3 Nslpkmf\_SLPKMFKeyRequest service 20

7.2.3.1 Nslpkmf\_SLPKMFKeyRequest\_UnicastKey service operation 20

7.2.3.2 Nslpkmf\_SLPKMFKeyRequest\_GroupcastKey service operation 20

Annex A (normative): Key derivation functions 21

A.1 KDF interface and input parameter construction 21

A.1.1 General 21

A.1.2 FC value allocations 21

A.2 Calculation of KSLP 21

A.3 Calculation of SLPTK 21

A.4 Calculation of keys from SLPTK 22

Annex B (informative): Change history 23

# Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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.

# 1 Scope

The present document specifies the security and privacy aspects of Ranging based services and Sidelink positioning in the 5G System (5GS) for commercial, V2X and public safety use cases, with the UE in coverage, partial coverage, and out-of-coverage of 5G network using 5G NR PC5 RAT, based on the architecture defined in TS 23.586 [2].

Security features for Ranging based services and Sidelink positioning include:

- authorization for Ranging/SL positioning service;

- security and privacy protection for Ranging/SL positioning UE discovery;

- security and privacy protection for unicast communication of Ranging/SL positioning control; and

- security and privacy protection for broadcast/groupcast communication of Ranging/SL positioning control.

# 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 23.586: "Architectural Enhancements to support Ranging based services and Sidelink Positioning".

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

[4] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

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

[6] 3GPP TS 33.503: "Security Aspects of Proximity based Services (ProSe) in the 5G System (5GS)".

[7] 3GPP TS 38.355: " NR; Sidelink Positioning Protocol (SLPP); Protocol Specification".

[8] 3GPP TS 33.536: "Security aspects of 3GPP support for advanced Vehicle-to-Everything (V2X) services".

[9] 3GPP TS 33.303: "Proximity-based Services (ProSe); Security aspects".

[10] 3GPP TS 33.535: "Authentication and Key Management for Applications (AKMA) based on 3GPP credentials in the 5G System (5GS)".

[11] 3GPP TS 33.501: "Security architecture and procedures for 5G System".

[12] 3GPP TS 33.220: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA)".

# 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 TS 23.586 [2] 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].

**Located UE**

**Network-based Operation**

**Positioning**

**Ranging**

**Ranging/SL Positioning Application Identifier**

**SL Reference UE**

**Sidelink Positioning**

**SL Positioning Client UE**

**SL Positioning Server UE**

**Target UE**

**UE-only Operation**

**User Info ID**

**Application Layer ID**

## 3.2 Symbols

Void.

## 3.3 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].

AKMA Authentication and Key Management for Applications

DCR Direct Communication Request

GBA Generic Bootstrapping Architecture

RSPP Ranging/SL Positioning Protocol

SLPEK Sidelink Positioning Encryption Key

SLPGK Sidelink Positioning Group Key

SLPIK Sidelink Positioning Integrity Key

SLPK SideLink Positioning Key

SLPKMF SideLink Positioning Key Management FunctionSLPP SideLink Positioning Protocol

SLPTK Sidelink Positioning Traffic Key

UTC Universal Time Coordinated

# 4 Overview of security architecture

## 4.1 General

The overall architecture for Ranging/SL Positioning is specified in clause 4.2 of TS 23.586 [2], which involves the LCS architecture specified in TS 23.273 [3] and 5G Prose architecture specified in TS 23.304 [4]. The reference architecture also supports roaming scenario and inter-PLMN scenario.

Based on the architecture specified in TS 23.586 [2], the security architecture for Ranging/SL Positioning also supports roaming and inter-PLMN scenario and reuses the security architecture of 5G ProSe services and security architecture of LCS services with necessary enhancements or adaptations.

## 4.2 Functional entities and reference points

### 4.2.1 Functional entities

#### 4.2.1.1 SideLink Positioning Key Management Function

The SideLink Positioning Key Management Function (SLPKMF) is the logical function handling network related operations required for generation and provisioning of security materials used for Ranging/SL positioning services. The SLPKMF has the similar functionalities as those of 5G Prose Key Management Function (PKMF) specified in TS 33.503 [6] and can be a standalone entity or collocated with 5G PKMF. In addition to the functionalities supported by 5G PKMF, the SLPKMF shall support the following functions:

- Support key management for secure unicast direct link establishment between the UEs for Ranging/SL Positioning services provided by network.

- Support UE role authorization via the UDM.

- Support key management for protection of SLPP signalling broadcast/groupcast.

The address of SLPKMF can be preconfigured on the UE or provisioned by the PCF to the UE.

### 4.2.2 Reference points

In addition to the reference points specified in clause 4.2 of TS 23.586 [2], the following reference points are added or enhanced for supporting Ranging/SL positioning security architecture:

**NL6:** The reference point between the UDM and the GMLC. It is used to transport the UE privacy profile to GMLC for authorization of Ranging/SL Positioning service exposure.

**PC8\*:** The reference point between the UE and the SLPKMF, which relies on 5GC user plane for transport (i.e. an "over IP" reference point). It is used to transport security materials to UEs for Ranging/SL Positioning discovery and communication.

**Npc9\*:** The reference point between the SLPKMFs of the UEs subscribed in different PLMNs. It is used to transport security materials between SLPKMFs to support Ranging/SL Positioning services in inter-PLMN scenarios.

**Npc10\*:** The reference point between the UDM and the SLPKMF. It is used to request subscription information related to Ranging/SL Positioning service from the UDM for UE authorization.

# 5 Common security

## 5.1 General

This clause describes the security requirements and procedures commonly applied to different features of Ranging/SL positioning services, including Ranging/SL positioning discovery, Ranging/SL positioning communication with unicast mode, broadcast/groupcast mode, etc.

## 5.2 Security for PC8\* interface

### 5.2.1 General

The security requirements on PC8\* interface between ProSe capable UE and SLPKMF are derived based on the definition of the SLPKMF described in clause 4.2.1.1 and the definition of PC8\* interface described in clause 4.2.2.

### 5.2.2 Security requirements

The 5G System shall support mutual authentication between the ProSe capable UE and the SLPKMF.

The 5G System shall support integrity protection for the transmission between the ProSe capable UE and the SLPKMF.

The 5G System shall support confidentiality protection for the transmission between the ProSe capable UE and the SLPKMF.

The 5G System shall support anti-replay protection for the transmission between the ProSe capable UE and the SLPKMF.

### 5.2.3 Security procedures for PC8\* using GBA

When using GBA for the security procedures on PC8\* interface, the use of either TLS v1.2 or TLS v. 1.3 as described in clause 5.3.3.2 of TS 33.303 [9] applies with the following changes:

- The SLPKMF takes the role of ProSe function.

- Confidentiality protection shall be enabled.

### 5.2.4 Security procedures for PC8\* using AKMA

When using AKMA for the security procedures on PC8\* interface, the specification in clause B.1.3.2 of TS 33.535 [10] applies with the following changes:

- The SLPKMF takes the role of AF.

- Confidentiality protection shall be enabled.

## 5.3 Security of service-based interfaces used in Ranging/SL Positioning

Npc9\* and Npc10\* defined in clause 4.2.2 are realized by corresponding NF service-based interfaces. Security procedures specified in clause 13 of TS 33.501 [11] apply to these interfaces.

# 6 Security for Ranging/SL positioning features

## 6.1 Void

## 6.2 Security for Ranging/SL positioning UE discovery

### 6.2.1 General

For ProSe capable UEs, the discovery procedures of both Model A and Model B defined in clause 6.3.2 of TS 23.304 [4] are used for Ranging/SL Positioning UE discovery.

For V2X capable UEs, the procedures for V2X communication defined in clause 6.3.3 of TS 23.287 [5] are used for Ranging/SL Positioning UE discovery.

### 6.2.2 Security requirements

The 5G system shall support integrity protection, confidentiality protection and anti-replay protection of discovery messages.

The SLPKMF shall be able to provision discovery security materials to ProSe capable UEs. The discovery security materials are associated with the Ranging/SL Positioning application identifier defined in TS 23.586 [2] and used to protect the integrity of discovery messages and privacy sensitive information (e.g. UE identity) in the messages.

The ciphering algorithm for discovery message confidentiality shall be configured by the network during discovery key request procedure.

### 6.2.3 Security procedures for ProSe capable UEs

The security mechanisms for both models of restricted 5G ProSe UE-to-Network Relay Discovery defined in clause 6.1.3.2 of TS 33.503 [6] are reused for ProSe capable UEs to provide protection for Ranging/SL positioning UE discovery with the following changes:

- SLPKMF rather than 5G DDNMF/5G PKMF is used to provision discovery security materials for Ranging/SL positioning UE discovery.

- Ranging/SL Positioning application identifier (as defined in clause 3.1 of TS 23.586 [2]) instead of the Relay Service Code (RSC) is included in the Discovery Key Request/Response messages.

- The SLPKMF of the monitoring/discoverer UE discovers the SLPKMF(s) of potential announcing/discoveree UE(s) supporting the Ranging/SL Positioning application identifier based on a configured list of PLMNs supporting the corresponding Ranging/SL Positioning application.

### 6.2.4 Security procedures for V2X capable UEs

Based on clause 5.3.3.1 of TS 33.536 [8], the Direct Communication Request (DCR) message is not protected for V2X capable UEs.

NOTE: Any information that needs security protection for Ranging/SL Positioning UE discovery needs to be sent in the Direct Security Mode Complete message.

## 6.3 Authorization for Ranging/SL positioning service

### 6.3.1 General

According to clause 4.1 of TS 23.586 [2], a UE capable of Ranging/SL Positioning may take different roles in various Ranging/SL Positioning operations. Each of the UEs in a Ranging/SL Positioning service acts in its own authorized role. The UE shall follow the policy/parameters defined in clause 5.1 of TS 23.586 [2] for authorization with the network. TS 23.586 [2] clause 5.6 also specifies that Ranging/SL Positioning service can be exposed to an authorized SL Positioning Client UE, 5GC NF or AF or LCS client to obtain the relative or absolution distance/direction result between two UEs capable of Ranging/SL positioning.

This clause specifies the authorization requirements and procedures for the operations in Ranging/SL positioning services wherever authorization or privacy check is required.

### 6.3.2 Authorization requirements

The 5G system shall support the authorization of the role of the UE (e.g. as a Target UE/SL Reference UE/SL Positioning Server UE/Located UE) in a Ranging/Sidelink Positioning service.

The 5G system shall support authorization of the UE for Ranging/SL positioning communication in unicast mode, broadcast/groupcast mode.

The 5G system shall support authorization of the AF, 5GC NF, LCS Client or SL Positioning Client UE for Ranging/SL Positioning service exposure.

The 5G system shall support privacy protection of the to-be-measured UEs for Ranging/SL Positioning service exposure.

### 6.3.3 Procedures of UE role authorization during discovery

According to TS 23.586 [2] clause 5.2, the role of the UE is included in discovery messages for 5G ProSe capable UEs and included in unicast link establishment messages for V2X capable UEs.

For ProSe capable UEs, before claiming its role to the peer UE(s) in the discovery message, the role of the claiming UE shall be authorized by the network. The UE role authorization shall be performed via the SLPKMF through Discovery Key Request/Response messages during the security procedure for Ranging/SL positioning discovery as defined in clause 6.2.3. The authorization information used to check whether the UE is allowed to act the claimed role in a Ranging/SL positioning service is included in UE subscription data as specified in clause 5.8 of TS 23.586 [2]. The SLPKMF shall retrieve subscription information from the UDM for authorizing the role claimed by the UE. Only after successful authorization of the UE's role, the SLPKMF shall then generate and provision discovery security materials to the UE, which indicates the successful authorization of the UE role.

If the UE claims its role to the peer UE(s) in DCR and DCA messages, the UE role authorization may be performed by the peer UE against its locally configured information, which can be provisioned by the application. If the UE role is not acceptable, the peer UE shall discard or reject the request directly.

### 6.3.4 Procedures of UE authorization for Ranging/SL positioning communication

The details of UE authorization for Ranging/SL positioning communication in unicast mode are specified in clause 6.4.3.

The details of UE authorization for Ranging/SL positioning communication in broadcast/groupcast mode are specified in clause 6.4.4.

### 6.3.5 Procedures for authorization of AF/5GC NF/LCS Client for Ranging/SL positioning service exposure

For the authorization of the AF, 5GC NF or LCS client for Ranging/SL Positioning service exposure, the SL-MT-LR procedure specified in TS 23.273 [3] is taken as the baseline. The authorization shall be performed towards all the n UEs (n ≥ 2), i.e. UE1, UE2, ..., UEn in the request message. If all of the UEs grant permission for Ranging/SL Positioning exposure, the GMLC shall forward the service request from the AF/5GC NF to the AMF. If none of the UEs grants permission for Ranging/SL Positioning exposure, the GMLC shall reject the service request. If part of the UEs grant and part of the UEs don't grant permission for Ranging/SL Positioning exposure, the GMLC shall decide t, o proceed with or reject the service request from the AF5GC NF or LCS client based on implementation, e.g. a local rule configured by the network operator. If the GMLC decides to accept the service request, it shall only inclu, de the identities of the UEs granting permission in the service request forwarded to the AMF.

When receiving the RangingSL Pos or LCS client itioning service request from the AF/5GC NF, the GMLC interacts with the UDM to check the UE privacy profile. The UE LCS Privacy Profile defined in clause 5.4.2 of TS 23.273 [3] is taken as the baseline for the UE privacy profile for Ranging/SL positioning services.

NOTE: The details of the UE privacy profile for Ranging/SL positioning services needs to be align with SA2.

The GMLC interacts with the AMF to request the ranging result of UEs, which may include an indication of a privacy related action. If the indicator of privacy check related action indicates that the UE must either be notified or notified with privacy verification, a notification invoke message is sent to the UE if the signalling connection established. However, if the Ranging/SL Positioning service is disallowed by the UE, or signalling connection establishment fails and UE notification (including UE notification with privacy verification) is required, the AMF shall provide failure response to the GMLC.

### 6.3.6 Procedures for authorization of UE for Ranging/SL positioning service exposure

#### 6.3.6.1 General

According to TS 23.586 [2], clause 5.6.2, Ranging/SL Positioning service can be exposed to the SL Positioning Client UE through PC5 or through 5GC control plane. The SL Positioning Client UE shall be authorized for Ranging/SL Positioning service exposure.

#### 6.3.6.2 Authorization procedure for Ranging/SL positioning service exposure through 5GC control plane

For Ranging/SL Positioning service exposure through the network via control plane (i.e. clause 6.7.1.2.3 of TS 23.586 [2]), the MO-LR authorization as specified in TS 23.273 [3] is reused for the authorization of the SL positioning Client UE.

If the Client UE is not authorized, the Ranging/SL Positioning service request shall be rejected.

To preserve the privacy of the Target/Reference UEs, the privacy profiles of the Target/Reference UEs shall be checked. Upon receiving Ngmlc\_Location\_ProvideRanging\_Request from the AMF (i.e. step 3 in clause 6.7.1.2.3 of TS 23.586 [2]), the GMLC shall perform the privacy check for the Target/Reference UEs as defined in clause 6.3.5 during the SL-MT-LR procedure (i.e. step 4 in clause 6.7.1.2.3 of TS 23.586 [2]).

#### 6.3.6.3 Authorization procedure for Ranging/SL positioning service exposure through PC5

For Ranging/SL Positioning service exposure through PC5 (i.e. clause 6.7.1.1 of TS 23.586 [2]), the SL Positioning Client UE authorization is triggered by the Reference/Target UE during PC5 link establishment. The authorization can be performed by the network via the SLPKMF for ProSe capable UEs or by the Reference/Target UE if the authorization information is available in the UE.

If the Client UE is not authorized, the Ranging/SL Positioning service request shall be rejected.

### 6.3.7 Procedure of UE privacy verification for UE-only operation

For UE-only Operation in which the network is not involved in Ranging/Sidelink positioning, the authorization for UE privacy is based on the local configured privacy verification information to determine whether its location related information can be exposed to the peer UE or not. If the privacy profile allows location exposure, the UE (e.g. Located UE) accepts the request to expose its location related information and proceeds.

## 6.4 Security for communication of Ranging/SL positioning control

### 6.4.1 General

Ranging/SL Positioning control is defined in TS 23.586 [2], which is supported by the Ranging/SL Positioning layer above the AS layer. The Ranging/SL Positioning layer provides the support of Ranging/SL Positioning Protocol (RSPP) (i.e. Sidelink Positioning Protocol (SLPP) defined in TS 38.355 [7]) between the UEs and between the UE and LMF for Ranging/SL Positioning.

Ranging/SL Positioning control over RSPP is performed on SR5 reference point between UEs. PC5-U is used as the transport layer for RSPP as specified in clause 5.3.2 of TS 23.586 [2]. Depending on type of the UE (V2X capable or 5G ProSe capable), V2X Communication procedures defined in TS 23.287 [5] or 5G ProSe Direct Communication procedures defined in TS 23.304 [4] are used for RSPP transport between UEs.

Ranging/SL Positioning control over the protocol between the UE and LMF is specified in clauses 6.20 of TS 23.273 [3].

### 6.4.2 Security requirements

The 5G system shall support mutually authentication between the UEs during unicast direct communication establishment for Ranging/SL Positioning control over RSPP.

The 5G system shall support integrity, confidentiality and anti-replay protection for the information transferred during unicast direct communication for Ranging/SL Positioning control over RSPP.

The 5G system shall support cryptographic separation for each SR5 interface and for each peer UE during unicast direct communication for Ranging/SL Positioning control over RSPP.

The 5G system shall support integrity, confidentiality and anti-replay protection for the information transferred during unicast communication for Ranging/SL Positioning control over the protocol between the UE and LMF.

The 5G system shall support a means to provide confidentiality, integrity and anti-replay protection of SL positioning signalling during broadcast/groupcast communication for Ranging/SL positioning.

The 5G system shall provide a means to mitigate trackability and linkability attacks of the UE during broadcast/ groupcast communication for Ranging/SL positioning.

### 6.4.3 Security procedures for unicast direct communication over RSPP between the UEs

#### 6.4.3.1 General

Ranging/SL Positioning services could be provided by an application provider (i.e. the services requested by a Ranging/SL positioning application server) or by a network operator (i.e. the services requested by a 5GC NF). For Ranging/SL Positioning services provided by application providers, long-term credentials provided by applications are assumed available on the UE. For Ranging/SL Positioning services provided by network operators (e.g. 5GC‑MO‑LR and 5GC-MT-LR services using SL positioning as defined in TS 23.586 [2] and TS 23.273 [3]), there are no long-term credentials provided by applications on the UE (e.g. Located UE). The security procedures for unicast communication for Ranging/SL Positioning services provided by application and for Ranging/SL Positioning services provided by network are specified separately in subclauses 6.4.3.2 and 6.4.3.3.

#### 6.4.3.2 Unicast direct communication for Ranging/SL Positioning services provided application

If long-term credentials provided by application are available on the UE, the security procedures defined for V2X unicast mode communication in clause 5.3 of TS 33.536 [8] are reused on V2X capable UEs. The security procedures defined for 5G ProSe unicast mode Direct Communication in clause 6.2.3 of TS 33.503 [6] are reused on ProSe capable UEs.

#### 6.4.3.3 Unicast direct communication for Ranging/SL Positioning services provided by network

For Ranging/SL Positioning services provided by network operators, the network shall support key provisioning and management for unicast direct communication. The security procedures defined for 5G ProSe UE-to-Network Relay communication in clause 6.3.3.2 of TS 33.503 [6] are reused with the following modifications:

- The SLPKMF instead of 5G PKMF is used to generate and provision the key materials for secure unicast direct communication of Ranging/SL Positioning services.

- UE SLP Key Request/Response are used instead of ProSe Remote User Key Request/Response.

- Ranging/SL Positioning Application Identifier is used instead of RSC.

- SLPK and SLPK ID are used instead of UP-PRUK and UP-PRUK ID.

- SLP Key Request/Response are used instead of Key Request/Response.

- KSLP is used instead of KNRP.

- KDF of KSLP uses Ranging/SL Positioning Application Identifier as input instead of RSC.

NOTE: This procedure does not apply to V2X capable UEs.

### 6.4.4 Security procedure for broadcast/groupcast communication over RSPP

#### 6.4.4.1 General

This clause describes the security mechanism for broadcast/groupcast communication over RSPP. The RSPP messages for broadcast/groupcast communication are protected at the RSPP layer.

#### 6.4.4.2 Security flows for broadcast/groupcast communication



Figure 6.4.4.2-1: Security flows for broadcast/groupcast communication

0a and 0b. Both sending and receiving UEs shall be provisioned with the parameters/policy for Ranging/SL positioning service as specified in clause 5.1 of TS 23.586 [2].

1a. The sending UE shall establish a secure connection with the Sidelink Positioning Key Management Function (SLPKMF) based on the security procedures specified in clause 5.2.5 of TS 33.503 [6]. The sending UE sends a Key Request message to Sidelink Positioning Key Management Function (SLPKMF) including the Ranging/SL positioning application identifier provisioned in step 0a, and UE security capabilities.

1b. The SLPKMF shall reply with the Key Response message containing the Sidelink Positioning Group Key (SLPGK), the Sidelink Positioning Group Key ID (SLPGK ID), the validity time, and the chosen ciphering and integrity algorithms. The SLPKMF may be locally configured with the UE's authorization information. Otherwise, the SLPKMF interacts with the UDM of the UE to retrieve the UE's authorization information. The chosen ciphering and integrity algorithms are determined by SLPKMF based on the received UE security capabilities in step 1a. The Key Response message may include multiple SLPGK and SLPGK ID pairs with different validity times. Group member ID shall be assigned by the SLPKMF which is included in the Key Response message. As an alternative, the sending UE may generate a Group member ID randomly.

NOTE 1: For V2X capable UEs, the security materials (e.g. SLPGK, SLPGK ID, validity time) and the ciphering and integrity algorithms used for broadcast/groupcast communication are provisioned at the application, which is out of the scope of the present document.

NOTE 2: In case the SLPLMF of a receiving UE is different from the SLPKMF of a sending UE, the provisioning of security materials as specified in clause 6.1.3.2 in TS 33.503 [6] is reused.

NOTE 3: Sidelink Positioning Group refers to a specific Ranging/SL positioning service. Accordingly, Group member ID refers to the identifier of the UE that is authorized to use the Ranging/SL positioning service.

2. The receiving UE shall perform a Key Request procedure to get security materials from the SLPKMF as described in step 1. This may happen any time before step 5.

3. The sending UE shall derive the Sidelink Positioning Traffic Key (SLPTK) from SLPGK using Group member ID, and SLPTK ID as specified in Annex A.3 of present document. SLPTK ID is a counter set to a unique value in the sending UE that has not been previously used together with the same SLPGK and the associated SLPGK ID. The UE shall use a new SLPGK and SLPGK ID pair based on step 1 before the SLPTK ID wraps around. The UE shall calculate the Sidelink Positioning Encryption Key (SLPEK) and Sidelink Positioning Integrity Key (SLPIK) from SLPTK using the chosen ciphering and integrity algorithms, respectively as specified in Annex A.4 of present document.

4. The sending UE shall protect the message as described in clause 6.4.4.3.1 and send the message.

5. Upon receiving the message matching the SLPGK ID, the receiving UE shall calculate SLPTK, SLPEK and SLPIK if it has not calculated them. The receiving UE derives security keys as in step 3 using the SLPGK ID, SLPTK ID and Group member ID (if it is included) in the received message. Then, the UE shall decrypt the message and verifies the integrity of the message as described in clause 6.4.4.3.2.

#### 6.4.4.3 Protection of messages between UEs

##### 6.4.4.3.1 Message processing in the sending UE

The UE sending a message shall construct the message as follows:

1) Form RSPP message header that contains Group member ID, SLPGK ID, SLPTK ID, and a counter. Then, append the Payload to it as illustrated in figure 6.4.4.3.1-1. The counter is used in combination with the selected ciphering algorithm and integrity algorithm.

NOTE 1: The counter can be a time counter.

2. If the chosen integrity algorithm is not the NULL algorithm, calculate MAC of the message header and the Payload based on the chosen integrity algorithm. If the chosen algorithm is the NULL algorithm, then the sending UE shall set the MAC to a 32-bit random string or all zeros in the message header. The use and mode of operation of the chosen integrity algorithm are specified in Annex D of TS 33.501 [11].

3. If the chosen ciphering algorithm is not the NULL algorithm, encrypt the Payload and MAC based on the chosen ciphering algorithm. The use and mode of operation of the chosen ciphering algorithm are specified in Annex D of TS 33.501 [11].

In case the Group member ID is provided by the SLPKMF, multiple Group member IDs can be provisioned for privacy. If multiple Group member IDs are provisioned by the SLPKMF or Group member IDs are self-generated, the sending UE shall change its Group member ID according to its policy.

NOTE 2: Additional procedures to mitigate trackability/linkability attacks may apply to Group member ID, SLPGK ID, SLPTK ID, and Counter.



Figure 6.4.4.3.1-1: RSPP message format for Sidelink Positioning  
broadcast/groupcast communication

##### 6.4.4.3.2 Protected message processing in the receiving UE

The UE receiving a message shall do the following steps:

1. If the chosen ciphering algorithm is not the NULL algorithm, undo confidentiality protection based on the chosen ciphering algorithm.

2. If the chosen integrity algorithm is not the NULL algorithm, verify the integrity of the received message by checking MAC based on the chosen integrity algorithm. The message with MAC part filled with all zeroes is discarded.

NOTE: Freshness verification may be required.

#### 6.4.4.4 Key hierarchy for broadcast/groupcast protection communication over RSPP

The key hierarchy for broadcast/groupcast communication over RSPP follows the key hierarchy for one-to-many ProSe direct communication as specified in TS 33.303 [9]. The different layers of keys (see figure 6.4.4.4-1) are the following:



Figure 6.4.4.4-1: Key hierarchy for broadcast/groupcast communication over RSPP

- SLPGK: SL Positioning Group Key is a 256-bit root key specific to a Ranging/SL positioning application (for broadcast) or group (for groupcast) provisioned with an expiry time. Each SLPGK has an SLPGK ID to identify it. This allows several SLPGKs to be held simultaneously for one Ranging/SL positioning application (for broadcast) or Ranging/SL positioning group (for groupcast). SLPGK may either be provisioned by the SLPKMF to the UE or be derived by the UE from locally configured long-term credentials.

- SLPTK: SL Positioning Traffic Key is a 256-bit intermediate key derived by the UE from SLPGK. It is unique per UE to ensure that each UE generates unique SLPTKs for protecting the messages it sends. Each SLPTK has a 16-bit SLPTK ID to identify it. SLPTK ID is a counter in the UE set to a unique value that has not been previously used together with the same SLPGK and associated SLPGK ID. Every time a new SLPTK needs to be derived, the SLPTK ID counter is incremented.

- SLPEK and SLPIK: The SL Positioning Encryption Key (SLPEK) and SL Positioning Integrity Key (SLPIK) are derived by the UE from SLPTK and used as broadcast/groupcast keys to protect the integrity and confidentiality of RSPP messages for Sidelink Positioning broadcast/groupcast communication respectively.

### 6.4.5 Security procedure for communication between the UE and LMF

The communication for Ranging/SL Positioning control between the UE and LMF is protected by using NAS security context created for the UE.

# 7 Security related services

## 7.1 General

This clause defines the network services required to support the security procedures described in clause 6.

## 7.2 SLPKMF services

### 7.2.1 General

The following table illustrates the SLPKMF Services and Service Operations.

Table 7.2.1-1: List of SLPKMF Services

|  |  |  |  |
| --- | --- | --- | --- |
| Service | Service Operations | Operation Semantics | Example Consumer(s) |
| Nslpkmf\_Discovery | AnnounceAuthorize | Request/Response | SLPKMF |
| MonitorAuthorize | Request/Response | SLPKMF |
| DiscoveryAuthorize | Request/Response | SLPKMF |
| Nslpkmf\_SLPKMFKeyRequest | UnicastKey | Request/Response | SLPKMF |
| GroupcastKey | Request/Response | SLPKMF |

### 7.2.2 Nslpkmf\_Discovery service

#### 7.2.2.1 Nslpkmf\_Discovery\_AnnounceAuthorize service operation

**Service operation name:** Nslpkmf\_Discovery\_AnnounceAuthorize.

**Description:** The consumer NF obtains the authorization from the SLPKMF for announcing in the PLMN.

**Input, Required:** User Info ID, Ranging/SL Positioning Application Identifier, UE Role.

**Input, Optional:** None.

**Output, Required:** Authorization result.

**Output, Optional:** None.

#### 7.2.2.2 Nslpkmf\_Discovery\_MonitorAuthorize service operation

**Service operation name:** Nslpkmf\_Discovery\_MonitorAuthorize.

**Description:** The consumer NF obtains the authorization from the SLPKMF for monitoring in the PLMN.

**Input, Required:** User Info ID, Ranging/SL Positioning Application Identifier, UE Role, PC5 UE security capability.

**Input, Optional:** None.

**Output, Required:** The chosen PC5 ciphering algorithm, discovery security materials.

**Output, Optional:** Discovery User Integrity Key (DUIK).

#### 7.2.2.3 Nslpkmf\_Discovery\_DiscoveryAuthorize service operation

**Service operation name:** Nslpkmf\_Discovery\_DiscoveryAuthorize.

**Description:** The consumer NF obtains the authorization from the SLPKMF for a discoverer UE in the PLMN to operate Model B restricted discovery.

**Input, Required:** User info ID, Ranging/SL Positioning Application Identifier, UE Role, PC5 UE security capability.

**Input, Optional:** None.

**Output, Required:** The chosen PC5 ciphering algorithm, discovery security materials.

**Output, Optional:** Discovery User Integrity Key (DUIK).

### 7.2.3 Nslpkmf\_SLPKMFKeyRequest service

#### 7.2.3.1 Nslpkmf\_SLPKMFKeyRequest\_UnicastKey service operation

**Service operation name:** Nslpkmf\_SLPKMFKeyRequest\_UnicastKey.

**Description:** Provides Ranging related keying material for unicast communication.

**Input, Required:** Ranging/SL Positioning Application Identifier, SLPK ID, KSLP freshness parameter 1.

**Input, Optional:** None.

**Output, Required:** KSLP, KSLP freshness parameter 2.

**Output, Optional:** None.

#### 7.2.3.2 Nslpkmf\_SLPKMFKeyRequest\_GroupcastKey service operation

**Service operation name:** Nslpkmf\_SLPKMFKeyRequest\_GroupcastKey.

**Description:** Provides Ranging related keying material for groupcast communication.

**Input, Required:** SLPGK ID, Group Identifier.

NOTE: For broadcast operation, Ranging/SL Positioning Application Identifier is used as the Group Identifier.

**Input, Optional:** None.

**Output, Required:** SLPGK.

**Output, Optional:** None.

Annex A (normative):  
Key derivation functions

# A.1 KDF interface and input parameter construction

## A.1.1 General

This annex specifies the use of the Key Derivation Function (KDF) specified in TS 33.220 [12] for the present document. This annex specifies how to construct the input string, S, and the input key KEY to the KDF. Note that "KEY" is denoted "Key" in TS 33.220 [12].

## A.1.2 FC value allocations

The FC number space used is allocated as per B.2.2 of TS 33.220 [12].

# A.2 Calculation of KSLP

When calculating KSLP from SLPK, the following parameters shall be used to form the input S to the KDF specified in Annex B of TS 33.220 [12]:

- FC = 0x8C

- P0 = Ranging/SL Positioning Application Identifier

- L0 = length of Ranging/SL Positioning Application Identifier (i.e. 0x00 0x03)

- P1 = KSLP nonce 1

- L1 = length of KSLP nonce 1 (i.e. 0x00 0x10)

- P2 = KSLP nonce 2

- L2 = length of KSLP nonce 2 (i.e. 0x00 0x10)

The input key to the KDF is the 256-bit SLPK.

# A.3 Calculation of SLPTK

When calculating a SLPTK from SLPGK, the following parameters shall be used to form the input S to the KDF that is specified in Annex B of TS 33.220 [12]:

- FC = 0x8D

- P0 = Group Member Identity

- L0 = length of Group Member Identity

- P1 = SLPTK Identity

- L1 = length of SLPTK Identity

The input key shall be the 256-bit SLPGK.

# A.4 Calculation of keys from SLPTK

When calculating a SLPIK or SLPEK from SLPTK, the following parameters shall be used to form the input S to the KDF that is specified in Annex B of TS 33.220 [12]:

- FC = 0x8E

- P0 = 0x00 if SLPEK is being derived or 0x01 if SLPIK is being derived

- L0 = length of P0 (i.e. 0x00 0x01)

- P1 = algorithm identity

- L1 = length of algorithm identity (i.e. 0x00 0x01)

The algorithm identity shall be set as described in TS 33.501 [11].

The input key shall be the 256-bit SLPTK.

For an algorithm key of length n bits, where n is less or equal to 256, the n least significant bits of the 256 bits of the KDF output shall be used as the algorithm key.

Annex B (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2023-09 | SA#101 | SP-230868 |  |  |  | Presented for information and approval | 1.0.0 |
| 2023-09 | SA#101 |  |  |  |  | EditHelp review and upgrade to change control version | 18.0.0 |
| 2023-12 | SA#102 | SP-231336 | 0001 | - | F | Update the FC Value in 33.533 | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0003 | 1 | F | Resolve the issue when SLPTK ID is about to wrap around | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0004 | 1 | F | Update the abbreviations in 33.533 | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0009 | - | F | Rel18 SL positioning - Updates on unicast direct communication security | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0017 | - | F | Update to the Reference Points in Clause 4.2.2 | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0018 | - | F | Update to Common Security in Clause 5 | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0019 | 1 | F | Add differences between Ranging discovery and ProSe discovery | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0020 | - | F | Update to failure handling for authorization of UE role included in DCR | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0021 | 1 | F | Update to AF authorization procedure for Ranging/SL positioning service exposure | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0022 | 1 | F | Add privacy handing for Ranging/SL positioning service exposure through 5GC CP | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0025 | 1 | F | Update to the title for unicast direct communication with long-term credential | 18.1.0 |
| 2023-12 | SA#102 | SP-231336 | 0031 | - | F | Clarification on the Ranging/SL Positioning service exposure | 18.1.0 |