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| 3GPP TR 23.752 V0.4.0 (2020-06) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on system enhancement for Proximity based Services (ProSe) in the 5G System (5GS)  (Release 17) | |
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| ***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 |
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# Foreword

This Technical Specification|Report 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:

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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 objective of this Technical Report is to identify and evaluate architecture enhancements of 5G System design needed to support proximity based services based on SA1 requirements defined in TS 22.278 [2], TS 22.261 [3] and TS 22.115 [4] and determine which of the solutions can proceed to normative specifications.

# 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 22.278: "Service requirements for the Evolved Packet System (EPS); Stage 1".

[3] 3GPP TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

[4] 3GPP TS 22.115: "Service aspects; Charging and billing; Stage 1".

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

[6] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[7] 3GPP TR 22.842: "Study on Network Controlled Interactive Service (NCIS) in the 5G System (5GS); Stage 1".

[8] 3GPP TS 23.502: "Procedures for the 5G System (5GS); Stage 2".

[9] 3GPP TS 23.303: "Proximity-based services (ProSe); Stage 2".

[10] IETF RFC 826: "An Ethernet Address Resolution Protocol".

[11] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description; Stage 2".

[12] 3GPP TS 29.343: "Proximity-services (ProSe) function to ProSe application server aspects (PC2); Stage 3".

[13] 3GPP TS 32.277: "Telecommunication management; Charging management; Proximity-based Services (ProSe) charging".

[14] 3GPP TR 23.713: "Study on extended architecture support for proximity-based services".

[15] 3GPP TS 32.255: "Telecommunication management; Charging management; 5G data connectivity domain charging; Stage 2".

[16] 3GPP TS 32.256: "Charging management; 5G connection and mobility domain charging; Stage 2".

[17] 3GPP TS 32.291: "Telecommunication management; Charging management; 5G system, charging service; Stage 3".

[18] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[19] 3GPP TS 22.186: "Service requirements for enhanced V2X scenarios".

[20] 3GPP TS 24.334: " Proximity-services (ProSe) User Equipment (UE) to ProSe function protocol aspects; Stage 3"

[21] 3GPP TS 24.333: " Proximity-services (ProSe) Management Objects (MO)"

[22] 3GPP TS 32.290: " Services, operations and procedures of charging using Service Based Interface (SBI) "

[23] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification"

[24] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services"

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

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

**Open ProSe Discovery**: ProSe Discovery without explicit permission from the ProSe-enabled UE being discovered, according to TS 22.278 [2].

**Restricted ProSe Discovery**:ProSe Discovery that only takes place with explicit permission from the ProSe-enabled UE being discovered, according to TS 22.278 [2].

**5G ProSe Direct Discovery:** A procedure employed by a ProSe-enabled UE to discover other ProSe-enabled UEs in its vicinity by using only the capabilities of the two UEs with NR technology.

**5G ProSe Direct Communication:** A communication between two or more UEs in proximity that are ProSe-enabled, by means of user plane transmission using NR technology via a path not traversing any network node.

**Direct Network Communication:** One mode of network communication, where there is no UE-to-Network Relay UE between a UE and the 5G network.

**Indirect Network Communication:** One mode of network communication, where there is a UE-to-Network Relay UE between a UE and the 5G network.

**5G ProSe UE-to-Network Relay:** A UE that provides functionality to support connectivity to the network for Remote UE(s).

**5G ProSe UE-to-UE Relay:** A UE that provides functionality to support connectivity between the Source UE and the Target UE(s).

**Remote UE:** A 5G ProSe-enabled UE that communicates with a DN via a 5G ProSe UE-to-Network Relay.

**Source UE:** A 5G ProSe-enabled UE that communicates with target UE(s) via a 5G ProSe UE-to-UE Relay.

**Target UE:** A 5G ProSe-enabled UE that communicates with Source UE via a 5G ProSe UE-to-UE Relay

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format (EW)

<symbol> <Explanation>

## 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].

Abbreviation format (EW)

<ACRONYM> <Explanation>

# 4 Architecture Requirements and Assumptions

Editor's note: This clause will document any architectural requirements and assumptions for FS\_5G\_ProSe.

## 4.1 Architecture Requirements

Solutions shall build on the 5G System architectural principles as in TS 23.501 [6], including flexibility and modularity for newly introduced functionalities.

In order to satisfy the normative stage-1 general requirements in TS 22.278 [2] and TS 22.261 [3] and TS 22.115 [4], the system shall:

- enable the direct discovery of the ProSe-enabled UE by other ProSe-enabled UEs within the same PLMNs or different PLMNs, including in coverage and out of coverage.

NOTE: This needs to be resolved by RAN.

- enable the ProSe direct communication functionality.

- enable the path selection functionality.

- enable the service authorization and provisioning of the ProSe-enabled UEs.

- enable QoS support on PC5.

- enable the operators (HPLMN or VPLMN) charging for the utilization of the ProSe functionality.

- enable UE-to-Network relay functionality (including service continuity).

- enable UE-to-UE relay functionality.

## 4.2 Architecture Assumptions

### 4.2.1 General

- Architecture reference models defined in TS 23.287 [5] (i.e. PC5 based eV2X architecture reference model) are used as reference architecture for supporting ProSe in 5GS.

- Architecture reference model defined in TS 23.501 [6] are used as basis architecture for supporting ProSe in 5GS.

- Group management is handled by application layer which is out of this document.

- NG-RAN is considered; non-3GPP AN is not considered in the release.

- NR based PC5 is considered.

- QoS handling for V2X communication over NR PC5 reference point defined in clauses 5.4.1 to 5.4.4 of TS 23.287 [5] is used as basis for supporting PC5 direct communication.

- The standardized PQI values defined for NR PC5 in TS 23.287 [5] can be used to support performance requirements defined in clause 7.6.2 of TS 22.261 [3] for interactive services if applicable.

### 4.2.2 Reference Architecture Model

V2X architecture as defined in TS 23.287 [5] will be used as baseline.

# 5 Key Issues

Editor's note: This clause will describe the key issues for the enhancement of ProSe supporting in 5GS.

## 5.1 Key Issue #1: ProSe Direct discovery

### 5.1.1 General description

The ProSe direct discovery procedure is used for a UE to discover or be discovered by other UE(s) in proximity over the PC5 interface. The UE can discover other UE(s) with interested application(s) and/or interested group(s) using the ProSe direct discovery procedure. This solution for this key issue should strive to achieve the common direct discovery procedure for discovering a 5G Prose enabled UE, 5G Prose UE-to-Network Relay and a 5G Prose UE-to-UE Relay.

Following issues need to be addressed in this key issue:

- Discover (or discovered by) other UE(s) in interested group(s) over PC5 interface, the group information can come from application layer.

- Discover (or discovered by) other UE(s) also supporting interested application(s) over PC5 interface.

- If the UE is out of coverage, discover (or discovered by) other UE(s) in coverage or out of coverage.

- Network is able to control the ProSe direct discovery procedure when the UE is in coverage.

NOTE: The ProSe direct discovery procedure can be used to perform the ProSe direct communication, e.g. one-to-many direct communication, one-to-one direct communication.

## 5.2 Key Issue #2: Support for NR PC5 ProSe communication

### 5.2.1 General description

In TS 22.261 [3] and TS 22.278 [2], use cases and requirements for ProSe services are described, including public safety and interactive services. NR PC5 ProSe communication including unicast and groupcast needs to be supported for the case of public safety and interactive service.

Following assumptions apply to this key issue:

- For one-to-many direct communication and one-to-one direct communication differences with what is documented in TS 23.287 [5] clause 5.2 will be documented;

- For QoS support differences with what is documented in TS 23.287 [5] clause 5.4 will be documented.

## 5.3 Key Issue #3: Support of UE-to-Network Relay

### 5.3.1 General description

According to TS 22.261 [3] and TS 22.278 [2], support for UE-to-Network Relay needs to be studied. In addition, the Rel-16 5G architectural design (e.g. flow-based QoS communication over PC5/Uu interface) shall be taken into consideration as well.

The case that UE may be able to access to network via the direct network communication or the indirect network communication illustrated in figure 5.3.1-1 needs to be considered, where path #1 is direct network communication path that may not exist, as well as path #2 and path #3 are indirect network communication paths via different UE-to-Network Relays.



Figure 5.3.1-1: Example scenario of direct or indirect network communication path between UE and Network

Therefore, 5G ProSe needs to support UE-to-Network Relay. In particular, the following aspects need to be studied:

- How to authorize a UE to be a 5G UE-to-Network Relay and how to authorize a UE to access 5GC via a 5G UE-to-Network Relay.

- How to establish a connection between Remote UE and a UE-to-Network Relay to support connectivity to the network for the Remote UE.

- How to support end-to-end requirements between Remote UE and the network via a UE-to-Network Relay, including QoS (such as data rate, reliability, latency) and the handling of PDU Session related attributes (e.g. S-NSSAI, DNN, PDU Session Type and SSC mode).

- How the network allows and controls the QoS requirement for 5G ProSe UE-to-NW relay.

- How to transfer data between the Remote UE and the network over the UE-to-Network Relay.

NOTE 1: Security and privacy aspects will be handled by SA WG3.

- How to (re)select a UE-to-Network Relay for communication path selection between two indirect network communication paths (i.e. path #2 and path #3 in figure 5.3.1-1).

- How to perform communication path selection between a direct network communication path (i.e. path #1 in figure 5.3.1-1) and an indirect network communication path (i.e. path #2 or path #3 in figure 5.3.1-1).

- How to guarantee service continuity during these communication path switch procedures for switching between a direct network communication path and an indirect communication path, as well as for switching between two indirect network communication paths.

NOTE 2: Support of non-unicast mode communication (i.e. one-to-many communication/broadcast or multicast) between network and UE-to-Network Relay UE and between UE-to-Network Relay and Remote UE(s) depends on the result of FS\_5MBS work.

Two cases can be considered regarding support of UE-to-Network Relay, i.e. UE-to-Network Relay served by gNB as shown in Figure 5.3.1-2 and UE-to-Network Relay served by ng-eNB as shown in Figure 5.3.1-3.



Figure 5.3.1-2: UE-to-Network Relay served by gNB



Figure 5.3.1-3: UE-to-Network Relay served by ng-eNB

NOTE 3: Whether to support the case that a UE-to-Network Relay is served by ng-eNB depends on solution to be identified in this study and RAN decision.

NOTE 4: When UE-to-Network Relay moves to E-UTRAN, LTE PC5 based ProSe UE-to-Network Relay can be supported as defined TS 23.303 [9] for Public Safety.

## 5.4 Key Issue #4: Support of UE-to-UE Relay

### 5.4.1 General description

This key issue intends to support for UE-to-UE Relay, including support for in coverage and out of coverage operation.

At least the following aspects need to be considered in potential solutions:

- How to (re)-select a UE-to-UE Relay UE in proximity?

- Whether and how for the network can control the UE-to-UE Relay operation, at least including how to:

- Authorize the UE-to-UE Relay, e.g. authorize a UE as UE-to-UE Relay?

- Authorize the Remote UE to access a UE-to-UE Relay?

- Provide the visibility of source/target UE and the UE-to-UE Relay to the network for the purpose of, e.g. charging?

- How to establish the connection between the source UE and the target UEs via UE-to-UE Relay?

- How to provide end-to-end QoS framework to satisfy the QoS requirements (such as data rate, reliability, latency)?

- How to enhance the system architecture to provide the security protection for relayed connection?

- How to provide a mechanism for path changing in case of e.g. UE-to-UE Relay changes?

NOTE 1: For the involvement of NG-RAN, coordination with RAN WGs is needed.

NOTE 2: For security aspects, coordination with SA3 is needed.

## 5.5 Key Issue #5: Support direct communication path selection between PC5 and Uu

### 5.5.1 General description

For 5GS, the proximity services are expected to be an important system wide enabler to support various applications and services (both in commercial and public safety domains). As an example, TR 22.842 [7] identified emerging Network-controlled Interactive services (NCIS) that share some commonality of requirements with public safety services and applications.

For either form of services, supporting the requirements for throughput, latency, reliability or other service requirements calls for employing path selection. To improve the support of proximity services, the appropriate direct communication path (or interface) could be selected by the UE based on some policy which may also be configured by the operator or assisted by the network when available. Therefore, this key issue addresses how to enhance the 5GS to support direct path selection. When studying the above aspect, the following needs to be considered:

- How to enable path selection between a ProSe direct communication path and a direct network communication path.

- What functional entities and triggers are responsible for the above path selection.

## 5.6 Key Issue #6: Support direct communication path switching between PC5 and Uu

### 5.6.1 General description

This key issue addresses how to enhance the 5GS to support direct communication path switching (when needed) from 5GC Uu path to PC5 (ProSe) path or vice versa for both commercial and public safety services.

When studying the above aspect, the following needs to be considered:

- How to enable network-controlled/network-assisted direct communication path switching between 5GC Uu path and PC5 path.

- What functional entities and triggers are responsible for direct communication path switching and their impact on the corresponding interfaces.

- How service continuity could be preserved during direct communication path switching, i.e. Uu to PC5 or PC5 to Uu.

- What are the possible impacts of direct communication path switching on QoS handling for ProSe Communication over PC5 path vs. over 5GC Uu path?

NOTE: This key issue is not addressed within Rel-17 timeframe.

## 5.7 Key Issue #7: Charging for PC5

### 5.7.1 General description

In order to fulfil the requirements in TS 22.115 [4] and TS 22.261 [3], this key issue is proposed to study how to accommodate charging for PC5 for commercial and public safety services based on the 5G service-based architecture.

This Key Issue shall study:

- Identify any architecture enhancements are needed to accommodate charging for PC5 on the 5G architecture.

- How to collect and report charging related data to accommodate charging for PC5?

## 5.8 Key Issue #8: Support of PC5 Service Authorization and Policy/Parameter Provisioning

### 5.8.1 General description

In order to enable PC5 service authorization and policy/parameter provisioning following aspects need to be studied:

- For the procedures related to PC5 service authorization and policy/parameter provisioning to a UE, only necessary enhancement with what is specified in TS 23.287 [5] clause 6.2 and TS 23.502 [8] clause 4.2.2.2 (Registration Procedure), 4.2.4.3 (UE Configuration Update procedure for transparent UE Policy Delivery), 4.16.11 (UE Policy Association Establishment procedure), 4.16.12 (UE Policy Association Modification procedure), will be documented.

- Identify necessary information for PC5 service authorization and provisioning based on what is specified in TS 23.287 [5] clause 5.1.2.1.

Authorisation and Provisioning as documented in TS 23.287 [5] clause 5.1 will be used as baseline for this key issue.

# 6 Solutions

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | | | |
| Solutions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | X |  |  |  |  |  |  | X |
| 2 | X |  |  |  |  |  |  | X |
| 3 | X |  |  |  |  |  |  |  |
| 4 | X | X |  |  |  |  |  |  |
| 5 |  | X |  |  |  |  |  |  |
| 6 |  |  | X |  |  |  |  |  |
| 7 |  |  | X |  |  |  |  | X |
| 8 |  |  |  | X |  |  |  |  |
| 9 |  |  |  | X |  |  |  |  |
| 10 |  |  |  | X |  |  |  |  |
| 11 |  |  |  | X |  |  |  |  |
| 12 |  |  |  |  | X |  |  |  |
| 13 |  |  |  |  |  |  | X |  |
| 14 |  |  |  |  |  |  | X |  |
| 15 |  |  |  |  |  |  | X |  |
| 16 |  |  |  |  |  |  |  | X |
| 17 |  |  |  |  |  |  |  | X |
| 18 | X |  |  |  |  |  | X |  |
| 19 | X |  | X |  |  |  |  |  |
| 20 |  | X |  |  |  |  |  |  |
| 21 |  | X |  |  |  |  |  |  |
| 22 | X | X |  |  |  |  |  |  |
| 23 |  |  | X |  |  |  |  |  |
| 24 |  |  | X |  |  |  |  |  |
| 25 |  |  | X |  |  |  |  |  |
| 26 |  |  | X |  |  |  |  |  |
| 27 |  |  | X |  |  |  |  |  |
| 28 | X |  | X |  |  |  |  |  |
| 29 |  |  | X |  |  |  |  |  |
| 30 |  |  | X |  |  |  |  | X |
| 31 |  |  |  | X |  |  |  |  |
| 32 |  |  |  | X |  |  |  |  |
| 33 | X |  |  | X |  |  |  |  |
| 34 |  |  |  |  |  |  | X |  |
| 35 |  |  | X |  |  |  |  | X |
| 36 |  |  |  | X |  |  |  | X |
| 37 |  | X |  |  |  |  |  |  |
| 38 |  |  | X |  |  |  |  |  |

## 6.1 Solution #1: Restricted direct discovery

### 6.1.1 Description

This solution provides the discovery procedure based on 5GC architecture, including authorization and provision, announcing and monitoring procedures, and protocol for discovery as detailed in clause 6.1.2.

In EPS, there are two types of ProSe Direct Discovery: open and restricted. Open discovery is the case where there is no explicit permission that is needed from the UE being discovered, whereas restricted discovery only takes place with explicit permission from the UE that is being discovered. In this solution, only restricted type is proposed.

Besides, there are two models for ProSe Direct Discovery exists in EPS: Model A and Model B. These two models are re-proposed in this solution as the same mechanism in EPS. And the definition for Model A and Model B is as defined in clause 5.3.1.2 of TS 23.303 [9].

### 6.1.2 Procedures

#### 6.1.2.1 Procedure for authorization and provision

**1. Authorization and provision to the UE**

For the direct discovery authorization and provision to the UE, it is expected the AF can provide the groups and/or service information to the PCF via NEF and the PCF provides the authorization to the UE according to the received information from the AF. The authorization and provision procedures in clauses 6.2.2 and 6.2.5 of TS 23.287 [5] are reused to provide at least the following configurations:

1) The AF request sent to the PCF (or via NEF) contains the information as below:

- The service information to be directly discovered over PC5 interface. The service information can contain, e.g. Application identifier;

- The group information (e.g. the external group identifier) to be directly discovered over PC5 interface;

- The information can per announcing and monitoring direction for Model A or per discoverer UE and discoveree UE for Model B;

- The area information, e.g. geographical information (longitude/latitude, zip code, etc).

Editor note: It is FFS whether and how to configure the metadata information to the UE and what is the size of meta data that can be efficiently sent as part of discovery over PC5.

2) The provision to the UE from PCF, contains the following information based on the information received from the AF and local policy:

- The service information to be directly discovered over PC5 interface. The service information can contain, e.g. Application identifier;

- The group information (e.g. the external group identifier) to be directly discovered over PC5 interface;

- The area information used for direct discovery over PC5 interface; The area information could be geographical TA list. It is expected PCF will map the area information provided by AF to a list of TAs.

- Security parameters used for direct discovery over PC5.

NOTE: Uu RAT restriction is not applied to PC5 operations for the UE. Uu RAT information is not needed to be provisioned in the UE, e.g. to authorize the UE to send or monitor direct discovery message only when the UE camps on NR.

**2. Authorization and provision to NG-RAN**

If the AMF determines the UE is authorised to use direct discovery based on the authorised area information, the AMF provides the UE is authorized to use direct discovery over PC5 interface to corresponding NG-RAN during N2 establishment for the UE.

#### 6.1.2.2 Procedure for announcing and monitoring discovery message



Figure 6.1.2.2-1: Procedure for discovery procedure

0. The user may obtain ProSe application user ID and ProSe application code for ProSe direct discovery using application layer mechanisms. The application layer in the UE provides application user ID and the application identifier to the ProSe Application Function. The ProSe Application Function allocates a ProSe application user ID and ProSe application code to the application layer in the UE.

NOTE: Step 0 is out of this specification. And this step is only needed for the applications for which there is privacy issue.

1. The UE obtains the authorization and provision for announcing discovery and/or for monitoring/ solicitation discovery as defined in clauses 6.2.2 and 6.2.5 of TS 23.287 [5]. The authorized parameters are shown in clause 6.1.2.1.

2a. When the announcing UE is triggered e.g. by an upper layer application to announce availability for interested groups and/or for interested applications, if the UE is authorised to perform the announcing UE procedure for the interested groups and/or the interested applications in step 1, then the UE shall generate a PC5 direct discovery message for announcement and includes the following information in this message. The announcing UE computes a security protection element (e.g. for integrity protection) and appends it to the PC5 message:

1) ProSe UE ID e.g. ProSe application user ID, Layer 2 ID.

2) The group ID(s) provided by the application layer.

3) The application ID(s) or ProSe application code(s) provided the application layer.

When the monitoring UE is triggered e.g. by an upper layer application or by the user to monitor proximity of other UEs for the interested group(s) and/or interested applications, and if the UE is authorised to perform the monitoring procedure for the group(s) and/or applications, then the UE monitors the discovery message. The monitoring UE verifies the security protection element using the provisioned security parameters corresponding to the application. If the verification of the security protection element succeeds, the service is successfully discovered by the monitoring UE. The monitoring UE may then notify the application layer using the result of the discovery.

2b. When the discoverer UE is triggered e.g. by an upper layer application or by the user to discover other UEs for the interested group(s) and/or interested applications, and if the UE is authorised to perform the discovery solicitation procedure for the group(s) and/or applications in step 1, then the UE sends solicitation message with the information of discoverer ProSe UE ID, application ID(s) or ProSe application code(s), group ID(s). The discoverer UE computes a security protection element (e.g. for integrity protection) and appends it to the PC5 message.

If the discoveree UE is able to and authorised to respond to the discovery solicitation according to the received information in the solicitation message, then it responds to the discovery message with the discoveree ProSe UE ID, the supported application ID(s) or ProSe application code(s) and group ID(s).

3a. If the monitoring UE/discoverer UE wants to request metadata corresponding to the discovered service in step 2, the monitoring UE/discoverer UE may send a unicast metadata request message to request discovery metadata. The monitoring UE/discoverer UE may use the Layer 2 ID of announcing UE/discoveree UE (received in step 2a or 2b) to send the Metadata Request message.

3b. The announcing UE/discoveree UE responds with the Metadata Response message. The announcing UE/discoveree UE includes the metadata information in the Metadata Response message.

Editor's note: It is FFS whether and how the dynamic metadata is exchanged between the peer UEs.

Editor's note: It is FFS whether the metadata request may be carried in step 2a and how to perform security protect for metadata.

### 6.1.3 Impacts on services, entities and interfaces

Impact on PCF:

* Provide discovery related authorization and provision;

Impact on UE:

* Support model A and model B procedure as described.

## 6.2 Solution #2: V2X based solution for ProSe direct discovery

### 6.2.1 Description

#### 6.2.1.1 General

This solution addresses Key Issue #1 (ProSe Direct discovery) and is mainly used to support ProSe direct discovery followed by subsequent ProSe direct communication (e.g. direct communication for playing a game together).

A UE may either listen for other UEs it is interested in, or it may broadcast its interest e.g. unique UE identity or group identity. TS 23.287 [5] already has the concept of implicit discovery, as defined in clause 6.3.3 for Unicast mode link establishment. It is proposed to use PC5-S direct communication procedure to implement the Direct Discovery.

The ProSe application layer, which in TS 23.287 [5] is the V2X application layer may provide information which should be either looked for or broadcast in the direct discovery procedure which includes application information, e.g. an Application ID and a UE’s ProSe Application Layer ID.

The Destination Layer-2 ID can be used to indicate if the message is unicast, groupcast or broadcast. There may also be situations when a unique Destination Layer-2-ID has been assigned to identify an application (e.g. as in TS 23.287 [5] a V2X service can be assigned a unique Destination Layer-2 ID), in such a situation it would not be expected to receive Destination Layer 2-ID from the application layer. In addition, a UE may be interested in only communicating with another specific UE(s), in such situations a Destination Layer-2-ID may not be sufficient and there might be a need to look for a specific UE that is independent of the Destination Layer-2-ID. The procedure is flexible so that ProSe Layer is provided a set of identities from the ProSe application layer and from provisioned information the ProSe Layer then uses these identities to do a match.

The Source Layer-2 ID and Frame type are as described in clause 6.3.1.

### 6.2.2 Procedures

#### 6.2.2.0 Policy/Parameter Description

##### 6.2.2.0.1 Identities

The following identities are required:

a) Application ID: An identity used by a UE to indicate a specific ProSe application. The ProSe application ID is assigned (provided) by the ProSe application layer and can be used to identify e.g.:

- An application e.g. Mission Critical Voice, Game A, Game B, Taxi Communications company Y

b) Destination Layer-2 ID Indicate

- A specific target UE layer-2 ID or layer-2 ID for initial signalling.

c) Source Layer-2 ID that is set to a unicast identifier of the transmitter.

d) Source UE’s ProSe Application Layer ID. An identity used to identify the source ProSe UE at the application layer. It is provided by the ProSe Application Layer to the ProSe Layer.

e) Target UE’s ProSe Application Layer ID. An identity used to identify the destination ProSe UE at the application layer. It is provided by the ProSe Application Layer to the ProSe Layer.

f) ProSe Application Layer Group ID. An identity used to identify a application layer group the UE belongs to.

g) Relay Service Code (for UE-to-Network Relay Discovery)

- Relay Service Code as defined in TS 23.303 [9].

h) Discovery Group ID (for Group Member Discovery)

- Discovery Group ID as defined in TS 23.303 [9].

All of the above identities can be either fixed over time or can be dynamic depending on operator configuration. When an identity is dynamic it will have a validity timer. Dynamic allocation of the identities by the ProSe Application layer allows for privacy support.

##### 6.2.2.0.2 Policy/Parameter provisioning

The same concept as in TS 23.287 [5] clause 5.1.1 shall be used.

See TS 23.287 [5] clause 5.1.2. Replace:

- V2X service by ProSe Application.

- PISD and ITS-AID by Application ID.

Add the following new requirements:

1) Policy/parameters related to if ProSe application is allowed to use PC5 direct discovery:

- The list of ProSe Applications that are allowed to use PC5 direct discovery.

2) Policy/parameters related to Destination Layer-2-ID for or unicast discovery:

- The mapping of default Destination Layer-2 ID(s) for initial PC5 direct discovery.

The parameters (e.g. Relay Service Code, Discovery Group ID) is provisioned by PCF as defined in solutions for Key Issue #8.

#### 6.2.2.1 General

ProSe Direct Discovery consists of 2 components:

**Listening:** This procedure consists of the UE listening for broadcast data. Depending on the ProSe application that the UE is wanting to use, the UE maybe required to listen for any or all of the following:

1 Destination Layer 2-ID;

2 ProSe Application ID.

3. Source User Info (Source UE’s ProSe Application Layer ID, ProSe Application Layer Group ID);

4. Target User Info (Target UE’s ProSe Application Layer ID);

5. Relay Service Code (for UE-to-Network Relay Discovery).

6. Discovery Group ID (for Group Member Discovery).

**Broadcasting:** This procedure consists of the UE broadcasting data that other UEs will be listening for. Depending on the ProSe application that the broadcasting UE is wanting to use, in addition to broadcasting the Origination and Destination Layer-2-IDs, the broadcasting UE maybe required to also broadcast any of the following:

1. Application ID.
2. 2. Source User Info(Source UE’s ProSe Application Layer ID, ProSe Application Layer Group ID);
3. 3. Target User Info(Target UE’s ProSe Application Layer ID);
4. 4. Relay Service Code.
5. 5. Discovery Group ID.

Clause 6.2.2.2 is based upon TS 23.287 [5] clause 6.3.3.

#### 6.2.2.2 Implementing ProSe Direct Discovery using the ProSe Direct Communication Procedure

To perform ProSe Direct Discovery communication over PC5-S reference point, the UE is configured with the related information as described in clause 6.2.2.0.2.

Figure 6.2.2.2-1 shows the procedure for implementing ProSe Direct Discovery using the ProSe Direct Communication procedure over PC5 reference point as defined in TS 23.287 [5] clause 6.3.3.1.



Figure 6.2.2.2-1: ProSe Direct Discovery procedure

1. The UE(s) determine the destination Layer-2 ID for signalling reception for PC5 unicast link establishment.

- Target User Info (Target UE’s ProSe Application Layer ID);

2. The ProSe application layer in UE-1 provides to the ProSe layer for PC5-S Direct Communication Request at any of the following:

- Application ID;

- Source User Info (Source UE’s ProSe Application Layer ID, ProSe Application Layer Group ID);

- Target User Info (Target UE’s ProSe Application Layer ID);

- Destination Layer-2 ID.

The Prose layer shall check to see if the Application ID received from the ProSe application layer is allowed to use ProSe PC5 communications discovery per the policy defined in clause 6.2.2.0.2.

a. If the Application ID is allowed per policy defined in clause 6.2.2.0.2 to use ProSe PC5 discovery, if the ProSe layer:

i. receives a Destination Layer-2-IDs from the ProSe application layer it shall be used as the Destination Layer-2-ID in step 3; or

ii. did not receive a destination layer 2-ID from the ProSe application layer, the ProSe layer shall determine if it has a provisioned Destination Layer-2-ID for that Application Layer ID as described in clause 6.2.2.0.2 If a Destination Layer-2 ID:

- has been provisioned it shall be used in step 3; or

- has not been provisioned then the ProSe Layer shall determine if a Destination Layer 2-ID has been provisioned for the type of Communication type being requested by analysing the ProSe Device ID to determine if group communication or unicast is being requested e.g. is there a Destination Layer 2-ID provisioned to identify Unicast, Broadcast or Groupcast.

b. If the Application ID is not allowed per policy defined in clause 6.2.2.0.2 to use ProSe PC5-S discovery then an error shall be indicated to the ProSe Application Layer. The procedure shall be terminated.

3. For the Broadcasting UE, UE-1, if the ProSe Layer received Location information, the ProSe Layer will only send a Direct Communication request message to announce itself in that location, else the ProSe Layer sends a Direct Communication request message to announce itself anywhere. The Direct Communication request message may include any of the following:

- Application Layer ID (if received in the User info);

- The Destination Layer-2-IDs as determined in step 2.

- The Source Layer 2-ID set to self assigned unicast identity.

- Source User Info;

- Target User Info;

- Relay Service Code (for UE-to-Network Relay Discovery)

- Discovery Group ID (for Group Member Discovery)

UE-1 sends the Direct Communication Request message via PC5 broadcast or unicast using the source Layer-2 ID and the destination Layer-2 ID.

4. Security with UE-1 is established as defined in TS 23.287 clause 6.3.3.1 step 4.

5. For the listening UE(s), UE-2 to UE-4, the ProSe Layer will listen for a Direct Communication Request message. Upon receiving a Direct Communication Request UE-2 will perform a match using the information received in step 1.

UE-2 responds to UE-1 with Direct Communication Accept message. The Direct Communication Accept message may include any combinations of the parameters: Application ID, Source User Info, Target User Info, Relay Service Code, Discovery Group ID.

### 6.2.3 Impacts on services, entities and interfaces

New UE procedures for using Rel-16 V2X unicast mode communication to implement ProSe Direct Discovery.

PCF needs to support the delivery of the ProSe 5G authorization and provisioning information using the PCF based Service Authorization and Provisioning mechanism defined in TS 23.287 [5] clause 6.2.2.

## 6.3 Solution #3: Solution for ProSe 5G Direct Discovery using PC5 communication channel

### 6.3.1 Description

ProSe 5G Direct Discovery using PC5 communication channel relies on signalling messages that are carried within the same layer-2 frames as those used for ProSe direct communication over NR PC5 reference point defined in TS 23.287 [5], clause 6.1.1.



Figure 6.3.1-1: Layer-2 frame format for ProSe 5G Direct Discovery

A simplified layer-2 frame format for ProSe Direct Discovery is shown in Figure 6.3.1-1. In reference to the header fields the following applies:

NOTE 1: The exact frame format for the discovery messages will be specified together with RAN WG2 and CT WG1.

- The Destination Layer-2 ID that can be set to a unicast, groupcast or broadcast identifier.

- The Source Layer-2 ID that is always set to a unicast identifier of the transmitter.

- Frame type indicates that it is a ProSe Direct Discovery message.

NOTE 2: Which protocol identifier in the Access Stratum the Frame Type field corresponds to will be decided by RAN2

- The following ProSe Direct Discovery messages are needed:

- Announcement message (for Model A discovery as defined in TS 23.303 [9]).

- Solicitation message (for Model B discovery as defined in TS 23.303 [9]).

- Response message (for Model B discovery as defined in TS 23.303 [9]).

The information contained in each discovery message is similar to what is described in TS 23.303 [9] clause 4.6.4.

NOTE 3: Depending on the use cases to be supported in ProSe 5G, not all information elements defined in TS 23.303 [9] need to be supported. For example, if only restricted, UE-to-UE Relay Discovery and UE-to-Network Relay Discovery need to be supported, there is no need for ProSe Application Code that is only used for open discovery.

### 6.3.2 Procedures

#### 6.3.2.1 Procedures for Direct Discovery Model A and B

Depicted in Figure 6.3.2.1-1 is the procedure for ProSe Direct Discovery with Model A.



Figure 6.3.2.1-1: ProSe Direct Discovery with Model A

Depicted in Figure 6.3.2.1-2 is the procedure for ProSe Direct Discovery with Model B.



Figure 6.3.2.1-2: ProSe Direct Discovery with Model B

Editor's note: In order to reduce power consumption whether there is an incentive to reduce the size of information carried in discovery messages and potentially also define some "longer" DRX values compared to the equivalent values that will be used for communication will be decided in RAN.

#### 6.3.2.2 Procedures for assignment of ProSe identifiers

Depending on the use cases of Direct Discovery e.g. commercial vs. public safety, and restricted vs. open, etc. the related information in the ProSe Direct Discovery message is either preconfigured in the UE or assigned dynamically. For instance, for Group Member Discovery, the information needs to be pre-configured in the UE in order to support "out of coverage" operation for public safety use. For cases where information needs to be assigned by the PLMN, the PC3 procedures defined in TS 23.303 [9] clause 5.3 between UE and a ProSe Function can be used, since PC3 is using user plane (HTTPS) and therefore the procedures are access agnostic. Only the procedures in clause 5.3 of TS 23.303 [9], i.e. the Direct Discovery Name Management Function (DDNMF), needs be supported.

The Direct Provisioning Function (DPF) defined in TS 23.303 [9] is replaced by PCF, based on the V2X architecture as defined in TS 23.287 [5], and is not supported by the DDNMF. The architecture reference model as described in Annex B.2 User Plane based architecture, with the following additional considerations:

- each PLMN deploys one logical 5G DDNMF;

- the 5G DDNMF interacts with PCF for the authorization of the ProSe discovery service;

- the 5G DDNMF in the HPLMN of a UE may interact with 5G DDNMF of other PLMNs (e.g. VPLMN/Local PLMN) to perform ProSe identifier allocation and management, as defined in clause 5.2 of TS 23.303 [9];

- the 5G DDNMF may interact with the ProSe Application Function for optional suffixes management for the discovery service as specified in clause 5.3.3 of TS 23.303 [9].

### 6.3.3 Impacts on services, entities and interfaces

New UE procedures for using ProSe Direct Discovery with NR PC5 communication channel.

UE and 5G DDNMF need to support the PC3 procedures defined in TS 23.303 [9] clause 5.3.

PCF needs to support the delivery of the ProSe 5G authorization and provisioning information using the PCF based Service Authorization and Provisioning mechanism defined in TS 23.287 [5] clause 6.2.2.

## 6.4 Solution #4: PC5 group communication for commercial services

### 6.4.1 Description

#### 6.4.1.1 General

This solution addresses Key Issue #1 (ProSe Direct discovery) and Key Issue #2 (Support for NR PC5 ProSe communication), and is mainly to support group communication over PC5 reference point for commercial services, e.g. interactive services.

The following steps describe an outline of the proposed solution:

1) USER#1 initiates to discover other users who are interested in APP#1 and in proximity by using direct discovery. For example, USER#1 wants to play some interactive game with other users by using group communication over PC5 reference point.

2) USER#1 gets a response from some users who want to play the interactive game together.

3) A UE of USER#1 (i.e. A leading UE) provides a Group Communication Candidate List including USER#1 and the users sent a response, and checks with an Application Server associated with APP#1 regarding which users can participate in the group communication.

4) After checking, the Application Server provides a Group Communication Member List and various information for this group communication including Application Layer Group ID and Destination IP address to the leading UE.

5) The leading UE provides the Application Layer Group ID and Destination Layer-2 ID to other member UEs in the Group Communication Member List.

6) Other member UEs obtain various information for this group communication including Destination IP address from the Application Server by submitting the Application Layer Group ID.

7) Based on the information for this group communication provided by the Application Server, all member UEs can perform the group communication.

As such, dynamic group communication can be achieved in a network controlled manner.

The application/service performing group communication proposed in this solution is operated with a group locally formed, that is, whose group member UEs are in proximity each other. Therefore, any Application Server, e.g. interactive game server, does not have to be involved to run the application/service. The Application Server introduced in this solution exchanges application layer signalling with UEs to support group communication over PC5 reference point.

#### 6.4.1.2 Differences from groupcast mode of V2X communication over PC5 reference point

The proposed solution has the following main differences from groupcast mode of V2X communication over PC5 reference point defined in TS 23.287 [5]:

- Discovery of other UEs participating in group communication is performed by using PC5 discovery messages.

- Application Server is involved in group management.

- Application Layer Group ID is provided by the Application Server.

- Destination Layer-2 ID for groupcast is assigned by a UE. i.e. leading UE.

- Information/parameters needed for groupcast are provided from the leading UE by using PC5 discovery messages and from the Application Server by using application layer signalling.

### 6.4.2 Procedures

#### 6.4.2.0 General

PC5 discovery messages are used for the messages exchanged over PC5 reference point in the procedures described in the following clauses.

NOTE 1: The application layer signalling messages exchanged between UE and Application Server in the procedures described in this clause are for information and out of scope of this study.

NOTE 2: For the interaction with Application server, coordination with SA6 is needed.

#### 6.4.2.1 PC5 group communication establishment for commercial services

The procedure is initiated when a UE wants to perform group communication over PC5 reference point with other UE(s) for any application, e.g. interactive game.



Figure 6.4.2.1-1: PC5 group communication establishment for commercial services

1. UE-1 sends a Discovery Request message. The broadcasted Discovery Request message includes:

- Application ID: the application requesting group communication. This is provided by the application layer.

- Application Layer User ID: the initiating UE's Application Layer User ID (i.e. UE-1's Application Layer User ID). This is provided by the application layer.

2. The UEs that are interested in performing group communication for the requested application respond to the request by sending a Discovery Response message (i.e. UE-2, UE-3 and UE-5 in Figure 6.4.2.1-1).

The Discovery Response message includes:

- Application ID: the application whose group communication was requested.

- Application Layer User ID: Application Layer User ID of the UE sending the Discovery Response message (i.e. UE-2's Application Layer User ID in step 2a, UE-3's Application Layer User ID in step 2b and UE-5's Application Layer User ID in step 2c). This is provided by the application layer.

After sending the Discovery Request message in step 1, UE-1 collects the Discovery Response message sent from other UE(s) during a configured time interval.

More than one UEs send a Discovery Request message including same Application ID almost simultaneously, so there may be the case that one UE receives multiple Discovery Request messages including same Application ID. In this case, the receiving UE responds to one of Discovery Request messages based on UE implementation or user input.

If privacy support is needed, the Application Layer User IDs used in step 1 and step 2 may be ones that were encoded, e.g. by the Application Server. The UE can have its encoded Application Layer User ID before this procedure.

3. The application layer of UE-1 sends a Group Communication Check Request message to the Application Server associated with the application. The Group Communication Check Request message includes:

- Application ID: the application requesting group communication.

- Group Communication Candidate List: a list of Application Layer User IDs of the initiating UE and the UE(s) sent a response (i.e. UE-1's Application Layer User ID, UE-2's Application Layer User ID, UE-3's Application Layer User ID and UE-5's Application Layer User ID).

The Application Server checks whether the UEs in the Group Communication Candidate List can perform group communication. In addition, the Application Server can check whether UE-1, i.e. initiating UE can be a leading UE for this group communication.

NOTE 1: UE-1 can continue group communication establishment although Discovery Response message was received from only one UE in step 2.

4. The Application Server sends a Group Communication Check Response message to the application layer of UE-1. The Group Communication Check Response message includes:

- Application ID: the application whose group communication was requested.

- Application Layer Group ID: an identity uniquely identifying a group communication (i.e. a group of users) within the context of the application whose group communication was requested.

- Group Communication Member List: a list of Application Layer User IDs of UEs that are authorized to participate in this group communication.

In Figure 6.4.2.1-1, UE-5 is not in this list because this user/UE is not authorized to participate in this group communication. Therefore, the list includes UE-1's Application Layer User ID, UE-2's Application Layer User ID and UE-3's Application Layer User ID.

- Destination IP address: a destination IP address to be used for this group communication.

- (Optional) Application Requirements: service requirements for this group communication, e.g. priority requirement, reliability requirement, delay requirement, range requirement.

- (Optional) Security related information: security related parameters used for this group communication.

The Application Layer Group ID, Destination Layer-2 ID and Destination IP address are assigned by the Application Server.

5. UE-1 sends a Discovery Accept message to each member UE included in the Group Communication Member List received in step 4 (to UE-2 and UE-3 in Figure 6.4.2.1-1).

The Discovery Accept message includes:

- Application Layer Group ID: provided by the Application Server in step 4.

- Destination Layer-2 ID: a destination link-layer identity to be used for this group communication. This is assigned by UE-1.

- HARQ operation related information: this information includes a Group Size and a Member ID.

The Member ID is an identifier uniquely identifying a member in this group communication. For example, 1 is provided to UE-2 as Member ID and 2 is provided to UE-3 as Member ID. UE-1 uses 0 as Member ID.

In Figure 6.4.2.1-1, the group size is 3.

6a. UE-2 needs to obtain information for this group communication from the Application Server.

Therefore, the application layer of UE-2 provides the Application Layer Group ID received from UE-1 in step 5 and its Application Layer User ID to the Application Server in order to request information for this group communication.

The Application Server provides Destination IP address for this group communication to the application layer of UE-2. Optionally, Application Requirements and Security related information are provided to the application layer of UE-2.

6b. UE-3 obtains information for this group communication from the Application Server as described in step 6a.

7a. UE-2 sends a Discovery Complete message to UE-1.

7b. UE-3 sends a Discovery Complete message to UE-1.

Each member UE determines the PC5 QoS parameters for this groupcast. (Please refer to TS 23.287 [5].)

The ProSe layer of each member UE passes groupcast related information/parameters such as Layer-2 ID information (i.e. source Layer-2 ID and destination Layer-2 ID), QoS related information, HARQ operation related information to the AS layer.

8. UE-1 sends the service data using the source Layer-2 ID/IP address and the destination Layer-2 ID/IP address by using groupcast.

NOTE 2: UE-2 and UE-3 can also send the service data using the source Layer-2 ID/IP address and the destination Layer-2 ID/IP address and this is not illustrated in Figure 6.4.2.1-1 for simplicity.

#### 6.4.2.2 PC5 group communication termination for commercial services



Figure 6.4.2.2-1: PC5 group communication termination for commercial services

1. The group communication is over in the application layer. For example, interactive game that UE-1, UE-2 and UE-3 play together ends.

2. The application layer of UE-1 that is a leading UE sends a Group Communication Termination Request message to the Application Server associated with the application. The Group Communication Termination Request message includes:

- Application ID: the application that has performed group communication.

- Application Layer Group ID: an identity identifying a group communication whose termination is requested.

3. The Application Server sends a Group Communication Termination Response message to the application layer of UE-1.

The ProSe layer of each member UE informs the AS layer that this groupcast has been terminated.

#### 6.4.2.3 PC5 group communication update (group member leaving) for commercial services



Figure 6.4.2.3-1: PC5 group communication update (group member leaving) for commercial services

1. The group communication established as described in clause 6.4.2.1 is ongoing. For example, UE-1, UE-2, UE-3 and UE-4 are playing together interactive game.

2. UE-3 leaves the group communication and this group member leaving is handled in the application layer, e.g. by exchanging some application layer signalling messages between UEs.

If each UE's application layer is able to provide updated Group Size and the UE's new Member ID if updated to the UE's ProSe layer, step 3 is not executed. Otherwise, step 3 is executed.

3. UE-1 that is a leading UE provides updated HARQ operation related information including a Group Size and a Member ID to each member UE, i.e. UE-2 and UE-4. In Figure 6.4.2.3-1, the group size becomes 3.

NOTE: Step 3 assumes that the application layer of the leading UE provides the updated Group Size and the Member ID for each member UE to the leading UE's ProSe layer.

#### 6.4.2.4 PC5 group communication update (new member joining) for commercial services



Figure 6.4.2.4-1: PC5 group communication update (new member joining) for commercial services

1. Same to step 1 of clause 6.4.2.3.

2. UE-1 periodically sends broadcasted Discovery Request messages for the ongoing group communication. If UE-5 attempts to join the group communication, it will interacts with UE-1 and the Application Server according to the procedures defined in clause 6.4.2.1. When UE-5 successfully joins the group communication, the group information will be updated among the group members.

If each UE's application layer is able to provide updated Group Size and the UE's new Member ID if updated to the UE's ProSe layer, step 3 is not executed. Otherwise, step 3 is executed.

3. UE-1 that is a leading UE provides updated HARQ operation related information including a Group Size and a Member ID to each member UE, i.e. UE-2, UE-3, UE-4 and UE-5. In Figure 6.4.2.4-1, the group size becomes 5.

NOTE: Step 3 assumes that the application layer of the leading UE provides the updated Group Size and the Member ID for each member UE to the leading UE's ProSe layer.

### 6.4.3 Impacts on services, entities and interfaces

**UE:**

- Performs direct discovery regarding an interested application for group communication.

- For a leading UE (i.e. initiating UE), checks the group members with the Application Server by using application layer signalling and provides Application Layer Group ID assigned by the Application Server to other member UEs by using PC5 discovery message.

- Obtains information for the group communication from the Application Server by using application layer signalling.

**Application Server:**

- Checks the group members that can participate in the group communication.

- Provides Application Layer Group ID to the leading UE.

- Provides information for the group communication to the leading UE and other group member UE(s).

## 6.5 Solution #5: ProSe communication based on V2X communication over PC5

### 6.5.1 Description

This solution addresses Key Issue #2 on ProSe communication. The solution takes V2X communication over PC5 in TS 23.287 [5] as a baseline.

In order to support unicast, groupcast and broadcast communication, the mechanism defined in TS 23.287 [5] clause 5.2 is reused with the following differences:

- Besides IPv6, IPv4 based ProSe communication over NR based PC5 reference point are supported.

- IPv4 address allocation for ProSe communication over NR based PC5 reference point follows the mechanism is defined in TS 23.303 [9] clause 4.5.3.

- Both Ethernet and Unstructured data unit types are supported by the 5G ProSe-enabled UE.

### 6.5.2 Procedures

The "Procedures for V2X communication over PC5 reference point" defined in TS 23.287 [5] clause 6.3 is reused to support ProSe communication over NR based PC5 reference point, and the differences are highlighted as followings.

- For broadcast and groupcast mode ProSe communication, the procedures as defined in TS 23.287 [5] clauses 6.3.1 and 6.3.2 are applied with the following differences are identified:

- The following data unit types are supported: IP, non-IP, Ethernet, Unstructured and Address Resolution Protocol (see RFC 826 [10]).

NOTE: Whether "non-IP type" is used for "Unstructured type" can be decided in normative phase.

- The ProSe Group IP multicast address for groupcast communication may be provisioned by PCF and is used to send and receive IP data.

- For unicast mode ProSe communication, the procedure as defined in TS 23.287 [5] clause 6.3.3 is applied with the following differences are identified:

- DHCPv4 based IP address allocation is supported.

- Both Ethernet and Unstructured data unit types are supported.

### 6.5.3 Impacts on services, entities and interfaces

UE impact:

- UE is enhanced to support ProSe communication over NR based PC5 reference point.

## 6.6 Solution #6: Layer-3 UE-to-Network Relay

### 6.6.1 Description

This is a solution for key issue #3, UE-to-Network Relay.

The ProSe 5G UE-to-Network Relay entity provides the functionality to support connectivity to the network for Remote UEs (see figure 6.6.1-1). It can be used for both public safety services and commercial services (e.g. interactive service).

A UE is considered to be a Remote UE for a certain ProSe UE-to-Network relay if it has successfully established a PC5 link to this ProSe 5G UE-to-Network Relay. A Remote UE can be located within NG-RAN coverage or outside of NG-RAN coverage.



Figure 6.6.1-1: Architecture model using a ProSe 5G UE-to-Network Relay

The ProSe 5G UE-to-Network Relay shall relay unicast traffic (UL and DL) between the Remote UE and the network. The ProSe UE-to-Network Relay shall provide generic function that can relay any IP, Ethernet or Unstructured traffic;

- For IP traffic over PC5 reference point, the ProSe UE-to-Network Relay uses IP type PDU Session towards 5GC.

- For Ethernet traffic over PC5 reference point, the ProSe UE-to-Network Relay can use Ethernet type PDU Session or IP type PDU Session towards 5GC.

- For Unstructured traffic over PC5 reference point, the ProSe UE-to-Network Relay can use Unstructured type PDU Session or IP type PDU Session (i.e. IP encapsulation/de-capsulation by UE-to-Network Relay) towards 5GC.

The type of traffic supported over PC5 reference point is indicated by the ProSe UE-to-Network Relay e.g. using the corresponding Relay Service Code. The UE-to-Network Relay determines the PDU Session Type based on, e.g. ProSe policy/parameters, URSP rule, Relay Service Code, etc.

NOTE: How the UE-to-NW relay determines PDU session type should be evaluated independent from other part of this solution while considering other PDU session parameters, e.g. DNN, SSC mode.

IP type PDU Session and Ethernet type PDU Session can be used to support more than one Remote UEs while Unstructured type PDU Session can be used to support only one Remote UE.

Editor's note: Support of non-unicast mode communication (i.e. one-to-many communication/broadcast or multicast) between network and UE-to-Network Relay UE and between UE-to-Network Relay and Remote UE(s) depends on the result of FS\_5MBS work.

One-to-one Direct Communication is used between Remote UEs and ProSe 5G UE-to-Network Relays for unicast traffic as specified in solutions for Key Issue #2.

The protocol stack for Layer-3 UE-to-Network Relays is shown in Figure 6.6.1-2.



Figure 6.6.1-2: Protocol stack for ProSe 5G UE-to-Network Relay

Hop-by-hop security is supported in the PC5 link and Uu link. If there are requirements beyond hop-by-hop security for protection of Remote UE's traffic, security over PDU layer needs to be applied.

Further security details (integrity and privacy protection for remote UE-Nw communication) will be specified in SA WG3.

### 6.6.2 Procedures

A ProSe 5G UE-to-Network Relay capable UE may register to the network (if not already registered) and establish a PDU session enabling the necessary relay traffic, or it may need to connect to additional PDU session(s) or modify the existing PDU session in order to provide relay traffic towards Remote UE(s). PDU session(s) supporting UE-to-Network Relay shall only be used for Remote ProSe UE(s) relay traffic.



Figure 6.6.2-1: ProSe 5G UE-to-Network Relay

0. During the Registration procedure, Authorization and provisioning is performed for the ProSe UE-to-NW relay(0a) and Remote UE(0b). Authorization and provisioning procedure may be any solution for key issue #1 and #3.

1. The ProSe 5G UE-to-Network Relay may establish a PDU session for relaying with default PDU session parameters received in step 0 or pre-configured in the UE-to-NW relay, e.g. S-NSSAI, DNN, SSC mode or PDU Session Type. In case of IP PDU Session Type and IPv6, the ProSe UE-to-Network Relay obtains the IPv6 prefix via prefix delegation function from the network as defined in TS 23.501 [6].

2. Based on the Authorization and provisioning in step 0, the Remote UE performs discovery of a ProSe 5G UE-to-Network Relay using any solution for key issue #1 and #3. As part of the discovery procedure the Remote UE learns about the connectivity service the ProSe UE-to-Network Relay provides.

3. The Remote UE selects a ProSe 5G UE-to-Network Relay and establishes a connection for One-to-one ProSe Direct Communication as described in TS 23.287 [5].

If there is no PDU session satisfying the requirements of the PC5 connection with the remote UE, e.g. S-NSSAI, DNN, QoS, the ProSe 5G UE-to-Network Relay initiates a new PDU session establishment or modification procedure for relaying.

According to the PDU Session Type for relaying, the ProSe 5G UE-to-Network Relay performs relaying function at the corresponding layer, e.g. acts as an IP router when the traffic type is IP, acts as an Ethernet switch when the traffic type is Ethernet, and performs generic forwarding for Unstructured traffic.

When the ProSe 5G UE-to-Network Relay uses Unstructured PDU session type for Unstructured traffic over PC5 reference point, it creates a mapping between the PC5 Link Identifier and the PDU Session ID, and a mapping between PFI for PC5 L2 link and the QFI for the PDU Session.

When the ProSe 5G UE-to-Network Relay uses IP PDU session type for Ethernet or Unstructured traffic over PC5 reference point, it locally assigns an IP address/prefix for the Remote UE and use that to encapsulate the data from the Remote UE. For downlink traffic, the ProSe 5G UE-to-Network Relay decapsulates the traffic from the IP headers and forwards to the corresponding Remote UE via PC5 reference point.

Editor's note: How the ProSe UE-to-NW relay determine the requirement of PC5 Connection, e.g. S-NSSAI, DNN, QoS will be specified in other solutions for KI#3.

Editor's note: How to support end-to-end QoS requirement of Remote UE, including QoS enforcement for PC5 and PDU session for relaying is addressed in other solutions.

4. For IP PDU Session Type and IP traffic over PC5 reference point, IPv6 prefix or IPv4 address is allocated for the remote UE as it is defined in TS 23.303 [9] clauses 5.4.4.2 and 5.4.4.3.From this point the uplink and downlink relaying can start. For downlink traffic forwarding, the PC5 QoS Rule is used to map the downlink IP packet to the PC5 QoS Flow. For uplink traffic forwarding, the 5G QoS Rule is used to map the uplink IP packet to the Uu QoS Flow.

Editor's note: General functionality for IPv6 prefix delegation as defined in TS 23.401 clause 5.3.1.2.6 needs to be added in 5GS and reference to TS 23.501 [6] can be added above.

5. The ProSe 5G UE-to-Network Relay sends a Remote UE Report (Remote User ID, Remote UE info) message to the SMF for the PDU session associated with the relay. The Remote User ID is an identity of the Remote UE user (provided via User Info) that was successfully connected in step 3. The Remote UE info is used to assist identifying the Remote UE in the 5GC. For IP PDU Session Type, the Remote UE info is Remote UE IP info. For Ethernet PDU Session Type, the Remote UE info is Remote UE MAC address which is detected by the UE-to-Network Relay. For Unstructured PDU Session Type, the Remote UE info contains the PDU session ID. The SMF stores the Remote User IDs and the related Remote UE info (if available) in the ProSe 5G UE-to-Network Relay's SM context for this PDU session associated with the relay.

For IP info the following principles apply:

- for IPv4, the UE-to-network Relay shall report TCP/UDP port ranges assigned to individual Remote UE(s) (along with the Remote User ID);

- for IPv6, the UE-to-network Relay shall report IPv6 prefix(es) assigned to individual Remote UE(s) (along with the Remote User ID).

Editor's note: The privacy protection for Remote User ID depends on SA3 design.

The Remote UE Report message shall be sent when the Remote UE disconnects from the ProSe 5G UE-to-Network Relay (e.g. upon explicit layer-2 link release or based on the absence of keep alive messages over PC5) to inform the SMF that the Remote UE(s) have left.

In the case of Registration Update procedure involving SMF change the Remote User IDs and related Remote UE info corresponding to the connected Remote UEs are transferred to the new SMF as part of SM context transfer for the ProSe 5G UE-to-Network Relay.

NOTE 1: In order for the SMF to have the Remote UE(s) information, the HPLMN and the VPLMN where the ProSe 5G UE-to-Network Relay is authorised to operate, needs to support the transfer of the Remote UE related parameters in case the SMF is in the HPLMN.

NOTE 2: When Remote UE(s) disconnect from the ProSe UE-to-Network Relay, it is up to implementation how relaying PDU sessions are cleared/disconnected by the ProSe 5G UE-to-Network Relay.

After being connected to the ProSe 5G UE-to-Network Relay, the Remote UE keeps performing the measurement of the signal strength of PC5 unicast link with the ProSe 5G UE-to-Network Relay for relay reselection.

The solution can also work when the ProSe 5G UE-to-Network Relay UE connects in EPS using LTE. In this case for the Remote UE report the procedures defined in TS 23.303 [9] can be used.

Editor's note: How to perform the rate limitation for remote UE is FFS.

### 6.6.3 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

**SMF:**

- Needs to support procedures for Remote UE report.

**UE:**

- Needs to support procedures for Remote UE and ProSe 5G UE-to-Network Relay.

## 6.7 Solution #7: Indirect Communication via Layer 2 UE-to-Network Relay UE

### 6.7.1 Introduction

The solution addresses the following aspect highlighted in key issue #3 (Support UE-to-Network Relay UE):

- How to transfer data between the Remote UE and the network over the UE-to-Network Relay UE.

The solution proposes a protocol architecture to support a Layer 2 UE-to-Network Relay UE (see Annex A).

This solution works only for NR/5GC network relays. It does not apply when the UE-to-Network Relay UE is out of coverage of NR/5GC.

### 6.7.2 Functional Description

#### 6.7.2.1 General

In this clause, the protocol architecture supporting a L2 UE-to-Network Relay UE is provided.

The L2 UE-to-Network Relay UE provides forwarding functionality that can relay any type of traffic over the PC5 link.

The L2 UE-to-Network Relay UE provides the functionality to support connectivity to the 5GS for Remote UEs. A UE is considered to be a Remote UE if it has successfully established a PC5 link to the L2 UE-to-Network Relay UE. A Remote UE can be located within NG-RAN coverage or outside of NG-RAN coverage.

#### 6.7.2.2 Control and User Plane Protocols

The control and user plane protocols stacks are based on the architectural reference model described in Annex A.

#### 6.7.2.3 Network Selection

Network selection comprises PLMN selection and access network selection. Access network selection for a Remote UE comprises UE-to-Network relay discovery and selection. The Remote UE performs PLMN selection in accordance with the PLMN selected by the UE-to-Network Relay.

The Remote UE and UE-to-Network Relay UE are by definition served by the same NG-RAN.

#### 6.7.2.4 Authorization and provisioning

In order to enable a (Remote) UE out of coverage to gain connectivity to the network, it is important to allow such UE by means of (pre)configuration to discover potential UE-to-Network Relay UEs through which it could gain access to the 5GS. To do so:

Parameters for UE-to-Network Relay UE discovery and for communication over NR PC5 may be made available to the Remote UE as follows:

- Pre-configured in the ME and/or configured in the UICC;

- Provided or updated by the PCF to the UE in the serving PLMN.

It is also important that a UE be authorized to operate as a UE-to-Network Relay UE. A UE may only operate as a UE-to-Network Relay UE when served by the network.

Parameters for a UE to operate as a UE-to-Network Relay UE, for discovery of Remote UEs over NR PC5 and for communication over NR PC5 may be made available to the UE as follows:

- Pre-configured in the ME and/or configured in the UICC;

- Provided or updated by the PCF to the UE in the serving PLMN.

It should be possible for the HPLMN PCF to provide authorization for a UE to operate as a Remote UE or as a UE-to-Network Relay UE on a per PLMN basis. It should also be possible for the Serving PLMN to provide/revoke such authorization in which case it shall override any corresponding information provided by the HPLMN.

Editor's note: Whether preconfigured credentials for ProSe discovery and for initial ProSe communication on PC5 out-of-coverage are needed is FFS.

PCF based service authorization and provisioning solution for Layer-2 UE-to-Network Relay could reuse Solution #16, with the difference that PDU session parameters used for UE-to-Network Relay discovery do not need to be provided to Remote UE and UE-to-Network Relay UE.

#### 6.7.2.5 Registration and Connection Management

##### 6.7.2.5.1 Registration Management

Registration Management for the UE-to-Network Relay UE follows the principles and procedures defined in TS 23.501 [6] and TS 23.502 [8]. The UE-to-Network Relay is served by a first AMF.

Registration Management for the Remote UE follows the principles and procedures defined in TS 23.501 [6] and TS 23.502 [8]. The Remote UE is served by a second AMF that may or may not be the same as the first AMF.

NOTE: The UE is authorized to act as a UE-to-Network Relay only if the Network (including RAN/CN) does not restrict it, e.g., authorization, Unified Access Control/NAS Congestion Control, and Remote UE and UE-to-Network Relay are in the same rPLMN or ePLMN .

##### 6.7.2.5.2 Connection Management

Connection Management for the UE-to-Network Relay UE follows at least the principles and procedures defined in TS 23.501 [6] and TS 23.502 [8].

Connection Management for the Remote UE follows the principles and procedures defined in TS 23.501 [6] and TS 23.502 [8].

The UE-to-Network Relay may only relay data/signaling for the Remote UE(s) when the UE-to-Network Relay is in CM-CONNECTED/RRC Connected states.

Table 6.7.2.5.2-1: CM State correspondence between Relay and Remote UEs

|  |  |  |  |
| --- | --- | --- | --- |
| Relay  Remote | CM\_IDLE | CM\_CONNECTED  RRC Inactive | CM\_CONNECTED (RRC Connected) |
| CM\_IDLE | N/A | N/A | ✓ |
| CM\_CONNECTED | N/A | N/A | ✓ |

Editor's note: Impact of the Remote UE CM states onto the UE-to-Network Relay UE CM states is FFS. E.g. the UE-to-Network Relay UE is expected to remain CM-CONNECTED when the Remote UE is CM-CONNECTED.

NOTE: The applied state needs to be coordinated and confirmed by RAN2.

For paging Remote UE, the concluded solution in clause 6.6.2 of TR 23.733 can be reused based on the assumption that option 2 of TR 36.746 is adopted by RAN2.

#### 6.7.2.6 QoS

As shown in Annex A, the NAS endpoints between a Remote UE and the network are as currently specified such that the operation via a UE-to-Network Relay UE should be transparent to the network NAS, with the exception of authorization/provisioning identified in clause 6.7.2.4.

This means that the 5GS flow-based QoS concept in particular should be reused between the Remote UE and the network, with necessary adaptation over the radio interface i.e. PC5 (for the Remote UE and UE-to-Network Relay UE) and Uu (for the UE-to-Network Relay UE). In other words, QoS flows established between the network and the Remote UE will be mapped to PC5 "radio bearers" seen by the Remote UE and to normal Uu radio bearers seen by the network, whereby the UE-to-Network Relay UE performs the necessary adaptation between Uu and PC5.

Editor's Note: The support of end-to-end QoS for the Remote UE is FFS, especially on how the QoS can be enforced on the PC5 link.

#### 6.7.2.7 Mobility

##### 6.7.2.7.1 Mobility Restrictions

The Remote UE is expected to operate within the boundaries of the Mobility Restrictions applicable to the UE to Network Relay UE.

The UE could act as a UE-to-Network Relay only if the relay could stay in CM-CONNECTED mode, see sub-clause 6.7.2.5.2.

NOTE: The applied state needs to be coordinated and confirmed by RAN2.

Editor's Note: It is FFS how the Remote UE performs network selection and access control via the UE-to-Network Relay based on the mobility restrictions listed below.

RAT Restriction:

- If Remote UE is restricted to use some RAT in a PLMN, the Remote UE is not allowed to access via UE-to-Network Relay using that RAT in that PLMN. If UE-to-Network Relay is restricted to use some RAT in a PLMN, the UE-to-Network Relay is not allowed to perform the Relay operation using that RAT in that PLMN.

Forbidden Area:

- If UE-to-Network Relay is in Forbidden Area, it is not allowed to perform the Relay operation. If the UE-to-Network Relay operates in a Forbidden Area of the Remote UE, the Remote UE is not allowed to access the network via this UE-to-Network Relay.

- A UE-to-Network Relay shall indicate to Remote UEs the Tracking Area of the cell to which the UE-to-Network Relay is connected. The indication is provided during discovery.

Service Area Restriction: Allowed Area, Non-Allowed Area

- Allowed Area applies as is for a UE-to-Network Relay and Remote UE. A UE-to-Network Relay (resp. Remote UE) is allowed to initiate communication with the network (resp. with the network via a UE-to-Network Relay) as allowed by subscription.

- A UE-to-Network Relay may only perform UE-to-Network Relay operation in an Allowed Area.

- Non-allowed Area applies as is for a UE-to-Network Relay and Remote UE. The UE (UE-to-Network Relay or Remote UE) and the network are not allowed to initiate Service Request or SM signalling to obtain user services (both in CM-IDLE and in CM-CONNECTED states). RM procedures for non-3GPP access aspects are not applicable for the Remote UE.

Core Network type restriction:

- The CN type restriction applies as is to a UE-to-Network Relay and Remote UE. A UE-to-Network Relay or Remote UE may only operate as such when not restricted to use 5GC.

Closed Access Group information:

- A UE permitted (resp. not permitted) to access a CAG cell is implicitly permitted (resp. not permitted) to access this CAG cell as a Remote UE via a UE-to-Network Relay. The Allowed CAG list and CAG-only indication of a UE apply to this UE when it is a Remote UE.

- A UE permitted (resp. not permitted) to access a CAG cell is implicitly permitted (resp. not permitted) to access this CAG cell as a UE-to-Network Relay. The Allowed CAG list and CAG-only indication of a UE apply to this UE when it operates as a UE-to-Network Relay.

- A UE-to-Network Relay shall indicate to Remote UEs the CAG identifiers of the CAG the UE-to-Network Relay is permitted to access via the cell to which it is connected. The indication is provided during discovery.

##### 6.7.2.7.2 Other

Mobility of a Remote UE within an NG-RAN node will be handled by the NG-RAN and the UE-to-Network Relay, allowing the Remote UE to maintain service when changing from a direct network connection to an indirect network connection (i.e. via L2 UE-to-Network Relay UE) and vice-versa without 5GC involvement.



Figure 6.7.2.6-1. Intra-NG-RAN mobility (no 5GC involvement)

Inter-NG-RAN mobility is depicted below. Mobility is expected to be possible with no impact on NAS and most impact on lower layers i.e. RAN WG2.



Figure 6.7.2.6-2: Inter-NG-RAN mobility

#### 6.7.2.8 Security

Security (confidentiality and integrity protection) is enforced at the PDCP layer between the endpoints at the Remote UE and the gNB. The PDCP traffic is relayed securely over two links, one between the Remote UE and the UE-to-Network Relay UE and the other between the UE-to-Network Relay UE to the gNB without exposing any of the Remote UE's plaintext data to the UE-to-Network Relay.

UP integrity protection is separated for direct PC5 communication and indirect communication. For indirect communication, the NG-RAN and Remote UE are the nodes that enforce the UP integrity protection for data transmission between NG-RAN and Remote UE.

Editor's Note: It is FFS whether the lack of UP integrity protection on the Relay node will cause failure of protection at Remote UE and NG-RAN, e.g. due to false traffic injection.

For direct PC5 communication, the UE-to-Network Relay UE and Remote UE are the nodes that enforce the UP integrity protection for data transmission between UE-to-Network Relay UE and Remote UE.

NOTE: Further analysis of security requirements will be done in SA WG3.

6.7.2.9 UE-to-Network Relay Discovery and Selection

Model A and Model B can be applied for Layer-2 UE-to-Network Relay discovery. The detailed UE-to-Network Relay discovery and selection solution for Layer-2 UE-to-Network Relay could reuse Solution #19, with the difference that slicing and DNN information do not need to be considered. In addition, CAG cell and TA need to be included in discovery message.

Editor's Note: It FFS how the Relay discovery can be performed with the PLMN selection for the Remote UE.

6.7.2.10 Path Selection

For initial access, Remote UE may perform communication path selection between direct Uu path and indirect Uu path based on the link quality and the configured threshold (pre-configured or provided by NG-RAN). For example, if Uu link quality exceeds configured threshold, the direct Uu path is selected. Otherwise, the indirect Uu path is selected by performing the UE-to-Network Relay discovery and selection.

For path switch case, NG-RAN may perform communication path selection based on the signal level/quality of different paths, which may be based on the path switch solution.

Editor's note: The final solution should be coordinated with RAN WG, and the specific radio criteria and corresponding thresholds are subject to RAN WG definition.

### 6.7.3 Procedures



Figure 6.7.3-1: Connection Establishment for Indirect Communication via UE-to-Network Relay UE

0. If in coverage, the Remote UE and UE-to-Network Relay UE may independently perform the initial registration to the network according to registration procedures in TS 23.502 [8]. The allocated 5G GUTI of the Remote UE is maintained when later NAS signalling between Remote UE and Network is exchanged via the UE-to-Network Relay UE.

NOTE 1: The current procedures shown here assume a single hop relay.

1. If in coverage, the Remote UE and UE-to-Network Relay UE independently get the service authorization for indirect communication from the network.

If the Remote UE is not in coverage, the pre-configured information will be used. If needed, the PCF could update the authorization information after step 7.

Editor's note: Details of security credentials to set up a security context for subsequent PC5 communication between the Remote UE and the UE-to-Network Relay UE are FFS.

Editor's note: It is FFS how to perform initial registration when the device has not been in coverage.

2-3. The Remote UE and UE-to-Network Relay UE perform UE-to-Network Relay UE discovery and selection.

Editor's note: The detailed solution depends on the output of discovery procedure for both cases where the Remote UE is out of coverage or in coverage.

Editor's note: Which entities perform UE-to-Network Relay selection and what criterion are used for UE-to-Network Relay selection are FFS.

4. Remote UE initiates a one-to-one communication connection with the selected UE-to-Network Relay UE over PC5, by sending an indirect communication request message to the UE-to-Network Relay.

5. UE-to-Network Relay UE has to be in CM\_CONNECTED state and is authorised to perform Relay service, and step 5 is omitted. To keep CM\_CONNECTED state, the UE-to-Network Relay UE may indicate its serving AMF that it is taking the role of relay for handling the relay services of remote UE, and may indicate the NG-RAN to keep the RRC connection.

Editor's note: How to indicate the NG-RAN is FFS.

Editor's note: It is FFS whether the relay indication can be provided to the AMF in other way (e.g. in N2 message) instead of in NAS message.

Editor's note: Whether AMF needs to further interact with PCF is FFS.

Editor's note: Potential interaction between the Relay UE's AMF and Remote UE's AMF is FFS.

6. The UE-to-Network Relay UE sends the indirect communication response message to the Remote UE.

7. Remote UE sends a NAS message to the serving AMF. The NAS message is encapsulated in an RRC message that is sent over PC5 to the UE-to-Network Relay UE, and the UE-to-Network Relay UE forwards the message to the NG-RAN. The NG-RAN derives Remote UE's serving AMF and forwards the NAS message to this AMF.

NOTE: It is assumed that the Remote UE's PLMN is accessible by the UE-to-Network Relay's PLMN and that UE-to-Network Relay UE AMF supports all S-NSSAIs the Remote UE may want to connect to.

Editor's note: Interaction between the Relay UE's AMF and Remote UE's AMF is FFS.

If Remote UE has not performed the initial registration to the network in step 0, the NAS message is initial registration message. Otherwise, the NAS message is service request message.

Editor's note: How the UE-to-Network Relay UE forwards the message to the NG-RAN depends on RAN specified L2 relay method.

If the Remote UE performs initial registration via the UE-to-Network relay, the Remote UE's serving AMF may perform authentication of the Remote UE based on NAS message validation and if needed the Remote UE's AMF checks the subscription data.

For service request case, User Plane connection for PDU Sessions can also be activated. The other steps follow the clause 4.2.3.2 in TS 23.502 [8].

8. Remote UE may trigger the PDU Session Establishment procedure as defined in clause 4.3.2.2 of TS 23.502 [8].

9. The data is transmitted between Remote UE and UPF via UE-to-Network Relay UE and NG-RAN. The UE-to-Network Relay UE forwards all the data messages between the Remote UE and NG-RAN using RAN specified L2 relay method.

NOTE: If the UE-to-Network Relay disconnects, the NG-RAN will trigger the AN release procedure of the Remote UE and the Remote UE goes to CM-IDLE.

### 6.7.4 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

**RAN:**

- Needs to support L2 relay functionality for forwarding the signalling and user data of the Remote UE.

**UE-to-Network Relay UE:**

- Needs to support L2 relay functionality for forwarding the signalling and user data between the Remote UE and RAN.

## 6.8 Solution #8: UE-to-UE Relay Selection Without Relay Discovery

### 6.8.1 Description

This proposal aims to ensure the relay discovery between the source and the target UE shall not be dependent on how the relay forward traffic between the source and the target UE, e.g. L2 or L3 relaying. This solution relies on the concept that the UE-to-UE discovery and selection can be integrated into the unicast link establishment procedure as described in clause 6.3.3 of TS 23.287 [5].

A new field is proposed to be added in the direct communication request to indicate whether relays can be used in the communication. The field can be called relay\_indication. When a UE wants to broadcast a direct communication request, it indicates in the message whether a UE-to-UE relay could be used. For Release 17, it is assumed that the value of the indication is restricted to single hop.

When a UE-to-UE relay receives a direct communication request with the relay\_indication set, then it shall decide whether to forward the request (i.e. broadcast this request in its proximity), according to e.g. the QoS requirements in the request, the current traffic load of the relay, the radio conditions between the source UE and the relay UE , or some other policies (e.g. it only serves some specific UEs or services).

It may be the situation where multiple UE-to-UE relays can be used to reach the target UE or the target UE may also directly receive the direct communication request from the source UE. The target UE may choose which one to reply according to e.g. signal strength, local policy (e.g. traffic load of the UE-to-UE relays) or operator policies (e.g. always prefer direct communication or only use some specific UE-to-UE relays).

The source UE may receive the direct communication accept message from multiple UE-to-UE relays and also from the target UE directly, the source UE chooses the communication path according to e.g. signal strength, local policy (e.g. traffic load of the UE-to-UE relays) or operator policies (e.g. always prefer direct communication or only use some specific UE-to-UE relays).

### 6.8.2 Procedures



Figure 6.8.2-1 5G ProSe UE-to-UE relay selection

Figure 6.8.2-1 illustrates the procedure of the proposed method.

0. UEs are authorized to use the service provided by the UE-to-UE relays. UE-to-UE relays are authorized to provide service of relaying traffic among UEs. The authorization and the parameter provisioning can use solutions for KI#8.

1. UE-1 wants to establish unicast communication with UE-2 and the communication can be either through direct link with UE-2 or via a UE-to-UE relay. Then UE-1 broadcasts directly communication request with relay\_indication =1. The request will be received by relay-1, relay-2. The request may also be received by UE-2 if it is in the proximity of UE-1.

2. Relay-1 and relay-2 decide to forward the request. They broadcast the message in their proximity with relay\_indication=0. If a relay receives this message, it will just drop it.

3. UE-2 receives the requests from relay-1 and relay-2.

4. UE-2 chooses relay-1 and replies with request accept. If UE-2 directly receives the direct communication request from UE-1, it may choose to setup a direct communication link by sending the request accept directly to UE-1. The response message includes indication on the type of communication link being established (e.g. via relay or direct).

5. UE-1 receives the request accept from relay-1. UE-1 chooses path according to e.g. policies (e.g. always choose direct path if it is possible), signal strength, etc. If UE-1 receives request accept directly from UE-2, it may choose to setup a direct L2 link as described in clause 6.3.3 of TS 23.287 [5], then step 6 is skipped.

6. UE-1 and UE-2 setup communication link through chosen UE-to-UE relay. The link setup information may vary depending on the type of relay, e.g. L2 or L3 relaying.

NOTE 1: In order to make a relay or path selection, the source UE can setup a timer after sending out the direct communication request for collecting the corresponding request accept messages before making a decision. Similarly, the target UE can also setup a timer after receiving the first copy of the direct communication request for collecting multiple copies of the request from different paths before making a decision.

NOTE 2: In the first time when a UE receives a message from a UE-to-UE relay, the UE needs to verify if the relay is authorized be a UE-to-UE relay. The verification details and the how to secure the communication between two UEs through a UE-to-UE relay is to be defined by SA WG3.

### 6.8.3 Impacts on services, entities and interfaces

UE impacts to support new Relay related functions.

## 6.9 Solution #9: Connection establishment via UE-to-UE Layer-2 Relay

### 6.9.1 Description

#### 6.9.1.1 General

Using the solution described in this clause, a UE-to-UE Relay enables the discovery of a source UE by a target UE. A UE-to-UE Relay is authorized to relay messages between two UEs over the PC5 interface via authorization and provisioning, as defined in clause 6.Y Solution for Key Issue #4: UE-to-UE Relay Authorization and Provisioning.

The source UE announces its supported applications or discovers a target UE using a known discovery mechanism, e.g. using user-oriented or service-oriented methods as defined in TS 23.287 [5].

The UE-to-UE Relay listens for ProSe applications advertisements (e.g. Direct Discovery or Direct Communication Request messages) from surrounding UEs and if a broadcasted application matches one of the applications from its provisioned relay policy/parameters, the UE-to-UE Relay advertises it as a relayed application by adding a relay indication to the message.

A target UE discovers a source UE via a UE-to-UE Relay. The target UE receives a broadcast Direct Communication Request message with a relay indication.

A secured "extended" PC5 link is set up between the source UE and the target UE via the UE-to-UE Relay. The source/target UEs do not know their respective peer UE's L2 IDs. Source/Target UEs send messages to the UE-to-UE Relay and receive messages through the UE-to-UE Relay. However, the security association and the PC5 unicast link are established directly between the source UE and target UE. The UE-to-UE Relay forwards the messages in opaque mode, without the ability to read, modify their content or replay them. The source/target UEs detect that the link establishment is going through a UE-to-UE Relay upon detecting a relay indication included in the received messages.

The UE-to-UE Relay assigns itself two Relay-L2 IDs when a unicast link is established between two peer UEs via the UE-to-UE Relay. The first Relay-L2 ID is used when forwarding a message to the target UE. The second Relay-L2 ID is used when forwarding a message to the source UE. The UE-to-UE Relay maintains a mapping table containing the mapping of peer UEs L2 IDs and the corresponding Relay-L2 IDs that have been self-assigned. When receiving a message, the UE-to-UE Relay uses its mappings table to find the source and destination IDs to be used to forward the message to the target UE. The UE-to-UE Relay uses the Relay-L2 ID specified in the destination field to find the related UE and uses the UE's L2 ID specified in the source field to find the related Relay-L2 ID. It then updates the source and destination fields of the received message with its corresponding UE's L2 ID and Relay-L2 ID before forwarding the message.

NOTE: Additional security-related parameters and procedures may be needed for the protection of relay related messages. Their definitions need to be coordinated with SA WG3.

Link management (i.e. keepalive, link modification, link identifier update and link release) is supported over direct unicast links and needs to be supported over extended PC5 links as well. Since the security association of extended PC5 links is between the peer UEs, all messages sent over the extended PC5 link, including link management (i.e. PC5-S) messages, may only be processed by those two UEs.

Having the PC5 link management messages processed by the peer UE is not a problem for most of the management functionality. For the keepalive functionality, both UEs may send/receive keepalive messages and validate that the extended link is still alive. For the link modification, that is used to add or remove QoS flows or services or modify QoS flows, it needs to be applied to the extended link and handled by the two peer UEs. For the link release, the peer UEs may exchange the release messages and then inform the UE-to-UE Relay (i.e. using the management link as defined in subclause 6.9.2.2) to allow it to clean-up its mapping table.

As for the link identifier update procedure, the peer UEs cannot update their Layer-2 IDs transparently to the UE-to-UE Relay. The reason is that the UEs do not know their peer’s Layer-2 ID since they are addressing their outgoing messages to the UE-to-UE Relay Layer-2 ID. The UE-to-UE Relay uses the Layer-2 IDs of the peer UEs for relaying purposes, thus the UE-to-UE Relay must be informed of the updated Layer-2 ID from both peer UEs. Additionally, the UE-to-UE Relay must change its Layer-2 IDs, associated to the extended link, whenever the peer UEs change their Layer-2 IDs since the UE-to-UE Relay L2 IDs used for this unicast link are visible in the header thus may be used to link the UEs old Layer-2 IDs with their new Layer-2 IDs. In summary, when the initiating UE changes its identifiers (e.g. Layer-2 ID and security info), the UE-to-UE Relay needs to update its Layer-2 ID used on the unicast link with the initiating UE and since the security info (established between the two peers UEs) is also updated, the identifiers used over the unicast link between the UE-to-UE Relay and the target UE also need to be updated.

To update identifiers used for unicast communication via a UE-to-UE Relay, i.e. for an extended unicast link, a “management” unicast link is established between each UE and the UE-to-UE Relay. This management link is secured (i.e. integrity and confidentiality protected) between the UE and the UE-to-UE Relay. It is used to manage extended links associated to the same UE-to-UE Relay as the management link. If multiple UE-to-UE Relays are used to reach peer UEs then multiple managements links may be created by a UE, e.g. one toward each UE-to-UE Relay.

Existing Link Identifier Update messages sent to the UE-to-UE Relay are modified to include additional information needed by the UE-to-UE Relay to identify the extended unicast link to which these messages apply. The additional information includes: 1) “extended link” indication, 2) UE’s current Layer-2 ID used on extended link, 3) UE’s new Layer-2 ID for extended link, 4) UE-to-UE Relay’s Layer-2 ID used on extended link.

A management link may be released once the link identifier update procedure is completed, or it may be kept. If it is kept then it is treated like any other PC5 unicast link, i.e. its Layer-2 IDs need to be updated periodically, keepalive may be exchanged, etc.

#### 6.9.1.2 Control and User Plane Protocol Stacks

Figure 6.9.1.2-1 illustrates control plane protocol stacks using a UE-to-UE Layer-2 Relay. UE-to-UE Layer-2 Relay uses self-generated own Layer-2 IDs inserted as source Layer-2 ID in the already formed L2 frames relayed between UE1 and UE2. L2 frames are forwarded based on mapped UE1 Layer-2 ID, UE2 Layer-2 ID. The signalling messages are transparently transferred between UE1 and UE2 over UE-to-UE Layer-2 Relay without any modification other than the source and destination Layer-2 IDs. The security is established end to end between UE1 and UE2 as shown by the PDCP layer terminating in UE1 and UE2.

 

*Figure 6.9.1.2-1: Control Plane protocol stacks for PC5 using a UE-to-UE Layer-2 Relay*

Figure 6.9.1.2-2 illustrates user plane protocol stacks using a UE-to-UE Layer-2 Relay. As for the control plane, the security is established end to end between UE1 and UE2. Therefore, user data is never exposed at the relay node since the relay function does not process/apply any security on relayed IP packets.



*Figure 6.9.1.2-2: User Plane protocol stacks using a UE-to-UE Layer-2 Relay*

The SDAP and PDCP protocols above are as specified in TS 38.300 [11].

Editor's note: The proposed protocol stacks are to be confirmed with RAN2 group.

### 6.9.2 Procedures

#### 6.9.2.1 Connection establishment

The two methods defined in TS 23.287 [5], i.e. service-oriented and user-oriented are supported using the procedure described in this clause.

Figure 6.9.2-1 shows the peer discovery and unicast link establishment over PC5 reference point via a UE-to-UE Relay.



Figure 6.9.2.2-1: Connection establishment procedure via a UE-to-UE Relay

0. UE-to-UE Relay registers with the network and specifies its UE-to-UE Relay capabilities. UE-to-UE Relay is provisioned from the network with relay policy parameters and with a unique Relay identifier (RID).

1. The target UEs (i.e. UE2, UE3 and UE4) determine the destination Layer-2 ID for signalling reception for PC5 unicast link establishment as specified in TS 23.287 [5] clause 5.6.1.4. The destination Layer-2 ID is configured with the target UEs as specified in TS 23.287 [5] clause 5.1.2.1.

On the source UE (i.e. UE1), the application layer provides information to the ProSe layer for PC5 unicast communication (e.g. broadcast Layer-2 ID, ProSe Application ID, UE's Application Layer ID, target UE's Application Layer ID, relay applicable indication), as specified in TS 23.287 [5] clause 6.3.3.1.

3. ProSe layer triggers the peer UE discovery mechanism by sending a broadcast Direct Communication Request message. The message is sent using the source Layer-2 ID and broadcast Layer-2 ID as destination, and includes other parameters related to the application offered, as specified in TS 23.287 [5] clause 6.3.3.1. Optionally, ProSe Application Code obtained from 5G DDNMF via the solution for KI#1 is also included in the message.

The UE-to-UE Relay receives the broadcast Direct Communication Request message and verifies if it's configured to relay this application, i.e. it compares the announce ProSe Application ID with its provisioned relay policy/parameters and, if it matches, the UE-to-UE Relay assigns itself a Relay-Layer-2 ID (e.g. R-L2 ID-a) for UE1 (i.e. related to UE1's L2 ID).

These 2 IDs (UE1's Layer-2 ID and Relay-Layer-2 ID-a) are saved in a local mapping table. The UE-to-UE Relay overrides the source field of the message with its R-L2 ID-a and adds its unique relay identifier (RID) as a relay indication. This relay indication is added by the UE-to-UE Relay only on broadcast messages since these messages are sent in clear text (i.e. without any encryption or integrity protection) thus may be modified. The UE-to-UE Relay proceeds in forwarding the broadcast Direct Communication Request message received from the source UE.

4. Target UE3 is interested in the announced application or it can match the ProSe Application Code contained in the request message thus, it triggers the authentication and security establishment with UE1, via the UE-to-UE Relay. UE3 keeps track of the Relay's identifiers, i.e. R-L2 ID-a and RID. UE3 sends the RID in a security protected message during the authentication and security establishment to inform UE1 that the communication is traversing the UE-to-UE Relay identified by RID.

UE-to-UE Relay receives the message from UE3 and uses the R-L2 ID-a specified in the destination field to find the related UE (i.e. UE1 in this case) in its mapping table.

UE-to-UE Relay assigns itself a new Layer-2 ID (e.g. R-L2 ID-b) for UE3 and stores the mapping between UE3's L2 ID and R-L2 ID-b.

UE-to-UE Relay sets the source field of the message to R-L2 ID-b and sets the destination field to UE1's Layer-2 ID (i.e. L2 ID1) retrieved from the mapping entry. UE-to-UE Relay sends the message to UE1.

UE1 receives the authentication message and keeps track of R-L2 ID-b and RID. R-L2 ID-b is used as the destination on subsequent messages destined to UE3 and sent via the UE-to-UE Relay.

Authentication and security establishment messages are exchanged between UE1 and UE3 via the UE-to-UE Relay. UE-to-UE Relay changes the source/destination Layer-2 IDs based on the information saved in its local mapping table.

Editor's note: The Details of the authentication and security procedure will be investigated by SA WG3 group.

5. Once the security is established, UE3 completes the unicast link establishment by sending a Direct Communication Accept message.

6. UE-to-UE Relay receives the message and sets the source field of the message to the R-L2 ID-b as found in the mapping entry and sets the destination field to the UE1's L2 ID also from the mapping entry. UE-to-UE Relay sends the modified message to UE1.

7. An "extended" unicast link is established between UE1 and UE3, via the UE-to-UE Relay. The extended link is secured end to end, i.e. a security association has been created between UE1 and UE3. Confidentiality and/or integrity/replay protected messages (i.e. data or PC5-S) may be exchanged between UE1 and UE3. The UE-to-UE Relay is not involved in the security association thus it cannot read nor modify the secured portion of the message (which excludes the source and destination fields).

In addition, the UE-to-UE Layer-2 Relay operation is also supported with the following principles:

- UE-to-UE Relay selection

It may be the situation where multiple UE-to-UE relays can be used to achieve the indirect communication between the target UE and source UE. The selection of the UE-to-UE Relay may be based on local configured rules on the UE, or based on other UE-to-UE Relay selection solutions, e.g. "UE-to-UE Relay Selection Without Relay Discovery " described in clause 6.8.

- QoS handling

During the process of the connection establishment between the Source UE1 and the Target UE3, the Source UE1 negotiates the PC5 QoS parameters with the UE-to-UE Relay UE and Target UE3 for fulfilling E2E QoS requirements. After that, PC5 QoS parameters for PC5 link between the Source UE and UE-to-UE Relay UE and PC5 link between the UE-to-UE Relay UE and Target UE are determined. AS layer configurations for PC5 QoS parameters in each PC5 link can be achieved according to legacy mechanisms in R16 V2X.

QoS flow concept in particular can be reused between the Source UE and the Target UE, where the UE-to-UE Relay UE performs the necessary adaptation between two PC5 interfaces, i.e., PC5 for the Source UE and UE-to-UE Relay UE and PC5 for the UE-to-UE Relay UE and Target UE.

Editor's note: The details of the adaptation between two PC5 interfaces are confirmed by RAN2 group.

- Charging support

The charging for Source UE and Target UE can be based on charging usage information configuration and UE reporting usage information. Solution for charging usage information configuration can reuse the PCF based solution,i.e., Solution #14. Solution for UE reporting usage information can reuse SMF based or AMF based solution, i.e., Solution #13 or Solution #15.

#### 6.9.2.2 Connection Management

##### 6.9.2.2 Link Identifier Update via a Management Link with the UE-to-UE Relay

Figure 6.9.2.2-1 shows the link identifier update procedure when an extended PC5 link is used. The procedure uses a management link established between UE1 and the UE-to-UE Relay serving this extended link and another management link established between UE2 and the same UE-to-UE Relay.



Figure 6.9.2.2-1: Link Identifier Update procedure via a Management Link with a UE-to-UE Relay

1. An “extended” unicast link is established between two peer UEs via a UE-to-UE Relay, i.e. as described in subclause 6.9.2.1 with end-to-end security enabled.
2. UE1 receives a trigger (e.g. privacy timer expiry or Application Layer ID change) to update its identifiers (i.e. Layer-2 ID, security information, Application Layer ID or IP address/prefix) associated to the extended link with UE2. UE1 establishes a secured unicast link with the UE-to-UE Relay for link management purposes, if such a link is not already established.
3. UE1 updates its identifiers (i.e. Layer-2 ID, security information and optionally Application Layer ID and IP address/prefix) and sends a Link Identifier Update Request message to the UE-to-UE Relay via the management link. The message includes UE1’s new Layer-2 ID and an indication (e.g. “extended link” indication) which specifies that the message is related to an extended link, i.e. it does not apply to the management link per se. The message also includes the UE-to-UE Relay’s Layer-2 ID and UE1’s Layer-2 ID used to identify the extended link.
   1. Other identifiers (i.e. security info, Application Layer ID and IP address/prefix) are not included since they are not used by the UE-to-UE Relay and should not be exposed to the UE-to-UE Relay.
4. UE-to-UE Relay saves UE1’s new Layer-2 ID in its mapping table, while preserving the current one, and updates its own Layer-2 ID to replace the current UE-to-UE Relay L2 ID used on the extended link and known by UE2. It replies with Link Identifier Update Response message including its new UE-to-UE Relay Layer-2 ID and the “extended link” indication.
5. UE1 sends a Link Identifier Update Request message to UE2 including the new UE-to-UE Relay L2 ID received at step 3, UE1’s updated security information and optionally new Application Layer ID and IP address/prefix.
   1. The Link Identifier Update Request message is used as usual, except for the new L2 ID parameter that carries the new UE-to-UE Relay L2 ID to be used by UE2.
6. UE2 keeps track of the received parameters and establishes a secured unicast link with the UE-to-UE Relay for extended unicast link management, if no such management link already exists.
7. As for UE1 in step 2, UE2 updates its identifiers associated to the extended link with UE1 and sends a Link Identifier Update Request message to UE-to-UE Relay via the management link. The Link Identifier Update Request message includes the “extended link” indication, the current UE-to-UE Relay’s Layer-2 ID and UE2’s Layer-2 ID (to identify the extended link) as well as UE2’s new Layer-2 ID associated to the extended link.
8. UE-to-UE Relay saves UE2’s new Layer-2 ID in its mapping table, while preserving the current one, and updates its own Layer-2 ID to replace the current UE-to-UE Relay L2 ID used on the extended link and known by UE1. It replies with Link Identifier Update Response message including its new UE-to-UE Relay Layer-2 ID and the “extended link” indication.
9. UE2 sends a Link Identifier Update Response message to UE1 including the new UE-to-UE Relay L2 ID received at step 7, UE2’s updated security information and optionally new Application Layer ID and IP address/prefix. UE2 also includes the parameters received on the Link Identifier Update Request message at step 4.
10. UE1 keeps track of the received updated parameters from UE2 and sends a Link Identifier Update Ack message to UE2, including the parameters received on the Link Identifier Update Response message at step 8.
11. UE1 sends a Link Identifier Update Ack message to the UE-to-UE Relay, including the new UE-to-UE Relay Layer-2 ID received at step 3 and the “extended link” indication.
12. UE2 sends a Link Identifier Update Ack message to the UE-to-UE Relay, including the new UE-to-UE Relay Layer-2 ID received at step 7 and the “extended link” indication. All UEs (i.e. UE1, UE2 and UE-to-UE Relay) start using the new Layer-2 IDs, new security information and optionally new Application Layer ID and new IP address/prefix.

### 6.9.3 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

**UE:**

- Needs to support procedures for ProSe 5G UE-to-UE Relay and communications via a ProSe 5G UE-to-UE Relay.

- Needs to support procedures for extended communication management, via communication with a ProSe 5G UE-to-UE Relay.

## 6.10 Solution #10: ProSe 5G Layer-3 UE-to-UE Relay based on IP routing

### 6.10.1 Description

In this solution, the ProSe 5G UE-to-UE Relay operations is supported with the following principles:

- Authorization and configuration:

- Only the UE authorized by the service authorization configuration can act as a ProSe 5G UE-to-UE Relay. These UEs will be configured according to the service authorization and provisioning mechanism defined in TS 23.287 [5] to operate in the UE-to-UE Relay mode.

- ProSe 5G UE-to-UE Relay discovery:

- The ProSe 5G UE-to-UE Relay sends out a Relay Discovery message periodically, announcing its availability for serving other UEs in the area.

- The ProSe 5G UE-to-UE Relay also supports the query and response mode for discovery. The ProSe 5G UE-to-UE Relay listens on a configured Layer-2 ID for the query, and would respond with its address and corresponding information to enable to other UE to establish a unicast connection with it. This process is similar to the unicast L2 link establishment procedure as defined in TS 23.287 [5] clause 6.3.3.1.

NOTE 1: The Layer-2 ID used for the discovery can be specific for UE-to-UE Relay discovery, or shared with other discoveries, e.g. UE-to-Network Relay discovery.

- ProSe 5G UE-to-UE Relay operation:

- Any UE that wants to make use of the ProSe 5G UE-to-UE Relay needs to establish a unicast L2 link with the UE-to-UE Relay, with IP configuration. The ProSe 5G UE-to-UE Relay allocates IP address/prefix to the other UEs.

- As part of the unicast L2 link establishment procedure, the ProSe 5G UE-to-UE Relay stores an association of the User Info of the peer UE of the unicast link (or ProSe Service provided by the peer UE) and the IP address/prefix allocated to the UE into its DNS entries. The ProSe 5G UE-to-UE Relay acts as a DNS server to other UEs.

- When a (source) UE needs to communicate with another (target) UE or needs to discover a ProSe service via the ProSe 5G UE-to-UE Relay, it sends a DNS query for the target UE (based on Target User Info) or for the ProSe Service to the ProSe 5G UE-to-UE Relay over the unicast link, which will return the IP address/prefix of the target UE or the IP address(es)/prefix(es) of UEs which provide the ProSe Service.

If there are multiple UEs supporting the same ProSe Service, the (source) UE can select a UE(s) based on UE implementation.

- The source UE sends the IP data or non-IP data encapsulated in IP to the target UE or to the selected UE(s) which provide(s) the ProSe Service via the unicast L2 link to UE-to-UE Relay that returned the IP address/prefix of the target UE or UE(s) which provide(s) the ProSe Service. The ProSe 5G UE-to-UE Relay acts as an IP router, and forwards the packets to the corresponding unicast L2 link towards the target UE or UE(s) which provide(s) the ProSe Service. Each of the unicast L2 link is treated as an IP interface.

- If there are multiple ProSe 5G UE-to-UE Relays in the proximity, UE can choose either one or more ProSe 5G UE-to-UE Relays to establish the unicast L2 link based on UE implementation. For example, the UE sends a DNS query on each of the unicast L2 link to the ProSe 5G UE-to-UE Relays. Then, the source UE may choose to use the first ProSe 5G UE-to-UE Relay that returns a positive DNS query for the target UE.

NOTE 2: The selection of the UE-to-UE Relay may be based on local configured rules on the UE, or based on other discovery solutions, e.g. "Stateful UE-to-UE Relay" described in clause 6.11.

- QoS handling:

- When the source UE establishes the unicast L2 link with the ProSe 5G UE-to-UE Relay, it can establish corresponding PC5 QoS Flows according to procedure defined in clause 6.3.3.1 of TS 23.287 [5]. It can also modify the PC5 QoS Flows at any time using procedure defined in clause 6.3.3.4 of TS 23.287 [5].

- Correspondingly, the ProSe 5G UE-to-UE Relay can also establish and modify the PC5 QoS Flows using the above-mentioned procedures over the unicast L2 Link with the target UE based on PC5 Packet Filter received from the source UE during the PC5 QoS flow establishment/modification procedure or destination IP address of IP packet received from the source UE for the forwarding of source UE's traffic. The ProSe 5G UE-to-UE Relay determines the PC5 QoS parameters of PC5 QoS Flows with target UE based on corresponding PC5 QoS Flows with target UE.

- Security handling:

- source UE and target UE can establish bearer level security with the UE-to-UE Relay for the unicast L2 Link, using procedures defined in TS 23.287 [5].

- If end-to-end security protection is required between source UE and target UE, IPSec can be used.

NOTE 3: The security protection of the traffic of source UE and target UE will be specified by SA WG3.

- Charging Support:

- ProSe 5G UE-to-UE Relay can follow the charging solution defined in TS 32.277 [13] to report the source and target UEs and corresponding traffic to the charging function.

### 6.10.2 Procedures



Figure 6.10.2-1 5G ProSe UE-to-UE Relay operation

Figure 6.10.2-1 provides an example operation for the 5G ProSe UE-to-UE Relay operation based on standard IP operation.

### 6.10.3 Impacts on services, entities and interfaces

There is no impact to NG-RAN, as the solution is using the existing features supported in Rel-16 NR V2X design.

UEs operate with existing IP operation, and the ProSe 5G UE-to-UE Relay supports the IP router function (for IP address allocation and traffic forwarding) and the functionality of a DNS server.

## 6.11 Solution #11: Stateful UE-to-UE Layer-2 or Layer-3 Relay for Public Safety

### 6.11.1 Introduction

The solution applies to Key Issue #4 "Support for UE-to-UE Relay".

The procedure for discovery of UE-to-UE Relay in this solution is based on TR 23.713 [14] clause 6.1.2.4.

The communication via the stateful UE-to-UE Relay can be performed at either Layer-3 (6.11.3.2.2) or at Layer-2 (refer to clause 6.11.3.2.3).

### 6.11.2 Functional Description

In reference to Figure 6.11.2-1, the UE-to-UE Relay (UE-R) is a logical functionality that assists a UE (e.g. UE-1) to discover its group members (e.g. UE-2) which may not be reachable directly over NR PC5, but each of which is reachable via the UE-to-UE Relay. Once the UE discovers other group member UEs that are reachable via the UE-to-UE Relay, it can engage in communication with them, the UE-to-UE Relay acting as a Layer-3 relay.



Figure 6.11.2-1: Stateful UE-to-UE Relay

The UE-to-UE Relay performs the following functionality:

- Group Member Discovery using Model A or Model B discovery as defined in TS 23.303 [9].

- UE-to-UE Relay Discovery using the procedures defined in clause 6.11.3.1.

- Acting as Layer-3 relay for communication between UEs using the procedures defined in clause 6.11.3.2.

### 6.11.3 Procedures

#### 6.11.3.1 UE-to-UE Relay discovery

##### 6.11.3.1.1 Model A

Depicted in figure 6.11.3.1.1-1 is the procedure for UE-to-UE Relay discovery Model A.



Figure 6.11.3.1.1-1: UE-to-UE Relay discovery with Model A

1. UE-1 ("this UE") performs the Group Member Discovery procedure (either Model A or Model B) as defined in TS 23.303 [9]. In the process UE-1 discovers UE-R as its only neighbour.

2. UE-R ("the potential relay") also performs the Group Member Discovery procedure (either Model A or Model B). In the process UE-R discovers two UEs in vicinity: UE-1 and UE-2.

NOTE 1: The execution of the Group Member Discovery procedure in steps 1 and 2 is a pre-requisite for the execution of the UE-to-UE Relay discovery procedure proper that only starts at step 3. Each of the UEs periodically performs the Group Member Discovery procedure in order to keep an up-to-date list of the neighbouring UEs that are directly reachable via NR PC5.

3. UE-R decides that it can act as a UE-to-UE Relay and announces this by periodically transmitting an Announcement message including the following parameters:

- Type = Announcement.

- Discovery Type = UE-to-UE Relay Discovery.

- Announcer Info (i.e. an upper layer identifier for the UE-R user).

- ProSe UE ID of UE-R (i.e. Layer-2 identifier of UE-R).

- A list of "Target User Info" parameters (including users of UE-1 and UE-2) that have been gathered during Group Member Discovery in step 2. "Target User Info" is an upper layer parameter identifying the target user. To support Layer-2 communication via the stateful UE-to-UE Relay, the “Target User Info” also includes the Layer-2 identifier of the target user’s UE.

4. Based on the information received in the previous step, UE-1 decides to establish a one-to-one communication link with UE-R and engage in communication with UE-2 via UE-R, as described in clause 6.11.3.2.

##### 6.11.3.1.2 Model B

Depicted in figure 6.11.3.1.2-1 is the procedure for UE-UE Relay discovery Model B.



Figure 6.11.3.1.2-1: UE-to-UE Relay discovery with Model B

1-2. These steps are identical to steps 1-2 in Figure 6.11.3.1.1-1.

NOTE: The execution of the Group Member Discovery procedure in steps 1 and 2 is a pre-requisite for the execution of the UE-to-UE Relay discovery procedure proper that only starts at step 3. Each of the UEs periodically performs the Group Member Discovery procedure in order to keep an up-to-date list of the neighbouring UEs that are directly reachable via NR PC5.

3. Having discovered its neighbours, UE-1 realises that the group member of interest ("target user") is not within direct range over NR PC5. UE-1 then (in the role of Discoverer) solicits potential UE-to-UE Relays by transmitting the Solicitation message including the following parameters:

- Type = Solicitation.

- Discovery Type = UE-to-UE Relay Discovery.

- Discoverer Info (i.e. an upper layer identifier for the UE-1 user).

- ProSe UE ID of UE-1 (i.e. layer-2 identifier of UE-1).

- A list of "Target User Info" parameters corresponding to the target user(s) of interest (in this case it is the user of UE-2). "Target User Info" is an upper layer parameter identifying the "target user" of interest.

4. Upon reception of the Solicitation message, UE-R (in the role of Discoveree) realises that it can act as a UE-to-UE Relay and replies with a Response message including the following parameters:

- Type = Response.

- Discovery Type = UE-to-UE Relay Discovery.

- Discoveree Info (i.e. an upper layer identifier for the UE-R user).

- ProSe UE ID of UE-R (i.e. layer-2 identifier of UE-R).

- A list of "Target User Info" parameters corresponding to the target user(s) of interest (in this case it is the user of UE-2). The latter have been gathered during Group Member Discovery in step 2. To support Layer-2 communication via the stateful UE-to-UE Relay, the “Target User Info” also includes the Layer-2 identifier of the target user’s UE.

5. Based on the information received in the previous step, UE-1 decides to establish a one-to-one communication link with UE-R and engage in communication with UE-2 via UE-R, as described in clause 6.11.3.2.

#### 6.11.3.2 Communication via the stateful UE-to-UE Relay

##### 6.11.3.2.1 General

The communication via the stateful UE-to-UE Relay can be performed at either Layer-2 or Layer-3.

##### 6.11.3.2.2 Communication via stateful Layer-3 UE-to-UE Relay

When the communication via the stateful UE-to-UE Relay is performed at layer-3, the simplified Layer-2 format for ProSe 5G communication is decpited in Figure 6.11.3.2.2-1.



Figure 6.11.3.2.2-1: Layer-2 frame format for ProSe 5G communication via Layer-3 UE-to-UE Relay

When UE1 sends a packet to UE2 via the Relay, in reference to Figure 6.11.3.2.2-1 the fields in the Layer-2 header are ste as follows:

- Source Layer-2 ID: Identifies the sender of the data (UE-1).

- Destination Layer-2 ID: Identifies the Relay (UE-R).

The final destination (i.e. UE-2) is identified via the Destination IP address in the IP packet header.

NOTE: The Layer-2 frame in Figure 6.11.3.2.2-1 is a high-level illustration of the required addressing functionality in Layer-2 header. The exact Layer-2 frame format is in the scope of RAN WGs.

The procedures for communication via the stateful UE-to-UE Layer-3 Relay are performed at layer-3 as described in clause 6.10, the stateful UE-to-UE Relay acting as an IP router.

##### 6.11.3.2.3 Communication via stateful Layer-2 UE-to-UE Relay

When the communication via the stateful UE-to-UE Relay is performed at layer-2, the Layer-2 frame header is used as illustrated in Figure 6.11.3.2.2-1. In addition to the Source Layer-2 ID and Destination Layer-2 ID fields, the header has in addition a “Relay Layer-2 ID” field and a “Direction” field:

- “Relay Layer-2 ID”: identifies the UE-to-UE Relay.

- “Direction” indicates whether the Layer-2 frame is being transmitted “To the Relay” or “From the Relay”.



Figure 6.11.3.2.3-1: Extended Layer-2 frame format for ProSe 5G communication via Layer-2 UE-to-UE Relay

When UE-1 wishes to send data to UE-2 via UE-R, the addressing identifiers in the Layer-2 frame are set as follows:

- Source Layer-2 ID: identifies UE-1.

- Destination Layer-2 ID: identifies UE-2.

- Relay Layer-2 ID: identifies the Relay (UE-R).

- Direction = “To Relay”.

When UE-R forwards the Layer-2 frame to UE-2, the addressing identifiers in the Layer-2 frame are set as follows:

- Source Layer-2 ID: identifies UE-1.

- Destination Layer-2 ID: identifies UE-2.

- Relay Layer-2 ID: identifies UE-R.

- Direction = “From Relay”.

NOTE1: The Layer-2 frame in Figure 6.11.3.2.3-1 is a high-level illustration of the required addressing functionality in Layer-2 header. The exact Layer-2 frame format is in the scope of RAN WGs.

NOTE2: The "Direction" field is used by the final receiver (UE-2) to eliminate duplicate frames in case UE-2 enters in direct transmission range of UE-1.

### 6.11.4 Impacts on services, entities and interfaces

**UE:**

- New functionality related to UE-to-UE Relay discovery, as well as communication via UE-to-UE Relay.

## 6.12 Solution #12: Policy based network-assisted Path Selection

### 6.12.1 Description

This solution addresses Key Issue #5 for the case without Relay. In this solution, the UE, assisted by network provided policy rules, selects a path for direct communication (either 5GC path via Uu or ProSe path via PC5).

In case that policy rules provided by the network indicate that a specific path can be used (Uu path only or PC5 path only) then the UE shall select only the path described in the policy rules for the corresponding traffic descriptor (i.e., location type of Service etc.). In case the UE can select between the PC5 path and the Uu path then the UE can use different type of information that could be locally available or requested by the network side.

The path selection policy rules are determined by PCF based on AF request (e.g. based on topology formation or changes observed [criteria outside of the scope of SA2]) or any other relevant network data analytics as defined in TS 23.288 [24] e.g., user data congestion analytics in clause 6.8 in TS 23.288 [24], QoS sustainability in clause 6.9 in TS 23.288 [24] and/or using existing (R)AN notifications as defined in TS 23.501 [6] (e.g. on expected QoS targets fulfilments).

For this solution, it is required that the UE has registered with the HPLMN and acquired the policies from the PCF.

Specifically, the network can provide policy rules that could be used by the UE to determine the direct communication path. The policy rules can indicate:

- Path preference: indicates the preferred path (i.e. PC5 path or Uu path) for the matching traffic

- only the PC5 path shall be used;

- only the Uu path shall be used (this does not apply to unlicensed spectrum);

- PC5 path preferred, where the UE can choose between the PC5 path or Uu path;

- Uu path preferred, where the UE can choose between the PC5 path or Uu path;

- no preference.

For path selection policy rules, UE may follow the same priority order as specified in clause 5.1.1, TS 23.287 [5] for V2X communications.

The policy rules that the network provides could associate the communication path with:

- Traffic descriptor that can consist of one or several of the following:

- Application descriptors; or

- the type of service; and/or

NOTE: The type of service can reuse the encoding proposed in TS 24.526, for the UE policy part contents (i.e., Traffic descriptor component), including a URSP rule. The list of type services can start with categories and types of services/scenarios agreed in SA1 (TS 22.186).

- the QoS class (e.g. 5QI, PQI) and/or QoS mapping rules; and/or

- each PC5 QoS mapping rule may have service identifiers and application requirements. PC5 QoS parameters can be re-used as specified in TS 23.287 [5] clause 5.4.2.

- the transmission mode (cast type).

- (over Uu) List of one or more NSSAI(s) or DNN(s).

- a policy validity timer, indicating the expiration time of the policy/parameter;

- Location information: the UE location where the policy rules are applicable.

- Radio parameters (if applicable) as specified in TS 23.287 [5] clause 5.1.2.1;

- a signal threshold, which defines a minimum that is required to select PC5 interface. If PC5 interface has better signal than threshold, UE can select PC5;

Different locations may have different rules (e.g. due to different network capabilities at specific regions).

The generated policy rules can be modified by the network (e.g. based on AF request).

### 6.12.2 Procedures

#### 6.12.2.1 Procedure for Direct Communication Path Selection



Figure 6.12.2.1-1: high-level procedure for direct communication path selection

1. Triggered by a ProSe AF request, the UE policy PCF composes ProSe policy for the UE. The SM PCF may set the QoS Notification Control parameter in the PCC rule as defined in TS 23.501 [6] clause 5.7.2.4. This information is about how to detect expected QoS targets fulfilment status over the Uu path (e.g. via leveraging QoS Notification Control from NG-RAN as defined in TS 23.501 [6] clause 5.7.2.4). The PCF provides the path selection Policy/parameters for Proximity Services to the UE by using the procedure as defined in clause 4.2.4.3 in TS 23.502 [8].

NOTE 1: The QoS Flow(s) related to QNC needs to be added to the PDU Session for the UE before step 1.

2a. The ProSe AF may subscribe to QNC from the SM PCF to receive notification on QoS fulfilment Status. If the NG RAN detects all QoS requirements cannot be fulfilled for one or more QoS Flows when requested by SMF for such notification, it may generate a notification towards the SM PCF. The ProSe AF will also be notified based on the subscription to the SM PCF.

2b. The ProSe AF can forward QNC Status update to the UE Policy PCF. The UE Policy PCF may utilise the notification information in updating the UE policy rules (incl. path selection policy/ parameters) composed in Step 1 for all related UEs.

Editor's note: New Interaction between AF and UE policy PCF is FFS.

Editor's note: In addition to new interaction between AF and UE policy PCF, whether there is other mechanism to communicate the QNC status to the UE policy PCF is FFS.

2c. The Prose AF may subscribe to NWDAF to receive analytics notification (e.g. relevant to QoS sustainability for all UEs in an area of Interest). In that case, the ProSe AF can forward such analytics notification to the UE Policy PCF. The UE Policy PCF may utilise the notification information in updating the UE policy rules (incl. path selection policy/ parameters) composed in Step 1 for all related UEs.

If SM PCF and UE Policy PCF are the same, Steps 2a and 2b can be altered and UE policy PCF may directly receive QNC notifications.

In Step 2c, for certain analytics types that are supported, the PCF may directly subscribe to the NWDAF to receive analytics relevant to UE Policy (incl. path selection policy/ parameters).

3. The PCF can define and update path policy rules using as a triggering event one or more of the options presented in step 2 that could be also complementary used.

4. The PCF provides the path selection Policy/parameters for Proximity Services to the UE by using the procedure as defined in clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy Delivery" in TS 23.502 [8]. The UE policy delivery procedure could be initiated by the PCF (as described in clause 6.2.2 in TS 23.287 [5]), by the UE (as described in clause 6.2.4 in TS 23.287 [5]), or by the AF (as described in clause 6.2.5 in TS 23.287 [5]).

NOTE 2: RAN QoS Notification Procedure towards PCF for Uu is as defined in TS 23.501 [6].

Editor's note: How and if RAN may detect expected QoS targets fulfilment status per path is subject to RAN WGs.

5. The UE checks the received policy rules and selects the appropriate communication path (PC5 or Uu).

The PCF decides if an update of a path selection policy rule is necessary based on the triggering event of step 3. If the PCF decides to update the path selection policy rules then this can involve any part of a policy rule (e.g. Path preference, traffic descriptor, location information). PCF functionality for path selection policy rules update should assure that the UE policy rules are not updated too frequently to avoid triggering many reselection processes at the UE side, leading to increase of signalling etc.

### 6.12.3 Impacts on services, entities and interfaces

Editor's note: This clause captures impacts on services and interfaces.

## 6.13 Solution #13: Charging reporting for PC5 Direct Communication

### 6.13.1 Description

In this solution, the PCF is responsible for generating a charging policy for PC5 direct communication by interacting with the AF and the enforcement of the policy decisions related to charging and applying the charging policy to the UE. The SMF is responsible to interact with the CHF for PC5 direct communication.

The PCF may generate the charging policy for PC5 by interacting with the AF as well as following the operator's policy. In addition to the basic charging data defined by TS 32.277 [13], the AF may provide charging related application level information.

### 6.13.2 Procedures



Figure 6.13.2-1: Procedure for Charging for PC5 Direct Communication

1. The ProSe service authorization has been successfully executed as per described in TS 23.303 [9]. The HPLMN pre-configures the UE with the authorization information for a list of PLMNs where a charging for PC5 Direct Communcation is possible. If a VPLMN is not listed as a PLMN where a charing for PC5 Direct Communication is possible and the service is not a Public Safety service, it is up to the HPLMN to decide whether to authorize the UE to perform ProSe Direct Discovery or ProSe Direct Communication or both and in addition information regarding out-of-coverage operation at that VPLMN may be provided or not.

NOTE: It is assumed that the SMFs and PCFs, which are associated with the ProSe service, a DNN and/or an S-NSSAI in a PLMN, homogeneously support the Charging for PC5 Direct Communication if that PLMN is considered as Charging for PC5 Direct Communication capable by the HPLMN.

2. The AF sends the PCF subscribed PC5 charging policy-related application level information, as defined in Solution #14 for Key Issue 7

3. The PCF delivers its PC5 charging related policies, which includes usage reporting rule to UE, as defined in Solution #14 for Key Issue 7.

4. Direct communication takes place over PC5.

5. The UE creates the usage information report when the reporting criteria is met. In the PC5 data usage reporting, information such as the roles (i.e. remote UE or Relay UE) of the UEs, and the Remote UE ID in the case of UE-Network Relay could be included.

Editor's Note: It is FFS whether there is a privacy concern to store permanent UE IDs (such as a Remote UE ID) of other UEs during PC5 usage reporting in a UE.

6. If there is an existing PDU session, the UE sends the SMF a NAS message with PC5 usage information report using the PDU session that is associated with the ProSe service based on the operator’s policy. If there is no existing PDU session, the UE initiates a PDU session establishment procedure using a DNN and./or S-NSSAI pre-configured in the UE for the the ProSe service, and then sends the SMF a NAS message with PC5 usage information report.

7. The SMF notifies the CHF to create a CDR. The CHF is selected as defined in clause 5.1.8 of TS 32.255 [15]. As the SMF obtains a Uu usage infomration report from an associated UPF, the SMF can report both Uu and PC5 related usage reports to the CHF according to the PCC rules. The SMF may send Uu related usage report and PC5 related usage report to the CHF independently or may conbine both usage reports and sends them to the CHF togeter.

8. The CHF creates a CDR. CDR is updated/terminated based on charging data request from SMF.

9. The CHF sends charging data response to the SMF.

### 6.13.3 Impacts on services, entities and interfaces

**PCF:**

- Retrieves charging policy for PC5 related information from the AF and configure the UE with the Charging Rule for PC5 Direct Communication.

**SMF:**

- Receives PC5 related usage reports from the UE and forwards it to the CHF.

**CHF:**

- Receives PC5 related usage reports from the SMF and generates a PC5 related CDR.

**UE:**

- Performs and reports usage related to PC5 direct communication to the SMF based on usage reporting rule enforced by the PCF.

**Configuration in the HPLMN:**

- The HPLMN configures the UE with the authorization information for a list of PLMNs where a charging for PC5 Direct Communication is possible.

## 6.14 Solution #14: Charging Usage Information Configuration

### 6.14.1 Description

The PCF provides usage reporting rule to the UE for controlling how usage reporting is performed. The PCF also provides reporting trigger events to the UE for when to report usage information over PC5. The reporting trigger events (e.g. triggers, threshold information etc.) is determined by the PCF. In addition to the charging information defined in TS 32.277 [13], the AF may provide additional charging information based on the assistance information from the external AF.

The provisioning procedure can reuse the existing provisioning procedure defined in clause 6.2.2 and clause 6.2.5 of TS 23.287 [5].

NOTE: The detailed usage reporting rule content is decided by SA WG5.

### 6.14.2 Procedures



Figure 6.14.2-1: Charging usage information provisioning

1. The PCF may obtain charging assistance information (e.g. service information, group information, UE to be charged information) from the AF.

2. The PCF generates the charging usage reporting rule sends the charging usage rule to the UE using the existing procedure as defined in clause 6.2.2 of TS 23.287 [5].

3. UE stores the charging usage rule and if PC5 communication happens, and the usage report is triggered as defined in charging usage rule configured in step 2.

UE sends charging usage report to the network as defined in other solutions in this TR.

### 6.14.3 Impacts on services, entities and interfaces

Impact on PCF:

* Generate charging rule for PC5 communication, additionally based on assistance information from AF.
* Provision the charging rule to the UE using existing provisioning procedure.

Impact on UE:

* Store the charging rule and report the usage information as the charging rule.

## 6.15 Solution #15: PC5 Direct Communication Reporting for Charging

### 6.15.1 Description

In this solution, the UE reports the usage information of PC5 to the AMF if the reporting criteria is met when the UE gets access to the network, and the AMF reports the usage information of PC5 to CHF using the existing interface.

NOTE: The reporting criteria in the UE is implementation specific.

### 6.15.2 Procedures



Figure 6.15.2-1: Reporting charging information for PC5 direct communication

In Figure 6.15.2-1, two UEs are shown as an example.

1. UE 1 and UE 2 has communicated directly over PC5.

UE1 and UE2 are required to generate usage data reporting and provide the information to the core network when the UE becomes connected to the 5GS via Uu interface. In the PC5 data usage reporting, information such as the roles (i.e. remote UE or Relay UE) of the UEs, and the Remote UE ID in the case of UE-Network Relay could be included.

Editor's Note: It is FFS whether there is a privacy concern to store permanent UE IDs (such as a Remote UE ID) of other UEs during PC5 usage reporting in a UE.

2. [Optional] If UE1 is not registered yet when it has coverage again, UE1 performs registration as specified in clause 4.2.2.2.2 of TS 23.501 [6].

3. If reporting criteria is met, UE 1 reports the usage information of PC5 Direct Communication to the AMF. The existing UL NAS TRANSPORT message is reused by extending the definition of Payload container type.

4. The AMF then forwards the usage reporting to the CHF for the purposes of charging usage. The AMF discovers CHF as specified in clause 5.1.3 of TS 32.256 [16], and same service operations as specified in TS 32.291 [17] will be reused.

5. For UE2, same handling in steps 2 to 4 applies for reporting of its usage.

### 6.15.3 Impacts on services, entities and interfaces

**UE:**

- Reports usage related to PC5 direct communication to the AMF.

**AMF:**

- Receiving the usage reporting for PC5 direct communication from the UE over NAS.

- Reporting the usage reporting for PC5 direct communication from the UE to the CHF using existing interface.

**CHF:**

- Handling charging for PC5 direct communication.

NOTE: Impact on CHF and type of data collection is to be detailed by SA WG5. LTE/EPC ProSe usage data reporting is assumed to be used as baseline information.

## 6.16 Solution #16: Service Authorization and Provisioning for UE-to-Network Relay

### 6.16.1 General

The procedures for service authorization and provisioning is based on the V2X Procedures for Service Authorization and Provisioning as specified in clause 6.2 of TS 23.287 [5].

Editor's note: This solution is used for Layer-3 UE-to-Network Relay. Whether this solution can also be used for Layer-2 UE-to-Network Relay is FFS.

### 6.16.2 PCF based Service Authorization and Provisioning to the UE-to-Network Relay

For PCF based Service Authorization and Provisioning to the UE-to-Network Relay, the Registration procedures as defined in clause 4.2.2.2 of TS 23.502 [8], UE Policy Association Establishment procedure as defined in clause 4.16.11 of TS 23.502 [8] and UE Policy Association Modification procedure as defined in clause 4.16.12 of TS 23.502 [8] apply with the following additions:

For UE-to-Network Relay:

- The UE indicates UE-to-Network Relay capability in the Registration Request message.

- The PCF determines the UE-to-Network Relay parameters for the UE-to-Network Relay and provides them to the UE-to-Network Relay as described in solution #17.

For Remote UE:

- The UE indicates UE-to-Network Relay Access capability in the Registration Request message.

- The PCF determines the parameters for the Remote UE to use a UE-to-Network Relay and provides them to the Remote UE as described in solution #17.

### 6.16.3 Authorization and Provisioning Parameters for UE-to-Network Relay

The following UE-to-Network Relay parameters are provided to the UE-to-Network Relay:

1) Authorisation policy for acting as a UE-to-Network Relay:

- PLMNs in which the UE is authorized to relay traffic for Remote UEs.

2) UE-to-Network Relay Discovery policy/parameters:

- UE-to-Network Relay Service Code or Service ID which identifies a connectivity service that the UE-to-Network Relay provides.

- The associated PDU session parameters (S-NSSAI, DNN, SSC mode, etc.) to be used for relayed traffic for each UE-to-Network Relay Service Code or Service ID.

NOTE 1: Whether the associated PDU session parameters is included depends on the UE-to-Network Relay Discovery solutions. For example, if the associated PDU session parameters can be broadcasted with Relay Service Code in PC5 interface, these parameters may not need for provisioning procedure.

NOTE 2: The UE-to-Network Relay's Configured NSSAI includes the S-NSSAIs needed to support relaying traffic for the associated Service code or Service ID.

Editor's note: Details of UE-to-Network Relay slicing configuration update aspects are FFS.

- Security related parameters for UE-to-Network Relay Discovery for each UE-to-Network Relay Service Code or Service ID.

NOTE 3: Further details on security requirements will be specified in SA WG3.

The following UE-to-Network Relay parameters are provided to the Remote UE:

1) Authorisation policy for acting as a Remote UE:

- Indicates whether the UE is authorised to use UE-to-Network Relay.

2) UE-to-Network Relay Discovery policy/parameters as provided to UE-to-Network Relay;

- Authorized UE-to-Network Relay Service Code/ID list.

- The associated PDU session parameters (S-NSSAI, DNN, SSC mode, etc.) for each UE-to-Network Relay Service Code or Service ID.

NOTE 4: Whether the associated PDU session parameters is included depends on the UE-to-Network Relay Discovery solutions. For example, if the associated PDU session parameters can be broadcasted with Relay Service Code in PC5 interface, these parameters may not need for provisioning procedure.

- UE-to-Network Relay selection policy.

Editor's note: Details of UE-to-Network Relay selection policy are FFS.

NOTE 5: In this clause, only UE-to-Network Relay service specific parameters are specified. All other parameters used for general Authorization and Provisioning parameters (e.g. Radio parameters for discovery or communication) will be defined by solutions for KI 8.

NOTE 6: This solution does not support the case when the NW relay is out-of-coverage or out-of-box operation required by public safety.

### 6.16.3 Impacts on services, entities and interfaces

**UE:**

- Needs to support Authorization and Provisioning procedures for Remote UE and UE-to-Network Relay.

**PCF:**

- Needs to support Authorization and Provisioning procedures for Remote UE and UE-to-Network Relay.

## 6.17 Solution #17: ProSe Authorization Policy and Parameter for Direct Discovery and Communication

### 6.17.1 Description

This solution addresses KI#8: Support of PC5 Service Authorization and Policy/Parameter Provisioning, two following major aspects are covered:

- For the procedures related to PC5 service authorization and policy/parameter provisioning to a UE, only necessary enhancement with what is specified in TS 23.287 [5] clause 6.2 and TS 23.502 [8] clause 4.2.2.2 (Registration Procedure), clause 4.2.4.3 (UE Configuration Update procedure for transparent UE Policy Delivery), clause 4.16.11 (UE Policy Association Establishment procedure), clause 4.16.12 (UE Policy Association Modification procedure), will be documented.

- Identify necessary information for PC5 service authorization and provisioning based on what is specified in TS 23.287 [5] clause 5.1.2.1.

The PCF based service authorization and provisioning as defined in TS 23.287 [5] are used as baseline for this solution.

### 6.17.2 Procedures

#### 6.17.2.1 Procedure Enhancement for Information Provisioning to UE

For PCF based Service Authorization and Provisioning to 5G ProSe UE, the Registration procedures as defined in clause 4.2.2.2 of TS 23.502 [8], UE Policy Association Establishment procedure as defined in clause 4.16.11 of TS 23.502 [8] and UE Policy Association Modification procedure as defined in clause 4.16.12 of TS 23.502 [8] apply with the following additions:

- If the UE indicates its PC5 capability for 5G ProSe with according RAT indication in the Registration Request message and if the UE is authorized for 5G ProSe service, the AMF selects the PCF which supports 5G ProSe information provisioning and establishes a UE policy association with the PCF for 5G ProSe information provisioning delivery.

- If the AMF receives the PC5 capability for 5G ProSe with according RAT indication in the Registration Request message from UE, the AMF further reports the PC5 capability for 5G ProSe with according RAT indication to the selected PCF. The PCF determines the 5G ProSe Policy and parameters based on the received PC5 capability for 5G ProSe with according RAT indication.

- If the UE supports PC5 capability for 5G ProSe and it does not have valid 5G ProSe authorization information, the UE includes the UE Policy Container with indicating the 5G ProSe Policy and parameter Provisioning request during registration procedure.

- If the UE indicates the 5G ProSe Policy and parameter Provisioning request in the UE Policy Container, the PCF determines whether to provision the 5G ProSe Policy and parameter to the UE, as specified in clause 6.1.2.2.2 of TS 23.503 [18], and the PCF provides the 5G ProSe Policy and parameters to the UE by using the procedure as defined in clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy Delivery" in TS 23.502 [8].

The PCF may update the 5G ProSe Policy and parameters to the UE in following conditions:

- UE Mobility, e.g. UE moves from one PLMN to another PLMN. This is achieved by using the procedure of UE Policy Association Modification initiated by the AMF, as defined in clause 4.16.12.1 of TS 23.502 [8].

- When there is a subscription change in the list of PLMNs where the UE is authorized to perform the 5G operation. This is achieved by using UE Policy Association Modification initiated by the PCF procedure as defined in clause 4.16.12.2 of TS 23.502 [8].

- When there is a change of service specific parameter as described in clause 4.15.6.7 of TS 23.502 [8].

If the serving PLMN is removed from the list of PLMNs in the service authorization parameters, the service authorization is revoked in the UE.

When the UE is roaming, the change of subscription resulting in updates of the service authorization parameters are transferred to the UE by H-PCF via V-PCF.

NOTE: The UE may perform UE triggered Policy Provisioning procedure to the PCF as specified in clause 6.2.4 of TS 23.287 [5] when the UE determines the 5G ProSe Policy and parameters are invalid (e.g. Policy/Parameter is outdated, missing or invalid).

#### 6.17.2.2 Procedure Enhancement for Information Provisioning to NG-RAN

The Registration procedure for UE is performed as defined in TS 23.502 [8] with the following additions:

- The UE includes the PC5 Capability for ProSe (i.e. LTE PC5 only, NR PC5 only, both LTE and NR PC5) as part of the "5GMM capability" in the Registration Request message. The AMF stores this information for ProSe operation. The PC5 Capability for ProSe indicates whether the UE is capable of supporting ProSe Direct Discovery and communication over PC5 reference point and which specific PC5 RAT(s) it supports.

- The AMF determines whether the UE is authorized to use ProSe Direct Discovery and communication over PC5 reference point based on UE's PC5 Capability for ProSe and the subscription data (i.e. "ProSe services authorized" indication and UE-PC5-AMBR per PC5 RAT, and cross-RAT PC5 control authorization if applicable) received from UDM, and stores the subscription data as part of the UE context.

- The PCF provides the PC5 QoS parameters to AMF. The AMF stores such information as part of the UE context.

- If the UE is PC5 capable for ProSe, and the UE is authorized to use ProSe Direct Communication over PC5 reference point based on the subscription data, then the AMF shall include in the NGAP message sent to NG-RAN:

- a "ProSe services authorized" indication, indicating the UE is authorized to use ProSe Direct Discovery and communication over PC5 reference point.

- UE-PC5-AMBR per PC5 RAT and cross-RAT PC5 control authorization if applicable, used by NG-RAN for the resource management of UE's PC5 transmission for ProSe services in network scheduled mode.

- the PC5 QoS parameters used by the NG-RAN for the resource management of UE's PC5 transmission for ProSe services in network scheduled mode.

Editor's note: LTE PC5 RAT related description may need to be revisited.

#### 6.17.2.3 The Policy/parameter for ProSe Direct Discovery

The following sets of information for ProSe Direct Discovery over PC5 reference point is provisioned to the UE:

1) Authorization policy:

- When the UE is "served by E-UTRA" or "served by NR":

- For open ProSe Direct Discovery, applicable only to non-Public Safety UEs:

a) open ProSe Direct Discovery Model A monitoring authorisation policy:

- PLMNs in which the UE is authorised to perform ProSe Direct Discovery monitoring.

b) open ProSe Direct Discovery Model A announcing authorisation policy:

- PLMNs in which the UE is authorized to perform announcing.

- Authorised discovery range for announcing per PLMN.

- For restricted ProSe Direct Discovery:

a) restricted ProSe Direct Discovery Model A monitoring authorisation policy:

- PLMNs in which the UE is authorised to perform restricted ProSe Direct Discovery Model A monitoring.

b) restricted ProSe Direct Discovery Model A announcing authorisation policy:

- PLMNs in which the UE is authorized to perform restricted ProSe Direct Discovery Model A announcing;

- Authorised discovery range for announcing per PLMN.

c) restricted ProSe Direct Discovery Model B Discoverer operation authorization policy:

- PLMNs in which the UE is authorized to perform Model B Discoverer operation;

- Authorised discovery range for announcing per PLMN.

d) restricted ProSe Direct Discovery Model B Discoveree operation authorization policy:

- PLMNs in which the UE is authorized to perform Model B Discoveree operation.

- Authorised discovery range for announcing per PLMN.

- For each above PLMN:

- RAT(s) over which the UE is authorized to perform ProSe Direct Communications over PC5 reference point.

- When the UE is "not served by E-UTRA" and "not served by NR":

- Indicates whether the UE is authorised to perform ProSe Direct Discovery for Model A and Model B when "not served by NG-RAN".

- RAT(s) over which the UE is authorized to perform ProSe Direct Discovery over PC5 reference point.

2) Radio parameters when the UE is "not served by E-UTRA" and "not served by NR":

- Includes the radio parameters per PC5 RAT (i.e. LTE PC5, NR PC5) with Geographical Area(s) and an indication of whether they are "operator managed" or "non-operator managed". The UE uses the radio parameters to perform ProSe Direct Discovery over PC5 reference point when "not served by E-UTRA" and "not served by NR" only if the UE can reliably locate itself in the corresponding Geographical Area. Otherwise, the UE is not authorized to transmit.

NOTE 1: Whether a frequency band is "operator managed" or "non-operator managed" in a given Geographical Area is defined by local regulations.

3) restricted ProSe Direct Discovery UE ID for Restricted Direct Discovery, applicable only to non-Public Safety UEs:

- ProSe Direct Discovery UE ID.

4) Group Member Discovery parameters:

- For each discovery group that the UE belongs to include the following parameters that enable the UE to perform Group Member Discovery when provisioned in ME from PCF or configured in UICC:

- Application Layer Group ID: Identifies an application layer group that the UE belongs to.

- User Info ID: For Model A, this corresponds to the Announcer Info parameter when the UE is acting as an announcing UE. For Model B, this corresponds to the Discoverer Info in Solicitation messages and the Discoveree Info in Response messages, when the UE is acting as a discoverer or discoveree UE respectively.

NOTE 2: User Info ID is expected to be assigned uniquely to a user within the discovery group.

- Discovery Group ID: identifier of a discovery group that the UE belongs to.

5) Validity timer indicating the expiration time of the Policy/Parameter for ProSe Direct Discovery.

#### 6.17.2.4 The Policy/parameter for ProSe Direct Communication

The following sets of information for ProSe Direct Communications over PC5 reference point is provisioned to the UE:

1) Authorization policy:

- When the UE is "served by E-UTRA" or "served by NR":

- PLMNs in which the UE is authorized to perform 5G ProSe Direct Communications over PC5 reference point when "served by E-UTRA" or "served by NR".

For each above PLMN:

- RAT(s) over which the UE is authorized to perform ProSe Direct Communications over PC5 reference point.

- When the UE is "not served by E-UTRA" and "not served by NR":

- Indicates whether the UE is authorized to perform ProSe Direct Communications over PC5 reference point when "not served by E-UTRA" and "not served by NR".

- RAT(s) over which the UE is authorized to perform ProSe Direct Communications over PC5 reference point.

2) Radio parameters when the UE is "not served by E-UTRA" and "not served by NR":

- Includes the radio parameters per PC5 RAT (i.e. LTE PC5, NR PC5) with Geographical Area(s) and an indication of whether they are "operator managed" or "non-operator managed". The UE uses the radio parameters to perform ProSe Direct Communications over PC5 reference point when "not served by E-UTRA" and "not served by NR" only if the UE can reliably locate itself in the corresponding Geographical Area. Otherwise, the UE is not authorized to transmit.

NOTE 3: Whether a frequency band is "operator managed" or "non-operator managed" in a given Geographical Area is defined by local regulations.

3) Policy/parameters per RAT for PC5 Tx Profile selection:

- The mapping of ProSe service type to Tx Profile.

4) Policy/parameters related to privacy:

- The list of ProSe service type with Geographical Area(s) that require privacy support.

5) Policy/parameters when LTE PC5 is selected:

- Same as specified in TS 23.303 [9] clauses 4.5.1.1.2.3, 4.5.1.1.2.3.3 and 4.5.1.1.2.3.3a.

6) Policy/parameters when NR PC5 is selected:

- The mapping of ProSe service type to radio frequencies with Geographical Area(s).

- The mapping of Destination Layer-2 ID(s) and the ProSe service type for broadcast.

- The mapping of Destination Layer-2 ID(s) and the ProSe service type for groupcast.

- The mapping of default Destination Layer-2 ID(s) for initial signalling to establish unicast connection and the ProSe service type.

NOTE 4: The same default Destination Layer-2 ID for unicast initial signalling can be mapped to more than one ProSe service. In the case where different ProSe services are mapped to distinct default Destination Layer-2 IDs, when the UE intends to establish a single unicast link that can be used for more than one ProSe service, the UE can select any of the default Destination Layer-2 IDs to use for the initial signalling.

- PC5 QoS mapping configuration:

- Input from ProSe application layer:

- ProSe service type.

NOTE 5: Details of ProSe Application Requirements for the ProSe service is up to implementation and out of scope of this specification.

- Output:

- PC5 QoS parameters defined in clause 5.4.2 of TS 23.287 [5] (i.e. PQI and conditionally other parameters such as MFBR/GFBR, etc).

- SLRB configurations, i.e. the mapping of PC5 QoS profile(s) to SLRB(s), when the UE is "not served by E-UTRA" and "not served by NR".

- The PC5 QoS profile contains PC5 QoS parameters described in clause 5.4.2 of TS 23.287 [5], and value for the QoS characteristics regarding Priority Level, Averaging Window, Maximum Data Burst Volume if default value is not used as defined in Table 5.4.4-1 of TS 23.287 [5].

7) Validity timer indicating the expiration time of the Policy/Parameter for ProSe Direct Communication.

Editor's note: It's FFS on whether ProSe service type needs to be standardized.

Editor's note: It's FFS on whether "not served by NR" needs to be refined.

### 6.17.3 Impacts on services, entities and interfaces

**UE:**

- Need to indicate its PC5 capability for 5G ProSe to AMF with according RAT indication;

- Need to include the UE Policy Container with indicating the 5G ProSe Policy and parameter Provisioning request;

- Receive and enforce the Policy and parameter for ProSe Direct Discovery and Communication.

**NG-RAN:**

- receive and store the UE's ProSe authorization information for network scheduled mode operation.

**AMF:**

- Determine whether UE is authorized for 5G ProSe service;

- Select a PCF capable of authorization Policy and parameter for 5G ProSe service;

- Send UE's PC5 Capability for 5G ProSe to PCF;

- Forward the UE's ProSe authorization information for network scheduled mode to NG-RAN.

**PCF:**

- Determine the UE's Authorization Policy and parameter for 5G ProSe and send it to UE;

- Send the according Authorization Policy and parameter to NG-RAN via AMF.

## 6.18 Solution #18: Control Plane based 5G DDNMF Deployment

### 6.18.1 Description

This solution addresses Key Issue#1 and provides the Open and Restricted ProSe Discovery procedure based on the architecture described in Annex B, clause B.3, which enables the 5G network to control the discovery procedure via control plane.

This solution also addresses Key Issue#7 and supports event based charging for ProSe Direct Discovery.

### 6.18.2 Procedures for ProSe Direct Discovery

#### 6.18.2.1 Policy/Parameter Description

The following identities are required for Open ProSe Direct Discovery:

a) Application ID: an identity used by a UE to indicate a specific ProSe application. The Application ID is assigned (provided) by the ProSe Application Server.

b) User identity:

- ProSe Application ID: the same concept as defined in TS 23.303 [9], clause 4.6.4.1.

- ProSe Discovery UE ID (PDUID): the same concept as defined in TS 23.303 [9], clause 4.6.4.7.

- Restricted ProSe Application User ID (RPAUID): the same concept as defined in TS 23.303 [9], clause 4.6.4.8.

c) Discovery Parameter:

- Discovery Code for Model A：

- ProSe Application Code: the same concept as defined in TS 23.303 [9], clause 4.6.4.2.

- ProSe Restricted Code: the same concept as defined in TS 23.303 [9], clause 4.6.4.6.

- Discovery Code for Model B：

- ProSe Query Code: the same concept as defined in TS 23.303 [9], clause 4.6.4.4.

- ProSe Response Code: the same concept as defined in TS 23.303 [9], clause 4.6.4.5.

- Discovery Filter: the same concept as defined in TS 23.303 [9], clause 4.6.4.2a.

d) Validity Timer: the same concept as defined in TS 23.303 [9], clause 4.6.4.2.

e) Announcer Info: provides information about the announcing user. The Announcer Info can be set to the DNN that the UE is able to access, or the UE capability such as VR/AR rendering index. This parameter is pre-configured in the UE.

#### 6.18.2.2 Procedure for ProSe Discovery

The following procedure is used for both open and restricted Prose discovery and supports both Model A and Model B discovery. The only difference is the User identity carried in the Discovery request message sent by different UEs (e.g., ProSe Application ID by Announcing UE, RPAUID by Discoveree UE) and the ProSe Discovery parameters retrieved from 5G DDNMF.

Multiple 5G DDNMFs may be involved in the ProSe Discovery parameters generation and provisioning, for example, when the Announcing UE is roaming or the ProSe Application Code that Monitoring UE is interested to monitor generated by a different PLMN. The detailed procedures and the interactions between multiple 5G DDNMFs are shown in clause 6.18.2.3 and 6.18.2.4.



Figure6.18.2.2-1: Overall procedures for Open ProSe Discovery (Model A)

0a. During the Registration procedure, Authorization and Policy/Parameter provisioning are performed for the ProSe-related services. Authorization and provisioning procedure may be solution for key issue #8.

0b and 0c. UEs are pre-configured/pre-provisioned with the User identity (i.e., ProSe Application ID and RPAUID) ProSe Application IDs. These steps are performed using mechanisms that are out of scope of this specification.

1. Announcing UE or Discoveree UE retrieves Discovery Parameter for announcing Discovery Parameter from the 5GS. This step is specified in clause 6.18.2.3 and 6.18.2.4.

2. Monitoring UE or Discoverer UE retrieves Discovery Parameter for announcing or monitoring from the 5GS. This step is specified in clause 6.18.2.3 and 6.18.2.4.

3. In Model A discovery, Announcing UE starts to announce the ProSe Application Code on PC5 interface and monitoring UE starts to monitor the ProSe Application Code on PC5 interface. In this step, Announcing UE may also start to announce the Announcer Info and Monitoring UE starts to monitor the Announcer Info on PC5 interface as described in clause 6.18.2.1.

4. In Model B discovery, Discoverer UE starts to announce the ProSe Query Code on PC5 interface and Discoveree UE starts to monitor the ProSe Query Code on PC5 interface. If a received ProSe Query Code matches any of the Discovery Query Filter(s), the UE announces the associated ProSe Response Code on the PC5 interface.

5. [Optionally]: If there is no stored relationship between ProSe Application Code and ProSe Application ID on the monitoring UE, the monitoring UE will report the matched code to the 5GS to fetch the corresponding ProSe Application ID.

#### 6.18.2.3 Procedure for ProSe Discovery Parameter retrieval (non-roaming/inter-PLMN transmission)

Figure 6.18.2.3-1 shows the procedure for ProSe Discovery Parameter retrieval in non-roaming cases, which corresponds to the step 1 and Step 2 in clause 6.18.2.2.



Figure 6.18.2.3-1: Procedure for Discovery Parameter retrieval in non-roaming or inter-PLMN transmission

1. If the UE is authorised to announce or monitor, it can request the 5G DDNMF for the ProSe Discovery Parameters defined in clause 16.8.2. when it is triggered by an application identified by an Application ID to announce or monitor other ProSe Discovery Parameter (s). Here, the UE can be Announcing UE or Monitoring UE in Model A or Discoveree UE or Discoverer UE in Model B discovery.The Request message can be transmitted within a Container via NAS message to the AMF. The Request message within the Container includes:

- User identity

- Model A discovery

- For Announcing UE: ProSe Application ID (open discovery) or RPAUID of Announcing UE (restricted discovery)；

- For Monitoring UE: ProSe Application ID of Monitoring UE and ProSe Application ID(s) which the Monitoring UE is interested to monitor (open discovery) or RPAUID of Monitoring UE and RPAUID(s) which the Monitoring UE is interested to monitor (restricted discovery);

- Model B discovery

- For Discoveree UE: RPAUID of Discoveree UE；

- For Discoverer UE: RPAUID of Discoverer UE and RPAUID(s) which the Discoverer UE is interested to monitor (restricted discovery);

- ProSe Application ID;

- Application ID;

- Discovery command: Announce or Monitor (Model A) and Response or Query (Model B);

- Discovery Type: Open or Restricted discovery;

- Discovery Model: Model A or Model B.

If the discovery command is Announce, the Announcing type can be set to "on demand" to indicate the "on demand" announcing is requested by UE for the indicated application.

2. AMF forwards the Container to the 5G DDNMF.

NOTE: It is assumed that there is only one 5G DDNMF in each PLMN.

3. For Open discovery, 5G DDNMF generates the ProSe Discovery Application Code or Discovery Filter according to the ProSe Application ID that is contained in the request message (i.e. Container). For Restricted discovery, the 5G DDNMF may interact with the ProSe AS to get the authorization for restricted discovery and retrieve the PDUID corresponding to the RPAUID before it generates the ProSe Discovery Code (ProSe Restricted Code for Model A and ProSe Query Code and ProSe Response Code for Model B) corresponding to PDUID.

If needed, 5G DDNMF may interact with UDR to check whether the UE is authorized to use the Application. Optionally, 5G DDNMF will assign a Validity Timer indicating how long the ProSe Discovery Parameter is valid.

4. If ProSe Direct Discovery with "on demand" announcing has been requested, the DDNMF determines if "on demand" announcing is authorized and enabled based on the Application ID and operator's policy. For inter-PLMN Discovery Filter(s) retrieval, based on PLMN ID(s) indicated in the ProSe Application ID(s) or PDUID(s), which the UE is interested to monitor, HPLMN 5G DDNMF send ProSe Discovery Parameter Retrieval message to 5G DDNMF in the corresponding PLMN(s) to retrieve ProSe Discovery Parameter. The ProSe Discovery Parameter Retrieval message includes:

- User identity

- Model A discovery

- For Announcing UE: ProSe Application ID (open discovery) or RPAUID of Announcing UE (restricted discovery)；

- For Monitoring UE: ProSe Application ID of Monitoring UE and ProSe Application ID(s) which the Monitoring UE is interested to monitor (open discovery) or RPAUID of Monitoring UE and PDUID(s) which the Monitoring UE is interested to monitor (restricted discovery);

- Model B discovery

- For Discoveree UE: RPAUID of Discoveree UE；

- For Discoverer UE: RPAUID of Discoverer UE and PDUID(s) which the Discoverer UE is interested to monitor (restricted discovery);

- Application ID;

- Discovery Model：Model A or Model B;

- Discovery Type: open or restricted.

- Discovery command: Announce or Monitor (Model A) and Response or Query (Model B);

If the 5G DDNMF of the other PLMN(s) stores valid Discovery Parameter corresponding to the User identity, then the 5G DDNMF of the other PLMN(s) returns the related Discovery Parameter and the corresponding Validity Time for each User identity respectively.

5. 5G DDNMF transmits the ProSe Discovery Parameter in the Container to the AMF. Optionally, the Validity Timer is also included in the Container .

If the "on demand" announcing is authorized and enabled in step 3, then DDNMF shall determine whether there is ongoing monitoring request. If not, the DDNMF does not provide a ProSe Application Code to the UE and responds to the UE with a Discovery Response (validity timer, Announcing Enabled indicator) message.

6. AMF sends the Discovery Parameter Response message including the Container to the UE.

#### 6.18.2.4 Procedure for ProSe Discovery Parameter retrieval (roaming)



Figure 6.18.2.4-1: Procedure for ProSe Discovery Parameter retrieval in roaming case

1. Same as the step 1 in clause 6.18.2.3.

2. AMF forwards the ProSe Container to 5G DDNMF with the SUPI/SUCI of Announcing UE.

3. Based on PLMN ID in the User identity of the UE, VPLMN 5G DDNMF forwards the Discovery Parameter Request to the HPLMN 5G DDNMF.

4. For Open discovery, HPLMN 5G DDNMF generates the ProSe ApplicationDiscovery Code or Discovery Filter according to the ProSe Application ID that is contained in the request message (i.e., Container). For Restricted discovery, HPLMN 5G DDNMF may interact with the ProSe AS to get the authorization for restricted discovery and retrieve the PDUID corresponding to the RPAUID before it generates the ProSe Discovery Code (ProSe Restricted Code for Model A and ProSe Query Code and ProSe Response Code for Model B) corresponding to PDUID.

If needed, 5G DDNMF may interact with UDR to check whether the UE is authorized to use the Application. Optionally, 5G DDNMF will assign a Validity Timer indicating how long the ProSe Discovery Parameter is valid.

5. Same as step 4 in clause 6.18.2.3.

6. HPLMN 5G DDNMF transmits the ProSe Discovery Parameter to the VPLMN 5G DDNMF.

7. VPLMN 5G DDNMF transmits the ProSe Discovery Parameter in the Container to the AMF. Optionally, the Validity Timer is also included in the Container.

8. AMF sends the Discovery Parameter Response message including the Container to the UE.

### 6.18.4 ProSe Direct Discovery Charging

5G DDNMF in HPLMN, VPLMN and local PLMNs are responsible for the ProSe Direct Discovery functionality, i.e. allocating the ProSe code and managing the ProSe UE’s ProSe discovery context, thus the chargeable ProSe direct discovery events can be collected and reported by the 5G DDNMFs to the corresponding CHF in the same PLMN.

Upon detecting the occurrence of the chargeable events during the ProSe Direct Discovery procedure, the 5G DDNMF shall further report the chargeable events to the CHF, including the relevant information as defined in clause 5.1.2 in clause TS 32.277[13]. Detailed list of these chargeable events can be defined on the basis of clause 5.2.1.2 in TS 32.277[13]

NOTE: other chargeable events needs to be added into the list will be specified by SA5 WG.

### 6.18.5 Impacts on services, entities and interfaces

#### 6.18.5.1 Impact on entities

UE:

- Request to perform ProSe Direct Discovery to the 5GS via NAS message;

- Announce or monitor the ProSe discovery code on PC5 interface;

- Announce or monitor the Announce Info in PC5 interface.

AMF:

- Transfer the ProSe Container between UE and 5G DDNMF.

UDR:

- Store the ProSe specific UE subscription data.

5G DDNMF:

- Support charging for Direct Discovery

- Transfer the charging data for Direct Discovery to CHF

CHF

- Receive the charging data for Direct Discovery to CHF

#### 6.18.5.2 Impact on interface:

* A new service-based interface between 5G DDNMFs in different PLMN.

## 6.19 Solution #19: UE-to-Network Relay discovery and selection

### 6.19.1 Description

#### 6.19.1.1 UE-to-Network Relay discovery

This solution provides a mechanism for the Remote UE to discover a UE-to-Network Relay and selects an appropriate UE-to-Network Relay.

The Model A and Model B procedure in solution #1 is applied for UE-to-Network Relay discovery procedure. In Model A mechanism, the UE-to-Network Relay announces the discovery message which includes relay related information. In Model B mechanism, the Remote UE requests relay related information in discovery solicitation message, the UE-to-Network Relay sends discovery response message which matches the information in discovery solicitation message.

In Model A, the UE-to-Network Relay includes at least the following information in discovery announce message:

- Service and application information that is enabled or authorised to be relayed.

- Group information the UE-to-Network Relay can provide the relay service.

- Slicing information (e.g. Allowed NSSAI) the UE-to-Network Relay is enabled or authorised to be relayed.

- The HPLMN or VPLMN for the UE-to-Network Relay.

In Model B, the Remote UE includes at least requested information for the relay in discovery solicitation message, the information listed in discovery announcement message of Model A can also be included in discovery solicitation message. The UE-to-Network Relays receiving the discovery solicitation message determines to send discovery response message if they can provide the relay connection associated with the information in the discovery solicitation message. And the UE-to-Network Relay includes the associated information in discovery response message.

Editor's note: Whether the above-announced information is applicable for Layer-2 based relay is FFS.

Editor's note: The privacy protection for S-NSSAI information and group information in discovery message and the security of pre-configuring, storing and exposing all this privacy sensitive information with the UE-to-Network relay is FFS and in coordination with SA WG3.

Editor's note: How to reduce the overhead and possible truncation of the discovery messages in case many different applications/services, groups and slices are available is left to stage 3.

#### 6.19.1.2 UE-to-Network Relay selection

When the Remote UE selects UE-to-Network Relay, the Remote UE considers the followings.

- PC5 radio condition for UE-to-Network Relay subjected to RAN WG definition

- the services that UE-to-Network Relay can relay.

- the groups that UE-to-Network Relay belongs to.

- the possible DNNs/S-NSSAIs for the service relayed by UE-to-Network Relay.

- the serving PLMN for UE-to-Network Relay.

- the relay UE pre-configured in the remote UE.

Editor's note: The relay UE selection needs to be coordinated with RAN working group.

Editor's note: Whether the relay selection conditions are applicable to Layer-2 based relay is FFS.

### 6.19.2 Procedures



Figure 6.19.2-1: UE-to-Network Relay discovery and selection

0. The user may obtain ProSe application user ID and ProSe application code for ProSe direct discovery using application layer mechanisms. The application layer in the UE provides application user ID and the application identifier to the ProSe Application Function. The ProSe Application Function allocates a ProSe application user ID and ProSe application code to the application layer in the UE.

NOTE: Step 0 is out of this specification. And this step is only needed for the applications for which there is privacy issue.

1. The UE obtains the authorization and provision to be a UE-to-Network Relay and/or a Remote UE as defined for service authorization solutions. The authorized parameters are shown in clause 6.19.1.1.

2a. (Model A) When a UE is triggered e.g. by an upper layer application or triggered by the user or is configured to announce to be a UE-to-Network Relay, the UE shall generate a PC5 direct discovery message for announcement and includes the relay related information (service/application IDs, group index(es), S-NSSAI(s), HPLMN or VPLMN) in this message. The UE-to-Network Relay computes a security protection element (e.g. for integrity protection) and appends it to the PC5 message.

When a UE is triggered e.g. by an upper layer application or by the user to discover a UE-to-Network Relay, and the Remote UE monitors the discovery message and try to select a UE-to-Network Relay. The Remote UE verifies the security protection element using the provisioned security parameters corresponding to the application. If the verification of the security protection element succeeds, the service is successfully discovered by the Remote UE.

2b. When a UE is triggered e.g. by an upper layer application or by the user to discover a UE-to-Network Relay for relay related service, and if the UE is authorised to be a Remote UE and perform the discovery solicitation procedure, the Remote UE sends discovery solicitation message with the information of discoverer ProSe UE ID, relay related information (service/application, group index, S-NSSAI). The remote UE computes a security protection element (e.g. for integrity protection) and appends it to the PC5 message.

If the UE-to-Network Relay is able to and authorised to respond to the discovery solicitation according to the received information in the solicitation message, then responds to the discovery message with the ProSe UE ID, service/application, group index, S-NSSAI, HPLMN or VPLMN).

3. Based on the discovered UE-to-Network Relay information, the Remote UE selects an appropriate UE-to-Network Relay as descripted in clause 6.19.1.

### 6.19.3 Impacts on services, entities and interfaces

- The UE is authorized to be a UE-to-Network Relay or a Remote UE.

- The UE-to-Network Relay sends discovery announcement, including relay related parameters.

- The Remote UE is able to discover and select UE-to-Network Relay.

## 6.20 Solution #20: QoS handling for ProSe communication

### 6.20.1 Description

In order to support QoS handling for ProSe communication, the mechanism defined in TS 23.287 [5] clause 5.4 is reused with the following differences:

- V2X Packet Filter Set is replaced by ProSe Packet Filter Set.

Editor's note: It is FFS which filter combination the ProSe Packet Filter Set is based on, e.g. Source/Destination Layer-2 ID, ProSe Application ID, etc.

For public safety services, considering the higher priority and higher reliability, new PQI values needs to be defined. The one-to-one mapping of standardized PQI values to PC5 QoS characteristics are defined as followings:

Table 6.20.1-1: Proposed Standardized PQIs to QoS characteristics mapping (*changes with respect to TS 23.287 [5] Table 5.4.4-1 in Bold-Italic text*)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PQI  Value | Resource Type | Default Priority Level | Packet Delay Budget | Packet Error  Rate | Default Maximum Data Burst Volume | Default  Averaging Window | Example Services |
| New value#1 | GBR | 1 | 150 ms | 10-2 | N/A | 2000 ms | Mission Critical user plane Push To Talk voice (e.g. MCPTT) |
| New value#2 |  | 2 | 200 ms | 10-2 | N/A | 2000 ms | Non-Mission-Critical user plane Push To Talk voice |
| New value#3 |  | 2 | 200 ms | 10-3 | N/A | 2000 ms | Mission Critical Video user plane |
| New value#4 | Non-GBR | 1 | 120 ms | 10-6 | N/A | N/A | Mission Critical delay sensitive signalling (e.g. MC-PTT signalling) |
| New value#5 |  | 6 | 400 ms | 10-6 | N/A | N/A | Mission Critical Data (e.g. example services are the same as 5QI 6/8/9) |

Editor's note: Whether the new defined PQI values can be supported by RAN needs to be checked with RAN WGs.

### 6.20.2 Procedures

The QoS handling defined in clauses 5.4.1.2 to 5.4.1.4 of TS 23.287 [5] is used.

### 6.20.3 Impacts on services, entities and interfaces

UE impact:

- UE is enhanced to support QoS handling for ProSe communication over NR based PC5 reference point.

## 6.21 Solution #21: QoS Support for NR PC5 ProSe communication

### 6.21.1 Description

This solution addresses Key Issue #2 (Support for NR PC5 ProSe communication). The QoS support differences with what is documented in TS 23.287 [5] clause 5.4 are analysed and new PC5 5QI requirements are added.

### 6.21.2 Identify QoS Support Difference

According to the agreed KPI table in TS 22.261 [3] (See Table 7.6.1-1), the *consume VR content via tethered VR headset* *in the interactive service* use case identified a new requirement for PC5 communication, where end-to-end latency is 5-10 ms and the required data rate requirement is 0.1-10 Gbps with reliability 99.99%. The decoding capability in the VR headset and the encoding/decoding complexity/time of the stream will set the required bit rate and latency over the direct wireless link between the tethered VR headset and its connected UE, i.e. 5 ms latency corresponds to 100 Mbps data rate and 10ms latency corresponds to 10Gbps.

Some eV2X scenarios can be mapped to already existing Delay Critical GBR PQI Values (see TS 23.287 [5], Table 5.4.4-1). The extended sensors scenario (Sensor information sharing between UEs supporting V2X application) needs to support up to 1Gbps data rate with 10 ms end-to-end latency (see TS 22.186 [19], Table 5.4-1), and support 50Mbps with 3ms end-to-end latency. That means that the recent requirement in V2X cannot satisfy the requirement for interactive service use case consume VR content via tethered VR headset.

Compared with the PQI table for V2X (see TS 23.287 [5]), to support the *consume VR content via tethered VR headset in interactive service* use case, new PDBs are needed and the corresponding typical MDBV should be updated according to the data rate requirement. Considering that the original Default Priority Level defined in V2X is for safety related communication (e.g. collision avoidance, or emergency trajectory alignment), for Interactive Service, the value Priority Level should be set larger (i.e. lower priority) than those for safety related issue. If the new PQI values are not added, the requirement of the use case consume VR content via tethered VR headset will not be able to find feasible PQI values to support.

### 6.21.3 Adding new PQI values for interactive service

Table 6.21.3-1: Standardized PQI to QoS characteristics mapping

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PQI  Value | Resource Type | Default Priority Level | Packet Delay Budget | Packet Error  Rate | Default Maximum Data Burst Volume | Default  Averaging Window | Example Services |
| New value#1 | Delay Critical GBR | 5 | 5ms | 10-4 | 2000 bytes | 2000 ms | Interactive service - consume VR content with high compression rate via tethered VR headset (100Mbps) |
| New value#2 |  | 6 | 10ms | 10-4 | 20000bytes | 2000 ms | interactive service - consume VR content with low compression rate via tethered VR headset (10Gbps) |

Considering the 10 ms corresponds to the data rate 10 Gbps, the typical MDBV is captured as 20000 bytes. The packet delay budgets are captured as 5 ms and 10 ms based on the end-to-end delay captured in TS 22.261 [3].

Editor's note: Whether the new defined PQI values can be supported by RAN needs to be checked with RAN WGs.

### 6.21.4 Impacts on services, entities and interfaces

## 6.22 Solution #22: V2X-based group communication for commercial services

### 6.22.1 Description

This solution addresses Key Issue #1 (ProSe Direct discovery) and Key Issue #2 (Support for NR PC5 ProSe communication) on the aspect of commercial services, e.g. interactive services. The solution takes V2X-based group communication over PC5 in TS 23.287 [5] as a baseline with following differences:

- Before initiating V2X-based group communication, group discovery will be performed.

- Application server needs to perform the group management, such as member matching and adding.

### 6.22.2 Procedures

NOTE : The support for out of coverage operation is not supported in this solution.

#### 6.22.2.1 V2X-based group communication for commercial services

The following figure 6.22.2.1-1 demonstrates the procedure of V2X-based group communication for commercial services, the procedure is initiated when a UE wants to perform group communication over PC5 reference point with other UE(s) for any application, e.g. interactive game.



Figure 6.22.2.1-1: V2X-based group communication for commercial services

NOTE1: The application layer signalling messages in steps 1 and 3 exchanged between UE and Application Server in the procedures described in this clause are for information and are not specified by SA WG2.

1. The application layer of UE-1 will perform the necessary application layer procedures to create a group. An Application Layer Group ID is provided to UE-1.

2. After receiving the Application Layer Group ID, UE-1 broadcasts a Prose Service Groupcast message to invite the group members. This message includes:

- Application ID.

- Application Layer User ID

- Application Layer Group ID provided in step 1.

NOTE2: The mechanism for converting the ProSe application layer provided group identifier to the destination Layer-2 ID depends on the conclusion of KI#8.

3. The UEs (UE-2, UE-3 and UE-5 in Figure 6.22.2.1-1) that are interested in the announced ProSe application decide to join this group, they will perform the necessary application layer procedures to join the group.

4. When UE-1 has been informed by the application layer that group communications can take place, UE-1 sends the service data using V2X-based group communication over PC5, as specified in clause 6.3.2 of TS 23.287 [5].

### 6.22.3 Impacts on services, entities and interfaces

**UE:**

- Obtains the Application Layer Group ID for the group communication from the Application Server by using application layer signalling.

- Determines the Destination Layer-2 ID based on the Application Layer Group ID.

**Application Server:**

- Provides Application Layer Group ID to the UE.

- Supports application layer group management functions and provides necessary group information to member UE(s).

## 6.23 Solution #23: End-to-End security for Layer-3 UE-to-Network Relay using N3IWF

### 6.23.1 General Description

This is a solution to support end-to-end security for Remote UE traffic transmitted using Layer-3 UE-to-Network Relay. It can be used for both public safety services and commercial services (e.g. interactive service). The solution is optional and complementary to base line Layer-3 UE-to-Network Rleay solutions, e.g. as described in clause 6.6. It can be used by the Remote UE for the services that requires end-to-end traffic confidentility and/or IP address preservation.

To provide end-to-end security for the remote UE traffic, the design of *“untrusted non-3GPP access to 5GC via N3IWF”* in clause 4.2.8 of TS 23.501 [6] or “Access to PLMN services via stand-alone non-public networks” in clause 5.30.2.7 of TS 23.501 [6] is leveraged. Remote UE follows the procedures defined in TS 23.502 [8] clause 4.12 to register to 5GC via N3IWF and establish corresponding PDU sessions. The data traffic over the PDU sessions are protected by IPSec between the Remote UE and N3IWF.

The N3IWF provides NAS connectivity to the 5GC and end-to-end security for Remote UEs (see figure 6.23.1-1) via UE-to-NW Relay Access. The N3IWF treats the Remote UE as any N3GPP UE, i.e. there is no impact on N3IWF.

Remote UE supports the PC5 procedures as defined in solution #6 in clause 6.6 for obtaining UE-to-NW Relay access.



Figure 6.23.1-1: Non-roaming Architecture model using N3IWF with UE-to-NW Relay Access

Since this solution is optional, not all UE-to-Network Relay provides the PDU session to access to N3IWF.

Editor’s note: The criteria and policies used by a Remote UE to decide between a secure N3IWF or otherwise need to be defined.

Editor’s note: The criteria and policies used by a UE-to-Network Relay to offer secure N3IWF access or otherwise need to be defined.

UE selection of the N3IWF follows the regulatory rules of the country where it is located, and when required by the regulations the Remote UE only selects a N3IWF within the local country. QoS differentiation can be provided on per-IPsec Child Security Association basis. N3IWF determines the IPsec child SAs as defined in TS 23.502 [3] clause 4.12. The N3IWF is preconfigured to allocate different IPsec child SAs for QoS Flows with different QoS profiles.

NOTE: In case the Remote UE and Relay UE registered to different PLMNs, there need to be SLA established to governed the QoS handling, e.g. when the Relay Service Code (RSC) is configured. The SLA can include the mapping between the DSCP markings for the IPsec child SAs with the Remote UE and the corresponding QoS, and N3IWF IP address(es). The non-alteration of the DSCP field between N3IWF and the Relay UE's UPF is also assumed to be governed by an SLA and by transport-level arrangements that are outside of 3GPP scope. The packet detection filters at the Relay UE's UPF can be based on the N3IWF IP address and the DSCP markings.

The 5GC to which the UE-to-Network Relay registers and the 5GC to which the Remote UE registers may be the same or different. The solution does not mandate the Remote UE to be served by the same PLMN as the Relay UE.

### 6.23.2 Protocol stacks

When access to N3IWF is used, the ProSe 5G UE-to-Network Relay shall be able to relay both control plane (NAS) and user plane unicast traffic (UL and DL) between the Remote UE and the network towards N3IWF. One-to-one Direct Communication is used between Remote UEs and ProSe 5G UE-to-Network Relays for unicast traffic as specified in solutions for Key Issue #2.

Remote UE and 5GC reuses the procedures defined in clause 4.12 of TS 23.502 [8] for supporting Registration and connection management from Remote UE to the 5GC over 5G ProSe UE-to-NW Relay access. Remote UE establishes signalling IPsec tunnel with the N3IWF over UE-to-NW relay access using the IKE procedures. Also, similar to untrusted non-3GPP Access, subsequent NAS messages between the UE and N3IWF are exchanged via the signalling IPsec SA over TCP/IP. The control plane protocol stack before establishing IPSec tunnel and after the setup of IPsec tunnel are same as the untrusted non-3GPP access protocol stacks and are shown in Figure 6.23.2-2.



Figure 6.23.2-2: Control plane protocol stacks between Remote UE and N3IWF for L3 UE-to-NW Relay Access

Remote UE supports NAS MM (after registration), SMS and PDU Session establishment/modification/release procedures with the 5GC for the Remote UE traffic by transporting the corresponding NAS Signaling over the signaling IPsec tunnel established with N3IWF.

Remote UE transmits/receives the UP traffic over the Relay's PDU session(s) established for the Remote UE traffic over PC5 UE-to-NW Relay path via child IPSec SA tunnel to the N3IWF. The PCF may provide corresponding URSP rules to assist the Remote UE to identify the services that requries access to N3IWF. In the deployment, the Relay UE's UPF and N3IWF may be collocated.

The user plane protocol stack for L3 UE-to-NW Relay access via N3IWF is same as the user plane protocol stack for untrusted non-3GPP access and is shown in Figure 6.23.2-3.

 Figure 6.23.2-3: User plane protocol stacks between Remote UE and N3IWF for L3 UE-to-NW Relay Access

The solution is transparent for NG-RAN. The NG-RAN (gNB) does not have any different treatment for the Remote UE's traffic comparing to that in baseline Layer-3 UE-to-Network Relay solutions, e.g. described in clause 6.6.

Editor’s Note: Whether there is potential impact from this solution, in terms of the overhead introduced by N3IWF access and L3 IP relay over the radio interface (esp. over PC5), should be evaluated by RAN WGs (at least in terms of radio efficiency, latency and reliability).

Editor’ Note: it is FFS how mobility restrictions will be imposed and enforced on the Remote UE

### 6.23.3 Procedures

A 5G ProSe UE-to-Network Relay capable of access to N3IWF may register to the network (if not already registered) and establish a PDU session enabling the necessary relay traffic to the N3IWF. The 5G ProSe UE-to-NW Relay may need to connect to additional PDU session(s) or modify the existing PDU session in order to provide relay traffic towards Remote UE(s).

As an option, the ProSe UE-to-NW Relay may use two different PDU sessions, one for NAS traffic of Remote UE and other for UP traffic of the Remote UE via N3IWF, if different handling, e.g. priority, is needed.



Figure 6.23.3-1: Remote UE 5GC Registration over L3 UE-to-NW Relay access

1 Remote UE and 5G ProSe UE-to-NW Relay when in-coverage may perform Registration procedures and obtain the ProSe policy and URSP policy information. The ProSe policy and URSP policy indicate whether Remote UE should access 5GC via N3IWF for a particular service or service flow (indicated by URSP). Authorization and provisioning procedure may be any solution for key issue #1 and #3.

Remote UE that has to operate out-of-the-box will be pre-configured with the ProSe policy and URSP policy information.

2-4. ProSe UE-to-NW Relay and Remote UE follow the procedures described in steps 1-4 in clause 6.6.2 Procedures, of solution #6: Layer-3 UE-to-Network Relay, with the below enhancements for N3IWF support:

- the Remote UE and ProSe UE-to-Network Relay are configured (either via provisioning or pre-configuration) of the specific Relay Service Codes;

NOTE: the services requiring the access via N3IWF may be configured with the RSC(s) that can be served by the same Relay.

5. Remote UE selects an N3IWF and determines the N3IWF IP address.

Editor's note: Remote UE N3IWF selection procedures are FFS. It can follow the N3IWF selection procedures defined in section 6.3.6.2 of TS 23.501 for untrusted non-3GPP access as baseline but modifications may be required.

6. Remote UE establishes signaling IPsec tunnel using IKE procedures with N3IWF and performs NAS Registration as shown in Figure 4.12.2.2-1 of TS 23.502 [8]. After the IPSec tunnel is established, Remote UE can perform any of the NAS procedures (incl. PDU Session establishment for the Relay PDU sessions) as specified in Section 4.12 of TS 23.502 [8].

IKE keep alive(s) between the Remote UE and the N3IWF are used for detecting possible path failure. The Remote UE may change Relay UE(s) while maintain the session with N3IWF when the Remote UE and N3IWF support MOBIKE. This is negotiated between the Remote UE and the N3IWF as specified in TS 23.502 [8], clause 4.12.2.2).

### 6.23.4 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

**5GC entitities (AMF, PCF, UPF):**

- Need to support the non-3GPP access via N3IWF as defined in TS 23.501 [6]

**NG-RAN:**

- Function on the solution adopted for QoS handling.

**N3IWF:**

- None.

**Relay UE:**

- Configured to establish a PDU session for relaying (network configuration ensures that this PDU Session provides access to N3IWF).

**Remote UE:**

- Remote UE needs to support running at least Rel-15 defined procedures for untrusted non-3GPP access via N3IWF over L3 UE-to-NW Relay.

## 6.24 Solution #24: End-to-End QoS support for Layer-3 UE-to-Network Relay

### 6.24.1 General Description

This solution addresses Key Issue#3 " Support of UE-to-Network Relay ". Specifically, this solution addresses the aspects on " How to support end-to-end requirements between Remote UE and the network via a UE-to-Network Relay, including QoS (such as data rate, reliability, latency)" and " How the network allows and controls the QoS requirement for 5G ProSe UE-to-NW relay."

In Layer 3 UE-to-NW relay solution (Solution #6), the Remote UE's data flow is served by the Relay UE's PDU Session. As the UE-to-Network relay path comprises of two legs (PC5 and Uu) as shown in figure 6.24.1-1 below, the end-to-end QoS can be met only when the QoS requirements are properly split and satisfied over the two legs respectively.



Figure 6.24.1-1. End-to-End QoS split for Layer 3 UE-to-Network Relay solution

The QoS requirements on the PC5 link are controlled with PC5 QoS rules and PC5 QoS parameters (PQI, GFBR, MFBR, PC5 LINK-AMBR, Range, etc) as specified in clause 5.4 of TS 23.287 [5]. The QoS requirements on the Uu link are controlled via with 5G QoS rules and 5G QoS parameters (5QI, GFBR, MFBR, etc) as specified in clause 5.7 of TS 23.501 [7].

The Uu leg's QoS is associated with the PDU Session established by the UE-to-Network Relay, and therefore the procedure as defined in TS 23.502 [8] clause 4.3.2 and 4.3.3 applies. The SMF of the UE-to-Network Relay would provide the corresponding QoS rules and flow level QoS parameters to the UE-to-Network Relay.

As explained above, the UE-to-Network Relay needs to translate the Uu QoS information into the corresponding PC5 QoS parameters in order to achieve the proper end-to-end QoS. Since the Remote UE and the UE-to-Network Relay uses PC5 unicast communication mode, most of the flow level QoS parameters can be directly reused. The only parameter that requires assistance in the translation is the mapping of 5QIs and PQIs. It is therefore necessary that the UE-to-Network Relay to be configured with the proper mapping information.

NOTE: The UE-to-Network Relay can be configured with a per Relay Service Code based mapping of 5QIs and PQIs.

Based on this information received form SMF, the UE-to-Network Relay establishes corresponding PC5 QoS Flows, using the procedure defined in TS 23.287 [5] clause 6.3.3.4. There can be a 1-to-1 mapping of the PC5 QoS Flow and the Uu QoS Flow for the Remote UE.

In case that the Remote UE requested dedicated PC5 QoS Flows when establishing the L2 Link over PC5, the UE-to-Network can map the PC5 QoS requirements into Uu QoS requirements and perform the UE requested PDU session Modification as defined in TS 23.502 [8] clause 4.3.3.

### 6.24.2 Enhancements to support dynamic QoS handling

As shown in figure 6.24.1-1, the end-to-end connection from the Remote UE to the AS involves two over-the-air links, i.e. Uu and PC5. Therefore, to meet the PDB for a particular service, the AN PDB utilized by the NG-RAN needs to be reduced, in order to give some budgets for the PC5 link. Note that this is independent of whether L2 or L3 Relay architecture is used.

One way to achieve this without affecting the NG-RAN is for the SMF to modify the PDB signalled to the NG-RAN in the QoS Profile for the QoS Flows of the Remote UE's traffic. SMF follows the PCC rules (if it is PCF determined) or based on local configuration to deduct the PDB.

When dynamic PCC control is supported, the SMF can base on the PCC rules to determine the PDB to use. Otherwise, SMF can base on pre-configuration, e.g. using DNN and/or S-NSSAI, to determine if and how to modify the PDB.

When dynamic PCC control is supported, it is possible that the AF may be able to request certain QoS handling of the traffic when the Remote UE initiated a session. This can be achieved by using the feature as defined in TS 23.503 [18] clause 6.1.3.22. The AF is able to locate the UE-to-Network Relay's PCF using the procedure as defined in TS 23.503 [18] clause 6.1.1.2, since the Remote UE uses an address belonging to the UE-to-Network Relay's PDU session.

The PCF can generate corresponding PCC rules, and the SMF in turn generate the QoS rules and flow level QoS parameters and signal to the UE-to-Network Relay using PDU Session Modification procedure. The UE-to-Network Relay then uses the L2 Link Modification procedure defined in TS 23.287 [5] clause 6.3.3.4 to set up the related PC5 QoS flows.

### 6.24.2 Procedures

Existing procedures defined in TS 23.502 and TS 23.287 can be used to manage the QoS flows and PC5 QoS flows to serve the Remote UE.

### 6.24.3 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

**SMF:**

- SMF optionally supports modifying the PDB for a QoS Flow serving the Remote UE based on either PCC rules or pre-configuration.

**UE:**

- 5G ProSe UE-to-Network Relay supports the mapping of Uu flow level QoS parameters to PC5 QoS parameters, including the mapping of 5QIs to PQIs, based on either configuration or standardized mapping.

## 6.25 Solution #25: QoS handling for Layer-3 UE-to-Network Relay

### 6.25.1 Description

This is a solution for Key Issue #3, UE-to-Network Relay. especially it’s used for the QoS control of Layer-3 UE-to-Network Relay.

For a Remote UE accessing network via UE-to-Network Relay, the QoS control between Remote UE and UPF includes two parts: one part is the QoS control for the connection between remote UE and UE-to-Network Relay, the other part is the QoS control for the connection between UE-to-Network Relay and UPF. In this solution PCF is responsible to set the QoS parameters between UE and UE-to-Network Relay, (we call it “PC5 QoS parameters”), and the QoS parameters between UE-to-Network Relay and UPF (we call it “Uu QoS parameters”) separately to support the QoS requirement between Remote UE and UPF.

For PC5 interface, when standardized PQI is used, the PC5 QoS parameters includes PQI and other optional QoS parameters, e.g. GFBR. When non-standardized PQI is used, the whole set of PC5 QoS characteristics is also included.

PCF ensures the PDB associated with the 5QI in the Uu QoS parameters and the PDB associated with the PQI in the PC5 QoS parameters supports the PDB between Remote UE and UPF. PCF also ensures other QoS parameters/QoS characteristics in the Uu QoS parameters and PC5 QoS parameters are compatible, e.g. have the same value.

The UE-to-Network Relay and Remote UE are pre-configured with authorized service(s) and the related PC5 QoS parameters. These can be provided by PCF during provisioning procedure. PCF may also provide default PC5 QoS parameters to NW Relay and Remote UE, this can be used for the out of coverage Remote UE or for the applications which is not frequently used.

When a Remote UE want to use the service offered by an AF through 3GPP network, it selects a UE-to-Network Relay and establishes a PC5 connection between Remote UE and NW Relay, if the Remote UE doesn’t have the PC5 QoS parameters of the service, a default PC5 QoS Flow is setup using the default PC5 QoS parameters in the provisioning information.

UE-to-Network Relay also setup a corresponding PDU session for relaying, e.g. based on the S-NSSAI, DNN requested by remote UE. After the IP address/prefix allocation, UE-to-Network Relay reports the IP info of remote UE to SMF, PCF also receives the IP info of remote UE from SMF.

If the Remote UE doesn’t have the PC5 QoS parameters of the service, After the PC5 connection and the related PDU session setup, remote UE interacts with AF for the application layer controlling messages required by the service, the interaction is transferred through the default PC5 QoS Flow and the default QoS Flow of the PDU session. Then AF provides the service requirement to PCF. As PCF has received the remote UE report from SMF, PCF knows the target UE requested by AF is a remote UE, PCF generates PCC rules (for QoS control on Uu) and the PC5 QoS parameters (for QoS control on PC5), the PCF decision for example could base on the received service requirements from AF and the operator policies and the charging rate of Uu and PC5.

### 6.25.2 Procedures



**Figure 6.25.1-1 QoS control for L3 UE-to-Network Relay**

1. When a Remote UE want to use the service offered by an AF through 3GPP network, it selects a UE-to-Network Relay and establishes a PC5 connection between Remote UE and NW Relay, it’s same as the PC5 part of step3 described in clause 6.6.2. In this step, if the Remote UE doesn’t have the PC5 QoS parameters of the service, a default PC5 QoS Flow is setup using the default PC5 QoS parameters in the provisioning information.
2. UE-to-Network Relay sets up a corresponding PDU session or uses an existing PDU session for relaying, e.g. based on the S-NSSAI, DNN requested by remote UE.
3. After the IP address/prefix allocation, UE-to-Network Relay reports the IP info of remote UE to SMF, SMF also forwards the received report to PCF.
4. If the Remote UE doesn’t have the PC5 QoS parameters of the service, Remote UE interacts with AF for the application layer controlling messages required by the service, the interaction is transferred through the default PC5 QoS Flow and the default QoS Flow of the PDU session.
5. Since the address used by Remote UE belongs to the UE-to-Network Relay's PDU session, AF is able to locate the UE-to-Network Relay's PCF and provides the service requirement to PCF.
6. PCF knows the target UE requested by AF is a remote UE, e.g. by the IP info provided by AF and the IP info of remote UE received from SMF. PCF generates PCC rules (for QoS control on Uu) and the PC5 QoS parameters (for QoS control on PC5), the PCF decision for example could base on the received service requirements from AF and the operator policies and the charging rate of Uu and PC5. PCF provides PCC decision to SMF.
7. Based on the PCC rules received from PCF, SMF may decides to setup a new QoS Flow or modify an existing QoS Flow for the PDU session. SMF generates QoS rule to be enforced at UE-to-Network Relay and the QoS profile to be enforced at RAN for the QoS control of Uu part. PDU session modification procedure is performed. The PC5 QoS parameters is also provided to UE-to-Network Relay together with the related QoS rule.
8. UE-to-Network Relay uses the PC5 QoS parameters received from CN to initiate the Layer-2 link modification procedure as described in TS 23.287 [5].

### 6.25.3 Impacts on services, entities and interfaces

- PCF generates PCC rules (for QoS control on Uu) and the PC5 QoS parameters (for QoS control on PC5).

- UE-to-Network Relay modify the Layer-2 link based on the PC5 QoS parameters received from CN.

## 6.26. Solution #26: URSP enhancements to support UE-to-Network Relay operation

### 6.26.1 General Description

When a Remote UE has discovered a UE-to-Network Relay, it would have a choice of different communications paths for an application/service, for example:

- Via Uu directly to the base station and network (does not use the UE-to-Network Relay);

- Via a UE-to-Network Relay (in-direct network access) and access the service via a UE-to-Network Relay's UPF (e.g. as described in Solution#6); or

- Via a UE-to-Network Relay (in-direct network access) but access the service via Remote UE's own UPF (e.g. as in Solution#7 or Solution #23 via N3IWF).

When the application traffic is routed along these different paths, different QoS and security/privacy considerations apply. For example, due to the use of Relay, and the additional PC5 link, the end-to-end PDB may be longer than the direct access to the network. Therefore, some of the services may not be suitable to be used over the Relay link. Additionally, if Remote UE uses the UE-to-Network Relay's UPF to access the service, it cannot enjoy the benefit provided by IP address preservation. The user experience would be similar to using NSWO.

In this sense, the Remote UE needs to know if an application's traffic can be routed via a certain path, so that the service requirements can be still met. URSP rules as defined in 3GPP TS 23.503[18] provide the policy control information to support this control at the Remote UE. In order to support the UE-to-Network Relay operation, the URSP definition and interpretation needs to be enhanced as following.

### 6.26.2 URSP enhancements to support UE-to-Network Relay operation

**Non-Seamless Offload indication**

In the current definition of URSP in TS 23.503 [18], the "Non-Seamless Offload indication" only applies to non-3GPP access. However, in case of UE-to-Network relay operation, when the Remote UE access the service via the Layer 3 UE-to-Network Relay's UPF (i.e. solution#6), the traffic handling is similar, i.e. sent outside of a Remote UE's PDU Session.

Thus, this *“Non-Seamless Offload indication”* can be extended with some value to indicate if the offloading is via non-3GPP access or a Layer 3 UE-to-Network Relay.

Alternatively, a new similar indicator, e.g. “ProSe Layer 3 UE-to-Network Relay offload indication”, can be added to the Route selection components to govern if the application traffic can be routed via a Layer 3 UE-to-Network Relay path.

The Remote UE can use this indicator to determine the corresponding operations when accessing a UE-to-Network Relay. For example, if any active application matches a URSP rule that does not have this indicator, the Remote UE should attempt to establish a PDU session based on the URSP rules, e.g. via the N3IWF over the Layer 3 UE-to-Network Relay, or use a Layer 2 UE-to-Network Relay.

If, however, the application matches a URSP rule that has this indicator present, the traffic can be routed via the Layer 3 UE-to-Network Relay directly, and no PDU session is required.

Editor’s note: It’s FFS whether the N3IWF identifier is included in ANDSP or 5G ProSe Remote UE Policy/parameters for accessing 5GC via a Layer 3 UE-to-Network Relay.

**Access Type Preference**

The current Access Type preference defined in TS 23.503 [18] only includes 3GPP or non-3GPP when the UE establishes a PDU session for the matching applications. However, when the UE-to-Network Relay is used, e.g. Layer 2 UE-to-Network relay (Solution#7) or Layer 3 UE-to-Network relay with N3IWF (Solution #23), the Remote UE supports the access via the UE-to-Network Relay path via PC5 link.

Therefore, it is preferable to extend the existing *“Access Type preference” IE* to include PC5 path, so that the Remote UE will be able to determine which type of access should be used.

### 6.26.3 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

**UE:**

- Remote UE needs to be able to interpret the URSP rules as defined above to assist the path selection in case of accessing service via UE-to-Network Relay.

## 6.27 Solution #27: Secondary Authentication for a Layer 3 Remote UE

### 6.27.1 Description

This is a solution for key issue #3, UE-to-Network Relay and based on Solution #6: Layer-3 UE-to-Network Relay. This solution is only applicable for Layer 3 UE-to-Network Relay. When a subscription indicates that secondary authentication is required, the Remote UE shall perform secondary authentication. Because Application cannot differentiate whether a UE is connected via UE-to-Network Relay or directly connected to the 5GC, if a UE connects to the application server without performing Secondary authentication, the application server may not provide service to the UE because application server may regard the UE as an abnormal UE. So secondary authentication should be supported even though a UE is connected via UE-to-Network Relay.

### 6.27.2 Procedures



Figure 6.27.2-1: Secondary authentication procedure for a Remote UE

1. Steps 0 ~ 4 in Figure 6.6.2-1.

2. Step 5 in Figure 6.6.2-1. The ProSe 5G UE-to-Network Relay sends a Remote UE Report (Remote User ID, IP info) message to the SMF for the PDU session associated with the relay.

3. When the SMF received Remote UE Report, based on local configuration of the SMF, the SMF may retrieve subscription data of the Remote UE from the UDM and may perform Secondary authentication/authorization for the Remote UE. The SMF sends PDU Session Authentication Command message to the 5G ProSe UE-to-Network Relay including Remote User ID.

4. The 5G ProSe UE-to-Network Relay sends EAP message to the Remote UE via PC5 signalling. The Remote UE sends EAP message to the 5G ProSe UE-to-Network Relay via PC5 signalling.

5. The 5G ProSe UE-to-Network Relay sends PDU Session Authentication Complete message to the SMF including Remote User ID and EAP message received from the Remote UE.

6. The SMF sends EAP message to the DN-AAA.

7. If the authentication/authorization success, the DN-AAA sends EAP-Success to the SMF.

8. If the authentication/authorization fails, the DN-AAA sends EAP-Failure to the SMF. The SMF sends NAS message (e.g. PDU Session Modification, Remote UE Release Command) to the 5G ProSe UE-to-Network Relay. The NAS message includes Remote User ID to indicate the Remote UE and the 5G ProSe UE-to-Network Relay releases the PC5 link with the Remote UE.

NOTE 1: It is possible to perform secondary authentication procedure in parallel when multiple Remote UEs are connected to the 5G ProSe UE-to-Network Relay almost at the same time.

NOTE 2: The DN-AAA does not know whether a UE is connected via 5G ProSe UE-to-Network Relay or connected directly to the network.

Editor's note: Whether this solution can satisfy the security requirement (e.g., EAP message forwarded by UE-to-Network Relay) will be investigated and confirmed by SA WG3 group.

### 6.27.3 Impacts on services, entities and interfaces

**Remote UE:**

- send and receives EAP message via PC5 signalling;

- execute secondary authentication with SMF.

**UE-to-Network Relay UE:**

- includes Remote User ID in the PDU Session Authentication message and relays EAP message between Remote UE and SMF.

**SMF:**

- decides whether to perform secondary authentication based on subscription of Remote UE;

- execute secondary authentication with Layer 3 Remote UE:

- when SMF performs secondary authentication for a Remote UE, Remote User ID is included in the PDU Session Authentication message;

- if secondary authentication is failed, the SMF sends NAS message to release PC5 link.

## 6.28 Solution #28: Layer-3 UE-to-Network Relay Discovery and Connection Establishment

### 6.28.1 Description

This solution provides a mechanism for the Remote UE to discover a Layer-3 UE-to-Network Relay and establish a PC5 unicast connection with a UE-to-Network relay.

#### 6.28.1.1 UE-to-Network Relay discovery

Both Model A and Model B discovery mechanisms can be used for Layer-3 UE-to-Network Relay discovery.

The Layer-3 UE-to-Network Relay acts as Announcing UE/Discoveree UE and the Remote UE acts as Monitoring UE/Discoverer UE with following enhancements:

- Model A: The Layer-3 UE-to-Network Relay announces UE-to-Network Relay Service Code which is associated to dedicated network slicing information, e.g. S-NSSAI. The Remote UE monitors announcement messages with UE-to-Network Relay Service Code.

- Model B: The Remote UE sends a solicitation message with the UE-to-Network Relay Service Code which is associated to dedicated network slicing information; the UE-to-Network Relay replies with a response message which includes a UE-to-Network Relay Service Code.

The Layer-3 UE-to-Network Relay and the Remote UE receive the association between UE-to-Network Relay Service Code and Slicing information during the Service Authorization and Provisioning procedure in solution #16.

NOTE: The privacy aspects of preconfiguring slicing information in UE-to-Network relays need to be coordinated with SA3

The Remote UE shall consider the network slicing information associated with the UE-to-Network Relay Service Code when selecting a UE-to-Network Relay.

#### 6.28.1.2 PC5 connection establishment

After UE-to-Network Relay discovery, the Remote UE may decide to establish a PC5 connection with a UE-to-Network Relay. The PC5 connection establishment reuses the Direct Communication procedure as described in subclause 6.3.3 of TS 23.287, with the following enhancements:

- The Remote UE determines the PDU session requirements (e.g. S-NSSAI, DNN) and includes the PDU session requirements in the Direct Communication Request message during the PC5 connection establishment procedure. How to determine the PDU session requirements is based on, e.g. URSP rules (pre-configured or received from PCF during previous Remote UE registration procedure as step 0 in Figure 6.6.2-1).

NOTE: The privacy aspects of transporting PDU session parameters using an unsecured PC5 Direct Communication Request message need to be coordinated with SA3

Editor’s note: It’s FFS on how to use the PDU session requirements at UE-to-Network Relay for the purpose of associating a PDU Session and how the UE-to-Network Relay to handle the case that the PDU session requirements cannot be satisfied.

Editor’s note: When the Remote UE and UE-to-Network Relay receive 5G ProSe Remote UE Authorization policy/parameters and URSP from different HPLMN, whether and how these PDU Session requirements received by the UE-to-Network Relay can be understood by it is FFS. In this case, whether the PDU Session requirements will be considered by UE-to-Network Relay is FFS.

- Upon receiving a Direct Communication Request message, the UE-to-Network Relay may decide to establish a new PDU session or modify an existing one for the traffic of the Remote UE, based on the PDU session requirements received from the Remote UE.

### 6.28.3 Impacts on services, entities and interfaces

Remote UE:

- Discover and select UE-to-Network Relay based on network slicing information.

- Provide PDU session requirements during PC5 connection establishment.

- Keep association between UE-to-Network Relay Service Code and Slicing information.

UE-to-Network Relay:

- Keep association between UE-to-Network Relay Service Code and Slicing information.

- Handle PDU session based on PDU session requirements received from the Remote UE.

## 6.29 Solution #29: Service continuity via L2 UE-to-Network Relay

6.29.1 Description

This solution, based on Solution 7, addresses Key Issue #3 and proposes a Layer-2 based UE-to-Network relay solution to ensure the service continuity between the remote UE and the network for the intra-NG-RAN case.

NOTE: This solution is documented for illustration purpose only. It will be updated to highlight the SA2 impact if identified any, or will be removed and replaced by referencing to RAN WG conclusion if any in this area.

6.29.2 Procedures

#### 6.29.2.1 From direct to indirect path under the same NG-RAN



Figure 6.29.2.1-1: Service continuity from direct to indirect under the same NG-RAN

0. It is assumed that the Remote-UE has been authorized to access to the network via a UE-to-Network Relay.

1. The Remote UE receives the measurement configuration via RRC message from the NG-RAN. The access stratum procedure that the Remote UE, UE-to-Network Relay and served NG-RAN node for handover is defined by RAN2.

2. The NG-RAN may trigger the AN initiated PDU Session Modification as specified in TS 23.502 [8].

#### 6.29.2.2 From indirect to direct path under the same NG-RAN



Figure 6.29.2.1-2: Service continuity from indirect to direct under the same NG-RAN

1.  The Remote UE receives the measurement configuration via RRC message from the NG-RAN as defined in TS38.331 [23]. The access stratum procedure that the Remote UE, UE-to-Network Relay and served NG-RAN node for handover is defined by RAN2.

2. The NG-RAN may trigger the AN initiated PDU Session Modification as specified in TS 23.502 [8].

6.29.3 Impacts on services, entities and interfaces

This solution needs to use the RAN specified L2 relay functionality for forwarding the signalling and user data between the Remote UE and the network.

Remote UE

- Sends AS message(s) to UE-to-Network Relay to execute handover. The procedure is decided by RAN.

NG-RAN

- AS procedures for handover. The procedure is decided by RAN.

AMF/SMF

- No impact.

## 6.30 Solution #30: Authorization of UE-to-Network Relay UE and Remote UE

### 6.30.1 Description

This solution applies to Key Issue 3 on authorization for Indirect 3GPP Communication, specifically on how to authorize a UE to access 5GC via a 5G UE-to-Network Relay. In this solution, the core network performs authorization functions when a Remote UE is accessing to the network via a specific UE-to-Network Relay UE. This solution is used for Layer 2 UE-to-Network Relay.

### 6.30.2 Procedures

0. UE performs the Registration and gets the service authorization parameters. This step can reuse the step 0a and step 0b in Solution #6, or the step 0 and step 1 in Solution #7.

1. Relay discovery and selection. This step can reuse the step 2 in Solution #6 (see clause 6.6.2), or the step 2 and step 3 in Solution #7 (see clause 6.7.2). Using restricted discovery with Relay Service Code can achieve a certain level of authorization.

2. The Remote UE sends communication request to the Relay UE. This step can reuse the step 3 in Solution #6, or step 4 in Solution #7.

3. The Relay UE, after receiving the communication request from the Remote UE, sends an authorization request to the CN NF (AMF or PCF). Relay UE may use NAS message, such as service request message or registration message, to send the authorization request. If authorization is performed by PCF, AMF transfers the authorization request to the AM PCF. The CN NF will check if the Remote UE is authorized to access 5GC via the Relay UE and indicate the result of the authorization check to the Relay UE. The CN NF may check the authorization based on subscription data of the Relay UE, such as list of Remote UEs allowed to use this Relay UE’s service. The Remote UE ID and the Relay UE ID are included in authorization request message. The UE ID can be same as Remote User ID in Solution#6, such as Upper layers User Info or SUPI.

4. The Relay UE sends the communication response message to the Remote UE, and may indicate the authorization result.

5. Other steps are performed, such as step 4-5 in procedure of Solution #6, or step 7-9 in procedure of Solution #7.



Figure 6.30.2-1: Authorization of UE-to-Network Relay UE and Remote UE

### 6.30.3 Impacts on services, entities and interfaces

The solution has impacts in the following entities:

Relay UE:

- Needs to support procedures for authorization.

AMF/PCF:

- Needs to support procedures for authorization.

## 6.31 Solution #31: QoS control for UE-to-UE Relay

### 6.31.1 Description

This is a solution for Key Issue #4, UE-to-UE Relay

Editor’s note: Whether this solution is applicable for Layer 2 UE-to-UE Relay is FFS.

When a source UE wants to establish unicast communication with a target UE, the source UE will decide the E2E QoS parameters between source UE and target UE based on the application layer requirements. The E2E QoS parameters, especially the PDB, needs to be split between the two PC5 interface.

Relay will split the E2E QoS parameters into two parts: one part is the QoS parameters between source UE and Relay (we call it “Source side PC5 QoS parameters”), the other part is the QoS parameters between Relay and the target UE (we call it “Target side PC5 QoS parameters”).

When standardized PQI is used, the Source side PC5 QoS parameters and the Target side PC5 QoS parameters include PQI and other optional QoS parameters, e.g. GFBR. When non-standardized PQI is used, the whole set of PC5 QoS characteristics is also included.

Relay ensures the PDB associated with the PQI in the Source side PC5 QoS parameters and the PDB associated with the PQI in the Target side PC5 QoS parameters supports the E2E PDB requirements between Remote UE and target UE. Relay also ensures other QoS parameters/QoS characteristics in the Source side PC5 QoS parameters and Target side PC5 QoS parameters are compatible, e.g. have the same value. The Relay decision may be based on the local policy or the low layer measurement.

### 6.31.2 Procedures



Figure 6.31.1-1 QoS control for UE-to-UE Relay

1. Source UE wants to establish unicast communication with target UE, it decides the E2E QoS parameters between source UE and target UE based on the application layer requirements. The Source UE sets up a PC5 QoS Flow with PFI=PFI\_s. Then Source UE provides the PFI\_s, E2E QoS parameters, source and target user info to UE-to-UE Relay. The process is similar to the unicast L2 link establishment or modification procedure as defined in TS 23.287 [5] clause 6.3.3.
2. Relay splits the E2E QoS parameters into two parts: one part is for the PC5 interface between source UE and Relay, the other part is for the PC5 interface between Relay and the target UE. Relay will setup a PC5 QoS Flow with PFI=PFI\_t using the target side PC5 QoS parameters between Relay and the target UE.
3. Relay provides the PFI\_t, target side PC5 QoS parameters, source and target user info to target UE. The process is similar to the unicast L2 link establishment or modification procedure as defined in TS 23.287 [5] clause 6.3.3.
4. Relay receives the Layer-2 link establishment/modification accept from target UE.
5. Relay provides the Layer-2 link establishment/modification accept to the source UE with the PFI\_s and the source side PC5 QoS parameters.

### 6.31.3 Impacts on services, entities and interfaces

- UE-to-UE Relay supports the E2E QoS parameters splitting between the two PC5 interfaces.

## 6.32 Solution #32: Support Layer-3 UE-to-UE Relay Based on IPv6 link-local addresses

### 6.32.1 Description

The basic idea of the solution is when a remote UE establishes a connection with a UE-to-UE relay, it uses its link-local IPv6 address as its IPv6 address and informs to the relay UE. The relay UE maintains a mapping between link-local IPv6 addresses to UE IDs (e.g. Application Layer IDs), as well as mapping from an Application User ID to a PC5 unicast link.

The solution is based on the following assumptions:

1. A remote UE establishes a unicast link to a relay UE for communicating with other remote UEs which connects to that relay UE.

2. For a specific remote UE, the traffic to other remote UEs through the same relay UE can share the same unicast link to that relay UE.

3. When the relay UE receives a packet from a remote UE, it forwards the packet to an PC5 unicast link according to the destination IP address in the packet.

### 6.32.2 Procedures

In this clause, UE-1 and UE-2 are remotes UEs, relay-1 is Layer-3 UE-to-UE relay.

#### 6.32.2.1 Relay path establishment procedure

Step 1. UE-1 and UE-2 do the relay selection. In this step, any solution for UE-to-UE relay selection can be applied here, e.g. solution#8.

Step 2. UE-1 and UE-2 establish individual unicast link to Relay-1, if they do not have unicast link with the relay for the UE-to-UE relaying communication use case.

UE forms its own link-local IPv6 address based on RFC 4862[xx] and informs the IP address to the relay UE. Relay UE maintains a mapping between the UE ID (e.g. Application Layer ID) and the link-local address.

NOTE 1: If the link-local IP address of UE-1 or UE-2 is conflicting with the link-local IP address of another remote UE that has already connected to the relay UE, the relay shall inform UE-1 or UE-2 to change its link-local IP address, e.g. using the address duplicate detection procedure defined in RCF 4862[xx].

In this step, the remote

Step 3. If UE-1 does not know the IP address of UE-2, it sends a request to the relay UE, asking the IP address of UE-2. The request includes the UE-2 ID, e.g. the Application Layer ID. Relay-1 gives the link-local IP address of UE-2 to UE-1. UE-2 does the same procedure if it does not know the IP address of UE-1.

Step 4. UE-1 and UE-2 can communicate with each other via Relay-1.

When the remote UEs change Layer-3 UE-to-UE relay, they can keep their link-local IP addresses. The old UE-to-UE relay shall remove the mapping between the link-local IP address and the remote UE.

Editor’s Note: Whether and how to support periodic change of the link-local IP address due to privacy requirement is FFS and co-ordinated with SA3 group.



**Figure 6.32.2.1-1 UE-1 communicates with UE-2 via Layer-3 UE-to-UE relay**

### 6.32.3 Impacts on services, entities and interfaces

The solution impacts the relay UE to support IP packets forwarding between remote UEs.

## 6.33 Solution #33: Network-Assisted UE-to-UE Relay Discovery and Selection

### 6.33.1 Description

For the dedicated application service, e.g. direct communication within a factory plant, the UEs in the same group may communicate with each other via direct PC5 link, such as the UE1, UE2, UE3 as shown in the graph below. However due to UE mobility, UE2 may move out of PC5 coverage of UE1, then there should be a UE3 to as a UE-to-UE relay to transfer the packets between UE1 and UE2.

Assuming two 5G ProSe-enabled UEs commnicate with each other using ProSe direct communication, due to the UE mobility, the communciation path may exceed the direct communication range. In order to continue the communication, a UE-to-UE relay is inserted to forward the traffic between the two UEs.

If 5G ProSe-enabled UEs are in coverage, 5G network can track the location of the UE. When 5G network determines the direct communication path will not be available, it may provide the UE-to-UE relay information to the 5G ProSe-enabled UE.

The UE-to-UE relay information e.g. UE ID and UE location, is retrived by the 5G network from the ProSe application server. 5G network authorizes UE-to-UE relay once provisioned by the ProSe application server. Besides of the UE-to-UE relay information, ProSe application server also provides information of the 5G ProSe-enabled UE using the ProSe direct communication, e.g. which two UEs are using ProSe direct communication.

5G network tracks the 5G ProSe-enabled UE based on their cell information, and in addition more accuracy location by LCS procedure.

If there is more than one candidate UE-to-UE relay, 5G network selects the most suitable UE-to-UE relay, based on the location and capability of the UE-to-UE relay.

When receiving the UE-to-UE relay information from the 5G network, 5G ProSe-enabled UE establishes the PC5 link with UE-to-UE relay and sends packet to the other 5G ProSe-enabled UE i.e. receiver UE, via the UE-to-UE relay.



Figure 6.33.1-1: Network-Assisted UE-to-UE relay Discovery and Selection

### 6.33.2 Procedure

Figure 6.33.2-1 shows the peer discovery and unicast link establishment over PC5 reference point via a UE-to-UE Relay.



Figure 6.33.2-1: Network-Assisted Connection establishment procedure via a UE-to-UE Relay

0. UE-to-UE Relay registers with the network and specifies its UE-to-UE Relay capabilities.

1-2. External AF may provide the UE trajectory information of UEs to network via NEF. For example, network may determine that Target UE may move out of PC5 coverage of Remote UE based on the Target UE or Remote UE’s trajectory, this step is optional.

3. UE-1 and UE-2 are communicating with each other via direct PC5 link.

4. After establishing PC5 link, UE-1 and UE-2 notify 5GS that they are communicating with each other via direct PC5, then 5GS may subscribe to (one of the) UEs for the PC5 link status.

5. Network locates the UE-1, UE-2, and UEs that have relay capability and are authorized to use ProSe periodically via the 5GC-MT-LR Procedure specified in clause 6.3.1 of TS 23.273, based on the AF request received in step 1.

6. Based on the relative distance and PC5 link status between UE-1 and UE-2 obtained in step 4 and step 5, AMF(or other NF) determine UE-2 and UE-1 cannot communicate with each other via direct PC5, and select a proper UE-R that locates between UE-1 and UE-2 to as the UE-to-UE relay based on the relative location information between each of them obtained in step 4.

7. (Optional) 5GC informs the UE-R to as the relay to transfer the packets between UE-1 and UE-2, this request includes the UE-1 identity, UE-1 Capability, UE-2 identity, UE-2 Capability.

8. 5GC informs the UE-1 that UE-R will be the relay for its connection with UE-2, this request includes the UE-R identity, UE-R Capability.

NOTE: it is up the UE-1 to establish the PC5 link with UE-R, using the information provided by the 5GC. UE-1 may have other means to discover and select a UE-R.

9. UE-to-UE Relay receives the message from UE-1and transfer the message to UE-2 according to the mapping entry relationship or the UE-2 destination address provided by UE-1.

Editor's note: The details of protocol stack and PC5 link establishment is FFS and need to be co-ordinated and confirmed by RAN WG2 group, and this solution does not have constraint upon Layer-2 or Layer-3 relay.

### 6.33.3 Impacts on services, entities and interfaces

AMF:

- Support for selecting a proper ProSe-enabled UE as the relay UE based on the relative distance calculation.

## 6.34 Solution #34: Charging support for 5G ProSe over U-plane

### 6.34.1 Description

In TS 32.277 [13], a complete charging system was specified for ProSe based on EPS system, including the support of charging support of ProSe Direct Discovery, one-to-many Direct Communication, and one-to-one Direct Communication including UE-to-Network Relay (for public safety use), and EPC based discovery.

Specifically, for the ProSe Direct Communication, offline charging is supported with the architecture in TS 32.277 [13] clause 4.2:

The PC3ch control protocol was defined in TS 24.334 [20], clause 10.3. The PC3ch goes through user-plane to the Charging Trigger Function (CTF). Since the Accounting Data Forwarding (ADF) function block of the CTF is a logical function, it can be residing anywhere in the network, e.g. co-located with a UPF. As specified in TS 24.334 [20], the UE can be configured with the IP address of the ADF, within the configuration from ProSe Function as defined in TS 24.333 [21].

When mapped to 5GS, the provisioning component of the ProSe Function is replaced by PCF. Therefore, the corresponding usage reporting configuration and rules, defined in TS 24.333 [21] clause 5.2, can be provisioned via PCF using the UE Policy provisioning mechanism as defined in TS 23.502 [8].

The reporting channel, i.e. PC3ch, can be setup over a PDU session that is established with the appropriate parameters. The URSP can be used to identify the corresponding parameters for the PDU session to use for this reporting purpose. For example, the reporting can be associated with a specific DNN and S-NSSAI, or connectivity type, as that defined in the Traffic Descriptor of URSP.

The interaction of the ADF (part of CTF) and CHF follows the model defined in TS 32.290 [22] via the Nchf interface that supports converged charging or offline only charging.

Editor's Note: The support of 5G ProSe charging over the Nchf interface needs to be specified by SA5.

### 6.34.2 Procedures

#### 6.34.2.1 UE Configuration for the ProSe usage reporting

Procedure defined in TS 23.502 [8] clause 4.2.4.3 UE Configuration Update procedure for transparent UE Policy delivery is used for provisioning the UE regarding the PC5 usage reporting to support ProSe charging.

The UsageInformationReprotingConfiguration as defined in clause 5.2.58 to 5.2.66B of TS 24.333 [21] should be contained in the UE Policy container to the UE, which contains the Server Address for the reporting of the usage over PC5.

In order to support the use cases that requires out of coverage operation or out of box operation, the configuration may be stored in the ME, UICC, or both, similar to the handling of V2X policies in TS 23.287 [5].

#### 6.34.2.2 UE usage reporting

Based on the configuration described in 6.34.2.1, the UE will establish a PDU session or use an existing PDU session, based on the URSP configuration, for the usage reporting.



Figure 6.34.2.2-1: ProSe Direct Communication offline charging architecture

### 6.34.3 Impacts on services, entities and interfaces

For 5G ProSe UEs, the authorization and provisioning polices needs to be extended to support the operation.

As for the network nodes, only the following need to be added:

- PCF needs to be enhanced to support the provisioning of the ProSe usage reporting configuration for charging support.

- UE needs support the ProSe usage reporting to the ADF/CTF as configured by PCF.

- A new ADF/CTF node need to be added to the system, that should be able to use Nchf interface to interact with CHF as defined in TS 32.290 [22].

## 6.35 Solution #35: Authorization for 5G ProSe UE-to-Network Relay Service

### 6.35.1 Description

This solution addresses KI#3 and 8 and applies to both Layer-2 and Layer-3 UE-to-Network Relay.

For KI#3 (Support of UE-to-Network Relay), following aspect is covered:

- How to authorize a UE to be a 5G UE-to-Network Relay and how to authorize a UE to access 5GC via a 5G UE-to-Network Relay.

For KI#8 (Support of PC5 Service Authorization and Policy/Parameter Provisioning), two following major aspects are covered:

- For the procedures related to PC5 service authorization and policy/parameter provisioning to a UE, only necessary enhancement with what is specified in TS 23.287 [5] clause 6.2 and TS 23.502 [8] clause 4.2.2.2 (Registration Procedure), 4.2.4.3 (UE Configuration Update procedure for transparent UE Policy Delivery), 4.16.11 (UE Policy Association Establishment procedure), 4.16.12 (UE Policy Association Modification procedure), will be documented.

- Identify necessary information for PC5 service authorization and provisioning based on what is specified in TS 23.287 [5] clause 5.1.2.1.

The PCF based service authorization and provisioning as defined in TS 23.287 are used as baseline for this solution.

For both Layer 2 and Layer 3 Relay:

* when the Remote UE is in coverage, the Remote UE can be provisioned with authorization policy and parameters by 5GC directly with enhancement described in clause 6.35.2.2.
* when the Remote UE is out of coverage, the Remote UE can use its preconfigured policy and parameter for PC5 discovery and communication to establish PC5 connection with a UE-to-Network Relay first, then:
  + For Layer 2 Relay, the existing PCF based service authorization and provisioning procedure can be used with enhancement described in clause 6.35.2.2, which applies to the communication between Remote UE and 5GC since the NAS signalling between Remote UE and 5GC is transparent to UE-to-Network Relay.

### 6.35.2 Procedures

#### 6.35.2.1 Procedure Enhancement for Information Provisioning to a 5G ProSe Remote UE/UE-to-Network Relay

For PCF based Service Authorization and Provisioning to 5G ProSe Remote UE/UE-to-Network Relay, the Registration procedures as defined in clause 4.2.2.2 of TS 23.502, UE Policy Association Establishment procedure as defined in clause 4.16.11 of TS 23.502 and UE Policy Association Modification procedure as defined in clause 4.16.12 of TS 23.502 apply with the following additions:

- If the UE indicates 5G ProSe capability as a Remote UE/UE-to-Network Relay in the Registration Request message and if the UE is authorized to be a 5G ProSe Remote UE/UE-to-Network Relay based on subscription data, the AMF selects the PCF which supports 5G ProSe information provisioning and establishes a UE policy association with the PCF for 5G ProSe Remote UE/UE-to-Network Relay information provisioning delivery.

- If the AMF receives the 5G ProSe capability as a Remote UE/UE-to-Network Relay in the Registration Request message from UE, the AMF further reports the 5G ProSe capability as a Remote UE/UE-to-Network Relay to the selected PCF. The PCF determines the 5G ProSe Remote UE/UE-to-Network Relay information based on the received 5G ProSe capability as a Remote UE/UE-to-Network Relay.

- If the UE supports 5G ProSe capability as a Remote UE/UE-to-Network Relay and it does not have valid 5G ProSe Remote UE/ UE-to-Network Relay information, the UE includes the UE Policy Container with indicating the 5G ProSe Remote UE/UE-to-Network Relay Information Provisioning request during registration procedure.

- If the UE indicates the 5G ProSe UE-to-Network Relay Information Provisioning request in the UE Policy Container, the PCF determines whether to provision the 5G ProSe Remote UE/UE-to-Network Relay Information to the UE, as specified in clause 6.1.2.2.2 of TS 23.503, and the PCF provides the 5G ProSe Remote UE/UE-to-Network Relay Information to the UE by using the procedure as defined in clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy Delivery" in TS 23.502.

The PCF may update the 5G ProSe Policy and parameters to the UE in following conditions:

- UE Mobility, e.g. UE moves from one PLMN to another PLMN. This is achieved by using the procedure of UE Policy Association Modification initiated by the AMF, as defined in clause 4.16.12.1 of TS 23.502.

- When there is a subscription change in the list of PLMNs where the UE is authorized to perform the 5G operation. This is achieved by using UE Policy Association Modification initiated by the PCF procedure as defined in clause 4.16.12.2 of TS 23.502.

- When there is a change of service specific parameter as described in clause 4.15.6.7 of TS 23.502.

If the serving PLMN is removed from the list of PLMNs in the service authorization parameters, the service authorization is revoked in the UE.

When the UE is roaming, the change of subscription resulting in updates of the service authorization parameters are transferred to the UE by H-PCF via V-PCF.

The UE may perform UE triggered Policy Provisioning procedure to the PCF as specified in clause 6.2.4 of TS 23.287 when the UE determines the 5G ProSe Policy and parameters are invalid (e.g. Policy/Parameter is outdated, missing or invalid).

#### 6.35.2.2 The Policy/parameter to a 5G ProSe UE-to-Network Relay

The following information is provisioned in the UE in support of the UE assuming the role of a 5G ProSe UE-to-Network Relay:

1) Authorisation policy for acting as a 5G ProSe UE-to-Network Relay:

- PLMNs in which the UE is authorized to relay traffic for 5G ProSe Remote UEs.

2) 5G ProSe Relay Discovery policy/parameters for 5G ProSe UE-to-Network Relay:

- Includes the parameters that enable the UE to perform 5G ProSe Relay Discovery as a UE-to-Network Relay when provisioned from the PCF in the ME or configured in the UICC:

- Indication to be a UE-to-Network Relay;

- 5G ProSe UE-to-Network Relay Discovery parameters (User Info ID, Relay Service Code(s)) as described in clause 6.35.2.5;

- For Layer 3 Relay, the PDU Session parameters (PDU Session type, DNN, SSC Mode, S-NSSAI, Access Type Preference) to be used for the relayed traffic for each ProSe Relay Service Code;

NOTE 1: Whether the associated PDU session parameters are included depends on the conclusion of UE-to-Network Relay Discovery solutions. For example, if the associated PDU session parameters are negotiated between the Remote UE and the UE-to-Network Relay during PC5 communication establishment phase, these parameters are not needed.

- Includes security related content for 5G ProSe Relay Discovery for each 5G ProSe Relay Service Code.

3) QoS mapping rule for Layer 3 Relay.

- Includes the rules that determine how the 5G ProSe UE-to-Network Relay maps between the 5QI of a QoS Flow over NR Uu and a 5G ProSe PQI value over NR PC5.

- Alternatively, includes the QoS mapping rule over PC5 for UE-to-Network relay service.

NOTE 2: Which QoS mapping rule is provisioned depends on the concluded UE-to-Network Relay QoS handling solution.

#### 6.35.2.3 The Policy/parameter to a Remote UE

The following information is provisioned in the UE in support of the UE assuming the role of a Remote UE and thereby enabling the use of a 5G ProSe UE-to-Network Relay:

1) Authorisation policy for acting as a Remote UE:

- Indicates whether the UE is authorised to access 5GC via a 5G ProSe UE-to-Network Relay.

2) Policy/parameters for 5G ProSe Relay Discovery and for enabling connection to the 5G ProSe UE-to-Network Relay after discovery is performed when provisioned from the PCF in the ME or configured in the UICC:

- 5G ProSe UE-to-Network Relay Discovery parameters (User Info ID, Relay Service Code(s)) as described in 6.35.2.5;

- For Layer 3 Relay, the PDU Session parameters (PDU Session type, DNN, SSC Mode, S-NSSAI, Access Type Preference) to be used for the relayed traffic for each ProSe Relay Service Code;

NOTE 1: Whether the associated PDU session parameters are included depends on the conclusion of UE-to-Network Relay Discovery solutions. For example, if the associated PDU session parameters are negotiated between the Remote UE and the UE-to-Network Relay during PC5 communication establishment phase, these parameters are not needed.

- Includes security related content for ProSe Relay Discovery for each ProSe Relay Service Codes.

3) QoS Mapping rules between for Layer 2 Relay.

- Includes the rules that determine how the 5G ProSe Remote UE maps between the 5QI of a QoS Flow over NR Uu via a UE-to-Network Relay and a 5G ProSe PQI value over NR PC5 with a UE-to-Network Relay.

NOTE 2: Whether QoS mapping rules are needed for Layer 2 Relay is based on the conclusion of PC5 protocol stack for Layer 2 Relay.

#### 6.35.2.4 5G ProSe UE-to-Network Relay Discovery parameters

5G ProSe UE-to-Network Relay Discovery parameters include:

- User Info ID: For Model A, this corresponds to the Announcer Info parameter when the UE is acting as an announcing UE. For Model B, this corresponds to the Discoverer Info in Solicitation messages and the Discoveree Info in Response messages, when the UE is acting as a discoverer or discoveree UE respectively.

- Relay Service Code(s): A Relay Service Code identifies a connectivity service the ProSe UE-to-Network Relay provides to applications. The Relay Service Codes are configured in the ProSe UE-to-Network Relays that provide connectivity services to applications. The Relay Service Codes are configured in the Remote UEs interested in related connectivity services

### 6.35.3 Impacts on services, entities and interfaces

5G ProSe UE-to-Network Relay:

* Indicates 5G ProSe capability as a UE-to-Network Relay in the Registration Request message;
* Includes the UE Policy Container with indicating the 5G ProSe UE-to-Network Relay Information Provisioning request during registration procedure;
* Receive and enforce the Policy and parameter as 5G ProSe UE-to-Network Relay.

5G ProSe Remote UE:

* Indicates 5G ProSe capability as a Remote UE in the Registration Request message;
* Includes the UE Policy Container with indicating the Remote UE Information Provisioning request during registration procedure;
* Receive and enforce the Policy and parameter as 5G ProSe Remote UE.

AMF:

* Determine whether UE is authorized to be a 5G ProSe UE-to-Network Relay or Remote UE;
* Select a PCF capable of authorization Policy and parameter for 5G ProSe UE-to-Network Relay;
* Select a PCF capable of authorization Policy and parameter for 5G ProSe Remote UE;
* Forward UE’s PC5 Capability for 5G ProSe UE-to-Network Relay to PCF;
* Forward UE’s PC5 Capability for 5G ProSe Remote UE to PCF.

PCF:

* Send the Authorization Policy and parameter to 5G ProSe UE-to-Network Relay;

Send the Authorization Policy and parameter to 5G ProSe Remote UE.

## 6.36 Solution #36: Authorization for 5G ProSe UE-to-UE Relay Service

### 6.36.1 Description

This solution addresses KI#3 and 8 and applies to both Layer-2 and Layer-3 UE-to-UE Relay.

For KI#4 (Support of UE-to-UE Relay), following aspect is covered:

- Authorize the UE-to-UE Relay, e.g. authorize a UE as UE-to-UE Relay?

For KI#8 (Support of PC5 Service Authorization and Policy/Parameter Provisioning), two following major aspects are covered:

- For the procedures related to PC5 service authorization and policy/parameter provisioning to a UE, only necessary enhancement with what is specified in TS 23.287 [5] clause 6.2 and TS 23.502[8] [8] clause 4.2.2.2 (Registration Procedure), 4.2.4.3 (UE Configuration Update procedure for transparent UE Policy Delivery), 4.16.11 (UE Policy Association Establishment procedure), 4.16.12 (UE Policy Association Modification procedure), will be documented.

- Identify necessary information for PC5 service authorization and provisioning based on what is specified in TS 23.287 [5] clause 5.1.2.1.

The PCF based service authorization and provisioning as defined in TS 23.287 are used as baseline for this solution.

NOTE: When the UE-to-UE Relay is out of coverage, it can act as a UE-to-UE Relay based on the preconfigured policy and parameters.

Editor’s note: Whether the Remote UE accessing a UE-to-UE Relay needs to be authorized is FFS.

### 6.36.2 Procedures

#### 6.36.2.1 Procedure Enhancement for Information Provisioning to a 5G ProSe UE-to-UE Relay

For PCF based Service Authorization and Provisioning to 5G ProSe UE-to-UE Relay, the Registration procedures as defined in clause 4.2.2.2 of TS 23.502[8], UE Policy Association Establishment procedure as defined in clause 4.16.11 of TS 23.502[8] and UE Policy Association Modification procedure as defined in clause 4.16.12 of TS 23.502[8] apply with the following additions:

- If the UE indicates 5G ProSe capability as a UE-to-UE Relay in the Registration Request message and if the UE is authorized to be a 5G ProSe UE-to-UE Relay based on subscription data, the AMF selects the PCF which supports 5G ProSe information provisioning and establishes a UE policy association with the PCF for 5G ProSe UE-to-UE Relay information provisioning delivery.

- If the AMF receives the 5G ProSe capability as a UE-to-UE Relay in the Registration Request message from UE, the AMF further reports the 5G ProSe capability as a UE-to-UE Relay to the selected PCF. The PCF determines the 5G ProSe UE-to-UE Relay information based on the received 5G ProSe capability as a UE-to-UE Relay.

- If the UE supports 5G ProSe capability as a UE-to-UE Relay and it does not have valid 5G ProSe UE-to-UE Relay information, the UE includes the UE Policy Container with indicating the 5G ProSe UE-to-UE Relay Information Provisioning request during registration procedure.

- If the UE indicates the 5G ProSe UE-to-UE Relay Information Provisioning request in the UE Policy Container, the PCF determines whether to provision the 5G ProSe UE-to-UE Relay Information to the UE, as specified in clause 6.1.2.2.2 of TS 23.503, and the PCF provides the 5G ProSe UE-to-UE Relay Information to the UE by using the procedure as defined in clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy Delivery" in TS 23.502[8].

The PCF may update the 5G ProSe Policy and parameters to the UE in following conditions:

- UE Mobility, e.g. UE moves from one PLMN to another PLMN. This is achieved by using the procedure of UE Policy Association Modification initiated by the AMF, as defined in clause 4.16.12.1 of TS 23.502[8].

- When there is a subscription change in the list of PLMNs where the UE is authorized to perform the 5G operation. This is achieved by using UE Policy Association Modification initiated by the PCF procedure as defined in clause 4.16.12.2 of TS 23.502[8].

- When there is a change of service specific parameter as described in clause 4.15.6.7 of TS 23.502[8].

If the serving PLMN is removed from the list of PLMNs in the service authorization parameters, the service authorization is revoked in the UE.

When the UE is roaming, the change of subscription resulting in updates of the service authorization parameters are transferred to the UE by H-PCF via V-PCF.

The UE may perform UE triggered Policy Provisioning procedure to the PCF as specified in clause 6.2.4 of TS 23.287 when the UE determines the 5G ProSe Policy and parameters are invalid (e.g. Policy/Parameter is outdated, missing or invalid).

#### 6.36.2.2 The Policy/parameter to a 5G ProSe UE-to-UE Relay

The following information is provisioned in the UE in support of the UE assuming the role of a 5G ProSe UE-to-UE Relay:

1. Authorisation policy for acting as a 5G ProSe UE-to-UE Relay:

- when the UE is "served by E-UTRA" or "served by NR:

- PLMNs in which the UE is authorized to relay traffic for 5G Remote UE accessing UE-to-UE Relays over PC5 reference point.

For each above PLMN:

- RAT(s) over which the UE is authorized to be a UE-to-UE Relay over PC5 reference point.

- when the UE is "not served by E-UTRA" and "not served by NR:

- Indicates whether the UE is authorized to be a UE-to-UE Relay over PC5 reference point.

- RAT(s) over which the UE is authorized to be a UE-to-UE Relay over PC5 reference point.

2) Radio parameters when the UE is "not served by E-UTRA" and "not served by NR":

- Includes the radio parameters with Geographical Area(s) that need to be configured in the UE in order to be able perform ProSe Direct Discovery and Communication procedures when acting as a 5G ProSe UE-to-UE Relay. These radio parameters (e.g. frequency bands) are defined in TS 38.331 [23] and are common for all types of 5G ProSe Direct Discovery (Group Member Discovery, ProSe UE-to-UE Relay Discovery or ProSe UE-to-UE Relay Discovery Additional Information). The UE uses the radio parameters only if the UE can locate itself in the corresponding Geographical Area. Otherwise, the UE is not authorised to transmit.

### 6.36.3 Impacts on services, entities and interfaces

5G ProSe UE-to-UE Relay:

* Indicates 5G ProSe capability as a UE-to-UE Relay in the Registration Request message;
* Includes the UE Policy Container with indicating the 5G ProSe UE-to-UE Relay Information Provisioning request during registration procedure;
* Receive and enforce the Policy and parameter as 5G ProSe UE-to-UE Relay.

AMF:

* Determine whether UE is authorized to be a 5G ProSe UE-to-UE Relay;
* Select a PCF capable of authorization Policy and parameter for 5G ProSe UE-to-UE Relay;
* Forward UE’s PC5 Capability for 5G ProSe UE-to-UE Relay to PCF.

PCF:

* Send the Authorization Policy and parameter to 5G ProSe UE-to-UE Relay.

## 6.37 Solution #37: Groupcast mode communication for commercial services and public safety

### 6.37.1 Description

This solution addresses Key Issue #1 (ProSe Direct discovery) and Key Issue #2 (Support for NR PC5 ProSe communication), and is applicable to both commercial and public safety services.

### 6.37.2 Procedures

Figure 6.37.1-1 describes the group management procedure, the ProSe Direct Discovery and the NR PC5 groupcast mode communication at the PC5 reference point, as well as the group management procedures at the Application Layer. The Figure is consistent with Figure 6.3.2-1 in TS 23.287 but highlights the ProSe Direct Discovery aspect. Each step in the procedure is described in more detail below.

Figure 6.37.1-1 also illustrates a strict separation between Application Layer procedures on one hand (beyond the scope of this specification and shown with dashed lines), and groupcast mode communication procedures at the PC5 reference point on the other hand (shown with solid lines).

The Application Layer procedures in step 1 and step 3 are beyond the scope of this specification.

Below follows a description of each step in the procedure.



Figure 6.37.1-1 Groupcast mode communication for commercial services and public safety over the PC5 reference point (the Application Layer procedures are beyond the scope of this specification).

1. A group is formed at the Application Layer.

In **alternative 1**, the group is formed on demand by communicating with an Application Server across the V1 reference point (see the V2X system architecture specified in TS 23.287), e.g. because a UE wants to perform ProSe group communication with other UEs in proximity. This alternative supports e.g. commercial services. An Application Layer Group ID is distributed to the group member UEs.

In **alternative 2**, group parameters, including an Application Layer Group ID, are pre-provisioned to the group member UEs. This alternative supports e.g. public safety.

2. At the PC5 reference point, group member UE discovery is performed using ProSe Direct Discovery based on Model A or Model B, see TS 23.303 section 5.3. For public safety, the procedure in TS 23.303 section 5.3.7 is used, if needed. DDNMF may be needed.

3. The completion of the group management procedure is confirmed at the Application Layer, optionally with support of an Application Server. At this stage, all parameters needed for groupcast mode communication have been set up in the group member UEs, such as the destination Layer-2 ID, and the QoS parameters as defined in TS 23.287.

4. Groupcast communication can now begin using the PC5 reference point. Depending on group policy configured at the Application Layer, all group member UEs or a subset of them can send groupcast messages to the group.

NOTE: Some of the solutions in TR 23.752 skip step 1in the procedure described above and only perform steps 2-4.

### 6.37.3 Impacts on services, entities and interfaces

UE needs to support Group Member Discovery as defined in TS 23.303 [9] clause 5.3.7 and Groupcast communication as defined in TS 23.287 [5] clause 6.3.2.

## 6.38 Solution #38: Layer 3 UE-to-Network Relay UE PDU session parameters

### 6.38.1 Description

This is a solution for key issue #3: UE-to-Network Relay and only applicable for Layer 3 UE-to-Network Relay.

When PDU Session is set up by the Relay UE for 5G ProSe relaying of Remote UE data, the Relay UE must determine PDU Session parameters. This solution documents the means to select pre-configured Route Selection Descriptor parameters matching the Traffic Descriptor for the PDU session establishment. Pre-requisite step of UE Route Selection Policy rule (URSP) provisioning to the Relay UE by the PCF is assumed. PCF procedures for provisioning URSP rule to UE are specified in TS 23.503 and this solution re-uses those procedures unchanged.

Traffic Descriptor part of the URSP rule already identifies specific services "ims", "mms" and "Internet" to enable PCF configuration and UE detection of the related Route Selection Descriptors.

This solution adds the detection of Relay UE's PDU session parameters in the Route Selection Descriptor matching with the Traffic Descriptor for "5G prose" traffic.

Editor's note: How to support different PDU session parameters for different remote UEs is FFS.

### 6.38.2 Procedures

PCF configures URSP Rule to UE with Layer 3 UE-to-Network Relay capability. The Traffic Descriptor part of the URSP rule is enhanced to allow the identification of "5G ProSe Layer 3 UE-to-Network" Connection Capability. This allows the configuration of the corresponding Route Selection Descriptor for 5G ProSe UE-to-Network Relay to use for setting up PDU Session for Remote UE traffic. The change needed in TS 23.503 Table 6.6.2.1-2 in the URSP rule Traffic Descriptor in the UE Route Selection Policy rule is shown in Table 6.38.2-1.

| Information name | Description | Category | PCF permitted to modify in a UE context | Scope |
| --- | --- | --- | --- | --- |
| Rule Precedence | Determines the order the URSP rule is enforced in the UE. | Mandatory (NOTE 1) | Yes | UE context |
| **Traffic descriptor** | *This part defines the Traffic descriptor components for the URSP rule.* | Mandatory (NOTE 3) |  |  |
| Application descriptors | It consists of OSId and OSAppId(s). (NOTE 2) | Optional | Yes | UE context |
| IP descriptors  (NOTE 5) | Destination IP 3 tuple(s) (IP address or IPv6 network prefix, port number, protocol ID of the protocol above IP). | Optional | Yes | UE context |
| Domain descriptors | Destination FQDN(s) or a regular expression as a domain name matching criteria. | Optional | Yes | UE context |
| Non-IP descriptors  (NOTE 5) | Descriptor(s) for destination information of non-IP traffic | Optional | Yes | UE context |
| DNN | This is matched against the DNN information provided by the application. | Optional | Yes | UE context |
| Connection Capabilities | This is matched against the information provided by a UE application when it requests a network connection with certain capabilities. (NOTE 4) | Optional | Yes | UE context |
| **List of Route Selection Descriptors** | A list of Route Selection Descriptors. The components of a Route Selection Descriptor are described in table 6.6.2.1-3. | Mandatory |  |  |
| NOTE 1: Rules in a URSP shall have different precedence values.  NOTE 2: The information is used to identify the Application(s) that is(are) running on the UE's OS. The OSId does not include an OS version number. The OSAppId does not include a version number for the application.  NOTE 3: At least one of the Traffic descriptor components shall be present.  NOTE 4: The format and some values of Connection Capabilities, e.g. "ims", "mms", "internet", "5G ProSe Layer 3 UE-to-Network Relay" etc., are defined in TS 24.526 [19]. More than one connection capabilities value can be provided.  NOTE 5: A URSP rule cannot contain the combination of the Traffic descriptor components IP descriptors and Non-IP descriptors. | | | | |

Table 6.38.2-1, 5G ProSe enhancement to Traffic Descriptor

Editor's note: Table 6.38.2-1 is intended as part of this solution even though only the addition of "5G prose" code point in TS 23.502, Table 6.6.2.1-2 is shown as revision.

If PDU Session establishment for 5G ProSe Relaying requires any additional 5G ProSe specific parameters, those can be added as part of Route Selection Descriptor part of the USRP rule in TS 23.503, Table 6.6.2.1-3.

### 6.38.3 Impacts on services, entities and interfaces

This solution impacts the following system entities.

PCF:

- Ability to identify ProSe Connection Capabilities and related Route Selection Descriptor in URSP rule.

UE:

- Ability to identify the Route Selection Descriptor for 5G ProSe Layer 3 UE-to-Network Relay PDU Session establishment.

## 6.X Solution for Key Issue #X: <Solution Title>

### 6.X.1 Description

Editor's note: This clause will describe the solution principles and architecture assumptions for corresponding key issue(s). Clause(s) may be added to capture details.

### 6.X.2 Procedures

Editor's note: This clause describes services and related procedures for the solution.

### 6.X.3 Impacts on services, entities and interfaces

Editor's note: This clause captures impacts on services and interfaces.

# 7 Overall Evaluation

Editor's note: This clause will provide evaluation of different solutions.

# 8 Conclusions

Editor's note: This clause will list conclusions that have been agreed during the course of the study item activities.

Annex A:  
Layer 2 Architecture Reference Model

# A.1 Introduction

The following clauses describe the control plane and user plane protocol stacks for supporting Layer 2 evolved UE-to-Network Relay UE, in case of 3GPP access.

# A.2 Control and User Plane Protocols

## A.2.1 User Plane Protocol Stack

Figure A.2.1-1, illustrates the protocol stack for the user plane transport, related to a PDU Session, including a Layer 2 UE-to-Network Relay UE. The PDU layer corresponds to the PDU carried between the Remote UE and the Data Network (DN) over the PDU session. The PDU layer corresponds to the PDU carried between the Remote UE and the Data Network (DN) over the PDU session. The SDAP and PDCP protocols are as specified in TS 38.300 [11]. It is important to note that the two endpoints of the PDCP link are the Remote UE and the gNB. The relay function is performed below PDCP. This means that data security is ensured between the Remote UE and the gNB without exposing raw data at the UE-to-Network Relay UE.



Figure A.2.1-1: User Plane Stack for L2 UE-to-Network Relay UE

The adaptation layer within the UE-to-Network Relay UE and gNB can differentiate signalling radio bearers (SRBs) and data radio bearers (DRBs) for a particular Remote UE. The adaption layer is also responsible for mapping PC5 traffic to one or more DRBs of the Uu. The definition of the adaptation layer is under the responsibility of RAN WG2.

Editor's note: The details of the services provided by the adaption layer is left to RAN WG2.

## A.2.2 Control Plane Protocol Stack

Figure A.2.2-1, illustrates the protocol stack of the NAS connection for the Remote UE to the NAS-MM and NAS-SM components. The NAS messages are transparently transferred between the Remote UE and gNB over the Layer 2 UE-to-Network Relay UE using:

- PDCP end-to-end connection where the role of the UE-to-Network Relay UE is to relay the PDUs over the signalling radio bear without any modifications.

- N2 connection between the gNB and AMF over N2.

- N11 connection AMF and SMF over N11.

The role of the UE-to-Network Relay UE is to relay the PDUs from the signalling radio bearer without any modifications.



Figure A.2.2-1: Control Plane for L2 UE-to-Network Relay UE

Editor's note: The Remote UE behaviour at the RRC layer is FFS in RAN WG2.

Annex B:  
Architecture Reference Model for 5G ProSe Direct Discovery

# B.1 Introduction

The following clauses describe the control plane based and user plane based architecture for supporting 5G ProSe Direct Discovery.

# B.2 User Plane based Architecture

## B.2.1 Description

This architecture proposes to adopt necessary function of ProSe Function as defined in TS 23.303 [9] into 5G system architecture. According to TS 23.303 [9], Direct Discovery Name Management Function (DDNMF) and Direct Provisioning Function (DPF) of ProSe Function are necessary to support ProSe in 5G system architecture. DPF is used to provision the UE with necessary parameters in order use 5G ProSe Direct Discovery and 5G Prose Direct Communication, which can be replaced by PCF. DDNMF is used to provide following procedures over PC3 interface:

- Discovery Request/Response Procedure: to provide IDs and filter for direct discovery.

- Match Report Procedure: to check direct discovery and provide mapping information for direct discovery.

- Announcing Alert Procedure: Support 'On-demand' ProSe Direct Discovery in case of ProSe restricted discovery model A.

- Discovery Update Procedure: to update/revoke a previously allocated IDs, filters.

5GS supports Service-Based Architecture, and DDNMF can be NF that is not only able to interact with 5G NFs (e.g. to consume Nudm service operation) but also connects with UE via user plane connectivity for support procedures over PC3 interface. In the architecture, it is proposed to introduce 5G DDNMF as shown in below:



Figure B.2.1-1: The proposed 5G System Architecture for ProSe

5G DDNMF is managed by MNO.

PC1 interface between ProSe Application in UE and ProSe Application Server is out of scope of SA2, and not shown in the Figure B.2.1-1.

5G DDNMF is able to consume service operation from other NFs in 5GC (e.g. Nudm or Npcf).

Editor's note: Which NF's service operation should be used by 5G DDNMF will be discussed with solution proposal.

PC3 interface supports Discovery Request/Response, Match Report Procedure, Announcing Alert Procedure, and Discovery Update Procedure as following baseline features defined in TS 23.303 [9].

NOTE: Which NSSAI or DNN to be used for user plane connectivity for PC3 interface is up to MNO's configuration (e.g. It can be controlled by URSP or local configuration in the UE).

Editor's note: Any further enhancement or modification of PC3 procedure will be discussed with solution proposal.

Editor's note: Inter PLMN or Roaming architecture is FFS (e.g. corresponding to PC6 or PC7 in TS 23.303 [9]).

PC2 interface is used for authorization of discovery request by interaction between 5G DDNMF and ProSe application server, as specified in TS 29.343 [12]. In the proposed architecture, there are two options to be supported as a deployment option as following:

Option 1) 5G DDNMF as a standalone function: 5G DDNMF interacts with ProSe Application Server via PC2 interface. There can be multiple relationships with 3rd party application service providers for ProSe, hence following relationship should be considered.



Figure. B.2.1-2: Multiple relationship between 5G DDNMF and 3rd party ProSe Application Servers

Option 2) 5G DDNMF collocated with ProSe Application Server: PC2 interface is supported internally and the 5G DDNMF provides PC1 interface and PC3 interface toward UE. 5G DDNMF is acting as NF if it needs to consume service operation provided by other NFs in 5GS. In this option, the PC3 interface can be replaced with application level interaction.

# B.3 Control Plane based Architecture

## B.3.1 Description

The proposed architecture adopts the functionalities of DPF and DDNMF as defined in TS 23.303 [9] for ProSe Function into 5G system. Similar with V2X, PCF is proposed to take the role of DPF for policy/parameter provisioning regarding the 5G ProSe Discovery and 5G ProSe Communication and provide/update them via control plane. In order to align with the control plane based parameter provisioning architecture as defined in TS 23.287 [5], 5G DDNMF is introduced as a new NF/NF Service into 5G system to response the discovery request, i.e. take the responsibilities of DDNMF as introduced in 4G and provide code and filters via control plane to the 5G ProSe UEs.

The proposed architecture is as showed in Figure B.3.1-1.



Figure B.3.1-1: Control Plane based architecture

5G DDNMF is defined to support the following functionalities:

- Support the ProSe Discovery features, e.g. ProSe Application Code allocation, Discovery Filter(s) generation and discovery request related parameters (e.g. Validity Timer) provisioning.

* Inter DDNMF interaction
* Roaming
* Interface and interaction with ProSe Application Server
* Event based charging in ProSe Discovery.

Annex C:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2019-10 |  |  |  |  |  | TR skeleton (approved in S2-19010697) | 0.0.0 |
| 2019-10 | SA2#135 |  |  |  |  | Inclusion of documents approved in SA2#135: S2-1910406, S2-1910698, S2-1910408, S2-1910819, S2-1910700, S2-1910533, S2-1910820, S2-1910821, S2-1910822, S2-1910823 and S2-1910705. | 0.1.0 |
| 2019-11 | SA2#136 |  |  |  |  | Inclusion of documents approved in SA2#136. | 0.2.0 |
| 2020-01 | SA2#136AH |  |  |  |  | Inclusion of documents approved in SA2#136AH: S2-2001486, S2-2001487, S2-2001488, S2-2001373, S2-2001374, S2-2001664, S2-2001490, S2-2001491, S2-2001492, S2-2001665, S2-2001494, S2-2001666, S2-2001496, S2-2001497, S2-2001498, S2-2001441, S2-2001499, S2-2001500, S2-2001501, S2-2001502, S2-2001667 and S2-2001353. | 0.3.0 |
| 2020-06 | SA2#139E |  |  |  |  | Inclusion of documents approved in SA2#136. | 0.4.0 |