**SA WG2 Meeting #139e *S2-2004201r04***

**Elbonia, June 1 – 12, 2020 (revision of S2-XXXXXX)**

**Source: Philips International B.V.**

**Title: UE-to-Network Relay discovery and handling of PDU session parameters with CN based relay selection.**

**Document for: Approval**

**Agenda Item: 8.8**

**Work Item / Release: FS\_5G\_ProSe / Rel-17**

*Abstract: This document addresses some issues related to KI#1 (ProSe direct discovery) and KI#3 (UE-to-Network relay) of TR 23.752, in particular related to the discovery of UE-to-Network relays and how this is linked to the usage of PDU session parameters for both layer-2 and layer-3 UE-to-Network relays..*

# 1. Discussion

As mentioned in KI#3 a solution is needed on how to handle PDU Session related attributes for UE-to-Network Relays. The PDU session attributes may have quite some impact on the UE-to-Network Relay. For example, if the Remote UE wishes to use a URLLC slice, but the UE-to-Network Relay has limited resources at that moment in time, it may not be able to address the low-latency requirements of the URLLC slice. Also, if a Remote UE wants to access a certain NPN, then also the UE-to-Network Relay may need to have permission to send data to the NPN.

Simply provisioning the UE-to-Network Relay with all kinds of information about supported slices, NPNs and other related attributes, and exposing this information during discovery of a UE-to-Network Relay is not desirable. A lot of this information is privacy and operator sensitive information, and a UE-to-Network Relay is likely to be an end user device that cannot be trusted with this information. It would also not be scalable, since the number of slices, NPNs is potentially quite large, and it is not known in advance which Remote UEs the UE-to-Network Relay will encounter. The Remote UE could also for example be an inbound roaming device, requesting access to a slice, NPN, or DNN of a roaming partner. So a UE-to-Network Relay would also need the necessary information on how to deal with that. Furthermore, this information would need to be kept up-to-date in the UE-to-Network Relay.

Therefore, we propose to keep as much of the information and decision power on whether a UE-to-Network Relay is capable to serve as relay for the Remote UE inside the core network, e.g. the AMF. The added benefit is that AMF can use the most up-to-date information combined from various network functions and use the combined information from various network functions to decide which UE-to-Network Relay amongst multiple relays is best suited to serve as relay for the Remote UE. Without involving the core network in the decision, the Remote UE is unlikely to have sufficient information about each Remote UE’s capabilities and current status to make a good decision, which may result in trial-and-error if the selected UE-to-Network relay does not meet the Remote UE’s requirements.

To deal with some of the privacy concerns, we propose to extend the concept of Relay Service Codes as defined in TS 23.303. In order to avoid the overhead of the existing ProSe framework in TS 23.303, we propose to apply these service codes to a UE-to-Network Relay discovery mechanism that leverages the V2X framework as defined in TS 23.287.

The main difference with S2-2004202 “KI#3, New Sol. for UE-to-Network Relay discovery and handling of PDU session parameters with Remote UE based relay selection” is that in this solution the AMF (and not the Remote UE) is responsible to select which UE-to-Network relay (amongst multiple discovered UE-to-Network relays in vicinity of the Remote UE) is best suited to serve as relay for the Remote UE’s requested PDU session parameters.

# 2. Text Proposal

It is proposed to capture the following solution in TR 23.752.

\* \* \* \* First change \* \* \* \*

## 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 |  |  |  |  |  |  |  |
| 19 | X |  | X |  |  |  |  |  |
| 20 |  | X |  |  |  |  |  |  |
| 21 |  | X |  |  |  |  |  |  |
| 22 | X | X |  |  |  |  |  |  |
| … | … | … | … | … | … | … | … | … |
| X | X |  | X |  |  |  |  |  |

\* \* \* \* Second change \* \* \* \*

6.x Solution #x: UE-to-Network Relay discovery and handling of PDU session parameters with CN based relay selection.

6.x.1 Description

This solution addresses the discovery of UE-to-Network Relays and usage of PDU session related attributes for key issues #1 and #3. The underlying principle of this solution is to make use of Relay Service Codes as defined in TS 23.303 in the context of the V2X architecture as defined in TS 23.287.The idea is that each Relay Service Code is mapped to a combination of PDU session parameter values, such as PLMN ID, S-NSSAI, DNN, PDU session type, etc., and possibly some additional parameters (such as group IDs, QoS requirements or frequency bands) that Remote UEs may wish to use for connecting to the core network via a UE-to-Network Relay.

 a set of(possibly after consulting other NFs)

The solution is based on the following assumptions:

1. Not all UE-to-Network Relays that are discoverable by a Remote UE may be able to handle the PDU session(s) that the Remote UE wishes to set up, e.g. the UE-to-Network Relay may not be able to meet the desired low-latency requirements for a URLLC slice that the Remote UE wishes to use at that time (e.g. because it is already serving several other Remote UEs or may be involved in a heavy online gaming session). Without involving the core network in the decision, the Remote UE is unlikely to have sufficient information about each UE-to-Network Relay’s capabilities and current status to make a good decision, which may result in trial-and-error if the selected UE-to-Network relay does not meet the Remote UE’s requirements
2. The UE-to-Network Relay cannot always decide on its own whether or not it is able to meet the requirements of the PDU session(s) that the Remote UE wishes to set up, given that it may have insufficient information or outdated information to base this decision on. For example, the UE-to-Network Relay may not know the SLA requirements for a certain slice. Also, the UE-to-Network Relay may not know whether or how some of its PDU sessions can be adjusted in order to accommodate the Remote UE’s PDU session. Furthermore, one UE-to-Network Relay may already serve as relay for various other Remote UEs, whilst a neighbor UE-to-Network Relay may not serve any Remote UE yet, so using the neighbor UE-to-Network Relay may be a better choice. Hence, in this solution, the AMF is responsible to perform the necessary assessment and select the most suited UE-to-Network Relay, whereby the AMF can make use of the most up-to-date information from various other network functions.
3. Detailed information on mapping Relay Service Codes to NSSAIs, NPNs, DNNs and other information needed (e.g. in Layer-3) to set up or (re-)configure a PDU session in the UE-to-Network Relay that can meet the requirements of the Remote UE’s indirect network communication traffic, is privacy and operator sensitive and should not be provisioned as such beforehand to UE-to-Network Relays, which are untrusted end-user devices. Therefore, in this proposal the privacy sensitive and operator sensitive information, such as S-NSSAI, is kept in the network, and only provided, if necessary, to the single UE-to-Network relay that is selected by the AMF to serve as UE-to-Network relay for the Remote UE at the time that it is needed.
4. The amount of Relay Service Codes to denote all possible combinations of values for PDU session parameters may potentially be quite high and may need to be updated regularly. This may require frequent messaging between the UE-to-Network relay and the core network to keep the information up to date. Also, a UE-to-Network Relay operating in a PLMN that is a VPLMN for the Remote UE may not know all the relay service codes of the Remote UE’s HPLMN. Therefore, in this proposal Generic Service Codes are introduced which can be used for discovery of UE-to-Network Relays. A Generic Relay Service Code is not bound to a single specific combination of PDU session parameters values, but rather can be seen as a “wildcard”, and should match a large number of UE-to-Network relays. In case such Generic Relay Service Code is used in a discovery message, the discovery message includes also a second Relay Service Code as payload in the message. This second Relay Service Code is, like other specific Relay Service Codes in this proposal, associated with a particular set of PDU parameter values. If the second Relay Service Code is not known by the UE-to-Network Relay, it can be forwarded to the Core Network to find out the specific PDU parameters that the Remote UE wishes to use, without the need for the UE-to-Network relay to know all possible and most up-to-date set of Relay Service Codes all the time.

In this solution the message that is used for discovery, is a (V2X) Direct Communication Request that is sent to the default “broadcast” L2 identifier which allow it to be received by multiple UE-to-Network relays. The benefit of using the (V2X) Direct Communication Request is that it allows subsequent reuse of the resulting PC5 connection between the Remote UE and the selected UE-to-Network Relay for the indirect communication with the core network.

The procedures which are described in detail in Section 6.x.2 require the following information to be provisioned in the Remote UE and UE-to-Network Relay beforehand, e.g. by using a Service Authorization and Provisioning procedure of Solution#16 or other solution for KI#8:

* For the Remote UE:
* One or more Relay Service Codes which the Remote UE is authorized to use, including a flag indicating for each Relay Service Code if it is a Generic Relay Service Code or a specific Relay Service Code.
* The mapping between each Relay Service Code that the Remote UE is authorized to use and the default “broadcast” Destination Layer-2 ID(s) for initial signalling.
* The mapping between each Relay Service Code and a set of PDU session parameter values, which may include amongst others one or more of the following:
	+ PLMN ID
	+ S-NSSAI
	+ DNN
	+ PDU Session Type
	+ …

NOTE: for a Generic Relay Service Code, the set may be empty or e.g. only contain a PLMN ID.

Editor’s note: it is FFS whether or not Generic Relay Service Codes will include some encoded substring/value matching filter information by which the UE-to-Network relay can perform some discovery message filtering.

* (Optional) The mapping between each Relay Service Code and an initial security context (e.g. set of credentials).
* Policy to restrict the Remote UE’s PDU sessions to the PDU session parameter values corresponding to a provisioned Relay Service Code.
* For the UE-to-Network Relay:
* One or more Relay Service Codes which the UE-to-Network Relay is authorized to expose and react upon during discovery, including a flag indicating for each Relay Service Code if it is a generic Relay Service Code or a specific Relay Service Code.

NOTE: as explained above, this is preferably a subset of all the Relay Service Codes, and may consist of only a single Generic Relay Service Code.

* The mapping between each of the Relay Service Code for which the UE-to-Network Relay is authorized to expose and react upon during discovery and the default “broadcast” Destination Layer-2 ID(s) for initial signalling.
* (Optional) The mapping between each Relay Service Code and an initial security context (e.g. set of credentials).

In addition, the AMF of the UE-to-Network Relay needs to be provided with the following information:

* An extensive list of Relay Service Codes which the UE-to-Network Relay may be able to handle and get authorized for, including a flag indicating for each Relay Service Code if it is a generic Relay Service Code or a specific Relay Service Code.
* The mapping between each Relay Service Code and a set of PDU session parameter values, which may include amongst others one or more of the following:
	+ PLMN ID
	+ S-NSSAI
	+ DNN
	+ PDU Session Type
	+ …

NOTE: Since the list of Relay Service Codes for the AMF may not always be updated at the same time as for the Remote UEs (and UE-to-Network Relays), which may be out-of-coverage for a while, the AMF should also keep a history of old Relay Service Codes.

6.x.2 Procedures

PCF

5: Direct Communication Accept

(with requested RSC)

Remote UE

UE-to-NW Relay

NG-RAN

AMF

UDM/NSSF

SMF

UE-to-NW Relay

UE-to-NW Relay

0: Authorization and provisioning of Remote UE and UE-to-Network Relays

1: Direct Communication Request (with requested RSC)

2 Discovery Report

3: UE-to-NW Relay’s AMF assesses which UE-to-NW relay best capable to serve as relay for the Remote UE’s requested PDU session parameters.

6: Configure NG-RAN and other NFs to enable the selected UE-to-NW relay to access the requested NPN, slice and/or DNN.

4: Send Relay Accepted message to selected UE-to-NW relay

8: Setup PDU session (layer-2) or send IP traffic (layer-3) via UE-to-NW relay

7: Update UE-to-NW relay PDU session(s) and/or reconfigure UE-to-NW relay

7: UE Configuration Update of selected UE-to-NW relay

**Figure 6.x.2.x: Illustration of the procedure**

**(NOTE: in this figure it is assumed that Remote UE and UE-to-NW relays are served by the same AMF)**

1. The Remote UE and UE-to-Network Relay are authorized for PC5 communication and relay discovery, and are provisioned with the respective information as described in Section 6.x.1, using one of the solutions for KI#8 “Support of PC5 Service Authorization and Policy/Parameter Provisioning”. In addition, the respective information as described in Section 6.x.1 for the AMF, is provided to the AMF of the UE-to-Network Relay.
2. The Remote UE can initiate discovery of UE-to-Network Relays by sending a Direct Communication Request over PC5 as specified in TS 23.287 (or a newly defined Indirect Communication Request as suggested in step 4 of Solution#7) with the requested Relay Service Code (RSC) being used as (V2X) service/application identifier. In case the requested Relay Service Code is a Generic Relay Service Code, the Direct Communication Request includes a second Relay Service Code as payload in the message, which is indicative of a set of specific PDU parameters that the Remote UE wishes to use.

NOTE: The Direct Communication Request uses the default “broadcast” Destination Layer-2 ID configured for the requested Relay Service Code (or if known the specific Layer-2 ID of the target UE-to-Network Relay if the Remote UE wants to send the request to a specific UE-to-Network Relay).

1. One or more UE-to-Network Relays receive the Direct Communication Request over PC5. If the Relay Service Code in the Direct Communication Request matches a Relay Service Code that is known to the UE-to-Network Relay, the UE-to-Network Relay sends a Discovery Report (i.e. a newly defined message) to the UE-to-Network Relay’s serving AMF via NG-RAN. The AMF may collect a number of these messages before continuing with step 3.

Discovery Report messages

Editor’s Note: it is FFS whether it would be beneficial and feasible to package the Discovery Reports as RRC messages (possibly combined with measurement reports related to the PC5 communication request) that are first collected by NG-RAN before sending an aggregated discovery report message via NG-AP to the AMF, in order to reduce the number of Discovery Report messages being sent to the AMF. Details of aggregating discovery report messages would need to be coordinated with RAN2.

1. The UE-to-Network Relay’s serving AMF will verify for each UE-to-Network Relay for which a Discovery Report was received, whether or not the UE-to-Network Relay is currently capable to meet the requirement associated with the Relay Service Code’s PDU session parameters, such as PLMN-ID, S-NSSAI, DNN. To this end, the AMF may contact some other network functions to verify if the UE-to-Network can meet those requirements, for example the AMF may contact:
	* NSSF, e.g. to verify if the UE-to-Network Relay is allowed access to a requested network slice, and if not whether or not the UE-to-Network relay can be given (temporary) access to the requested network slice for the purpose of relaying.
	* SMF, e.g. to check about other ongoing PDU sessions of the UE-to-Network Relay and their QoS.

Editor’s note: it is FFS whether other NFs may be used for this, such as (), UDM (e.g. to verify if the UE-to-Network Relay is allowed to act as relay for a requested NPN), or NWDAF (e.g. for mobility analytics, user data congestion analytics, communication patterns).

After assessing for each UE-to-Network Relay for which a Discovery Report was received, the AMF will select the UE-to-Network Relay that is best suited to serve as relay for the requested PDU session parameters from the Remote UE.

Editor’s Note: it is FFS how to deal with the case that multiple UE-to-Network Relays in vicinity of the Remote UE use different AMFs.

1. The AMF sends a Relay Accepted message (i.e. a newly defined message) to the selected UE-to-Network Relay.

NOTE: optionally, the AMF may send a “Relay rejected” message for the requested Relay Service Code to the UE-to-Network relays that have not been selected.

1. The selected UE-to-Network Relay performs the PC5 unicast link security procedure and sends a Direct Communication Accept message to the Remote UE that includes the given Relay Service Code as (V2X) service/application identifier. This message may include some additional information about the relay, such as IP configuration information (e.g. for layer-3 relaying).
2. ask the SMF to update an ongoing PDU session of the UE-to-Network relay, or ask the PCF to update certain policies for the UE-to-Network Relay. The AMF may also trigger an update to NG-RAN, e.g. send a PDU Session Resource Modify Request for one or more PDU sessions of the UE-to-Network Relay

NOTE: For any policy updates, the solutions for KI#8 “Support of PC5 Service Authorization and Policy/Parameter Provisioning” are expected to be used.

1. Depending on step 6, the AMF , and/or the SMF may issue a PDU session modification command, and/or the NG-RAN may issue a . Upon receiving one or more of these commands,
2. In case of layer-2 relay, the Remote UE continues with step 4 of Solution#7 over the PC5 connection established in step 5, whilst restricting the PDU parameters (e.g. in the Initial Registration) to the configured PDU parameters related to the Relay Service Code as received in the Direct Communication Accept message.

In case of layer-3 relay, the Remote UE continues with step 4 of Solution#6, whereby the Remote UE can assume the IP traffic is forwarded to the correct destination based on the configured PDU parameters related to the Relay Service Code.

If the Remote UE wants/needs to establish a PDU session with different PDU parameters (e.g. different S-NSSAI), the Remote UE shall repeat steps 1-8. The AMF should monitor whether the Remote UE (in case of layer-2 relay) or the UE-to-Network Relay (in case of layer-3 relay) starts using PDU session parameters that do not correspond to the Relay Service Code that was initially requested by the Remote UE, and may reject such PDU session.

6.7.4 Impacts on Existing Nodes and Functionality

This solution may impact the following entities:

**Remote UE:**

* Support for using (V2X) Direct Communication Request with Relay Service Codes.
* Support provisioning of Relay Service Codes and related PDU session parameter information.

**UE-to-Network Relay:**

* Support for using (V2X) Direct Communication Request with Relay Service Codes.
* Support provisioning of Relay Service Codes.
* Support discovery reporting .
* Support Relay Accepted/Rejected messages.

**AMF:**

* Support configuring the mapping of Relay Service Codes and related PDU session parameter information
* Support assessment, selection of the best UE-to-Network Relay and reconfiguration of the selected UE-to-Network Relay based on requested Relay Service Code.
* Support discovery reporting
* Support Relay Accepted/Rejected messages.

\* \* \* \* End of changes \* \* \* \*