**SA WG2 Meeting #139e *S2-2004202r05***

**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 Remote UE 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, 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 AMF can use the most up-to-date information combined from various network functions. 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 S2-2004201 “KI#3, New Sol. for UE-to-Network Relay discovery and handling of PDU session parameters with CN based relay selection” is that in this solution the Remote UE (and not the AMF) is responsible to select the UE-to-Network relay (amongst multiple discovered UE-to-Network relays in vicinity of the Remote UE) to serve as relay for the Remote UE’s requested PDU session parameters. The discovery step makes sure that only UE-to-Network relays that are currently capable to serve as relay for the Remote UE’s requested PDU session parameters will respond.

# 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 Remote UE 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. Similarly to the solution “UE-to-Network Relay discovery and handling of PDU session parameters with CN based relay selection **[S2-2004201]**”, 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.

Editor’s Note: the two references above to **[S2-2004201]** need to be removed and changed to a section number before integrating this solution in TR 23.752. These were added as reference for clarity during the proposal phase.

Editor’s Note: need to better explain the differences between this solution and solution “UE-to-Network Relay discovery and handling of PDU session parameters with CN based relay selection”.

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). To avoid trial-and-error, in this solution the discovery step is enhanced so that only UE-to-Network Relays that are capable to meet the requirements of the desired PDU session at that time will respond. Without doing this, the Remote UE may select a UE-to-Network Relay that is unsuited to meet its 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 UE-to-Network Relay can get assistance from the AMF to perform the necessary assessment, whereby the AMF can make use of the most up-to-date information from various other network functions. If the AMF responds positively, the UE-to-Network Relay responds to the Discovery Request. When and in which situations these steps should be performed can be configured by operator policy, e.g. unknown relay service code received or when the information in the relay has not been refreshed for long time.
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 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. 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.

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
	+ NID/CAG 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.

* (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.
* Policy defining the conditions under which Relay Service Codes need to be sent to the AMF for assessment, and under which conditions the UE-to-Network Relay can respond directly to a Discovery Request.
* (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
	+ NID/CAG 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

UE-to-NW Relay

UE-to-NW Relay

UE-to-NW Relay

PCF

UDM/NSSF

SMF

AMF

NG-RAN

Remote UE

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

2:Decide to respond directly to RSC or RSC needs to be sent to AMF

1: Discovery Request

(with requested RSC)

3: Discovery Report (with requested RSC)

4: UE-to-NW Relay’s AMF assesses for each UE-to-NW relay whether it is capable to serve as relay for the Remote UE’s requested PDU session parameters.

5: Relay accepted/rejected

6: Discovery Response(s)

(with requested RSC)

7:Select relay

9: Registration Update/Service Request

 (with requested RSC)

8: (In)Direct Connection Request

to selected relay (with requested RSC)

10: UE-to-NW Relay’s AMF decides based on the requested RSC how to reconfigure the UE-to-NW relay to serve as relay for the Remote UE’s requested PDU session parameters.

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

13: (In)Direct Connection Accept

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

14: Setup PDU session (layer-2) or send IP traffic (layer-3) via 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. Remote UE can initiate discovery of UE-to-Network Relays by sending a Discovery Request over PC5 (i.e. a newly defined message) 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 Discovery 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 Discovery Request uses the default broadcast Destination Layer-2 ID configured for the requested Relay Service Code (or if known and desired, the unicast Layer-2 ID of a single target UE-to-Network Relay).

1. One or more UE-to-Network Relays receive the Discovery Request over PC5. Depending on the Relay Service Code received from the Remote UE and based on operator policy as provisioned in step 0, the UE-to-Network Relay decides whether the requested Relay Service Code needs to be sent to the AMF or whether the UE-to-Network Relay can immediately send a Discovery Response.
2. Depending on the Relay Service Code and operator policy, the UE-to-Network Relay sends a Discovery Report (i.e. a newly defined message) to the UE-to-Network Relay’s serving AMF. The Discovery Report includes the requested Relay Service Code, or alternatively if the requested Relay Service Code was a Generic Relay Service code, then the UE-to-Network Relay includes the second specific Relay Service Code (as included in the payload of the Direct Communication Request) instead
3. Based on the received Relay Service Code in the Discovery Report, the UE-to-Network Relay’s serving AMF will verify whether or not a 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, CAG ID/NID, 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.
	* PCF, e.g. to fetch the policies, such as the UE Route Selection Policy (URSP), that are currently active for a UE-to-Network relay.

Editor’s note: it is FFS how the parameter / policy obtained from other NFs are used, e.g. how to determine whether it is capable to serve as Relay considering the “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 NWDAF (e.g. for mobility analytics, user data congestion analytics, communication patterns), or the UDM (e.g. to verify if the UE-to-Network Relay is allowed to act as relay for a requested NPN).

1. If the AMF decides that a UE-to-Network Relay can serve as relay for the requested PDU session parameters, then the AMF will send a Relay Accepted (i.e. newly defined message) to that UE-to-Network Relay, including the given Relay Service Code.

NOTE: optionally, if the AMF decides that the UE-to-Network Relay cannot serve as relay for the requested PDU session parameters, the AMF may send a “Relay rejected” message to the UE-to-Network relay.

1. If the UE-to-Network relay receives a Relay Accepted message from the AMF, the UE-to-Network Relay sends a Discovery Response (i.e. newly defined message) to the Remote UE that includes the given Relay Service Code.

Editor’s note: it is FFS on how the following steps 7-14 could be integrated with or reuse another solution in the document

1. After receiving one or more Discovery Responses from UE-to-Network Relays, the Remote UE selects the UE-to-Network Relay for setting up the indirect communication with the core network.
2. The Remote UE sends 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) to the selected UE-to-Network Relay with the requested specific Relay Service Code (RSC) being used as (V2X) service/application identifier.
3. Upon receiving the Direct Communication Request from the Remote UE, the selected UE-to-Network Relay issues a Registration Update or Service Request (or other similar message) to its serving AMF (not only in CM\_IDLE state. as described in step 5 of Solution#7 for layer-2 UE-to-Network Relays, but also in CM\_CONNECTED state). The Registration/Service Request includes the requested Relay Service Code.
4. The AMF decides based on the requested Relay Service Code on how to reconfigure the UE-to-Network Relay to serve as relay for the Remote UE’s requested PDU session parameters corresponding to the requested Relay Service Code.
5. Optionally, the AMF may trigger an update of some of the other network functions to enable the UE-to-Network Relay to serve as a relay for the requested PDU session parameters, e.g. it may 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 11, the AMF may send a UE Configuration Update message to the UE-to-Network Relay, and/or the SMF may issue a PDU session modification command and/or the NG-RAN may issue an RRC Connection Reconfiguration.
2. Upon receiving one or more of these commands in step 12, the UE-to-Network Relay performs the connection reconfiguration (e.g. update or re-establish or start a new PDU session that will be used to relay the traffic from the Remote UE to the core network, and possibly also update the RAN connection, e.g. to connect a particular CAG cell in case of NPN), and performs the PC5 unicast link security procedure, after which it sends a Direct Communication Accept message to the Remote UE. This message may include some additional information, such as IP configuration information (e.g. for layer-3 relaying).
3. In case of layer-2 relay, the Remote UE continues with step 7 of Solution#7 over the PC5 connection established in step 13, 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 or different CAG ID/NID), the Remote UE should repeat steps 1-14. 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 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:**

* New UE procedures for Discovery using Relay Service Codes
* 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:**

* New UE procedures for Discovery using Relay Service Codes
* Support for using (V2X) Direct Communication Request with Relay Service Codes.
* Support provisioning of Relay Service Codes.
* Support extended Registration Update/Service Request procedure with Relay Service Code

**AMF:**

* Support configuring the mapping of Relay Service Codes and related PDU session parameter information
* Support assessment and reconfiguration of the UE-to-Network Relay based on requested Relay Service Code.
* Support Discovery reporting and Relay Accepted/Rejected messaging
* Support extended Registration Update/Service Request procedure with Relay Service Code

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