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Title: Discussion on TEI19 support for ProSe in NPNs

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Abstract: Analysis and proposal to include ProSe support for NPNs as a Rel-19 TEI.

# Introduction

As explicitly indicated in TS 23.501 clauses 5.30.2.0 and 5.30.3.1, ProSe is currently not supported for NPNs. It is important to consider this topic for inclusion in release 19, given that without NPN support, deployment of ProSe (e.g. in factories) is hampered, and important SA1 use cases identified and requirements for ProSe (e.g. collaborating mobile robots as specified in TS 22.104) cannot be fully supported. This would also not be in line with the requirements in TS 22.261, which require support for ProSe in NPNs.

As indicated in LS S2-2311029, various whitepapers from 5G-ACIA such as “Using 5G sidelink in industrial factory applications” show the need for 5G sidelink communication to be supported in non-public networks (SNPN, PNI-NPN). Not supporting ProSe in NPNs also affects other programs, such as Ranging, i.e. ranging cannot be deployed in NPNs unless support for ProSe in NPNs is added.

This discussion paper describes which changes are needed to the 5G ProSe specification TS 23.304 to enable support for ProSe in NPNs.

## Architecture updates

As per TS 23.501, roaming is not supported for SNPNs. Hence, non-roaming architecture in clause 4.2.1 of TS 23.304 also applies to NPNs, but the roaming architecture in clause 4.2.2 of TS 23.304 is not supported for SNPNs. Given that roaming is not supported for SNPNs, it is also logical that the use of Local PLMN for direct discovery as defined in TS 23.303 and referred to in TS 23.304 is not supported for SNPNs. Similarly, the roaming architecture for 5G ProSe Layer-3 UE-to-Network Relay in clause 4.2.7.1 of TS 23.304 also does not need to be supported for SNPNs. The non-roaming Inter-PLMN architecture in clause 4.2.3 TS 23.304 can be reused for inter-SNPN operation without requiring any significant changes, so it is proposed to support this. It only requires allowing the combination of PLMN ID with NID for 3 identifiers in the N5g-ddnmf service definition, i.e. ProSe Application ID, ProSe Application Code and Monitored PLMN ID. See section 3 below for more information.

Although clause 5.30 of TS 23.501 supports onboarding of UEs to an SNPN, it is not needed to support access to an onboarding network via 5G ProSe UE-to-Network Relay, since this could lead to potential complexity and there is insufficient justification to support it.

## Expanding PLMN terminology and PLMN IDs to NPNs

The 5G ProSe specification TS 23.304 contains many instances in which the term PLMN is explicitly used. For most instances of the term PLMN, this can simply be replaced by “PLMN/NPN”. In some cases only SNPNs need to be explicitly mentioned rather than PNI-NPN. In such cases, the term SNPN or term PNI-NPN needs to be used explicitly. The term HPLMN can be replaced with “home network” to cover both types of networks. PLMN terminology is not updated or expanded if the terminology of PLMN pertains to VPLMNs or Local PLMNs.

TS 23.304 uses PLMN ID explicitly in certain interfaces or identifiers. The following instances have been identified:

- **ProSe Application ID:** as per clause 4.6.4.1 of TS 23.303 this identifier is composed of a ProSe Application ID Name and a PLMN ID. It is proposed to enable combining the PLMN ID with a Network Identifier (NID) to identify an SNPN.

- **ProSe Application Code:** as per clause 4.6.4.2 of TS 23.303 this identifier is composed of a temporary identity that corresponds to the ProSe Application ID Name and a PLMN ID. It is proposed to enable combining the PLMN ID with a NID to identify an SNPN.

- **Monitored PLMN ID:** as per clause 6.1.3.2 of TS 32.277 this identifier is a PLMN identifier. Hence in order to enable the identification of an SNPN, it is proposed to enable combining this PLMN identifier with a NID to identify an SNPN. Note that this identifer is not yet listed in the list of identifiers in clause 5.8.1 of TS 23.304, even though it is used in N5g-ddnmf service definition in clause 7.1.2 of TS 23.304. Hence, it is proposed to add it to clause 5.8.1 of TS 23.304, which contains an overview of all relevant identifiers.

- **Announcing PLMN ID:** as per clause 6.1.3.2 of TS 32.277 this identifier is a PLMN identifier. However, this identifier does not seem necessary in the context of SNPNs. Note that for the Announcing PLMN ID it is actually not clear if/how this is used in 5G ProSe, since it is e.g. not used in the N5g-ddnmf service definition for PLMN operation, so perhaps it can be removed completely.

- **NCGI:** as per clause 11.2.12 of TS 24.554 this identifier is composed of a PLMN ID and an NR cell identity, and is exchanged as part of U2N relay discovery messages. Hence in order to enable the identification of an SNPN, it is proposed to enable combining this identifier with a NID to identify an SNPN. This would be in line with TS 29.571.

- **TAI:** as per clause 11.2.10 of TS 24.554 this identifier is composed of a PLMN ID and a Tracking Area Code, and is exchanged as part of U2N relay discovery messages. Hence in order to enable the identification of an SNPN, it is proposed to enable combining this identifier with a NID to identify an SNPN. This would be in line with TS 29.571.

The details of how these extended values are specified can be left to CT1.

## Discovery of U2N Relays that support access to an NPN

As mentioned in section 3 above, the values NCGI and TAI that can be exchanged during U2N relay discovery can be extended to indicate an SNPN as serving network of the U2N Relay.

In addition, some mechanism is needed to indicate during U2N Relay discovery if the U2N Relay is actually able to camp on a CAG cell related to a particular PNI-NPN in case a remote UE wishes to use the U2N Relay to communicate with a PNI-NPN. In particular for layer-2 U2N relay, as per TS 38.300, the U2N Relay needs to be able to perform its own RRC connection establishment with a CAG cell in order to get to RRC\_CONNECTED state. Even though the RRC\_Container containing cell access related information of SIB1 of the serving cell is exchanged during U2N Relay discovery, the list of CAG IDs provided in SIB1 may include more CAG IDs than the relay UE is actually able/allowed to use. In particular if the remote UE is configured to only access the PNI-NPN via CAG, it needs to be able to discover and select U2N Relays that are able to connect to a related CAG cell. Also in case of layer-3 relay that wants to connect to a certain PNI-NPN it is useful to know if the relay UE can actually support that.

Instead of extending the discovery information with a list of CAG identifiers that the U2N Relay is able/allowed to use, given that the resources for discovery over PC5 are limited, it is proposed to leverage the RSC mechanism to convey if the U2N Relay is able to use and/or is connected to a CAG cell. This can be done by extending the policy/parameter information that is provisioned to a U2N Relay and U2N Remote UE, i.e. by adding an optional CAG Indicator to one or more RSCs in the 5G ProSe UE-to-Network Relay Discovery parameters. The optional CAG Indicates can include a list of CAG identifiers for which the RSC is only allowed to be used if the 5G ProSe UE-to-Network Relay is currently served by a CAG cell or can connect to a CAG cell that supports a CAG identifier indicated by the CAG Indicator. In this manner, certain RSCs will only be discoverable by a Remote UE if the U2N Relay can actually connect or is served by a CAG cell. This allows the Remote UE that wants to connect to certain PNI-NPN to select a U2N Relay according to its exposed RSCs. Using RSCs also provides a first level of authorization/filtering of Remote UEs that connect to such RSC, since existing security mechanisms for RSC authorization of Remote UEs can be reused, i.e. only Remote UEs that are authorized for such particular RSC may use the PNI-NPN related CAG cell.

## Proposal

It is proposed to specify the following enhancements to 5GS to support Proximity Services in the context of NPNs based on the above analysis and solution details:

- Expand the non-roaming architecture for ProSe to also cover NPN support, including support for inter-SNPN operation in non-roaming deployment.

- Enable combining PLMN IDs with a Network Identifier (NID) to enable identification of SNPNs, and update PLMN specific terminology to also cover NPNs.

NOTE: PLMN terminology is not updated and PLMN IDs are not combined with NID if the terminology of PLMN and the use of PLMN ID pertains to VPLMNs or Local PLMNs or Announcing PLMN IDs.

- Enable discovery and selection of 5G ProSe UE-to-Network Relays that support access to an NPN (e.g. that are registered to a certain SNPN and/or that camp on a CAG cell of a certain PNI-NPN).