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# Foreword

This Technical 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:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# Introduction

A non-public network is a network that is intended for non-public use. Deployments of non-public networks in private environments (e.g. factories, enterprises) to provide coverage within a specific geographic area for non-public use is a key demand of emerging 5G applications and verticals. Non-public networks may be deployed as completely standalone networks or with the support of a PLMN. The 5G system supports non-public networks.

The present document studies the management aspects of non-public networks.

# 1 Scope

The present document describes use cases, potential requirements and solutions (from the perspective of services based management architecture) for the management aspects of non-public networks. The present document provides conclusions and recommendations on the next steps for the standardization.

# 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 22.261: "Service requirements for next generation new services and markets; Stage 1".

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

[4] 5G-ACIA White paper: "5G Non-Public Networks for Industrial Scenarios", July 31, 2019.

[5] 3GPP TS 23.003: "Numbering, addressing and identification".

[6] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[7] 3GPP TS 28.530: "Concepts, use cases and requirements".

[8] 3GPP TR 28.805: "Study on management aspects of communication services".

[9] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[10] 3GPP TS 28.541: "Management and Orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[11] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP 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 3GPP TR 21.905 [1].

**Non-Public Network:** See definition in TS 22.261 [2].

**Public network integrated NPN:** See definition in TS 23.501 [3].

**Stand-alone Non-Public Network:** See definition in TS 23.501 [3].

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

MnS Management Service

NPN Non-Public Network

PNI-NPN Public Network Integrated NPN

SNPN Stand-alone NPN

# 4 Concepts and background

## 4.1 General

A Non-Public Network (NPN) is a 5GS deployed for non-public use, see TS 23.501 [3]. In contrast to public networks that offer mobile network services to the general public, non-public networks are intended for the sole use of a private entity such as a college or an enterprise. Non-public networks may be deployed on the entity's defined premises such as a campus or a factory to provide coverage within a specific geographic area.

Non-public networks may be deployed in a variety of configurations, utilising both virtual and physical network functions, see TS 22.261 [2]. Specifically, see TS 23.501 [3], an NPN may be deployed as:

- a Stand-alone Non-Public Network (SNPN), i.e. operated by an NPN operator and not relying on network functions provided by a PLMN; or

- a Public network integrated NPN (PNI-NPN), i.e. a non-public network deployed with the support of a PLMN.

From the view of 5G-ACIA, non-public networks can be desirable for several reasons, see clause 4 of [4]:

- High quality-of-service requirements

- High security requirements, met by dedicated security credentials

- Isolation from other networks, as a form of protection against malfunctions in the public mobile network. Also, isolation may be desirable for reasons of performance, security, privacy, and safety

- Accountability. A non-public network makes it easier to identify responsibility for availability, maintenance, and operation

## 4.2 Model of roles

In the context of NPNs, responsibilities regarding operations have to be clearly defined and assigned to roles. The roles related to NPNs include:

- NPN operator: designs, builds and operates an NPN providing all the required network services and resources.

- NPN service provider: provides non-public communication services using an NPN. Designs, builds and operates these services, which are supported by the NPN operator provided network services.

- NPN service customer: consumes services offered by an NPN service provider.

There is a direct mapping between these roles and the ones defined in clause 4.8 of TS 28.530 [7], when network and services under consideration are non-public. The NPN operator role is a particularization of the Network Operator (NOP) role, the NPN service provider role is a particularization of the Communication Service Provider (CSP) role and the NPN service customer role is a particularization of the Communication Service Customer (CSC) role.

Depending on actual scenarios and the type of NPN under consideration, i.e. SNPN or PNI-NPN, different relationships can be found between NPN related roles and potential stakeholders. This means:

- each role can be played by one or more organizations simultaneously. For example, in PNI-NPN deployments the NPN operator role can be shared between a MNO and a vertical (or a private company acting on behalf of it). In the same way, in SNPN deployments the NPN operator role can be played by either a vertical (or a private company on behalf of it) or a MNO which manages the SNPN;

- an organization can play one or several roles simultaneously. For example, a company can play both NPN operator and NPN service provider roles.

## 4.3 Management of Stand-alone Non-Public Networks

An SNPN is deployed as an independent, isolated network. As shown in figure 4.3-1, all SNPN network functions are located inside the logical perimeter of the defined premises (e.g. factory) and the SNPN is separate from the public network. The SNPN operator has full management control over the exclusive SNPN network functions, e.g. the non-public 5G Core Network and/or 5G Access Network part of SNPN.

**SNPN**

Public Network Management

SNPN Management

**PLMN**

Figure 4.3-1: SNPN deployment and SNPN management

To manage a SNPN, which is based on 3GPP-defined technologies, the standalone SNPN management system needs a dedicated NPN identifier. The combination of a PLMN ID and Network identifier (NID) is used to identify an SNPN. The NID supports two assignment models, see clause 5.30.2 of TS 23.501 [3]:

- Locally managed NIDs are assumed to be self-managed by SNPNs (i.e. chosen individually by SNPNs) at deployment time (and may therefore not be unique) but use a different numbering space than the universally managed NIDs as defined in TS 23.003 [5].

- Universally managed NIDs are assumed to be globally unique.

Additional considerations:

- With respect to the management of the NG-RAN segment of the SNPN:

- The following roles are involved:

- NPN Service Provider: played by the Vertical.

- NPN Operator: played by the Vertical, for the NG-RAN segment.

- NPN Service Customer: can be played by Vertical's employees, Vertical's applications, Vertical's customers, etc.

- The NG-RAN segment of the NPN is operated by the Vertical (see note 1, note 2 and note 3);

- The NG-RAN segment of the NPN is deployed in well-defined areas (e.g. within Vertical's premises, factory, along railroad tracks, etc.) to meet the Vertical's requirements;

- Only the Vertical's UEs are authorized to gain access to the NPN;

- The following variants may exist:

- Fully isolated SNPN (see [4] clause 5.2, Figure 1 with the optional connection not being deployed); or

- SNPN partly integrated with a PLMN (see [4] clause 5.2, Figure 1 with the optional connection being deployed from SNPN to PLMN only). In such a case, the management of the connection between the SNPN and the PLMN is shared between proponents.

- With respect to the management of the 5GC segment of the SNPN:

- The following roles are involved:

- NPN Service Provider: played by the Vertical

- NPN Operator: played by the Vertical, for the 5GC segment (see note 1)

- NPN Service Customer: can be played by Vertical's employees, Vertical's applications, Vertical's customers, etc.

- Virtualization Infrastructure Service Provider (VISP): played by a 3rd-party cloud service provider.

- The 5GC segment of the NPN is deployed in Vertical's premises. Alternatively, in case of virtualization of some 5GC network functions, the Vertical may rely on one or more VISPs (see TS 28.530 [7], clause 4.8) to host its virtualized 5GC network functions, out of the Vertical's premises;

- In the 5GC segment, the Vertical may utilize 'Network Slice as NOP Internals' model (see TS 28.530 [7], clause 4.1.7) to accommodate services to be provided to its own customers.

NOTE 1: Whether the Vertical outsources (part of) its network management tasks to other stakeholder(s) is out of scope of the present document.

NOTE 2: The focus is put here on which roles are involved in the operation of the NPN segments, not on which roles are involved in their deployment. Whether a NPN segment is deployed by the Vertical, or by a Network Operator or by anyone else on behalf of them, is out of scope of the present document

NOTE 3: How dedicated licensed spectrum is obtained by the Vertical to operate its NPN is out of the scope of the present document.

## 4.4 Management of PNI-NPN

### 4.4.1 NPN supported by network slice instance of a PLMN

A Public Network Integrated NPN (PNI-NPN) can be made available by PLMNs e.g. using one (or more) network slice instance(s). The existing network slicing functionalities apply as described in clause 5.15 of TS 23.501 [3].

A Closed Access Group identifies a group of subscribers who are permitted to access one or more CAG cells associated to the CAG. A CAG is identified by a CAG Identifier which is unique within the scope of a PLMN ID, see clause 5.30.3.2 of TS 23.501 [3]. The management system of the PNI-NPN takes charge of the management of CAG Identifiers.

From a management viewpoint, the provision of a network slice instance can follow the Network Slice as a Service (NSaaS) principles as described in clause 4.1.6 of TS 28.530 [7]. Figure 4.4.1-1, as an example, illustrates how a PLMN operator can rely on NSaaS capabilities (e.g. OAM, exposure) for the provisioning of a PNI-NPN to a vertical. This PNI-NPN, which is deployed across one PLMN and the vertical's premises (e.g. factory), can be seen as an end-to-end network composed of two differentiated segments: one public, consisting of a (R)AN and network functions built upon public 5G network resources; and one private, consisting of network functions deployed using private 5G network resources. Using the NSaaS approach:

- The public segment is made available by the PLMN in the form of a network slice instance, and provisioned by the PLMN operator using NSaaS. In this service provisioning, the PLMN operator and the vertical play the roles of NSaaS provider and NSaaS customer, respectively.

- The PLMN operator can offer possibilities (e.g. exposed MnS to manage the network slice instance) for the vertical to manage the provided network slice instance according to TS 28.531 [6].

- The vertical adds the private segment to the network slice instance obtained from the PLMN operator. The resulting combination, i.e. PNI-NPN, is a new network slice instance or a new network.

- In the case of a new network slice instance, following 3GPP 5G Network Resource Model (NRM) [10], the PNI-NPN's public segment can be modelled as a network slice subnet instance whilst the private segment can be modelled as one or more network slice subnet instances according to the vertical's policy.

- In the case of a new network, the PNI-NPN's public segment can be modelled as a network slice instance (i.e. remains unchanged as the network slice instance obtained from the PLMN operator) with interaction with private segment.

- The vertical uses the PNI-NPN to provide non-public communication services to his customer(s). In this case, the vertical plays the role of NPN service provider, and his customer(s) play the role of NPN service customer(s). For more information on these NPN related roles, see clause 4.2.

A screenshot of a cell phone

Description automatically generated

Figure 4.4.1-1: PNI-NPN provisioning with NSaaS

Additional considerations:

- With respect to the management of the NG-RAN segment of the PNI-NPN:

- the Network Operator grants access to the Vertical to the whole Network Operator NG-RAN, or only to a part of it;

- whatever the part of the NG-RAN of the Network Operator which access is granted to the Vertical, this part of the NPN is operated by the Network Operator;

- a roaming agreement or, alternatively, a RAN sharing agreement between the Vertical and the Network Operator may be required;

- one (or more) Closed Access Group(s) (CAG), identifying which Vertical's UEs are permitted to access Network Operator NG-RAN cells may have to de defined. Since only the Network Operator has management access to the NG-RAN, the Vertical and the Network Operator may have to interact (Vertical requests the network Operator to add, delete, modify the list of Vertical's UEs allowed to access the Network Operator cells);

- the same as above applies to CAG cells;

- there may be more than one Network Operator involved in this scenario (e.g. for coverage requirements).

- With respect to the management of the 5GC segment of the PNI-NPN:

- The 5GC segment of the NPN is operated by a Network Operator, whether the 5GC is:

i) wholly deployed in Vertical's premises (see [4] clause 5.3.1, Figure 2); or

ii) partly in Vertical's premises (e.g. UPFs) and partly in the Network Operator's domain (e.g. 5GC control plane network functions); or

iii) wholly in the Network Operator's domain.

- In the 5GC segment, the Network Operator may utilize "Network Slice as a Service" model (see TS 28.530 [7], clause 4.1.7) and/or "Network Slice as NOP internals" model (see TS 28.530 [7], clause 4.1.7).

# 5 Use Cases

## 5.1 Use cases related to management of stand-alone NPN

### 5.1.1 Stand-alone NPN provisioning with 3GPP and non-3GPP segments

#### 5.1.1.1 Create a stand-alone NPN with 3GPP and non-3GPP segments

A non-public network, which includes 3GPP and non-3GPP segments, needs to be created for use of a private company in the form of a stand-alone NPN. From a management viewpoint, this means that the 3GPP and non-3GPP segments of this NPN are completely independent and separated from PLMN provided network functions.

The NPN management system in charge of operating this stand-alone NPN consists of:

- A 3GPP management system, responsible for managing the 3GPP segment of the NPN.

- one (or more) non-3GPP-management system(s), responsible for managing the non-3GPP segment(s) of the NPN.

- An interworking management function, which makes 3GPP and non-3GPP management systems work together without the necessity to introduce modifications on their design. The interworking management function sits on top of these management systems, coordinating the execution of activities across them, by sending one management system notifications about the state of the activities carried out in other management system if necessary. The interworking function is also responsible of performing any necessary model translation when exchanging notifications across 3GPP and non-3GPP management systems.

The main aspects of management to support the creation of a stand-alone NPN which consists of 3GPP and non-3GPP segments include:

- The NPN management system receives the requirements of the requested stand-alone NPN from a private company, e.g. coverage requirement within a specific geographic area, isolation requirement, deterministic communication requirements, etc.

- The interworking function decomposes these requirements into 3GPP-related NPN requirements and non-3GPP-related NPN requirements. Based on the NPN requirements from the private company, the 3GPP segment of the NPN may include either only the RAN part or only the CN part or both the RAN and CN parts. This means that 3GPP-related requirements may include either only RAN part-related requirements or only CN part-related requirements or both the RAN part- and CN part-related requirements.

- To trigger the creation of the 3GPP segment for the requested NPN, the 3GPP management system takes the 3GPP-related requirements from the interworking management function.

- Based on the 3GPP-related NPN requirements, the 3GPP management system determines to reuse an existing 3GPP segment or create a new 3GPP segment for the requested NPN. If a 3GPP segment from an existing stand-alone NPN can be reused, the NPN operator may reconfigure that NPN.

NOTE 1: Reusing the 3GPP segment from an existing NPN requires that the requested NPN and existing NPN can be shared with each other.

- In case of creating a new 3GPP segment for the NPN:

- Based on RAN part-related requirements, the 3GPP management system determines to utilize new RAN NE(s).

- Based on CN part-related requirements, the 3GPP management system determines to utilize new CN NF(s) or CN NF service(s).

- The 3GPP management system notifies the created 3GPP segment information to the interworking management function.

- To trigger the creation of the non-3GPP segment(s), the non-3GPP management system(s) takes information about created 3GPP segment as well as non-3GPP-related NPN requirements from the interworking management function.

NOTE 2: How the non-3GPP management system(s) proceeds with the creation of non-3GPP segment(s) is out of the scope of the present document.

A stand-alone NPN consisting of 3GPP and non-3GPP segments is created.

## 5.2 Use cases related to management of PNI-NPN

### 5.2.1 NPN provisioning by a network slice of a PLMN

#### 5.2.1.1 Create a Network Slice Instance for a NPN

An operator decides to deploy a PLMN-integrated NPN in the local data network, for example, deploying an NSI at the enterprise's premise or in the factory. The NSI, based on the NPN requirement from the enterprise includes either only the RAN part or only the CN part or both the RAN part and the CN part.

For the CN part, there may be some network functions/network function services locally deployed at the enterprise's premise or in the factory, and some other network functions/network function services being deployed in the PLMN network (outside of enterprise's premise or outside the factory). This CN part may be supported by two network slice subnet instances. The network slice subnet instance(s) may be dedicated for a single enterprise or may be shared by multiple enterprises.

For the RAN part, some network functions may be deployed in the PLMN network. This RAN part may be supported by one or more network slice subnet instances. The network slice subnet instance(s) may be dedicated for a single enterprise or may be shared by multiple enterprises.

The main aspects of management to support NSI creation for a NPN includes:

- Based on the NPN SLA requirements from NPN customer, for example coverage requirement within a specific geographic area, slicing isolation level requirement, downlink/uplink throughput requirements, latency requirement, 3GPP management system determines the requirements for both the RAN part and the CN part.

- 3GPP management system determines to reuse an existing NSI or create a new NSI for the NPN. If an existing NSI can be reused, the operator may reconfigure the existing NSI.

- In case of creating a new NSI for the NPN:

- The 3GPP management system determines to utilize the existing RAN NE(s) or a new RAN NEs.

- The 3GPP management system determines to utilize new or existing CN NF(s) or CN NF service(s) of the CN part that are deployed in the PLMN network.

- The 3GPP management system determines to utilize new CN NF(s) or CN NF service(s) of the CN part that are deployed locally at the enterprise's premise or in the factory.

An NSI for a NPN is created.

### 5.2.2 Exposure of management capability of NPN

#### 5.2.2.1 Providing specific management capability of configuration and monitoring to an NPN operator

A PLMN operator has created an NSI, which includes either only the RAN part or only the CN part or both the RAN part and the CN part, for an enterprise. CN part is provided by the PLMN operator and the RAN part is either provided by the PLMN operator or the NPN operator.

The service request from the NPN customer includes a requirement of a limited management capability exposure which would enable the NPN customer to dynamically change the configuration parameters and policies related to traffic controlling and performance monitoring and associated data analytics requirements. The NPN customer can then use the NPN most effectively for its traffic. As an example, an NPN network may have a partial failure and running with limited capabilities and in such a situation, only the critical traffic is allowed by means of admission control or prioritization as required by the NPN customer which may depend on the network condition and traffic demand at that time.

The performance monitoring capabilities that may be provided to the NPN customer may include creation of certain measurement jobs and selecting the type of data analytics and performance to be monitored, e.g., performance related to various traffic types, geographical areas, different device types, for a specific group of devices, for certain traffic congestion situation and analytical KPIs related to performance predictions.

### 5.2.3 UE related data issues

#### 5.2.3.1 Collecting UE related data and providing to authorized NPN service customer

UEs under service of NPN may have various forms, such as phones or PCs or IoT terminals, some of them are assets of the NPN service customer. In some cases, UE related data including UE locations, measurements, etc. is required by the NPN service customer to help their own business. Such UE related data is easier or more cost-efficient to be acquired by NPN UEs compared with being acquired by other methods e.g. by add-on devices or applications. For example, healthcare industry NPN customers require location information of their NPN UEs applied in mobile medical machines for asset management; enterprise NPN customers require location information of the NPN UEs of their employees for attendance management.

In this case, the NPN management system may need to collect UE related data and provide to authorized NPN service customer. Such collected UE related data are generated by management services which are defined and implemented in 3GPP system, such as:

- MDT data, including Immediate MDT, Logged MDT, RLF reports, accessibility measurements.

- Trace data, to track traffic process of UEs and locate possible causes of traffic problems for example.

Furthermore, according to pre-defined agreements among the NPN roles (see clause 4.2), some specific UE related data can be provided to authorized NPN customer, e.g. to promote their positioning ability or evaluate QoE. Such data may be processed or masked based on collected data such as MDT or trace. For example, GNSS information can be distracted from MDT to locate assets in NPN.

# 6 Potential requirements

## 6.1 Potential common requirements for management of NPN

**REQ-NPN-CON-01** The 3GPP management system shall have the capability to monitor the performance metrics related to an NPN.

**REQ-NPN-CON-02** The 3GPP management system shall have the capability to provide KPIs related to an NPN to authorized NPN service provider or NPN service consumer.

**REQ-NPN-CON-03** The 3GPP management system shall have the capability to receive SLA from authorized NPN service consumer and then translating the SLA into network resources related requirements.

**REQ-NPN-CON-04** The 3GPP management system shall have the capability to evaluate SLS fulfilment related to an NPN.

**REQ-NPN-CON-05** The 3GPP management system shall have the capability to manage an NPN that provide coverage within a specific geographic area.

**REQ-NPN-CON-06** The 3GPP management system shall have the capability to manage identifiers for a large number of NPNs to minimize collision probability between assigned identifiers.

## 6.2 Potential requirements for management of SNPN

**REQ-SNPN-CON-01** The 3GPP management system shall have the capability to support standalone operation of an NPN without dependency on a PLMN.

**REQ-SNPN-CON-02** The 3GPP management system shall have the capability to support management of dedicated NPN identifier which is used to identify an SNPN.

**REQ-SNPN-CON-03** The 3GPP management system shall have the capability to interwork with one or more non-3GPP management systems to support the operation of a SNPN which includes 3GPP and non-3GPP segments.

## 6.3 Potential requirements for management of PNI-NPN

**REQ-PNIN-CON-01** The 3GPP management system shall have the capability to support management of CAG which identifies a group of subscribers who are permitted to access one or more CAG cells associated to the CAG.

**REQ-PNIN-CON-02** The 3GPP management system shall have the capability to configure a CAG cell with a CAG list containing up to 12 CAG-identifiers, as defined in TS 38.331 [11].

**REQ-PNIN-CON-03** The 3GPP management system shall have the capability to support exposure of management services defined in clause 6.1 of TS 28.531 [6] to authorized NPN service consumer.

**REQ-PNIN-CON-04** The 3GPP management system shall have the capability to collect NPN UE related data which may include MDT data and trace data.

**REQ-PNIN-CON-05** The 3GPP management system shall have the capability to provide NPN UE related data to authorized NPN service customer according to pre-defined agreements.

**REQ-PNIN-CON-06** The 3GPP management system shall have the capability to provision a PNI-NPN using Network Slice as a Service (NSaaS), with the Vertical taking the NSaaS customer role.

# 7 Potential solutions

## 7.1 Solutions for management of SNPN

### 7.1.1 Solution for SNPN provisioning with 3GPP and non-3GPP segments

An SNPN, which includes 3GPP and non-3GPP segments, needs to be created for use of a NPN service customer (e.g. a private company). From management viewpoint, this means that the 3GPP and non-3GPP segments of this NPN are completely independent and separated from PLMN provided network functions.

1) NPN service provider, receives SLA information of the requested SNPN from NPN service customer. The SLA information may include coverage requirement within a specific geographic area, isolation requirement, deterministic communication requirements, etc.

2) The NPN service provider translates the received SLA information into SLA requirements, i.e. the service and network requirements derived from SLA. The solution for translation of SLA into SLA requirements documented in clause 6.2 of TR 28.805 [8] may be reused for the context of NPN service.

3) The NPN service provider decomposes these requirements into 3GPP-related NPN requirements and non-3GPP-related NPN requirements:

a) Based on the NPN requirements from NPN service customer, the 3GPP-related NPN requirements may include either only RAN part-related requirements or only CN part-related requirements or both the RAN part- and CN part-related requirements.

4) The NPN service provider sends the 3GPP-related NPN requirements to NPN operator to trigger the provisioning of the 3GPP segment for the requested NPN.

5) Based on the 3GPP-related NPN requirements, the NPN operator determines to reuse an existing 3GPP segment or create a new 3GPP segment for the requested NPN. If a 3GPP segment from an existing stand-alone NPN can be reused, the NPN operator may reconfigure that NPN:

a) In case of creating a new 3GPP segment for the NPN:

- Based on RAN part-related requirements, the 3GPP network management system determines to utilize new RAN NE(s).

- Based on CN part-related requirements, the 3GPP network management system determines to utilize new CN NF(s) or CN NF service(s).

6) The NPN operator notifies the created 3GPP segment information (e.g. a dedicated SNPN identifier which is the combination of a PLMN ID and NID, see clause 5.30.2 of TS 23.501 [3]) to the NPN service provider.

7) To trigger the provisioning of the non-3GPP segment(s), the non-3GPP management system(s) takes information about created 3GPP segment as well as non-3GPP-related NPN requirements from an interworking management function which makes 3GPP and non-3GPP management systems work together without the necessity to introduce modifications on their design or the 3GPP network management system.

NOTE 1: The interworking management function sits on top of 3GPP and non-3GPP management systems, coordinating the execution of activities across them, by sending one management system notifications about the state of the activities carried out in other management system if necessary. The interworking function is also responsible of performing any necessary model translation when exchanging notifications across 3GPP and non-3GPP management systems.

NOTE 2: How the non-3GPP management system(s) proceeds with the creation of non-3GPP segment(s) is out of the scope of the present document.

8) A stand-alone NPN consisting of 3GPP and non-3GPP segments is created.

### 7.1.2 Solution for SNPN provisioning with 3GPP segments only

An SNPN, which includes 3GPP segment only, needs to be created for use of a NPN service customer (e.g. a private company). From management viewpoint, this means that the 3GPP segment of this NPN are completely independent and separated from PLMN provided network functions.

1) NPN service provider receives SLA information of the requested SNPN from NPN service customer. The SLA information may include coverage requirement within a specific geographic area, isolation requirement, deterministic communication requirements, etc.

2) The NPN service provider converts the received SLA information to SLA requirements, i.e. the service and network requirements derived from SLA. The solution for translation of SLA into SLA requirements documented in clause 6.2 of TR 28.805 [8] may be reused for the context of NPN service.

3) Based on the NPN requirements from NPN service customer, the 3GPP-related NPN requirements may include either only RAN part-related requirements or only CN part-related requirements or both the RAN part- and CN part-related requirements.

4) The NPN service provider sends the 3GPP-related NPN requirements to NPN operator to trigger the provisioning of the 3GPP segment for the requested NPN.

5) Based on the 3GPP-related NPN requirements, the NPN operator determines to reuse an existing 3GPP segment or create a new 3GPP segment for the requested NPN. If a 3GPP segment from an existing stand-alone NPN can be reused, the NPN operator may reconfigure that NPN:

a) In case of creating a new 3GPP segment for the NPN:

- Based on RAN part-related requirements, the 3GPP network management system determines to utilize new RAN NE(s).

- Based on CN part-related requirements, the 3GPP network management system determines to utilize new CN NF(s) or CN NF service(s).

6) The NPN operator notifies the created 3GPP segment information (e.g. a dedicated SNPN identifier which is the combination of a PLMN ID and NID, see clause 5.30.2 of TS 23.501 [3]) to the NPN service provider.

7) A stand-alone NPN consisting of 3GPP segment only is created.

## 7.2 Solutions for management of PNI-NPN

### 7.2.1 Solution for NPN provisioning by a network slice of a PLMN

An NPN operator decides to deploy a PNI-NPN in the local data network, for example, by deploying an NSI at the enterprise's premise or in the factory. The NSI, based on the requirements from the NPN service customer, includes either only the RAN part or only the CN part or both the RAN part and the CN part.

The main aspects of NPN provisioning by a network slice of a PLMN include:

1) CSMF receives SLA information from NPN service customer (e.g. a private company), the SLA information may include coverage requirement within a specific geographic area, isolation requirement, downlink/uplink throughput requirements, latency requirement, etc.

2) The CSMF translates the received SLA information to SLA requirements, i.e. the service and network requirements derived from SLA, the solution for translation of SLA into SLA requirements documented in clause 6.2 of TR 28.805 [8] may be reused for the context of NPN service.

3) Based on the translated NPN SLA requirements from CSMF, NSMF determines the requirements for NG-RAN part and/or 5GC part and/or TN part:

a) If any, the NG-RAN domain related requirements are provided to NSSMF which manages NG-RAN domain.

b) If any, the 5GC domain related requirements are provided to NSSMF which manages 5GC domain.

c) If any, the TN domain related requirements are provided to the management system of TN domain.

4) NSMF determines to reuse an existing NSI or create a new NSI for the NPN. If an existing NSI can be reused, the NSMF may reconfigure the existing NSI.

5) In case of creating a new NSI for the NPN, based on the requirements from the NPN service customer (e.g. enterprise, factory) includes either only the RAN part or only the CN part or both the RAN part and the CN part:

- The NG-RAN domain NSSMF determines to utilize the existing NG-RAN NE(s) or new NG-RAN NEs that are deployed in the PLMN network or deployed locally at the enterprise's premise or in the factory.

- The 5GC domain NSSMF determines to utilize new or existing 5GC NF(s) or 5GC NF service(s) of the 5GC part that are deployed in the PLMN network or deployed locally at the enterprise's premise or in the factory.

- If any, the TN domain related requirements are provided to the management system of TN domain.

6) An NSI for a PNI-NPN is allocated.

### 7.2.2 Solution for exposure of management capability of NPN

Authorized NPN management service consumer can obtain certain management capability to manage the NPN (e.g., provisioning, monitoring) from NPN management service producer according to their pre-defined agreements.

- Using exposure of generic provisioning management services (see clause 5 of TS 28.532 [9]) and management services for provisioning of networks and network slicing (see clause 6 of TS 28.531 [6]), NPN customers can dynamically change the configuration parameters and policies related to performance monitoring.

- Using exposure of generic fault supervision management service (see clause 6 of TS 28.532 [9]) and generic performance assurance management service (see clause 7 of TS 28.532 [9]), NPN customers can create certain measurement jobs and select the type of data analytics and performance to be monitored, e.g., performance related to various traffic types, geographical areas, different device types, for a specific group of devices, for certain traffic congestion situation and analytical KPIs related to performance predictions.

Depending on different scenarios, an NPN role can play management service consumer or management service producer simultaneously. For example, an NPN service provider A can be management service consumer and management service producer simultaneously for the following cases:

- NPN service provider A acts as a management service consumer who obtain the allowed management capability to manage the NPN A provided by NPN management service producer (e.g. NPN operator A).

- Another NPN service provider B acts as a management service consumer who obtain the allowed management capability to manage the NPN B provided by NPN service provider A as the NPN management service producer.

### 7.2.3 Solution for collecting UE related data and providing to authorized NPN service customer

UEs under service of NPN are assets of NPN service customer in some cases. UE related data including UE locations, measurements, etc. can help NPN service customer own business.

Authorized NPN service customer can obtain the following NPN UE related data from NPN operator according to their pre-defined agreements.

- MDT data, including Immediate MDT, Logged MDT, RLF reports, accessibility measurements.

- Trace data, to track traffic process of UEs and locate possible causes of traffic problems for example.

- Furthermore, according to pre-defined agreements among the NPN roles (see clause 4.2), some specific UE related data can be provided to authorized NPN customer, such data may be processed or masked based on collected data such as MDT or trace. For example, GNSS information can be distracted from MDT to locate assets in NPN.

# 8 Conclusions and recommendations

## 8.1 Conclusions

### 8.1.1 Management of SNPN

The study has identified use cases, potential requirements and solutions for management of SNPN.

To manage a SNPN which is based on 3GPP-defined technologies, the study has identified that the SNPN management system needs to allocate and manage a dedicated NPN identifier for the SNPN. The combination of a PLMN ID and NID is used as a dedicated NPN identifier to identify an SNPN.

The NPN service provider role can be played by a vertical (or a 3rd party service provider acting on behalf of it) or a MNO which provides non-public services.

The NPN operator role can be played by either a vertical (or a private company on behalf of it) or a MNO which manages the SNPN.

### 8.1.2 Management of PNI-NPN

The study has identified use cases, potential requirements and solutions for management of PNI-NPN.

The NPN service provider role can be played by a vertical (or a private company acting on behalf of it) or a MNO which provides the NPN service.

The NPN operator role can be played by a MNO or be shared between a MNO and a vertical (or a private company acting on behalf of it).

To manage a PNI-NPN which is made via PLMN, the study has identified that the PNI-NPN management system needs to allocate and manage CAG identifiers.

The NPN operator can offer possibilities (e.g. exposed MnS to manage the network slice instance) for the NPN service provider to manage the NPN network slice instance according to TS 28.531 [6].

Authorized NPN service customer can obtain NPN UE related data (e.g. MDT and trace data) from NPN operator according to their pre-defined agreements.

## 8.2 Recommendations

### 8.2.1 Management of SNPN

To manage an SNPN, which includes 3GPP and non-3GPP segments, it is recommended to manage the 3GPP and non-3GPP segments of this NPN separately, means:

- Using 3GPP management system to manage 3GPP segments of NPN which are completely independent and separated from PLMN provided network functions.

- Using non-3GPP management system to manage non-3GPP segments.

- How the non-3GPP management system(s) cooperate with 3GPP management system, for example, an interworking management function, which makes 3GPP and non-3GPP management systems work together without the necessity to introduce modifications on their design, needs further work during the normative work on the management of SNPN in Rel-17.

To manage a SNPN which is based on 3GPP-defined technologies, it is recommended to allocate and manage a dedicated NPN identifier for the SNPN. The combination of a PLMN ID and NID is used as a dedicated NPN identifier to identify an SNPN. For other aspects of management, it is recommended to re-use and enhance the existing 3GPP network management solutions as much as possible.

### 8.2.2 Management of PNI-NPN

To manage PNI-NPN, it is recommended to start further normative work focusing on the following main aspects:

- NPN specific SLA translation, such as specific SLA information which may include coverage requirement within a specific geographic area, specific isolation requirement, specific latency requirement, etc.

- NPN specific SLA assurance.

- NPN specific KPI reporting and performance measurements.

It is recommended to re-use and enhance the existing 3GPP network management solutions as much as possible.

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 04-2019 | SA5#125 | S5-193146 |  |  |  | Skeleton | 0.0.0 |
| 04-2019 | SA5#125 | S5-193521 |  |  |  | Editorial changes | 0.0.1 |
| 08-2019 | SA5#126 | S5-195881  S5‑195883  S5‑195282  S5‑195884 |  |  |  | Update to implement the agreed pCRs in SA5#126:   1. S5‑195881 pCR TR 28.807 NPN terminologies and abbreviations 2. S5‑195883 pCR 28.807 Add scope of TR 3. S5‑195282 pCR 28.807 Add concept of NPN 4. S5‑195884 pCR TR 28.807 UC public network integrated NPN deployment | 0.1.0 |
| 10-2019 | SA5#127 | S5-196713  S5‑196734  S5‑196710  S5‑196709  S5-196711  S5-196712  S5-196737  S5-196736 |  |  |  | Update to implement the agreed pCRs in SA5#127:   1. S5‑196713 pCR TR 28.807 Roles related to NPN management 2. S5‑196734 UC Deployment of a stand-alone NPN with 3GPP and non-3GPP segments 3. S5‑196710 pCR 28.807 Update on general concept 4. S5‑196709 pCR 28.807 clean-up use case of NPN provisioning by a network slice of a PLMN 5. S5‑196711 pCR 28.807 Management of stand-alone non-public networks 6. S5‑196712 pCR 28.807 Management of public network integrated NPN 7. S5‑196737 pCR 28.807 Add requirements for management of public network integrated NPN 8. S5‑196736 pCR 28.807 Add use case of providing traffic management and monitoring capability to an NPN operator | 0.2.0 |
| 11-2019 | SA5#128 | S5-197557  S5‑197313  S5‑197558  S5‑197563  S5-197561  S5-197800 |  |  |  | Update to implement the agreed pCRs in SA5#128:   1. S5‑197557 pCR 28.807 Clean-up for roles related to NPN management 2. S5‑197313 pCR 28.807 Clarification on NPN use cases 3. S5‑197558 pCR 28.807 Add potential requirements for management of NPN 4. S5‑197563 pCR 28.807 Add clauses for solutions and conclusions 5. S5‑197561 Add NPN management use case 6. S5‑197800 Add potential requirement for management of NPN | 0.3.0 |
| 03-2020 | SA5#129e | S5-201593  S5-201594  S5-201595  S5-201596 |  |  |  | Update to implement the agreed pCRs in SA5#129e:   1. S5-201593 pCR 28.807 Add introduction 2. S5-201594 pCR 28.807 Solutions and conclusion for mgmt of SNPN 3. S5-201595 pCR 28.807 Solutions and conclusion for mgmt of PNI-NPN 4. S5-201596 pCR 28.807 Network Slice as a Service in the management of PNI-NPN | 0.4.0 |
| 2020-03 | SA#87-e | SP-200199 |  |  |  | Presented for information | 1.0.0 |
| 04-2020 | SA5#130e | S5-202196  S5-202197  S5-202198  S5-202336  S5-202337  S5-202338  S5-202339 |  |  |  | Update to implement the agreed pCRs in SA5#130e:   1. S5-202196 pCR 28.807 Use PNI-NPN terminology 2. S5-202197 pCR 28.807 Rapporteur clean up proposal 3. S5-202198 pCR 28.807 clarification on NPN supported by network slice instance of a PLMN 4. S5-202336 pCR 28.807 Add CAG configuration requirement 5. S5-202337 pCR 28.807 Add management requirement 6. S5-202338 pCR 28.807 Add requirements for management of SNPN and PNI-NPN 7. S5-202339 pCR 28.807 Additional considerations on NPN | 1.1.0 |
| 06-2020 | SA5#131e | S5-203162  S5-203163 |  |  |  | Update based on MCC EditHelp version.  Update to implement the agreed pCRs in SA5#131e:   1. S5-203162 pCR 28.807 Rapporteur clean up proposal 2. S5-203163 pCR 28.807 Update on recommendation for management of PNI-NPN | 1.2.0 |