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| Technical Report |
| 3rd Generation Partnership Project;Technical Specification Group Services and System Aspects;Management and orchestration;Network Slice Management Enhancement (Release 17) |
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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:

**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

**can** indicates that something is possible

**cannot** indicates that something is impossible

**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

**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

# Introduction

# 1 Scope

The present document describes potential enhancements to network slice management.

The present document considers the following issues:

* The potential network slice information model and management service enhancements to support cross-operator network slice management use case.
* The potential new management capabilities to support end to end network slicing.
* The potential new management capabilities to support security management of network slice.

# 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 TS 23.501 v16.6.0: "System architecture for the 5G System (5GS); Stage 2"

[2] 3GPP TS 28.541 v17.0.0: "5G Network Resource Model (NRM); Stage 2 and stage 3"

[3] 3GPP TS 28.531 v16.7.0: "Management and orchestration; Provisioning"

[4] 3GPP TS 28.530 v16.3.0: "Management and orchestration; Concepts, use cases and requirements"

[5] 3GPP TS 28.532 v16.6.0: "Management and orchestration; Generic management services"

[6] 3GPP TS 28.545 v16.1.0: "Management and orchestration; Fault Supervision (FS)"

[7] 3GPP TS 28.550 v16.7.0: "Management and orchestration; Performance assurance"

[8] 3GPP TS 28.554 v17.1.0: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)"

[9] 3GPP TS 23.558 v1.2.0: "Architecture for enabling Edge Applications"

[10] 3GPP TS 22.011 v17.3.0 “Service accessibility”

# 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].

**<defined term>:** <definition>.

## 3.2 Symbols

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

<symbol> <Explanation>

## 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].

<Abbreviation> <Meaning>

# 4 Concepts and overview

## 4.1 Network slice management terms

The following terms are defined by SA2 in 3GPP specifications

|  |  |  |
| --- | --- | --- |
| **Term** | **Reference** | **Definition** |
| Network Slice | TS 23.501 [1] | A logical network that provides specific network capabilities and network characteristics*.* |
| Network Slice instance | TS 23.501 [1] | A set of Network Function instances and the required resources (e.g. compute, storage and networking resources) which form a deployed Network Slice. |
| NSI ID | TS 23.501 [1] | An identifier for identifying the Core Network part of a Network Slice instance when multiple Network Slice instances of the same Network Slice are deployed, and there is a need to differentiate between them in the 5GC. |

The following terms are defined by SA5 in 3GPP specifications

|  |  |  |
| --- | --- | --- |
| **Term** | **Reference** | **Definition** |
| network slice | TS 28.530 [4] | A logical network that provides specific network capabilities and network characteristics, supporting various service properties for network slice customers. |
| <<InformationObjectClass>>NetworkSlice | TS 28.541 [2] | This IOC represents the properties of a network slice instance in a 5G network. |
| NetworkSlice instance | TS 28.530 [4] | A Managed Object Instance (MOI) of NetworkSlice IOC. |
| NetworkSlice identifier | TS 28.531 [3] | To identify a NetworkSlice instance defined in TS 28.530, it is DN of a managed object instance of NetworkSlice IOC [2]. |
| cNSIIdList | TS 28.541 [2] | It is a set of NSI ID. NSI ID is an identifier for identifying the Core Network part of a Network Slice instance when multiple Network Slice instances of the same Network Slice are deployed, and there is a need to differentiate between them in the 5GC. |
| network slice subnet | TS 28.530 [4] | A representation of a set of network functions and the associated resources (e.g. compute, storage and networking resources) supporting network slice. |
| <<InformationObjectClass>>NetworkSliceSubnet | TS 28.541 [2] | This IOC represents the properties of a network slice subnet instance in a 5G network. |
| NetworkSliceSubnet instance | TS 28.530 [4] | A Managed Object Instance (MOI) of NetworkSliceSubnet IOC. |
| NetworkSliceSubnet identifier | TS 28.531 [3] | To identify a NetworkSliceSubnet instance defined in TS 28.530, it is DN of a managed object instance of NetworkSliceSubnet IOC [2]. |

## 4.2 Multi-operator relationships in network slice management

Multi-operator network slice management refers to scenarios where multiple network operators are involved in providing a network slice.

The following figure is a subset of 28.530 [4] Figure 4.8.1, with focus on the relationship between the Communication Service Provider and Network Operator.

Provider

Client

Communication Service Provider

Network Operator

Figure 4.2.1: High-level model of roles

However, 28.530 [4] does not describe the fact that multiple Network Operators may be involved. The following figure considers a scenario where Network Operator A may source network resources from another Network Operator B. The sourced network resources are packaged as a Communication Service, therefore Network Operator A behaves as a Communication Service Customer and Network Operator B behaves as a Communication Service Provider.

Provider

Provider

Client

Client

Communication Service Customer

Communication Service Provider A

Communication Service Customer A

Network
Operator B

Communication Service Provider B

Network
Operator A

Figure 4.2.2: Multi-operator scenario

## 4.3 End to end management of network slice

Management of network slices is the set of management and orchestration activities that allow the deployment and operation of network slices across multiple administrative and network management domains. According to 28.530 [4], a network slice includes all the network function instances, with their supporting resources, to provide a certain set of communication services to serve a certain business purpose.

## 4.4 Multi-operator concepts

In this clause different Multi-operator concepts are described.

### 4.4.1 National roaming concept

National Roaming is defined in TS 22.011 [10] as a service whereby a UE of a given PLMN is able to obtain service from another PLMN of the same country, anywhere, or on a regional basis. It is used today e.g between EPS networks. In the following figure, Network operator A and B have a national roaming agreement and subscribers of network operator A can use the 5GS network of network operator B, while using the communication services of network operator A.

Provider

Provider

Client

Client

Communication Service Customer

Communication Service Provider A

Communication Service Provider B

Network
Operator A

Communication Service Customer

Client

Provider

Radio Network
 A

Radio Network
 B

Communication Service Provider B

Network
Operator B

Figure 4.4.1.1: National roaming concept

Management interactions between and by network operators involved here: both the network operator A and B have instantiated network slices. Network operator B determines which network slices are allowed to be used by inbound roamers from network operator A, and if needed, will configure its network to support mapping of S-NSSAI as defined in TS 23.501 [1].

If subscribers of network operator A are visiting the network of network operator B the roaming principles as standardized in TS 23.501 [1] apply, i.e., the UE of network operator A will register into 5GC with an AMF in network operator B, and will receive Allowed NSSAI and other network slicing related information as needed. In case of home routing, PDU sessions with an S-NSSAI are established with V-SMF in network operator B and H-SMF in network operator A.

# 5 Scenarios for Network Slicing Management Enhancements

## 5.1 Network Slice covering multiple networks

### 5.1.1 Description

CSP wishes to provide a communication service in multiple countries or regions. The CSP has selected NOP-A as network slice provider. NOP-A does not have RAN coverage in all of the geographical areas that are required by the CSP.

NOP-A selects NOP-B to provide RAN coverage for one or more geographical areas, and agrees slice subnet requirements with NOP-B.

NOP-A orders the allocation of a network slice by NOP-B which will contain the required RAN network slice subnet. NOP-A may issue the request to NOP-B’s 3GPP management system, or NOP-B may issue the request to its own 3GPP management system.

The network slice instance is modelled as a set of MOIs which exist partially in NOP-A’s management system and partially in NOP-B’s management system.

NOP-A’s management system will contain a NetworkSlice MOI, the cross-domain NetworkSliceSubnet MOI, and the CN NetworkSliceSubnet MOI.

NOP-B’s management system will contain a NetworkSlice MOI and RAN NetworkSliceSubnet MOI.

As part of the provisioning phase, the cross-domain NetworkSliceSubnet MOI in NOP-A’s management system should be configured with a reference to the RAN NetworkSliceSubnet MOI in NOP-B’s management system.

###

No technical issues have been identified, but there is no guidance for a NOP on the management capabilities that should be exposed to allow different management levels for a network slice.

Editor’s note: It is FFS how MCEG and EGMF can be used to expose different management levels for a network slice.

## 5.2 Use case – Isolated deployment of multiple network slices of same customer

### 5.2.1 Introduction

In this use case, one network slice customer (e.g. a public safety department, or NSC\_PS-1) requests two network slices from a network slice provider to support mIoT services of two regions, e.g. in two cities, and other service requirements (besides coverage area) of the two slices can be different also. The isolation requirements of the two mIoT network slices are same, both require to physically isolate user plane of the network slice from network slices of other network slice customers (no restriction on control plane). In addition, to save total cost, the network slice customer NSC\_PS-1 agrees that the two mIoT network slices can share resources with each other without physical isolation. As shown in below, user plane of both NS\_mIoT-1 and NS\_mIoT-2 are separated from NS\_x1 and NS\_x2, e.g. NS\_mIoT-1 and NS\_mIoT-2 are deployed on different physical nodes (e.g. physical gNBs, physical UPFs or servers to accommodate virtualized UPF instances) than nodes of NS\_x1 and NS\_x2. However, NS\_mIoT-1 and NS\_mIoT-2 could share same physical resources, e.g. physical UPF or server/host OS in where the virtualized UPF instances are deployed.



Figure 5.2.1-1 Example of isolated deployment of two network slices of same customer

In other words, NS\_mIoT-1 and NS\_mIoT-2 of NSC\_PS-1 are deployed in one security domain (refer to 33.210), which is isolated from other security domains. The NS\_mIoT-1 and NS\_mIoT-2 share isolation requirements, as well as resources.

To optimize operational procedures, an MNO/NOP (as internal customer) may create network slices for their own eMBB service subscribers in different cities. e.g. NS\_eMBB-1 and NS\_eMBB-2, and other service requirements (besides coverage area) of the two slices can be different also. To better utilize resource, these two eMBB services can share same resources. As shown in below, resource of both NS\_eMBB-1 and NS\_eMBB-2 are separated from NS\_x1 and NS\_x2, but NS\_eMBB-1 and NS\_eMBB-2 could share same resource.



Figure 5.2.1-2 Example of isolated deployment of two network slices of operator

### 5.2.2 Potential requirement

* The 3GPP management system could have the capability to allocate network slice based on granular isolation requirements on the network slice

Note: For example, instead of binary sharing/non-sharing indicator, granular isolation requirements could be multi- levels requirement, such as isolation attribute specified in GSMA PRD NG.116

* The 3GPP management system could have the capability to group network slices with same isolation requirements and security level
* The 3GPP management system could have the capability to support authorized network slice related management service consumer to query and select group to the network slice to be deployed

Note: For example, the authorized network slice related management service consumer could be another high privileged management system or administrator of the NOP.

### 5.2.3 Issue and gaps

The resourceSharingLevel attribute is defined in ServiceProfile dataType - see Network Slice IOC defined in 5G Network Resource Model (NRM). This attribute only specifies whether the resources to be allocated to the network slice can be shared with other network slice(s). The existing 3GPP management system capabilities cannot support the use cases and potential requirements described above, which implied not only granular isolation requirements for network slice (e.g. isolation attribute specified in GSMA PRD NG.116), but also flexible inclusion/exclusion rules between network slices (e.g. group network slices with same isolation requirement and security level together, and isolate the network slices in the group from network slices in other groups).

## 5.3 Deployment of edge application service

### 5.3.1 Description

NOP wishes to provide an edge application service which is to be deployed as part of a network slice.

NOP allocates a network slice for the new service, which includes Edge Application Server (EAS) and Edge Enablement Server (EES) as Core Network NFs. An S-NSSAI identifies the allocated network slice.

If NOP is the owner of the Edge Configuration Server (ECS), NOP configures ECS with the relevant S-NSSAI for the new edge application service. Otherwise, NOP informs the owner of the ECS of the relevant S-NSSAI and the owner of the ECS configures the ECS.

When a UE registers on the network, the UE sends a service provisioning request to ECS. The response from ECS includes the S-NSSAI for the edge application service (ref 23.558 [9] clause 8.3.3).

### 5.3.2 Identified problems

When allocating a network slice, it is not possible to specify in ServiceProfile that the network slice should contain EAS and EES, and that the network slice should support a particular edge application service.

NRM for Edge Configuration Server should include S-NSSAI for the edge application service.

Editor’s note: This clause may need to be updated depending on changes in 23.558 and 28.814. The relationship between the NOP and the ECS provider needs to be clarified. The use of network slice(s) needs to be clarified, especially which entity is responsible for configuring the S-NSSAI information in ECS.

# 6 Potential requirements for Network Slicing Management Enhancements

# 7 Possible solutions for Network Slicing Management Enhancements

## 7.1 Possible solutions for network slice isolation

It is proposed to enhance the 5G NRM to support network slice isolation

* Define isolation group in NRM to represent a group of network slice sharing same isolation requirements and resources. The group can be based on tenant, SST, region, security level, etc.
* Define isolation profile in NRM to represent a set of isolation requirements.
* Associate a network slice to an isolation group
* Associate an isolation group to an isolation profile



Figure 7.1-1 NRM fragment proposal for network slice isolation

## 7.2 Possible solutions for network slice covering multiple networks

This clause describes how 3GPP management capabilities may be used to allow NOP-A to manage a network slice which is provided by NOP-B.

As part of the provisioning phase, the cross-domain NetworkSliceSubnet MOI in NOP-A’s management system should be configured with a reference to the RAN NetworkSliceSubnet MOI in NOP-B’s management system. To obtain this reference, NOP-A’s management system may read the NetworkSlice instance which was returned by NOP-B after allocateNsi operation (cf. 28.531 [3], clause 6.5.1), and read the attribute NetworkSliceSubnetRef. This assumes that NOP-A has read access to the generic provisioning management service of NOP-B, and has the authority to read the NetworkSlice instance.

Therefore, to allow NOP-A to manage the network slice using a 3GPP Management System, NOP-B may allow NOP-A read access to the managed object NetworkSlice via the getMOIAttributes operation, defined in 28.532 [5]. This will allow NOP-A to read the operationalState and administrativeState of the NetworkSlice instance, and also the networkSliceSubnetRef of the NetworkSliceSubnet.

If NOP-B wishes to allow NOP-A to control the adminstrativeState of the NetworkSlice instance, NOP-B may allow NOP-A write access to the managed object NetworkSlice via the modifyMOIAttributes operation, defined in 28.532 [5]. However, this would also allow NOP-A to alter the ServiceProfileList, which may not be desirable. Therefore, NOP-B must implement checks on any change to the attribute ServiceProfileList, see “Procedure of Network Slice Instance Modification” in 28.531 [3] and any undesirable changes should be rejected.

If NOP-B wishes to allow NOP-A to view alarms related to the NetworkSlice instance, NOP-B may expose the “FS Data Report for NSI” Service, as described in 28.545 [6]. NOP-B should only allow operations by NOP-A where the baseObjectInstance is equal to the DN of the NetworkSlice instance.

If NOP-B wishes to allow NOP-A to manage alarms related to the NetworkSlice instance, NOP-B may expose the “FS Control for NSI” Service, as described in 28.545 [6]. NOP-B should only allow operations by NOP-A where the baseObjectInstance is equal to the DN of the NetworkSlice instance.

If NOP-B wishes to allow NOP-A to view performance measurements related to the NetworkSlice instance, NOP-B may expose the operations and notificationsdescribed in 28.550 [7]. NOP-B should only expose measurements related to the S-NSSAI of the NetworkSlice instance.

If NOP-B wishes to allow NOP-A to view KPIs related to the NetworkSlice, NOP-B may expose the KPIs as described in 28.554 [8]. NOP-B should only expose KPIs related to the NetworkSlice instance or KPIs related to the S-NSSAI of the NetworkSlice instance.

# 8 Conclusions and recommendations

Annex A (informative):
Change history

|  |
| --- |
| **Change history** |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2019-07 | - | n/a | - | - | - | Initial skeleton | 0.0.0 |
| 2020-08 | SA5#132e | S5-204041 | - | - | - | 28.811 skeleton | 0.1.0 |
| 2020-08 | SA5#132e | S5-204582 | - | - | - | Add concepts | 0.1.0 |
| 2020-08 | SA5#132e | S5-204583 | - | - | - | Add scope | 0.1.0 |
| 2020-11 | SA5#134e | S5-206065 | - | - | - | Update scope to include security aspects | 0.2.0 |
| 2020-11 | SA5#134e | S5-206399 | - | - | - | Add cross-operator concept | 0.2.0 |
| 2020-11 | SA5#134e | S5-206400 | - | - | - | Add end to end concept | 0.2.0 |
| 2020-11 | SA5#134e | S5-206401 | - | - | - | Update references and terms | 0.2.0 |
| 2020-11 | SA5#134e | S5-206402 | - | - | - | Deploy two network slices of same customer | 0.2.0 |
| 2020-11 | SA5#134e | S5-206403 | - | - | - | Add cross-operator network slicing scenario | 0.2.0 |
| 2021-02 | SA5#135e | S5-211434 | - | - | - | Add deployment of edge application service | 0.3.0 |
| 2021-02 | SA5#135e | S5-211435 | - | - | - | Add description of cross-operator management of network slice | 0.3.0 |
| 2021-02 | SA5#135e | S5-211476 | - | - | - | Update to end to end network slice concept | 0.3.0 |
| 2021-02 | SA5#135e | S5-211477 | - | - | - | Multi-operator concepts | 0.3.0 |