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| Technical Report |
| 3rd Generation Partnership Project;Technical Specification Group Services and System Aspects;Study on intent-driven management for network slicing(Release 18) |
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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;

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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

With the recent introduction of intent driven management a service provider or network operator can manage 5G network and services through the expression of intents (expectations). Network slice requirements are specified in service profile(s) which can be viewed as expectations on a network slice.

# 1 Scope

The present document specifies potential use cases, requirements, and solutions for intent driven management for network slicing. The document provides conclusions and recommendations on the next steps in 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 28.530: "Management and orchestration; Concepts, use cases and requirements".

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

[4] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[5] 3GPP TS 28.312: "Management and orchestration; Intent driven management services for mobile networks"

[6] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[7] 3GPP TR 28.912: "Study on enhanced intent driven management services for mobile networks".

[8] 3GPP TS 28.536: "Management and orchestration; Management services for communication service assurance; Stage 2 and stage 3".

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

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

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

**intent:** expectations including requirements, goals and constraints given to a 3GPP system, without specifying how to achieve them.

NOTE 1: see TS 28.312 [5]

**network slice:** a logical network that provides specific network capabilities and network characteristics, supporting various service properties for network slice customers.

NOTE 2: see TS 28.530 [2]

NOTE 3: NetworkSlice Information Object Class (IOC) in TS 28.541 [4] is used to model network slice.

NOTE 4: Represent network slice defined in TS 23.501 [6] with added service properties.

## 3.2 Symbols

Void.

## 3.3 Abbreviations

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

CRUD Create, Read, Update, Delete

CSC Communication Service Customer

CSP Communication Service Provider

DNN Data Network Name

NF Network Function

NSC Network Slice Customer

NSP Network Slice Provider

NOP Network Operator NRF Network Resource Function

S-NSSAI Single-Network Slice Selection Assistance Information

UPF User Plane Function

# 4 Concepts and Overview

## 4.1 General

Network slicing is one of the key 5G features. The lifecycle of a Network Slice instance can be described by the following: commissioning, operation and decommissioning. Before a NetworkSlice instance can be created there is a preparation phase. The different phases are described in more detail in TS 28.530 [2].

The attributes in ServiceProfile represent the network slice related requirements, and the attributes in SliceProfile represent network slice subnet related requirements. The uses of ServiceProfile and SliceProfile are described in TS 28.531 [3] and TS 28.541 [4].

Figure 4.1-1: Intent-driven MnS

In Intent-driven management, the MnS consumer provides its intent to the MnS producer. The producer of an Intent-driven MnS permits the consumer to manage the service and / or network resources through the use of intents.

## 4.2 Classification of use cases in TS 28.531

The use cases for provisioning of a network slice instance and a network slice subnet instance described in TS 28.530 [2] and TS 28.531 [3] are as follows:

- Create a network slice instance;

- Activate a network slice instance;

- De-active a network slice instance;

- Modify a network slice instance;

- Terminate a network slice instance;

- Create a network slice subnet instance;

- Activate a network slice subnet instance;

- De-active a network slice subnet instance;

- Modify a network slice subnet instance;

- Terminate a network slice subnet instance.

The technical specification TS 28.531 [3] describes specification level use cases related to network slice management and network slice subnet management. Table 4.2-1 provides the classification of those use cases related to network slice instance and network slice subnet management to required management capabilities. The detail information about use cases and management capability supporting the use cases are described in TS 28.531 [3].

Table 4.2-1: Classification of use cases in TS 28.531 [3]

|  |  |  |
| --- | --- | --- |
| Clause | Use case | Management capabilities required |
| 5.1.1 | Network slice instance allocation | Provisioning of a network slice |
| 5.1.2 | Network slice instance subnet allocation | Provisioning of a network slice subnet |
| 5.1.3 | Network slice instance deallocation | Provisioning of a network slice |
| 5.1.4 | Network slice subnet instance deallocation | Provisioning of a network slice subnet |
| 5.1.5 | Obtaining network slice subnet instance information | Query information |
| 5.1.6 | Network slice feasibility check | Provisioning of a network slice (subnet) |
| 5.1.7 | Network slice instance activation | Provisioning of a network slice |
| 5.1.8 | Network slice instance deactivation | Provisioning of a network slice |
| 5.1.9 | Network slice instance modification | Modification of a network slice |
| 5.1.10 | Network slice subnet instance activation | Provisioning of a network slice subnet |
| 5.1.11 | Network slice subnet instance deactivation | Provisioning of a network slice subnet |
| 5.1.12 | Network slice subnet instance modification | Modification of a network slice subnet |
| 5.1.13 | Network slice subnet configuration | Modification of a network slice subnet |
| 5.1.14 | Exposure of network slice management data | Query information |

## 4.3 Background information of Intent-driven management and intent driven management MnS

The intent driven management solution is specified in TS 28.312[5] and was introduced in release 17. As described in TS 28.312[5], an intent specifies expectations including requirements, goals and constraints for a specific service or network management workflow.

As described in TS 28.312[5] clause 4.1.2, based on network slice management, an intent can be categorized based on user types as follows:

- Intent-CSC MnS producer provides intent driven MnS for communication services.

- Intent-CSP MnS producer provides intent driven MnS for network services.

- Intent-NOP MnS producer provides intent driven MnS for network equipment.

Similar with the intent types for CSC, CSP and NOP, the TS 28.530 [2] describes roles related to 5G network and network slicing, some examples of roles are:

- Communication Service Customer (CSC): Uses communication services.

- Communication Service Provider (CSP): communication service provided by CSP can be built with or without network slice

- Network Operator (NOP): Designs, builds, and operates networks and provides related services, including network services and network slices.

## 4.4 Background information on the 5G features QoS and network slicing

Intent-driven management solution tries to relieve the consumer of the management system from (artificial) complexity. In the end the consumer of a management system is not interested in instances of IOC like NetworkSlice, which are concepts introduced to manage slices by classical configuration management. Instead, the consumer of a management system wants to request mobile communication for UE -without the need to know about details of the management system.

The management system needs to offer the flexibility as provided by the network architecture described in TS 23.501 [6], while at the same time any request needs to obey to the limitations of the architecture. The following paragraphs give a brief summary of the basic concepts of QoS and slicing which are the basis for intent-driven management of network slices.

The QoS framework (clause 5.7) and network slicing (clause 5.15) are two independent key features of the 3GPP mobile network architecture [6]. According to TS 23.501 [6]:

- One network slice (identified by its S-NSSAI) supports one or more PDU Connectivity Service ("PDU sessions”) i.e. services that provide exchange of PDUs between a UE and a data network identified by a DNN.

- Each PDU connectivity service contains one or more QoS flows, which might be of different QoS characteristics and which all terminate at the same DNN via the same UPF.

- Each QoS flow is associated to one "requested” QoS profile and additionally might be associated to "alternative” QoS profiles. Depending on the experienced network conditions the network can switch between these QoS profiles.

On one hand this concept is the basis to use network slices as internal means for the network operator to partition the network in a way, that QoS flows of similar QoS characteristics are grouped to PDU connectivity services that are tagged by the same S-NSSAI. This specific combination of QoS and network slicing results in that network slices as a whole might be optimized for certain traffic, i.e. to optimize certain NF specifically for the assigned traffic and to assign these NF in NRF to the S-NSSAI. An operator might prepare several of such network slices for traffic of different QoS characteristics; Once a customer requests a PDU connectivity service that matches the QoS characteristics of such prepared network slice, the operator assigns the PDU connectivity services to the correspondingly optimized network slice.

On the other hand, the concept offers the flexibility for CSP and NOP to offer to CSCs a dedicated network slice as a product, that carries all PDU connectivity services as the CSC requires, potentially towards different DNNs (e.g., local breakout in the tenants computing centre, public voice to IMS, and towards public internet), while each PDU connectivity service might carry multiple QoS flows of different QoS.

This flexibility enables the CSC to request PDU connectivity services that are terminating at DNN as required by the CSC (e.g. breakout at local UPF) and that carry QoS flows of specific QoS characteristics. Depending on technical bordering conditions of the requested PDU connectivity services and by the business model of CSP and NOP, CSP or NOP might use the S-NSSAI to group PDU connectivity services to network slices.

## 4.5 Benefits of intent driven management approach to network slicing

One of the drivers of adoption of 5G in the Telecoms industry is support for network slicing. The management solution for network slicing enables an operator to provision a network slice, to do fault supervision and performance assurance of a network slice. Over time more features have been specified to make network slice management more efficient and effective, one example is the ability to create and monitor closed control loops that automatically adjust the network resources to assure that the goals specified in a service profile or slice profile are continuously met without manual intervention. The granularity of this solution is that of ServiceProfile/NetworkSlice and SliceProfile/NetworkSliceSubnet, the fulfilment information is reported on the granularity of a ServiceProfile/SliceProfile.

- Currently the standards support an MnS consumer to request provision of a NetworkSlice or NetworkSliceSubnet using the mechanism in TS 28.531 [3], and to assure the performance using the mechanism in TS 28.536 [8], see reference [8], this means that a consumer handles two separate requests to provision and to assure a NetworkSlice as the consumer does not know the ServiceProfile Id and may not know the NetworkSlice Id both of which are needed as input to closed loop assurance (fulfilment). With the introduction of intent, the consumer can combine the provisioning and assurance requirements in a single request for an intent which contains a combination of a network slice provisioning expectation and a network slice assurance expectation.

- Allows decoupling the lifecycle management of network slice requirements from the lifecycle management of the actual network slice. This enables MnS consumer to focus on expressing network slicing requirements (and obtain fulfilment information for those requirements), without knowing how to deal with the detailed management of a network slice. The latter is on MnS producer side.

- With an intent driven management solution, the consumer automatically receives information about the intent fulfilment status which simplifies the interaction with the producer.

- Simplified approach, allows using one single unified solution to support the wide variety of slice management functionalities which can be fulfilled by different solutions with the existing slicing management approach, including;

- Network Slice provisioning allocation/deallocation functionality. In existing slicing management approach, this is implemented by (de-)allocateNSI operation or CRUD operations defined in TS 28.531[3].

- Network Slice modification, query functionality. In existing slicing management approach, this is implemented by CRUD operation with Network slicing NRM fragment defined in TS 28.532 [9] and TS 28.541[4].

- Network Slice SLS assurance functionality. In existing slicing management approach, this is implemented by CRUD operation with Assurance closed control loop NRM fragment defined in TS 28.532 [9] and TS 28.536 [8].

- Network Slice Feasibility check. In existing slicing management approach, this is implemented by CRUD operation with feasibility check NRM fragment defined in TS 28.532 [9] and TS 28.541[4].

- In current TS 28.531[3] solutions, when the consumer needs to be more aware of concerns such as the timing and sequencing of CM changes required to modify the NetworkSlice or NetworkSliceSubnet requirements. For example, the consumer needs to issue requests to the MnS producer, monitor the results and issue subsequent requests carefully as the producer will initiate each provisioning procedure upon receiving each request.

- With an intent driven management solution, the consumer does not need to be aware of the underlying provisioning procedures. The consumer simply modifies their requirements, and the producer decides whether and when a provisioning procedure will be initiated. This can provide the convenience and benefit for Intent driven MnS consumer to express and modify the network slice expectations and its interactions provided by a more MnS consumer friendly management capability.

- The object in case of using the intent interface is the intent's object type, the fulfilment information can be reported at the level that matches the requirements of the MnS consumer at the intent level. This is independent of the internal object type(s) used by the producer to fulfil the intent.

- For an MnS consumer it is easier to express the network slice expectations including requirements, goals and constraints using the data structures used for intent.

- An MnS consumer does not have to have the knowledge about the relations between NetworkSlice provisioning and assurance, or between NetworkSliceSubnet provisioning and assurance.

# 5 Use cases and potential requirements

## 5.1 Intent driven management for Network slice life cycle management

### 5.1.1 Use case of Intent driven management to deliver a network slice instance

#### 5.1.1.1 Introduction

To satisfy the requirement of network operator for allocation of a network slice instance with certain characteristics, the 3GPP management system requests creation of new or using existing network slice instance.

#### 5.1.1.2 Pre-condition

CSP provides the intent driven management service to CSC to create a communication service.

Network operator is capable to provide the life cycle management of network slice instance in management system to invoke the proper intent driven MnS or existing MnSs.

#### 5.1.1.3 Description

In order to enable a group of end users to connect to communication service provided by a 3GPP network, a MnS Consumer expresses its intent to order a communication service to network operator.

The operator provides the expectation of intent of creating a network slice instance with a set of network characteristics. The intent driven management service producer is capable to translate the intent of creating a network slice instance to relevant requirements of creating a network slice instance. Regarding the intent MnS request received, the intent driven-management service provider may decide management capabilities to meet the requirements of creating a network slice instance, for example allocating a network slice instance. The intent driven management service producer is also capable to provide the management capabilities to support the provisioning of a network slice instance addressing the capability of network slice instance, QoS requirement and other requirement derived from the expression of the intent.

#### 5.1.1.4 Post-condition

The communication service creation operation expressed by intent for a specified group of end users is fulfilled.

#### 5.1.1.5 Requirements

**REQ-Intent\_Deploy\_Slice-CON-1:** The intent driven MnS shall have capability enabling MnS consumer to express intent containing an expectation for delivering a communication service.

**REQ-Intent\_Deploy\_Slice-CON-2:** The intent driven MnS shall have capability enabling MnS consumer to express intent containing an expectation for delivering a network slice instance.

### 5.1.2 Use case of Intent driven management to deliver a network slice subnet instance

#### 5.1.2.1 Introduction

To satisfy the requirement of network operator for allocation of a network slice subnet instance with certain characteristics, the 3GPP management system requests creation of new or using existing network slice subnet instance. The examples of network slice subnet instance are CN slice subnet instance or RAN slice subnet instance.

#### 5.1.2.2 Pre-condition

Network operator provides the intent driven management service to create a network slice subnet instance.

Network operator is capable to provide the life cycle management of network slice subnet instance in management system to invoke the proper intent driven MnS or existing MnSs.

#### 5.1.2.3 Description

In order to create the network slice subnet provided by a 3GPP network, a MnS Consumer expresses its intent to create network slice subnet instance.

The operator provides the expectation of intent of creating a network slice subnet instance with a set of network characteristics. The intent driven management service producer is capable to translate the intent of creating a network slice subnet instance to relevant requirements of creating a network slice subnet instance. Regarding the intent MnS request received, the intent driven-management service provider may decide management capabilities to meet the requirements of creating a network slice subnet instance, for example allocating a network slice subnet instance. The intent driven management service producer is also capable to provide the management capabilities to support the provisioning of a network slice subnet instance addressing the capability of network slice subnet instance, QoS requirement and other requirement derived from the expression of the intent.

#### 5.1.2.4 Post-condition

The network slice subnet instance creation operation expressed by intent for a specified group of end users is fulfilled.

#### 5.1.2.5 Requirements

**REQ-Intent\_Deploy\_Slice-CON-3:** The intent driven MnS shall have capability enabling MnS consumer to express intent containing an expectation for delivering a network slice subnet instance.

## 5.2 Intent driven management for network slice service assurance

### 5.2.1 Use case of Intent driven management to express expectation of network slice service assurance

#### 5.2.1.1 Introduction

To satisfy the requirement of network operator for network slice instance service assurance with certain characteristics, the intent driven MnS producer receive the intent expectation of network slice service assurance and provide the management capabilities to support network slice service assurance.

#### 5.2.1.2 Pre-condition

CSP provides the intent driven management service to CSC to provide service assurance for a communication service.

Network operator is capable to provide network slice instance service assurance in management system to invoke the proper intent driven MnS.

#### 5.2.1.3 Description

In order to enable a group of end users to connect to communication service provided by a 3GPP network, a MnS Consumer expresses its intent for a communication service assurance with proper network characteristics to network operator.

The operator provides the expectation of intent of network slice instance service assurance with a set of network characteristics. The intent driven management service producer is capable to translate the intent of a network slice instance service assurance to relevant requirements e.g., keep QoS performance in specific time duration. Regarding the intent MnS request received, the intent driven-management service provider may decide management capabilities to meet the requirements of assurance a network slice instance service quality, for example monitoring particular performance, use closed control loop for assurance target(s). The intent driven management service producer is also capable to provide the report of intent fulfilment of a network slice instance service assurance addressing the capability QoS requirement of the intent.

#### 5.2.1.4 Post-condition

The communication service assurance expectation expressed by intent for a specified group of end users is fulfilled.

#### 5.2.1.5 Requirements

**REQ-Intent\_Assure\_Slice-CON-1:** The intent driven MnS shall have capability enabling an MnS consumer to express intent expectations for communication service so that the MnS producer can do assurance.

**REQ-Intent\_Assure\_Slice-CON-2:** The intent driven MnS shall have capability enabling an MnS consumer to express intent expectation for network slice service so that the MnS producer can do assurance.

### 5.2.2 Use case of Intent driven management to express expectation of network slice subnet service assurance

#### 5.2.2.1 Introduction

To satisfy the requirement of network operator for network slice subnet instance service assurance with certain characteristics, the intent driven MnS producer receive the intent expectation of slice subnet instance service assurance and provide the management capabilities to support network slice subnet service assurance.

#### 5.2.2.2 Pre-condition

NOP provides the intent driven management service to provide service assurance for a network slice subnet instance.

Network operator is capable to provide network slice subnet instance service assurance in management system to invoke the proper intent driven MnS.

#### 5.2.2.3 Description

In order to enable a group of end users to connect to communication service provided by a 3GPP network, a MnS Consumer expresses its intent for a communication service assurance with proper network characteristics to network operator.

The network operator provides the expectation of intent of network slice subnet instance service assurance with a set of network characteristics. The intent driven management service producer is capable to translate the intent of a network slice subnet instance service assurance to relevant requirements e.g., keep QoS performance in network slice subnet. Regarding the intent MnS request received, the intent driven-management service provider may decide management capabilities to meet the requirements of assurance a network subnet slice instance service quality, for example monitoring particular performance measurement, use closed control loop for assurance target(s) of the network slice subnet instance. The intent driven management service producer is also capable to report of intent fulfilment of a network slice subnet instance service assurance addressing the capability QoS requirement of the intent.

#### 5.2.2.4 Post-condition

The communication service assurance expectation expressed by intent for a specified group of end users is fulfilled.

#### 5.2.2.5 Requirements

**REQ-Intent\_Assure\_Slice-CON-3:** The intent driven MnS shall have capability enabling MnS consumer to express intent expectation for network slice subnet service so that the MnS producer can do assurance.

# 6 Potential solutions

## 6.1 Solution for intent-driven management to deliver a network slice instance

### 6.1.1 Description

This potential solution describes the possible actions of an intent MnS to deliver one network slice instances for the phase of the intent deployment. The intent-driven MnS allows a consumer to declare the desired intent following information model defined in TS 28.312 [5] and implements a number of intent lifecycle management functionalities to reach a successful deployment of the intent, given by the availability of one or more network slice instances capable of meeting the intent expectations.

### 6.1.2 Details

Figure 6.1.2-1 represents the system components for the intent-driven management procedure to deliver a network slice instance. In the proposed solution:

- The Intent Owner acts as intent MnS consumer.

- The Intent Handler acts as intent MnS producer.

- Both Intent Owner and Intent Handler belong to the CSP administrative domain.

- The intent issued by the Intent Owner and fulfilled by the Intent Handler belongs to the Intent-CSP category. For further details on the different intent categories, see TS 28.312 [5], clause 4.1.2.

Figure 6.1.2-1: Potential solution for intent-driven management to deliver a network slice

The Intent Owner issues an intent to the Intent Handler. The intent is initially validated by the Intent Validation module, which verifies:

i) the compliance of the intent format with the information model defined in TS 28.312 [5]; and

ii) the consistency among the intent expectations that constitute the whole intent.

The intent asks for the accommodation of the requirements of one or more communication services.

Once validated, the intent is sent over to the Intent Translation module, which is in charge of translating the intent semantics into a number of executable actions. In this case, the executable actions consist of provisioning and activation of one or more network slice instances, re-using one or more existing network slice instances, re-configuring one or more existing network slice instances or a combination of them. To trigger the resulting executable actions, the Intent Translation module consumes management services produced by the network slice provisioning service [3].

NOTE: In case of new or updated network slices, the ServiceProfile [4] is also elaborated by the Intent Translation module on the basis of the intent expectations.

Finally, after the enforcement of executable actions, there is a need to verify whether the intent is fulfilled or not. In this vein, the Intent Fulfilment Evaluation module is defined. This module makes use of information retrieved from network slice provisioning service, and computes a validation result. This result is included in the intent report which is sent back to the intent owner.

### 6.1.3 Evaluation

The proposed solution splits the capabilities of the intent-driven MnS producer (see TS 28.312 [5], clause 4.2.2) in dedicated modules that interacts together to implement the whole action of the intent deployment applied to the delivery of a network slice instance.

The translation module may use a rule-based mechanism to translate the intent expectations into one or more ServiceProfile [4] constructions. More elaborated solutions may involve AI/ML based mechanisms to improve the quality of the translation decisions.

The intent fulfilment evaluation module may use a rule-based mechanism to evaluate whether the expectations of the intent are satisfied or not. In case of failed validation, closed loop mechanisms potentially assisted by AI/ML based mechanisms may be adopted to suggest countermeasures that the intent deployment module may apply in the context of closed loop network automation.

## 6.2 Solution for expressing service requirements as intent expectations.

### 6.2.1 Description

In TS 28.541 [4], clause 6.3.3.1 the description says that the service profile represents the properties of the network slice related requirements and that these should be supported by a NetworkSlice instance in a 5G network. Based on the definition for service profile, it is obvious that service profile represents MnS consumer's expectations for network slice, which is aligned with intent definition (expectations including requirements, goals and constraints given to a 3GPP system, without specifying how to achieve them).

Following are some benefits to introduce the intent driven approach for network slice compared to existing slice solution:

 - Simplified approach, allows using one single unified solution (CRUD operation with intent NRM fragment) to support the wide variety of slice management functionalities which fulfilled by different solutions in the existing slicing management approach, including

- Network Slice provisioning allocation/deallocation functionality. In existing slicing management approach, this is implemented by (de-)allocateNSI operation defined in TS 28.531[3].

- Network Slice modification, query functionality. In existing slicing management approach, this is implemented by CRUD operation with Network slicing NRM fragment defined in TS 28.532 [9] and TS 28.541[4].

- Network Slice SLS assurance functionality. In existing slicing management approach, this is implemented by CRUD operation with Assurance closed control loop NRM fragment defined in TS 28.532 [9] and TS 28.536 [8].

- Network Slice Feasibility check. In existing slicing management approach, this is implemented by CURD operation with feasibility check NRM fragment defined in TS 28.532 [9] and TS 28.541[4].

- Allows decoupling the lifecycle management of network slice requirements from the lifecycle management of the actual network slice. This enables MnS consumer to focus on expressing network slicing requirements (and obtain fulfilment information for those requirements), without knowing how to deal with the detailed management of a network slice. The latter is on MnS producer side.

Currently the ServiceProfile is modelled as a set of properties, while IntentExpectation is composed of expectationObject, expectationTargets and expectationContexts, so it is necessary to investigate each attribute in ServiceProfile to identify which attribute can be represented by which intent expectation components (including expectationObject, expectationTargets and expectationContexts).

Following subclauses give the detailed solution for how to model service profile as intent expectation and how to model slice subnet profiles for RAN and CN as intent expectations.

NOTE: Whether the exact mapping between the ServiceProfile attributes and IntentExpectation components is to be standardised is not adressed in the present document.

### 6.2.2 Alternative 1: Network slice and network slice subnet expectations

#### 6.2.2.1 Modelling service profile attributes as intent expectation for network slice

##### 6.2.2.1.1 ExpectationObject

Following are the specific allowed values when implemented the IntentExpectation for Network Slice Expectation.

Table 6.2.2.1.1-1

|  |  |
| --- | --- |
| Attribute | Allowed Values |
| ObjectType (CM) | NetworkSlice |
| objectInstance (CM) | DN of the NetworkSlice |

Following attributes in ServiceProfile can be used as input for modelling. ObjectContexts these attributes represent the functional requirements for the network slice.

Table 6.2.2.1.1-2

|  |  |
| --- | --- |
| Attributes in ServiceProfile | Object Context |
| coverageArea | contextAttribute: "coverageArea"contextCondition: "IS\_ALL\_OF"contextValueRange: coverageArea defined in clause 6.4.1 of TS 28.541 [4]. |
| radioSpectrum | contextAttribute: "radioSpectrum"contextCondition: "IS\_ALL\_OF"contextValueRange: radioSpectrum defined in clause 6.3.31 of TS 28.541 [4]. |

##### 6.2.2.1.2 ExpectationTargets

Following attributes in ServiceProfile can be used as input for modelling as ExpectationTargets, these attributes represent the capacity and performance requirements for the network slice.

Table 6.2.2.1.2-1

|  |  |
| --- | --- |
| Attributes in ServiceProfile | Expectation Target |
| dLLatency | targetName: "dLLatency"targetCondition: "IS\_LESS\_THAN "targetValueRange: integer |
| uLLatency | targetName: "uLLatency"targetCondition: "IS\_LESS\_THAN"targetValueRange: integer |
| dLThptPerUE | targetName: "dLThptPerUE"targetCondition: "IS\_WITHIN\_RANGE"targetValueRange: A pair of integers to represent the guaranteed data rate and the maximum data rate. |
| uLThptPerUE | targetName: "uLThptPerUE"targetCondition: "IS\_WITHIN\_RANGE"targetValueRange: A pair of integers to represent the guaranteed data rate and the maximum data rate. |

NOTE: Whether any of the remaining attributes (e.g. maxNumberofUEs, activityFactor, maxNumberofPDUSessions) in ServiceProfile can be used as input for modelling IntentExpectation is not addressed in the present document.

##### 6.2.2.1.3 ExpectationContext

Following attributes in ServiceProfile can be used as input for modelling as ExpectationContext, these attributes used to represent additional requirements for network slice (e.g. operational requirements):

Table 6.2.2.1.3-1

|  |  |
| --- | --- |
| Attributes in ServiceProfile | ExpectationContext |
|  |  |

#### 6.2.2.2 Modelling RANSliceProfile attributes as intent expectation for RAN network slice subnet service delivering and assurance

The RadioServiceExpectation described in TR 28.912 [7] can be reused for expectations for RAN network slice subnet service delivering and assurance with some potential extensions. The detailed definition for RadioServiceExpectation see clause 5.1.2 in TS 28.912 [7]. The RAN network slice subnet service can be represented by the RadioService object in clause 5.1.2 in TS 28.912 [7].

#### 6.2.2.3 Modelling CNSliceProfile attributes as intent expectation for CN network slice subnet

A new CNServiceExpectation can be introduced for CN network slice subnet service delivery and assurance based on the attributes of CNSliceSubnetProfile described in TS 28.541 [4] which are coverageAreaTAListContext, maxNumberofUEsTarget, dLThptPerUETarget, uLThptPerUETarget, dLLatencyTarget, uLLatencyTarget, dLMaxPktSizeTarget,and uLMaxPktSizeTarget.

## 6.3 Solution for intent driven management to express expectation of network slice service assurance

### 6.3.1 Introduction

This potential solution describes the possible actions of an intent MnS producer to assure network slice service. The intent driven MnS producer allows an IDMS consumer to express intent expectations of network slice service assurance. Two assumptions are taken into account:

1) 3rd party IT systems are ready to become MnS consumers, they understand SA5 MnS language and structure;

2) MnS consumers are already authorized to consume intent management capabilities, meaning they have been subjected to access control solutions.

### 6.3.2 Description

The intent driven management service consumer of network slice sends a request to create an intent for the expectation on network slice service for network slice service delivering as well as network slice service assurance. Intent expectation can include one or multiple specific SLA-related indicators as input attributes of ExpectationTargets, e.g., dLlatency.

The intent is then validated and translated into a number of executable actions by IDMS producer. Furthermore, the intent driven MnS producer can monitor KPI and fault information, and evaluate whether the service assurance expectations regarding network slice instance are satisfied. Then, the intent MnS producer informs the intent MnS consumer about the fulfilment information in the form of intent report.

### 6.3.3 Evaluation

The proposed solution describes network slice service assurance capability provided by intent driven management. The relevant service assurance information can be informed to the intent driven MnS consumer in the form of intent report.

## 6.4 Procedures for intent driven approach for network slice (subnet) delivering and assurance

### 6.4.1 Introduction

This clause describes the procedures for intent driven approach for network slice (subnet) delivering and assurance based on generic intent creation procedure defined in clause 6.3.2 in TS 28.312 [5].

### 6.4.2 Procedure for intent driven approach for network slice service delivering and assurance

Figure 6.4.2-1 illustrates the procedure for intent driven approach for network slice delivering and assurance, which allows MnS\_Consumer\_for\_Slice (as the role of CSP) to express network slice related requirements as intent expectations to MnS\_Producer\_for\_Slice (as the role of NOP) to deliver and assure a network slice.

Figure 6.4.2-1: Intent driven approach for network slice delivering and assurance

1. MnS\_Consumer\_for\_Slice sends a request to create an intent for the expectation on network slice to MnS\_Producer\_for\_Slice with intent information specified including expectation targets (e.g., latency and throughput) and contexts (e.g., coverageArea) for network slice delivering and assurance.

2. Based on the received request, the MnS\_Producer\_for\_Slice creates the concrete intent MOI for MnS consumer’s expectation on network slice and configures the new created intent MOI with the received intent information (including expectation targets and contexts for network slice delivering and assurance).

3. MnS\_Producer\_for\_Slice sends a response to the MnS\_Consumer\_for\_Slice with DN of the created intent MOI.

4. Based on the created intent MOI for the expectation on network slice, MnS\_Producer\_for\_Slice performs the feasibility check of the expectation targets and contexts for network slice delivering and assurance.

In case the feasibility check result is 'feasible', following step 5a - step 9 are executed:

For the network slice delivering phase:

5a. MnS\_Producer\_for\_Slice performs management tasks to deliver a network slice to fulfil the expectation targets and contexts for network slice, including the required intent fulfilment which is not specified (per TS 28.312[5], 4.2.2) but may include the following steps:5a-1. MnS\_Producer\_for\_Slice decides to create a new NSI or using an existing NSI.

5a-2a. If using an existing NSI and the existing NSI needs to be modified to satisfy the expectation targets and contexts for network slice, the MnS\_Producer\_for\_Slice invokes the procedure to modify the existing NSI to support the required network slice.

5a-2b-1. If creating a new NSI, the MnS\_Producer\_for\_Slice derives the network slice subnet requirements (the network slice subnet requirements also can be formulated as expectation targets and contexts) from the received expectation targets and contexts for network slice.

5a-2b-2. The MnS\_Producer\_for\_Slice invokes the procedures for delivering corresponding network slice subnet(s). The procedure for delivering network slice subnet can use intent driven approach or non-intent driven approach.

5a-2b-3 The MnS\_Producer\_for\_Slice creates the MOI for NetworkSlice and configures the MOI with the DN of MOI for the NetworkSliceSubnet.

6. MnS\_Producer\_for\_Slice should notify MnS\_Consumer\_for\_Slice about the result (DN of intent instance, MOI of ExpectationObject) of the delivered network slice.

For the network slice assurance phase (step6-step8 are executed continuously until the intent for expectation on network slice is deleted). MnS\_Producer\_for\_Slice may use one or multiple closed control loop(s) for network slice assurance.

7. MnS\_Producer\_for\_Slice evaluates and monitors intent report information (including intent fulfilment information and achievedValue for expectation target) for the intent on network slice.

8. MnS\_Producer\_for\_Slice analyses and adjusts management tasks to ensure the intent on network slice is continuously satisfied.

9. MnS\_Producer\_for\_Slice should notify MnS\_Consumer\_for\_Slice about the intent report information (DN of intent MOI, intent fulfilment information and achievedValues for expectation targets) for the intent on network slice.

In case the feasibility check result is 'infeasible', following step 5b is executed.

5b. MnS\_Producer\_for\_Slice notifies the MnS\_Consumer\_for\_Slice about the result of feasibility check is 'infeasible' and the network slice cannot be delivered. The notification includes the reasons why the feasibility check result is infeasible (e.g., invalid intent expression, the intent conflict) and corresponding recommendations can also be included in the notification.

In addition, after step3, the MnS\_Consumer\_for\_Slice may check the status and completion of the network slice instance delivering and assurance procedure by monitoring the values of Intent instance attributes by querying the values or by subscribing to notifications.

### 6.4.3 Procedure for intent driven approach for network slice subnet delivering and assurance

Figure 6.4.3-1 illustrates the procedure for intent driven approach for network slice subnet delivering and assurance, which allows MnS\_Consumer\_for\_SliceSubnet (as the role of NOP) to express network slice subnet delivering and assurance requirements as intent expectation to MnS\_Producer\_for\_SliceSubnet (as the role of NEP) to assure the quality of the network slice subnet.

Figure 6.4.3-1: Procedure for intent driven approach for network slice subnet delivering and assurance

1. MnS\_Consumer\_for\_SliceSubnet sends a request to create an intent for the expectation on network slice subnet to MnS\_Producer\_for\_SliceSubnet with intent information specified (including expectation targets and contexts for network slice subnet delivering and assurance.

2. Based on the received request, the MnS\_Producer\_for\_SliceSubnet creates the concrete intent MOI for MnS consumer’s expectation concerning the network slice subnet and configures the new created intent MOI with the received intent information (including expectation targets and contexts for network slice subnet delivering and assurance).

3. MnS\_Producer\_for\_SliceSubnet sends a response to the MnS\_Consumer\_for\_SliceSubnet with DN of the created intent MOI.

4. Based on the created intent MOI for the expectation on network slice subnet, MnS\_Producer\_for\_SliceSubnet performs the feasibility check of the expectation targets and contexts for network slice subnet delivering and assurance.

In case the feasibility check result is 'feasible', following step 5a-step9 are executed:

For the network slice subnet delivering phase:

5a. MnS\_Producer\_for\_SliceSubnet performs management tasks to deliver a network slice subnet to fulfil the expectation targets and contexts for network slice subnet, which may include:

5a-1. MnS\_Producer\_for\_SliceSubnet decides to create a new NSSI or use an existing NSSI.

5a-2a. If using an existing NSSI and the existing NSSI needs to be modified to satisfy the expectation targets and contexts for network slice subnet, the MnS\_Producer\_for\_SliceSubnet invokes the procedure to modify the existing NSSI to support the required network slice subnet.

5a-2b. If creating a new NSSI, the MnS\_Producer\_for\_SliceSubnet invokes the procedures to create the NSSI to support the required network slice subnet.

6. MnS\_Producer\_for\_SliceSubnet should notify the MnS\_Consumer\_for\_SliceSubnet about the results (DN of intent instance, MOI of ExpectationObject) of the delivered network slice subnet.

For the network slice subnet assurance phase (step 6 - step 8 are executed continuously until the intent for expectation on network slice subnet is terminated). Subnet Intent\_Producer may use one or multiple closed control loop(s) for network slice subnet assurance.

7. MnS\_Producer\_for\_SliceSubnet evaluate and monitors intent report information (including intent fulfilment information and achieved value for expectation target) for the intent on network slice subnet.

8. MnS\_Producer\_for\_SliceSubnet analyses and adjusts management tasks to ensure the intent on network slice subnet is continuously satisfied.

9. MnS\_Producer\_for\_SliceSubnet should notify the MnS\_Consumer\_for\_SliceSubnet about the intent report information (DN of intent MOI, intent fulfilment information and achievedValue for expectation targets) for the intent on network slice subnet.

In case the feasibility check result is 'infeasible', following step 5b is executed.

5b. MnS\_Producer\_for\_SliceSubnet notifies MnS\_Consumer\_for\_SliceSubnet about the result of feasibility check is 'infeasible' and the network slice subnet cannot be delivered. The notification includes the reasons why the feasibility check result is infeasible (e.g., invalid intent expression, the intent conflict) and corresponding recommendations also can be included in the notification.

In addition, after step3, the MnS\_Consumer\_for\_SliceSubnet may check the status and completion of the network slice subnet instance delivering and assurance procedure by monitoring the values of Intent instance attributes by querying the values or by subscribing to notifications.

# 7 Conclusion and Recommendation

## 7.1 Conclusions

The study has investigated the potential mapping of slice management concepts, use cases and operations in TS 28.531[3] and TS 28.541[4] to corresponding intent-driven management concepts, use cases and operations in TS 28.312[5] and concluded that the dataTypes defined in TS 28.312[5] could be used to express network slice requirements.

The present document has investigated that the feasibility check for intent driven management of network slicing can reuse the concepts and basis of the feasibility check in IDMS specified in TS 28.312 [5].

## 7.2 Recommendations

### 7.1.2 Intent driven management for network slice service assurance

It is recommended to express the requirements for network slice service assurance as intent expectation(s) which can include SLA-related characteristics as input attributes of an ExpectationTarget. The fulfilment information of intent expectations related to a network slice or a communication service is conveyed in an intent report.

### 7.2.2 Intent driven management for fulfilment of a request for network slice

It is recommended that intent expectations are defined for an NSC to convey requirements to an NSP (Network Slice Provider) using an intent interface. The requirements from an NSC currently captured as ServiceProfile, RANSliceSubnetProfile or CNSliceSubnetProfile parameters could be captured as Intent expectations.

Annex A:
Key issues

# A.1 Key issues of intent driven management for network slice life cycle management

Regarding the use case of intent driven management for network slice life cycle management as described in clause 5.1 in the present document, the key issues derived by those use cases to investigate the technical solutions in this study are:

- What and how to express the requirements of network slice (subnet) life cycle management.

- What and how to report the fulfilment of management requirement of network slice (subnet) life cycle management expressed by intent.

- What and how to use the attributes in service profile and slice profile (including the network slice subnet profile) which are used to form intent driven management of network slice (subnet) life cycle management.

# A.2 Key issues of network slice service assurance

Regarding the use case of service assurance in scenario of network slice instance and network slice subnet instance assurance as described in clause 5 in the present document, the intent driven management should take follow key issues into account:

- What and how intent driven management expresses the requirements of assurance of network slice instance and network slice subnet instance, based on the input attributes of service profile and slice profile.

- What and how intent driven management reports the fulfilment of assurance requirements of network slice (subnet) instance.

Annex B:
Change history

|  |
| --- |
| **Change history** |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-04 | SA5#142-e | S5-222098 |  |  |  | skeleton | 0.0.0 |
| 2022-04 | SA5#142-e | S5-222039 |  |  |  | Structure | 0.1.0 |
| 2022-04 | SA5#142-e | S5-222040 |  |  |  | Add scope | 0.1.0 |
| 2022-04 | SA5#142-e | S5-222041 |  |  |  | Add introduction | 0.1.0 |
| 2022-04 | SA5#142-e | S5-222636 |  |  |  | Add background of mapping in TS 28.531 | 0.1.0 |
| 2022-04 | SA5#142-e | S5-222637 |  |  |  | Add background information related to 28.312 | 0.1.0 |
| 2022-05 | SA5-143-e | S5-223572 |  |  |  | pCR 28.836 Add concept of service profile and slice profile | 0.2.0 |
| 2022-05 | SA5-143-e | S5-223573 |  |  |  | pCR 28.836 Add use case of network slicing allocation | 0.2.0 |
| 2022-05 | SA5-143-e | S5-223574 |  |  |  | pCR 28.836 Add key issue of network slice life cycle management | 0.2.0 |
| 2022-05 | SA5-143-e | S5-223575 |  |  |  | pCR 28.836 Add key issue of network slice service assurance | 0.2.0 |
| 2022-11 | SA5-146 | S5-226956 |  |  |  | pCR 28.836 Solution for intent-driven management to deliver a network slice | 0.3.0 |
| 2023-03 | SA5-147 | S5-232948 |  |  |  | pCR TR 28.836 Add solutions for expressing service and slice profile requirements as intent expectations | 0.4.0 |
| 2023-04 | SA5-148e | S5-233279 |  |  |  | Add solution for intent expectation for RAN network slice subnet service delivering and assurance | 0.5.0 |
| 2023-04 | SA5-148e | S5-233347 |  |  |  | Add potential solution for IDM to express expectation of network slice service assurance | 0.5.0 |
| 2023-04 | SA5-148e | S5-233572 |  |  |  | Add description of network slice subnet instance in clause 4.2 | 0.5.0 |
| 2023-04 | SA5-148e | S5-233586 |  |  |  | Add procedures for network slice (subnet) delivering and assurance  | 0.5.0 |
| 2023-04 | SA5-148e | S5-233573 |  |  |  | Add background information on the 5G features QoS and slicing | 0.5.0 |
| 2023-04 | SA5-148e | S5-233325 |  |  |  | Restructure solutions to allow multiple alternatives | 0.5.0 |
| 2023-05 | SA5-149 | S5-234162 |  |  |  | pCR 28.836 Clarify the roles in requirements clause 5.2 | 0.6.0 |
| 2023-05 | SA5-149 | S5-234164 |  |  |  | pCR 28.836 Update table on classification in 4.2 and editorials in 4.3 and 4.4 | 0.6.0 |
| 2023-05 | SA5-149 | 55-234736 |  |  |  | pCR TR 28.836 Add solution for Intent expectation for network slice delivering and assurance | 0.6.0 |
| 2023-05 | SA5-149 | S5-234523 |  |  |  | pCR 28.836 Add benefits of intent driven management approach to network slicing | 0.6.0 |
| 2023-05 | SA5-149 | S5-234526 |  |  |  | pCR 28.836 Add conclusion and recommendation for network slice service assurance | 0.6.0 |
| 2023-05 | SA5-149 | S5-234831 |  |  |  | pCR TR 28.836 Enhancement on 6.1 supporting solution to deliver a network slice subnet instance | 0.6.0 |
| 2023-06 | SA#100 | SP-230641 |  |  |  | Presented for information | 1.0.0 |
| 2023-06 | SA#100 |  |  |  |  | EditHelp review | 1.0.1 |
| 2023-08 | SA#150 | S5-235344 |  |  |  | pCR TR 28.836 Remove figure of how ServiceProfile can be represented by intent expectation components | 1.1.0 |
| 2023-08 | SA#150 | S5-235104 |  |  |  | pCR TR 28.836 Rapporteur update addressing edithelp comments | 1.1.0 |
| 2023-08 | SA#150 | S5-235830 |  |  |  | pCR 28.836 Clarifications related to network slice provisioning and assurance | 1.1.0 |
| 2023-08 | SA#150 | S5-235935 |  |  |  | pCR TR 28.836 Update the solution and procedure for Network slice and network slice subnet expectations | 1.1.0 |
| 2023-10 | SA#151 | S5-237174 |  |  |  | pCR TR 28.836 Enhance benefit description in 4.6 | 1.2.0 |
| 2023-10 | SA#151 | S5-236509 |  |  |  | Rel-18\_CR\_28836\_Correct issues of procedure for NS delivering and assurance | 1.2.0 |
| 2023-10 | SA#151 | S5-236487 |  |  |  | pCR 28.836 Add solution of modelling CNSliceProfile attributes as intent expectation for CN network slice subnetwork | 1.2.0 |
| 2023-11 | SA#152 | S5-237738 |  |  |  | pCR TR 28.836 Rapporteur clean-up template information | 1.3.0 |
| 2023-11 | SA#152 | S5-238252 |  |  |  | pCR TR 28.836 Add definitions and abbreviations | 1.3.0 |
| 2023-11 | SA#152 | S5-238263 |  |  |  | pCR TR 28.836 Update conclusions and recommendations | 1.3.0 |
| 2023-12 | SA#102 | SP-231527 |  |  |  | Presented for approval | 2.0.0 |
| 2023-12 | SA#102 |  |  |  |  | Upgrade to change control version | 18.0.0 |