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# Foreword

This Technical Specification 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

The present document describes closed control loop assurance solution enabling a service provider or an operator to continuously deliver the requested level of communication service quality to the customer and is part of a TS-family covering the 3rd Generation Partnership Project Technical Specification Group Services and System Aspects Management and orchestration of networks, as identified below:

TS 28.535: Management Services for Communication Service Assurance; Requirements

**TS 28.536: Management Services for Communication Service Assurance; Stage 2 and stage 3**

The solution described builds upon the management services specifications as identified below:

TS 28.530: Management and orchestration; Concepts, use cases and requirements

TS 28.533: Management and orchestration; Architecture framework

TS 28.532: Management and orchestration; Generic management services.

TS 28.540: Management and orchestration; 5G Network Resource Model (NRM); Stage 1

TS 28.541: Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3

TS 28.531: Management and orchestration; Provisioning

TS 28.545: Management and orchestration; Fault Supervision (FS)

TS 28.550: Management and orchestration; Performance assurance

TS 28.552: Management and orchestration; 5G performance measurements

TS 28.554: Management and orchestration; 5G End to end Key Performance Indicators (KPI)

# 1 Scope

The present document describes the management services for communication service assurance and specifies stage 2 and stage 3 for closed control loop communication service assurance solution that adjusts and optimizes the services provided by NG-RAN and 5GC.

# 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] Void

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

[4] Void

[5] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[6] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[7] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[8] 3GPP TS 32.302: "Telecommunication management; Configuration Management (CM); Notification Integration Reference Point (IRP); Information Service (IS)".

[9] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[10] 3GPP TS 32.160: "Management and orchestration; Management service template".

[11] 3GPP TS 29.520: "5G System; Network Data Analytics Services; Stage 3".

[12] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[13] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[14] 3GPP TS 28.625: "State Management Data Definition Integration Reference Point (IRP); Information Service (IS)".

[15] ITU-T Recommendation X.731: "Information technology - Open Systems Interconnection - Systems Management: State management function".

[16] Void

# 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].

## 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].

COSLA Closed control loop SLS Assurance

CSC Communication Service Customer

CSP Communication Service Provider

IOC Information Object Class

IS Information Service

JSON JavaScript Object Notation

YAML YAML Ain't Markup Language

MDAS Management Data Analytics Service

MDT Minimization of Drive Tests

MnS Management Service

NF Network Function

NRM Network Resource Model

NSSI NetworkSlice Subnet Instance

NWDAF NetWork Data Analytics Function

QoE Quality of Experience

SLA Service Level agreement

SLS Service Level Specification

# 4 Communication service assurance service

## 4.1 Stage 2

### 4.1.1 Void

### 4.1.2 Model

#### 4.1.2.1 Imported and associated information entities

##### 4.1.2.1.1 Imported information entities and local labels

|  |  |
| --- | --- |
| Label reference | Local label  |
| TS 28.622 [5], IOC, Top | Top |

##### 4.1.2.1.2 Associated information entities and local labels

|  |  |
| --- | --- |
| Label reference | Local label  |
| TS 28.622 [5], IOC, SubNetwork | SubNetwork |
| TS 28.541 [6], IOC, NetWorkSlice | NetworkSlice |
| TS 28.541 [6], IOC, NetWorkSliceSubnet | NetworkSliceSubnet |
| TS 28.622 [5], IOC, ManagedElement | ManagedElement |
| TS 28.541 [6], attribute, serviceProfileId | serviceProfileId |
| TS 28.541 [6], attribute, sliceProfileId | sliceProfileId |

#### 4.1.2.2 Class diagram

#### 4.1.2.2.1 Relationships

This clause depicts the set of classes that encapsulates the information relevant for this MnS. This clause provides an overview of the relationships between relevant classes in UML.



Figure 4.1.2.2.1.1: Assurance management NRM fragment

#### 4.1.2.2.2 Inheritance



Figure 4.1.2.2.2.1: Assurance management inheritance relationships

#### 4.1.2.3 Class definitions

##### 4.1.2.3.1 AssuranceClosedControlLoop

4.1.2.3.1.1 Definition

This class represents the information for controlling and monitoring an assurance closed control loop associated with a NetworkSlice or NetworkSliceSubnet. It can be name-contained by SubNetwork or ManagedElement.

To express the assurance closed control loop requirements, the MnS consumer needs to request MnS producer to create an AssuranceClosedControlLoop on the MnS producer. The MnS producer may trigger to create the AssuranceClosedControlLoop as well, for example, when an instance of NetworkSlice or NetworkSliceSubnet is created, MnS producer may create an instance of AssuranceClosedControlLoop associated to the instance of NetworkSlice or NetworkSliceSubnet to assure the target described in ServiceProfile or SliceProfile. For ultimate deletion of assurance closed control loop, the MnS consumer needs to request the MnS producer to delete the AssuranceClosedControlLoop to free up resources on the MnS producer. MnS producer also can trigger to delete AssuranceClosedControlLoop to free up resources by itself.

For temporary deactivation of assurance closed control loop, the MnS consumer can manipulate the value of the administrative state attribute to “LOCKED”. The MnS producer may disable assurance closed control loop as well, for example in conflict situations. This situation is indicated by the MnS producer with setting the operational state attribute to “disabled”. When closed control loop is enabled by the MnS producer the operational state is set again to “enabled”. For activation of assurance closed control loop, the MnS consumer can manipulate the value of the administrative state attribute to “UNLOCKED”.

An AssuranceClosedControlLoop can name-contain multiple instances of AssuranceGoal which represents the assurance goal and corresponding observed or predicted goal fulfilment information (see clause 4.1.2.3.2).

The attribute “controlLoopLifeCyclePhase” is used to keep track of the lifecycle of an AssuranceClosedControlLoop

4.1.2.3.1.2 Attributes

The AssuranceClosedControlLoop IOC includes attributes inherited from Top IOC (defined TS 28.622[5]) and the following attributes:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Support Qualifier | isReadable | isWritable | isInvariant | isNotifyable |
| operationalState | M | T | F | F | T |
| administrativeState | M | T | T | F | T |
| controlLoopLifeCyclePhase | M | T | T | F | T |

4.1.2.3.1.3 Constraints

No constraints have been defined for this document.

4.1.2.3.1.4 Notifications

The common notifications defined in clause 4.1.2.5 are valid for this IOC, without exceptions or additions.

##### 4.1.2.3.2 AssuranceGoal

4.1.2.3.2.1 Definition

This IOC represents assurance goal and corresponding observed or predicted goal fulfilment information.

To express a new assurance goal for the assurance closed control loop, the MnS consumer needs to request the MnS producer to create an instance of AssuranceGoal. MnS producer can also trigger the creation of an instance of AssuranceGoal. For example, when a new instance NetworkSLice or NetworkSliceSubnet is created on the MnS producer and the corresponding SLS needs to be assured, a new instance of AssuranceGoal needs to be created and associated to the new instance NetworkSLice or NetworkSliceSubnet by configuring the attribute “networkSliceRef” or “networkSliceSubnetRef” and corresponding attribute “serviceProfileId” and “sliceProfileId“.

The attribute “assuranceTargetList” defines a list of assurance targets (the subset of attributes (typically characteristics attributes) from an SLS, i.e. a ServiceProfile or a SliceProfile, that are subject to assurance requirements.) that should be assured by the AssuranceClosedControlLoop. The attribute “assuranceTargetList” is configured by MnS producer based on the specified ServiceProfile or SliceProfile.

To obtain the observed predicted status of the the goal fulfilment information, the MnS consumer can query the attribute “AssuranceGoalStatusObserved” and “AssuranceGoalStatusPredicted”from MnS producer. The attribute “AssuranceGoalStatusObserved” and “AssuranceGoalStatusPredicted” is configured by MnS producer at the end of an observation period. The observation period is assigned by MnS consumer through requsting the MnS producer to set attribute “observationTime”.. The status of the goal fuilfilment is considered FULFILLED if all the constituent target are FULFILLED.

NOTE: Multiple instances of AssuranceGoal can be created for a single instance of NetworkSlice or NetworkSliceSubnet.

4.1.2.3.2.2 Attributes

The AssuranceGoal IOC includes attributes inherited from Top IOC (defined TS 28.622[5]) and the following attributes:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Support Qualifier | isReadable | isWritable | isInvariant | isNotifyable |
| assuranceTargetList | M | T | F | F | T |
| sliceProfileId | CM | T | T | F | T |
| serviceProfileId | CM | T | T | F | T |
| observationTime | M | T | T | F | T |
| AssuranceGoalStatusObserved | O | T | F | F | T |
| AssuranceGoalStatusPredicted | O | T | F | F | T |
| **Attributes related to role** |  |  |  |  |  |
| networkSliceRef | CM | T | T | F | T |
| networkSliceSubnetRef | CM | T | T | F | T |

.

4.1.2.3.2.3 Attribute constraints

|  |  |
| --- | --- |
| Name | Definition |
| sliceProfileId | Condition: the AssuranceGoal applies to a NetworkSliceSubNet |
| serviceProfileId | Condition: the AssuranceGoal applies to a NetworkSlice |
| networkSliceSubnetRef | Condition: the AssuranceGoal applies to a NetworkSliceSubNet |
| networkSliceRef | Condition: the AssuranceGoal applies to a NetworkSlice |

4.1.2.3.2.4 Notifications

The common notifications defined in subclause 4.1.2.5 are valid for this IOC, without exceptions or additions.

##### 4.1.2.3.3 Void

##### 4.1.2.3.4 Void

##### 4.1.2.3.5 AssuranceTarget <<dataType>>

4.1.2.3.5.1 Definition

This data type represents a single attribute name-value-pair of which one or more are included in an AssuranceGoal. The AssuranceTarget include the status of the target fulfilment.

4.1.2.3.5.2 Attributes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Support Qualifier | isReadable | isWritable | isInvariant | isNotifyable |
| assuranceTargetName | M | T | F | F | T |
| assuranceTargetValue | M | T | F | F | T |
| AssuranceTargetStatusObserved | O | T | F | F | T |
| AssuranceTargetStatusPredicted | O | T | F | F | T |

4.1.2.3.5.3 Attribute constraints

No constraints have been defined for this document.

4.1.2.3.5.4 Notifications

The common notifications defined in clause 4.1.2.5 are valid for the <<IOC>> using this <<dataType>> as one of its attributes, shall be applicable.

#### 4.1.2.4 Attribute definitions

##### 4.1.2.4.1 Attribute properties

The following table defines the properties of attributes that are specified in the present document.

Table 4.1.2.4.1.1

| Attribute Name | Documentation and Allowed Values | Properties |
| --- | --- | --- |
| controlLoopLifeCyclePhase | It indicates the lifecycle phase of the AssuranceClosedControlLoop instance. AllowedValues: Preparation, Commissioning, Operation and Decommissioning.  | type: Enummultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: NULL isNullable: False |
| assuranceTargetName | The name of the attribute which is part of AssuranceTarget.The assuranceTargetName shall be equal to the name of an attribute in the relevant ServiceProfile or SliceProfile. The relevant ServiceProfile or SliceProfile is identified by the attribute serviceProfileId or sliceProfileId in the AssuranceGoal. | type: Stringmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: NoneisNullable: False |
| assuranceTargetValue | The value of the attribute which is part of AssuranceTarget | type: Stringmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: NoneisNullable: False |
| assuranceTargetList | This is an attribute containing a list of AssuranceTarget(s) that are part of an AssuranceGoal | type: AssuranceTargetmultiplicity: 1..\*isOrdered: N/AisUnique: N/AdefaultValue: NoneisNullable: False |
| observationTime | It indicates the time duration over which an AssuranceGoal is observed. The observation time is expressed in seconds. | type: Integermultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| assuranceGoalStatusObserved | It holds the status of the observed goal fulfilment to the assuranceGoal. The value is FULFILLED only if all the constituent assuranceTargetStatusObserved are FULFILLED.allowedValues: "FULFILLED", “NOT\_FULFILLED  | type: ENUMmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| assuranceGoalStatusPredicted | It holds the status of the predicted future goal fulfilment to the assuranceGoal . The value is FULFILLED only if all the constituent assuranceTargetStatusPredicted are FULFILLED.allowedValues: "FULFILLED", “NOT\_FULFILLED" | type: ENUMmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| assuranceTargetStatusObserved | It holds the status of the observed target fulfilment to the assuranceGoal. allowedValues: "FULFILLED", “NOT\_FULFILLED  | type: ENUMmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| assuranceTargetStatusPredicted | It holds the status of the predicted future target fulfilment to the assuranceGoal allowedValues: "FULFILLED", “NOT\_FULFILLED" | type: ENUMmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| networkSliceRef | It holds the reference to the NetworkSlice instance subject to assurance requirements | type: Dnmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| networkSliceSubnetRef | It holds the reference to the NetworkSliceSubnet instance subject to assurance requirements | type: Dnmultiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: None isNullable: False |
| operationalState | It indicates the operational state of the AssuranceClosedControlLoop instance. It describes whether the resource is installed and partially or fully operable (Enabled) or the resource is not installed or not operable (Disabled).Allowed values; Enabled/DisabledallowedValues: "ENABLED", "DISABLED".The meaning of these values is as defined in 3GPP TS 28.625 [14] and ITU-T X.731 [15]. | type: ENUM multiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: DisabledallowedValues: Enabled, DisabledisNullable: False |
| administrativeState | It indicates the administrative state of the AssuranceClosedControlLoop instance. It describes the permission to use or the prohibition against using the AssuranceClosedControlLoop instance. The administrative state is set by the MnS consumer. Allowed values; Locked/UnlockedallowedValues: "LOCKED", "UNLOCKED".The meaning of these values is as defined in 3GPP TS 28.625 [14] and ITU-T X.731 [15]. | type: ENUM multiplicity: 1isOrdered: N/AisUnique: N/AdefaultValue: LockedallowedValues: Locked, UnlockedisNullable: False |
| NOTE 1: VoidNOTE 2: Void |

##### 4.1.2.4.2 Constraints

No constraints have been identified for this document.

##### 4.1.2.4.3 Notifications

This subclause presents a list of notifications, defined in [7], that provisioning management service consumer can receive. The notification parameter objectClass/objectInstance, defined in [10], would capture the DN of an instance of an IOC defined in the present document.

#### 4.1.2.5 Common notifications

##### 4.1.2.5.1 Alarm notifications

This clause presents a list of notifications, defined in TS 28.532 [7], that an MnS consumer may receive. The notification header attribute objectClass/objectInstance, defined in TS 32.302 [8], shall capture the DN of an instance of a class defined in the present document.

| Name | Qualifier | Notes |
| --- | --- | --- |
| notifyNewAlarm | M | -- |
| notifyClearedAlarm | M | -- |
| notifyAckStateChanged | M | -- |
| notifyAlarmListRebuilt | M | -- |
| notifyChangedAlarm | O | -- |
| notifyCorrelatedNotificationChanged | O | -- |
| notifyChangedAlarmGeneral | O | -- |
| notifyComments | O | -- |
| notifyPotentialFaultyAlarmList | O | -- |

##### 4.1.2.5.2 Configuration notifications

This clause presents a list of notifications, defined in TS 28.532 [7], that an MnS consumer may receive. The notification header attribute objectClass/objectInstance, defined in TS 32.302 [8], shall capture the DN of an instance of a class defined in the present document.

| Name | Qualifier | Notes |
| --- | --- | --- |
| notifyMOICreation | O | -- |
| notifyMOIDeletion | O | -- |
| notifyMOIAttributeValueChanges | O | -- |
| notifyEvent | O | -- |

### 4.1.3 Procedures

#### 4.1.3.1 SLS Assurance Procedure



Figure 4.1.3.1.1 SLS assurance procedure

For the purpose of the procedure shown in Figure 4.1.3.1.1 "entities participating in the loop" refers to any entity in the 3GPP management system responsible for the functioning of an ACCL to ensure the AssuranceControlLoopGoal required by an AssuranceControlLoop\_Consumer.

1. AssuranceControlLoop\_consumer derives AssuranceControlLoopGoal from the ServiceProfile or SliceProfile.

2. AssuranceControlLoop\_consumer provides the AssuranceControlLoopGoal to Entities\_Participating\_in\_loop by utilizing the provision management services defined in as defined in clause 11.1.1.3 of TS 28.532 [7].

NOTE 1: In case the Entities\_Participating\_in\_loop represents CrossDomain\_Entities\_Participating\_in\_loop, the AssuranceControlLoopGoal is the attribute(s) of the ServiceProfile. In case the Entities\_Participating\_in\_loop represents Domain\_Entities\_Participating\_in\_loop, the AssuranceControlLoopGoal is the attribute(s) of the SliceProfile.

3. Entities\_Participating\_in\_loop subscribes the related performance data (e.g., the packet delay related measurements), fault data, QoE data (e.g., buffer level) and MDT data from respective sources by utilizing the Operation establishStreamingConnection as defined in clause 6.2.1 of TS 28.550 [3].

4. Entities\_Participating\_in\_loop, optionally, subscribes the related analytical data from MDAS or network functions, e.g., NWDAF. In case of NWDAF as a provider, Nnwdaf\_EventsSubscription Service as defined in clause 4.2 of TS 29.520 [11] is used.

5. Entities\_Participating\_in\_loop collects the related performance, fault, QoE and MDT data (e.g., the packet delay related measurements), fault data, QoE data (e.g., buffer level) and MDT data from respective sources by utilizing the Operation establishStreamingConnection as defined in clause 6.2.1 of TS 28.550 [3].

6. Entities\_Participating\_in\_loop, optionally, collects the related analytical data from MDAS or network functions, e.g., NWDAF. In case of NWDAF as a provider, Nnwdaf\_EventsSubscription Service as defined in clause 4.2 of TS 29.520 [11] is used.

7. Entities\_Participating\_in\_loop assesses if the AssuranceControlLoopGoal has been fulfilled.

8. Entities\_Participating\_in\_loop assesses if and which action to take in case the AssuranceControlLoopGoal has not been fulfilled.

9. As per the mitigation action (e.g., scale out) resources are changed, the generic provisioning management service as defined in clause 11.1 of TS 28.532 [7] is utilized for the same.

10. Action completed.

NOTE 2: The Entities\_Participating\_in\_loop continues to monitor and analyse the performance and perform the adjustment until the attribute(s) of SliceProfile is assured.

11. AssuranceControlLoop\_consumer receives the confirmation of assurance fulfilment from Entities\_Participating\_in\_loop by utilizing the provision management services defined in clause 11.1.1.3 of TS 28.532 [7].

## 4.2 Stage 3

### 4.2.1 Solution Set (SS) for JSON/YAML

The JSON/YAML solution set is documented in clause B.2.

Annex A (informative):
Control loop deployed in different layers

## A.1 Introduction

This example gives a high-level view of control loops deployed in different layers, which consists of control loop in communication service layer, control loop in network slice layer, control loop in network slice subnet layer and control loop in NF layer, as described as Figure A.1.1, where the analytic could be leverage MDAS, and different control loops can provide input (interact with) to other control loops (in the same layer or different layers) and obtain the output from other control loops (in the same layer or different layers).



Figure A.1.1: Control loop in different layers

## A.2 Control loop in communication service layer

SLA/SLS requirements provided from CSC are translated into serviceProfile, which represents the requirements for communication service assurance to the CSP. Coordination between control loop in communication service layer and control loop in network slice layer is needed to calculate the communication service resource requirements and to assure the communication service SLA/SLS requirements.

When the communication service is active, network slice performance is monitored and analysed for the communication service according to end user service experiences.

If service degradation occurs or it is predicted, the 3GPP management system could take actions, i.e. the allocated resources are scaled up or the SLS is adjusted based on pre-agreement/interaction between CSP and CSC.

## A.3 Control loop in network slice layer

After receiving SLA/SLS requirements from service profile and completing the network slice provisioning, the network slice performance (e.g. KPI, QoE) are monitored and reported. Compared to the SLA/SLS requirements from service profile, when network slice performance is not met, the 3GPP management system identifies the root cause and may reconfigure the resources according to analytical report from MDAS producer. The network slice resources are also modified accordantly in case the network slice performance requirement needs to be changed based on communication service requirement adjustment.

## A.4 Control loop in network slice subnet layer

After decomposing service profile to slice profile, the performance requirements for each network slice subnet are obtained. The 3GPP management system could have the capability of service observation (e.g., the supervision to the NSSI) based on MDAS. Based on such observation and comparison with initial subnet performance requirements, management actions on the NSSI might be performed if NSSI performance requirements fulfillment indicates a problem. Another possible scenario is that, when the NSSI performance requirement is changed because of the network slice modification management action, the NSSI resources might be also reconfigured.

## A.5 Control loop in NF layer

NOTE: The control loop in NF layer is not addressed in the present document.

Annex B (normative):
OpenAPI definition of the COSLA NRM

# B.1 General

This annex contains the OpenAPI definition of the COSLA NRM in YAML format.

The Information Service (IS) of the COSLA NRM is defined in clause 4.

Mapping rules to produce the OpenAPI definition based on the IS are defined in TS 32.160 [10].

# B.2 Solution Set (SS) definitions

## B.2.1 OpenAPI document "coslaNrm.yml"

openapi: 3.0.2

info:

 title: coslaNrm

 version: 16.4.0

 description:

 OAS 3.0.1 specification of the Cosla NRM

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externalDocs:

 description: 3GPP TS 28.536 V16.4.0; Cosla NRM

 url: http://www.3gpp.org/ftp/Specs/archive/28\_series/28.536/

paths: {}

components:

 schemas:

#------------ Type definitions ---------------------------------------------------

 ControlLoopLifeCyclePhase:

 type: string

 enum:

 - PREPARATION

 - COMMISSIONING

 - OPERATION

 - DECOMMISSIONING

 ObservationTime:

 type: integer

 AssuranceGoalStatusObserved:

 type: string

 enum:

 - FULFILLED

 - NOT\_FULFILLED

 AssuranceGoalStatusPredicted:

 type: string

 enum:

 - FULFILLED

 - NOT\_FULFILLED

 AssuranceTargetStatusObserved:

 type: string

 enum:

 - FULFILLED

 - NOT\_FULFILLED

 AssuranceTargetStatusPredicted:

 type: string

 enum:

 - FULFILLED

 - NOT\_FULFILLED

 AssuranceTarget:

 type: object

 properties:

 assuranceTargetName:

 type: string

 assuranceTargetValue:

 type: string

 assuranceTargetStatusObserved:

 $ref: '#/components/schemas/AssuranceTargetStatusObserved'

 assuranceTargetStatusPredicted:

 $ref: '#/components/schemas/AssuranceTargetStatusPredicted'

 AssuranceTargetList:

 type: array

 items:

 $ref: '#/components/schemas/AssuranceTarget'

#-------- Definition of concrete IOCs --------------------------------------------

 SubNetwork-Single:

 allOf:

 - $ref: 'genericNrm.yaml#/components/schemas/Top'

 - type: object

 properties:

 attributes:

 allOf:

 - $ref: 'genericNrm.yaml#/components/schemas/SubNetwork-Attr'

 - $ref: 'genericNrm.yaml#/components/schemas/SubNetwork-ncO'

 - type: object

 properties:

 AssuranceClosedControlLoop:

 $ref: '#/components/schemas/AssuranceClosedControlLoop-Multiple'

 ManagedElement-Single:

 allOf:

 - $ref: 'genericNrm.yaml#/components/schemas/Top'

 - type: object

 properties:

 attributes:

 allOf:

 - $ref: 'genericNrm.yaml#/components/schemas/ManagedElement-Attr'

 - $ref: 'genericNrm.yaml#/components/schemas/ManagedElement-ncO'

 - type: object

 properties:

 AssuranceClosedControlLoop:

 $ref: '#/components/schemas/AssuranceClosedControlLoop-Multiple'

 AssuranceClosedControlLoop-Single:

 allOf:

 - $ref: 'genericNrm.yaml#/components/schemas/Top'

 - type: object

 properties:

 attributes:

 type: object

 properties:

 operationalState:

 $ref: 'comDefs.yaml#/components/schemas/OperationalState'

 administrativeState:

 $ref: 'comDefs.yaml#/components/schemas/AdministrativeState'

 controlLoopLifeCyclePhase:

 $ref: '#/components/schemas/ControlLoopLifeCyclePhase'

 AssuranceGoal:

 $ref: '#/components/schemas/AssuranceGoal-Multiple'

 AssuranceGoal-Single:

 allOf:

 - $ref: 'genericNrm.yaml#/components/schemas/Top'

 - type: object

 properties:

 attributes:

 allOf:

 - type: object

 properties:

 observationTime:

 $ref: '#/components/schemas/ObservationTime'

 assuranceTargetList:

 $ref: '#/components/schemas/AssuranceTargetList'

 assuranceGoalStatusObserved:

 $ref: '#/components/schemas/AssuranceGoalStatusObserved'

 assuranceGoalStatusPredicted:

 $ref: '#/components/schemas/AssuranceGoalStatusPredicted'

 serviceProfileId:

 type: string

 sliceProfileId:

 type: string

 networkSliceRef:

 $ref: 'comDefs.yaml#/components/schemas/Dn'

 networkSliceSubnetRef:

 $ref: 'comDefs.yaml#/components/schemas/Dn'

#-------- Definition of JSON arrays for name-contained IOCs ----------------------

 AssuranceClosedControlLoop-Multiple:

 type: array

 items:

 $ref: '#/components/schemas/AssuranceClosedControlLoop-Single'

 AssuranceGoal-Multiple:

 type: array

 items:

 $ref: '#/components/schemas/AssuranceGoal-Single'

#------------ Definitions in TS 28.536 for TS 28.623 -----------------------------

 resources-coslaNrm:

 oneOf:

 - $ref: '#/components/schemas/AssuranceClosedControlLoop-Single'

 - $ref: '#/components/schemas/AssuranceGoal-Single'

 - $ref: '#/components/schemas/SubNetwork-Single'

 - $ref: '#/components/schemas/ManagedElement-Single'

Annex C (normative):
AssuranceClosedControlLoop state management

An AssuranceClosedControlLoop is a logical object in the management system that represents complex interaction between the assurance information and configuration information of a grouping of resources. At any time, the management system needs to know the state of an AssuranceClosedControlLoop.

The ITU-T X.731 [15], to which [14] refers, has defined the inter-relation between the administrative state and operational state of systems in general. Figure X.1 shows the state diagram of an AssuranceClosedControlLoop, where the number in the Figure identify the state changes. The explanations for the state changes are described in Table C.1.



Figure C.1: AssuranceClosedControlLoop state diagram

In an AssuranceClosedControlLoop deployment scenario, the interactions between various management services allow the reconfiguration of the resources controlled by the AssuranceClosedControlLoop based on predefined goal(s). The interactions specified under the column "The state transition events and actions" of Table C.1 shall be present for the state transition.

Table C.1: The AssuranceClosedControlLoop state transition table

|  |  |  |
| --- | --- | --- |
| Trigger number | The state transition events and actions | State |
| 0 | The Assurance MnS producer responds positively to the “create ACCL" message, the ACCL is created and the state is set to Locked  | Locked & Disabled |
| 1 | The Assurance MnS producer has assurance goals to fulfil and starts or resumes operation by setting the operational state to Enabled | Locked & Enabled |
| 2 | The Assurance MnS consumer suspends operation of the ACCL by setting the adminstrative state to Locked  | Locked (Enabled or Disabled) |
| 3 | The Assurance MnS consumer resumes operation of the ACCL by setting the administrative state to Unlocked. | Unlocked(Enabled or Disabled) |
| 4 | The Assurance MnS producer does not have any assurance goals to fulfil and suspends operation by setting the operational state to Disabled  | Disabled(Locked or Unlocked) |
| 5 | The Assurance MnS producer responds positively to the “delete ACCL" message, the ACCL is deleted, and the state is set to NULL (the Initial and Final state) | NULL |

NOTE: The trigger numbers in the first column represent the state changes in Figure C.1

Annex D (informative):
Change history

|  |
| --- |
| **Change history** |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2020-07 | SA#88e |  |  |  |  | Upgrade to change control version | 16.0.0 |
| 2020-09 | SA#89e | SP-200749 | 0001 | - | F | Update control loop deployed in different layers with SLA decomposition | 16.1.0 |
| 2020-09 | SA#89e | SP-200750 | 0004 | - | F | Add references to clause 4.1.2.3 | 16.1.0 |
| 2020-09 | SA#89e | SP-200750 | 0005 | - | F | Correct title and add references in clause 4.1.1 | 16.1.0 |
| 2020-09 | SA#89e | SP-200750 | 0006 | - | F | Remove Editor's Note in clause 4.1.1 | 16.1.0 |
| 2020-09 | SA#89e | SP-200750 | 0007 | - | F | Replace Editors Note in clause Annex A.5 with a Note | 16.1.0 |
| 2020-09 | SA#89e | SP-200750 | 0003 | - | F | Add abbreviations to clause 3.3 | 16.1.0 |
| 2020-12 | SA#90e | SP-201050 | 0008 | - | F | Update references to other specifications | 16.2.0 |
| 2020-12 | SA#90e | SP-201056 | 0011 | - | F | Update and make closed control loop term consistent | 16.2.0 |
| 2020-12 | SA#90e | SP-201056 | 0013 | -  | F | Add Annex on state management | 16.2.0 |
| 2020-12 | SA#90e | SP-201056 | 0016 | - | F | Implement Assurance Closed Loop model changes | 16.2.0 |
| 2020-12 | SA#90e |  |  |  |  | Correction in history table of SP numbers | 16.2.1 |
| 2021-03 | SA#91e | SP-210151 | 0017 | - | F | Remove conflicting attribute definitions | 16.3.0 |
| 2021-03 | SA#91e | SP-210151 | 0018 | - | F | Clarify modelling of AssuranceGoal | 16.3.0 |
| 2021-03 | SA#91e | SP-210151 | 0019 | 3 | F | Correct OpenAPI definition of the COSLA NRM | 16.3.0 |
| 2021-03 | SA#91e | SP-210151 | 0022 | - | F | Remove overview from stage 2 description | 16.3.0 |
| 2021-03 | SA#91e | SP-210151 | 0025 | 2 | F | Correct the misalignment information for COSLA NRM | 16.3.0 |
| 2021-03 | SA#91e | SP-210151 | 0027 | 1 | F | Add explanation of entities in closed loop | 16.3.0 |
| 2021-06 | SA#92e | SP-210405 | 0028 | - | C | Moving Assurance Observed and Predicted | 16.4.0 |
| 2021-06 | SA#92e | SP-210405 | 0029 | - | B | Improve the readabililty of closed control loop NRM fragment | 16.4.0 |