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Procedures for Network Slice Capability Exposure for  
Application Layer Enablement Service  
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650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex - FRANCE

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Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B  
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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.

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## Introduction

Network slice capability enablement (NSCE) is a service that enables the network slice related capabilities towards 3<sup>rd</sup> party on the basis of R17 SEAL. The NSCE service provides additional functionality and exposes slice capabilities based on 5GS management system services (e.g MnS services) and 5GS network services (e.g. NEF APIs, NWDAF APIs, NSACF APIs). This technical specification provides architecture and procedures for enabling NSCE service over 3GPP networks.

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# 1 Scope

The present document specifies the procedures and information flows necessary for Network Slice Capability Exposure for Application Layer Enablement on the basis of SEAL.

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# 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 23.434: "Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows".
- [3] 3GPP TS 23.222: "Functional architecture and information flows to support Common API Framework for 3GPP Northbound APIs; Stage 2".
- [4] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".
- [5] GSMA NG.116 - Generic Network Slice Template.
- [6] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1".
- [7] 3GPP TS 28.532: "Management and orchestration; Generic management services".
- [8] 3GPP TS 28.531: "Management and orchestration; Provisioning".
- [9] 3GPP TS 28.537: "Management and orchestration; Management capabilities".
- [10] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".
- [11] 3GPP TS 28.535: "Management and orchestration; Management services for communication service assurance; Requirements".
- [12] 3GPP TS 23.502: "Procedures for the 5G System (5GS)".
- [13] 3GPP TS 29.536: "5G System; Network Slice Admission Control Service; Stage 3".
- [14] 3GPP TS 33.501: "Security architecture and procedures for 5G System"
- [15] 3GPP TS 28.530: "Management and orchestration; Concepts, use cases and requirements"
- [16] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".
- [17] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System; Stage 2".
- [18] 3GPP TS 23.548: "5G System Enhancements for Edge Computing; Stage 2".
- [19] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".
- [20] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

- [21] 3GPP TS 28.104: "Management and orchestration; Management Data Analytics". [22] 3GPP TS 23.558: "Architecture for enabling Edge Applications".
- [22] 3GPP TS 33.434: "Service Enabler Architecture Layer (SEAL); Security aspects for Verticals".
- [23] 3GPP TS 28.545: "Management and orchestration; Fault Supervision (FS) "
- [24] 3GPP TS 32.111-1: "Management and orchestration; Fault management, Part 1: 3G fault management requirements".
- [25] 3GPP TS 28.533: "Management and orchestration; Architecture framework".
- [26] 3GPP TS 23.436: "Procedures for Application Data Analytics Enablement Service"
- [27] 3GPP TS 26.114: "IP Multimedia Subsystem (IMS); Multimedia Telephony; Media handling and interaction ".
- [28] 3GPP TS 28.202: "Charging management; Network slice management charging in the 5G System (5GS); Stage 2".

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## 3 Definitions of terms, symbols and abbreviations

### 3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**VAL server policy:** Network slice management Policy which can be seen as application function policy from VAL Provider/ slice customer/ASP, abstracted based on the slice usage pattern of application, consisting of trigger event and expected action. When provided to NSCE server, the NSCE server will trigger the expected action based on the policy.

**MNO policy:** The network slice management policy between the VAL and MNO pertaining to a specific service and slice, including ranges of network slice capabilities which can be adapted, i.e. Network slice Service level agreement.

**NSCE service provider policy (NSPP):** The network slice capability enablement service policy between the VAL and NSCE service provider pertaining to a specific service and slice, including ranges of network slice capability enablement service which can be adapted, i.e. NSCE service level agreement.

**Policy harmonization:** The NSCE service that harmonizing the VAL server policy parameter, to make sure the VAL server policy is compatible with the policies of the MNO and NSCE service provider policy for the same service or slice.

**Requirement alignment:** The NSCE service that aligning the network slice performance and the VAL service requirement in the request.

### 3.2 Symbols

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

<symbol>            <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

ASP	Application Service Provider
Auto-NS-LCM	Automatic Application Layer Network Slice Lifecycle Management
EDN	Edge Data Network
EGMF	Exposure Governance Management Function
GST	Generic Network Slice Template
KPI	Key Performance Indicator
KQI	Key Quality Indicator
MnS	Management Service
MNO	Mobile Network Operator
NEF	Network Exposure Function
NEST	Network Slice Template
NOP	Network Operator
NSCE	Network Slice Capability Enablement
NSaaS	Network Slice as a Service
NSI	Network Slice Instance
NSSI	Network Slice Subnet Instance
NWDAF	Network Data Analytics Function
NSACF	Network Slice Admission Control Function
NSC	Network Slice consumer
NSP	Network Slice Provider
NSMF	Network Slice Management Function
OAM	Operation, administration and maintenance
QoE	Quality of Experience
S-NSSAI	Single Network Slice Selection Assistance Information
SLA	Service Level agreement
VAL	Vertical Application Layer

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## 4 Overview

### 4.1 Registration

This functionality enables the VAL server to become a recognized user of CAPIF. VAL server registration procedures are specified in clause 9.2.

### 4.2 Slice API configuration and translation

This functionality is provided to the vertical application specific layer and configures the exposure of APIs in a slice-tailored manner. It is assumed that the VAL server is not initially aware of the all the API exposure capabilities and information which will be needed for the given slice based on the SLA, and NSCE plays a vital role in configuring and translating the slice API based on the per slice requirements to service APIs. Slice API configuration and translation procedures are specified in clause 9.3.

### 4.3 Application layer network slice lifecycle management

Application layer network slice lifecycle management is provided to the VAL to better meet consumer's requirement without having to interact with 5GS frequently, based on network slice status collected from 5GS and QoE collected from application layer. Application layer network slice lifecycle management procedures are specified in clause 9.4.

## 4.4 Network slice optimization based on VAL server policy

Network slice optimization based on VAL server policy optimizes the network slice for the vertical applications by triggering the network slice modification exposed by EGMF defined in SA5. Network slice optimization based on VAL server policy procedures are specified in clause 9.5.

## 4.5 Discovery of management service exposure

This network slice capability enablement feature supports the initial discovery of MnS for a given slice based on VAL server request, and the discovery of new/modified MnS with the required exposure (for example the permissions of the VAL server over the target MnS, e.g. read, write operations). This feature consists of two procedures, which are specified in clause 9.6:

- Discovery of management service capabilities and related permissions (e.g. permitted CRUD operations) based on VAL server request;
- Discovery and exposure of new or modified management service capabilities based on changes at OAM.

## 4.6 Network slice performance and analytics monitoring

This functionality is provided to the VAL to get end to end network slice related performance and analytic monitoring. The NSCE server identifies which data are needed, collects the data from different data sources (e.g., the OAM system, the 5GC Network, etc.), performs data processing and abstraction, exposes the processed data to VAL servers. Network slice performance and analytics monitoring procedures are specified in clause 9.7.

## 4.7 Information collection from NSCE server(s)

The network slice status collected by the NSCE server could be exposed to other NSCE server(s) if some agreement has been made. Information collection from NSCE server(s) procedures are specified in clause 9.8.

## 4.8 Predictive slice modification in edge based NSCE deployments

This feature addresses scenarios where the NSCE server is deployed at the edge and the migration to different Data Network will require that the ongoing slice is supported at the target area to ensure meeting the application session requirements. The slice parameters monitoring at the target area (e.g. for per NSI/NSSI resource situation) need to be known at the server NSCE server to allow for pro-active slice (or slice subnet) modification trigger to avoid degradation of the application service performance. Predictive slice modification procedures are specified in clause 9.9.

## 4.9 Multiple slices coordinated resource optimization

This functionality is provided to the VAL to monitor the slice usage status of multiple slices (PNI-NPN slice(s) and its private slice in the PLMN) of the PNI-NPN owner in a combined manner. It makes resource adjustment between different slices in one PLMN to realize optimized and efficient resource usage among multiple slices sharing common network resources. Coordinated PLMN and PNI-NPN slice resource optimization procedures are specified in clause 9.10.

## 4.10 Network slice adaptation for VAL application

This functionality is provided to the VAL to adapt the network slice for the VAL application. Such adaptation assumes that the UE is subscribed to more than one slice and is done via providing a guidance to update the URSP rules at the 5GS. The network slice adaptation request can be triggered by VAL server or VAL UE. Network slice adaptation for VAL application procedures are specified in clause 9.11.



## 4.11 Slice related communication service lifecycle management

This functionality is provided to the VAL server to make slice related communication service lifecycle management. The NSCE server can acquire the application services related requirements for a specific VAL service from the vertical industry perspective, evaluate these requirements and then determines the network slice by pre-configured industry mapping relations or by KQI-KPI translation algorithms. After the network slice requirements are determined, the NSCE server allocates proper network slice resources to support the application services. Slice related communication service lifecycle management exposure procedures are specified in clause 9.12.

## 4.12 Predictive slice modification in Inter-PLMN based slice service continuity

This functionality is provided to the VAL to make predictive slice modification where NSCE service provider provides its services when connected to two PLMNs and has SLA with them. The NSCE server checks with 5GS (OAM, 5GC) whether the serving slice is available and can offer the same performance at the target PLMN and make slice modification decision if needed. Predictive slice modification in Inter-PLMN based slice service continuity procedures are specified in clause 9.13.

## 4.13 Network slice diagnostics

Network slice diagnostics provides possibility for the vertical/ASP using VAL server to receive information about the specific event(s) related to service experience. The vertical/ASP using the VAL server has estimated bad QoE for a mobile user or service – either reported from a mobile user or service or detected by application, can initiate a check with NSCE. The NSCE server can provide Network slice diagnostics details related to the identified event as specified in clause 9.14.

## 4.14 Network slice fault management capability exposure

Network slice fault management capability exposure gathers data from different sources (e.g., OAM, VAL server, NSCE client) and provides fault data that characterize the quality of the network connections and services to ensure a quick reaction to identify network connectivity, performance related problems. The Network slice fault management capability exposure is specified in clause 9.15.

## 4.15 Slice requirements verification and alignment capability exposure

Slice requirements verification and alignment capability exposure provides the capability of comparing the QoS achievement status together with the OAM QoS data versus real customer QoS data (e.g., Mean Opinion Score) collected from VAL client by checking whether the existing QoS/Slice related data is able to satisfy the VAL clients. Periodically alignment notifications are sent to VAL server for the slice requirements alignment. The Slice requirements verification and alignment capability exposure is specified in clause 9.16.

## 4.16 Network Slice Information delivery

The Network Slice information delivery sends the Network Slice information to VAL server and NSCE client. With that information, the VAL server is able to manage the network slice for their service such as preparation, creation, activation and termination (tear-down) of network slice. The Network Slice Information delivery is specified in clause 9.17.

## 4.17 Network Slice Allocation

The NSCE server performs the Network Slice allocation operation on behalf of the VAL server if non-trusted 3<sup>rd</sup> party application (i.e., VAL server) cannot access to the 5GS management system directly. The specific service is specified in clause 9.18.

## 5 Business models and relationships for NSCE

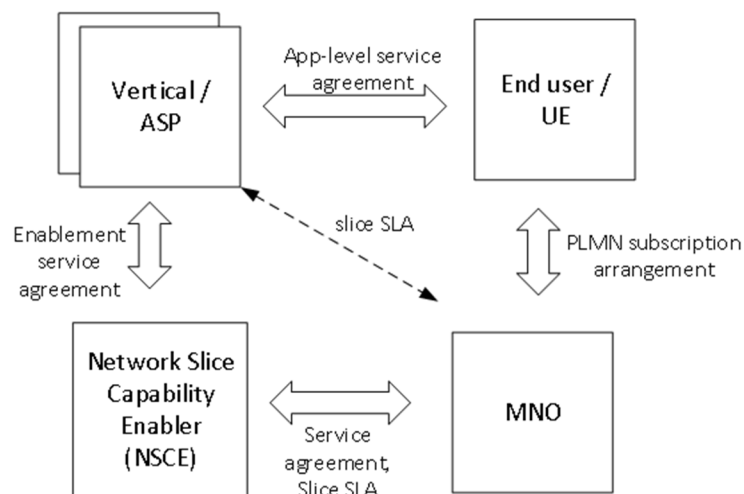
NSCE layer provides value added services to VAL customers, based on consuming 5GS services related to slicing (from OAM, 5GC) and based on interacting with the VAL UE side. The variety of services and the deployment aspects depend on the different assumptions for the slice owner / provider, the slice customer and the SEAL service provider. With respect to NSCE, the NSCE server belongs to the SEAL provider (as stated in TS 23.434 [2] clause 5) who can be either the MNO itself, or the vertical customer (e.g. factory owner, automaker X) or the edge/cloud provider (e.g. hyperscaler) who provides such platform services related to slice capability exposure to the vertical customer on top of the MNO. Thus, NSCE can play different roles based on the business models. For example, NSCE server can be:

- deployed by NOP / MNO.
- deployed by an Edge / Cloud Provider. In this case, it is assumed that the NSCE server is acting as an authorized AF/AS.
- deployed by a vertical industry, which can be the end slice customer.

From business perspective, the following business model applies. In Figure 5-1, the different interactions among all the involved entities are provided. More specifically, in this model the end user is the consumer of the applications provided by the vertical/ASP and can have app-level service agreement with vertical/ASP(s).

The end user/UE also has a PLMN subscription arrangement with the MNO. The UE used by the end user is allowed to be registered on the MNO's network. MNO (via OAM) can have a slice SLA with the vertical / ASP, which is optional when vertical customer is the NSC. In addition, due to the involvement of a NSCE service provider, additional agreements can be possible between the NSCE server and VAL/ASP layer and the NOP/MNO(s):

- the enablement service agreement between VAL/ASP layer and the NSCE service provider include the agreement on the value-added services, which in case on NSaaS these are services related to the consumed slice from NOP. So, the end customer (VAL) subscribes to NSCE server for receiving additional services for optimizing the slice utilization. In case that the NSCE server is a NSP towards VAL customer, then such agreement can relate to slice SLA (for the slice provided by the NSCE server). When the NSCE server is part of the vertical, the service agreement between VAL/ASP layer and the NSCE service provider is internal to a single organization.
- the service agreement between MNO and NSCE service provider is for consuming 5GS services (and being also authorized to provide additional services on top). Such agreement could be also a slice SLA for the scenarios when NSCE server is the NSC of the MNO (in NSaaS model).



**Figure 5-1: Business relationships**

In case of shared RAN between operators, one NSCE service provider (slice service provider) can use NSCE to offer slice services using resources of these operators to end customer (VAL) using the shared RAN via one or both operators.

In case of national roaming between operators, one NSCE service provider (slice service provider) can use NSCE to offer slice services using resources of these operators to end customer (VAL).

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## 6 Architectural requirements

### 6.1 General Description

The following clauses specify the requirements for network slice capability enablement services for application layers.

### 6.2 General requirements

[AR-6.2-1] The NSCE architecture shall support the NSCE server to communicate with the VAL server with one or more applications.

[AR-6.2-2] The NSCE architecture shall support the NSCE server to communicate with one or more VAL servers.

[AR-6.2-3] The NSCE architecture shall support the NSCE server to interact with 3GPP network management system(s) to consume network slice management services provided by MNO(s). The network management system(s) can belong to the same PLMN or different PLMNs on which the NSCE service provider offers its services.

[AR-6.2-4] The APIs interactions between the vertical application server(s) and NSCE server(s) shall conform to CAPIF as specified in 3GPP TS 23.222 [3].

[AR-6.2-5] The NSCE architecture shall support the NSCE server to communicate with one or more other NSCE server(s).

### 6.3 Network slice Lifecycle management requirements

[AR-6.3-1] The NSCE architecture shall enable lifecycle management capability exposure of network slice by authorized VAL server.

[AR-6.3-2] The NSCE architecture shall enable lifecycle management capability exposure of network slice communication service to authorized VAL server.

[AR-6.3-3] The NSCE architecture shall support the interactions with 3GPP network management system to consume network slice lifecycle management service provided by MNO.

### 6.4 Performance data retrieval requirement

[AR-6.4-1] The NSCE architecture shall support the end-to-end network slice performance and analytics monitoring capability exposure to authorized VAL server.

### 6.5 Network slice adaption requirement

[AR-6.5-1] The NSCE architecture shall support the network slice adaption capability exposure to authorized VAL server.

[AR-6.5-2] The NSCE architecture shall support the network slice adaption capability exposure to authorized NSCE client.

### 6.6 Network slice configuration and translation requirement

[AR-6.6-1] The NSCE architecture shall support the network slice configuration capability exposure to authorized VAL server.

[AR-6.6-2] The NSCE architecture shall support the network slice translation capability to enable the translation of slice API invoked by VAL server.

## 6.7 Multiple slices combined management requirement

[AR-6.7-1] The NSCE architecture shall support the interactions with OAM or 5GC of 3GPP PLMN to provide multiple slices combined management service of that PLMN.

[AR-6.7-2] The NSCE architecture shall provide multiple slices combined performance monitoring service of the PLMN and its PNI-NPNs to authorized VAL server.

[AR-6.7-3] The NSCE architecture shall provide multiple slices coordinated resource optimization service between the PLMN and its PNI-NPNs to authorized VAL server.

## 6.8 Security requirements

[AR-6.8-1] The NSCE architecture shall provide mechanisms to authorize the usage of network slicing related services by the VAL servers and NSCE clients, conform to CAPIF as specified in 3GPP TS 23.222 [3].

[AR-6.8-2] The NSCE architecture shall support mutual authentication and authorization check between clients and servers, servers and servers that interact, conform to CAPIF as specified in 3GPP TS 23.222 [3].

NOTE: The authentication and authorization aspects related to VAL servers and NSCE enablers are out scope of this study and to be addressed by SA3, in TS 33.434[21].

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# 7 Application architecture for NSCE

## 7.1 General

The architecture for the network slice capability enablement is based on the generic functional model specified in clause 6.2 of 3GPP TS 23.434 [2]. It is organized into functional entities to describe a functional architecture which addresses the support for network slice capability enablement aspects for vertical applications. Since the slicing is a feature which considers the Uu interfaces, only the on-network functional model is specified in this clause.

## 7.2 Architecture description

Figure 7.2-1 depicts the network slice capability enablement architecture in the non-roaming case, using the reference point representation showing how various entities interact with each other.

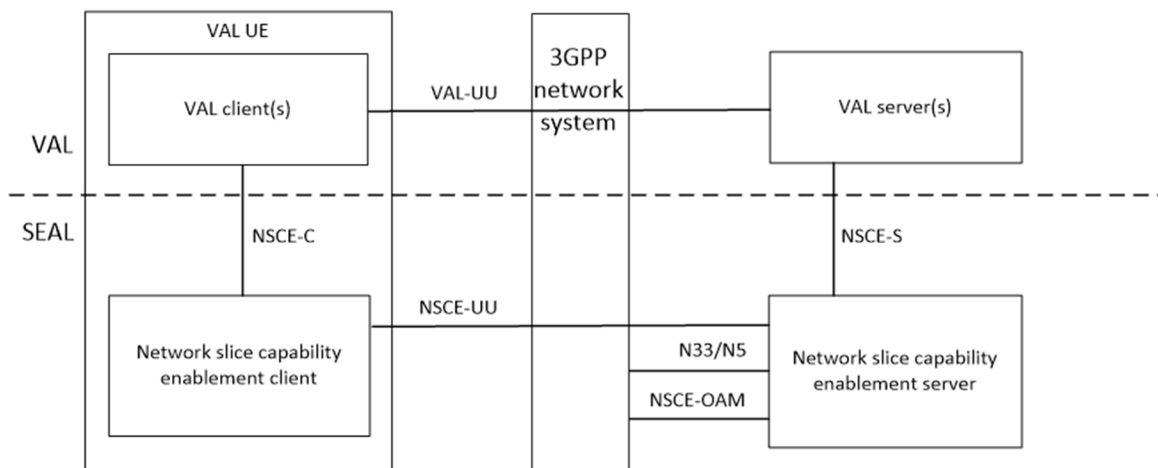
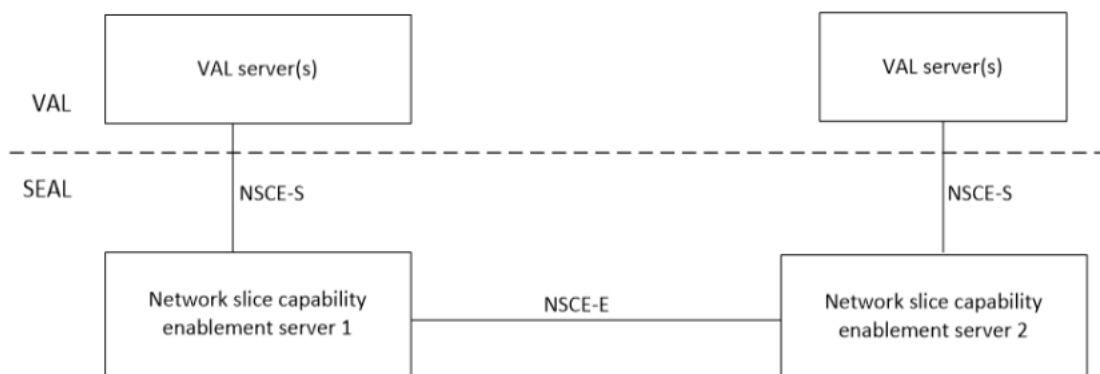


Figure 7.2-1: Architecture for network slice capability enablement – reference points representation

The network slice capability enablement client communicates with the network slice capability enablement server over the NSCE-UU reference point. The network slice capability enablement client provides the support for network slice capability enablement functions to the VAL client(s) over NSCE-C reference point. The VAL server(s) communicates with the network slice capability enablement server over the NSCE-S reference point. It is assumed that the network slice capability enablement server is deployed at the 5G system domain. The network slice capability enablement server, acting as AF, may communicate with the 5G Core Network functions via NEF (N33) reference point (for interactions with PCF, NSACF, etc.). The network slice capability enablement server may interact with OAM system over NSCE-OAM reference point, as consumer in both NSaaS and NoP model defined in the clause 4.1.6 and clause 4.1.7 of 3GPP TS 28.530 [15] (for Network Slice Provisioning capabilities, Performance Assurance, Fault Supervision etc.).

NOTE: OAM interfaces and/or network slice information can be exposed to an authorized (trusted) third-party (NSCE) only after a contract has been signed between the MNO and this third-party. Whether and how CAPIF/EGMF can be used to expose management services (MnS) is up to SA5 decision.

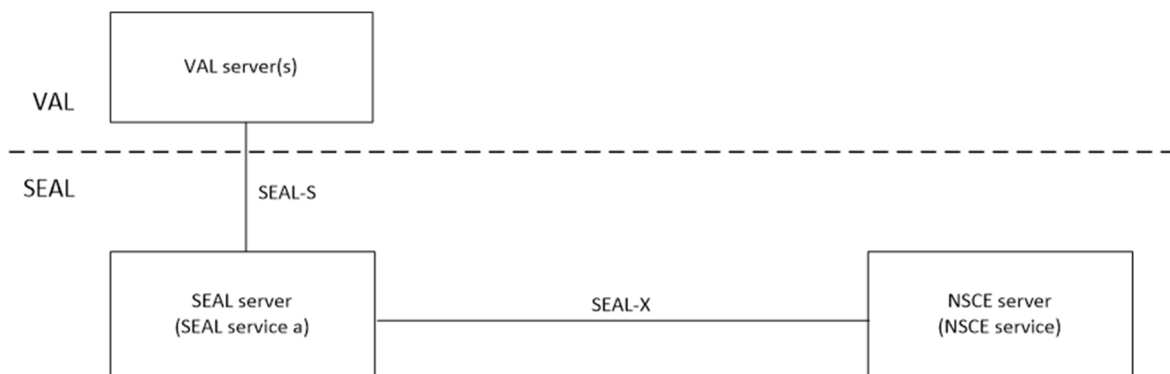
Figure 7.2-2 illustrates the architecture for interconnection between NSCE servers.



**Figure 7.2-2: Interconnection between NSCE servers**

The NSCE server could interact with another NSCE server over NSCE-E reference point.

Figure 7.2-3 illustrates the architecture for inter-service communication between NSCE servers and other SEAL server.



**Figure 7.2-3: Inter-service communication between NSCE server and other SEAL server**

The NSCE server interacts with another SEAL server for inter-service communication over SEAL-X reference point.

## 7.3 Functional entities description

### 7.3.1 General

The functional entities for network slice capability enablement SEAL service are described in the following subclauses.

## 7.3.2 Network slice capability enablement server

The network slice capability enablement server functional entity provides the application layer enablement of the network slicing aspects to support the VAL applications. The network slice capability enablement server acts as CAPIF's API exposing function as specified in 3GPP TS 23.222 [3].

## 7.3.3 Network slice capability enablement client

The network slice capability enablement client functional entity acts as the application client for the slice enablement. The network slice capability enablement client interacts with the network slice capability enablement server to trigger network slice related operations such as adaptation due to an application requirement change. This trigger may be due to an application QoS requirement change, a service operation change. The NSCE client may receive a network slice / DNN re-mapping notification from the NSCE server. The NSCE client may optionally notify the VAL client on the network slice / DNN re-mapping.

# 7.4 Reference points description

## 7.4.1 General

The reference points for the functional model for network slice capability enablement are described in the following subclauses.

## 7.4.2 NSCE-UU

The interactions related to network slice capability enablement functions between the network slice capability enablement server and the network slice capability enablement client are supported by NSCE-UU reference point. This reference point utilizes Uu reference point as described in 3GPP TS 23.501 [14].

## 7.4.3 NSCE-C

The interactions related to network slice capability enablement functions between the VAL client(s) and the network slice capability enablement client within a VAL UE are supported by the NSCE-C reference point. The NSCE client may receive application requirement change, application client information (such as its KQI) over NSCE-C. Further, the NSCE client may provide a notification on the network slice adaptation upon successful adaptation of the slice to application mapping.

## 7.4.4 NSCE-S

The interactions related to network slice capability enablement functions between the VAL server(s) and the network slice capability enablement server are supported by the NSCE-S reference point. This reference point is an instance of CAPIF-2 reference point as specified in 3GPP TS 23.222 [3].

## 7.4.5 N33

The reference point N33 supports the interactions between the network slice capability enablement server and the NEF and is specified in 3GPP TS 23.501 [14]. N33 is used for the network-based mechanism for slice re-mapping, where NSCE server acting as AF influences the URSP rules for the application traffic per UE by providing a guidance on the route selection parameters (including the S-NSSAI and DNN mapping), as specified in 3GPP TS 23.502 [12] clause 4.15.6.10, 3GPP TS 23.503 [17] clause 6.6.2.2, 3GPP TS 23.548 [18] clause 6.2.4.

## 7.4.6 NSCE-E

The interactions between the NSCE servers are generically referred to as NSCE-E reference point. This reference point supports information collection from other NSCE servers as defined in clause 9.8, Service continuity negotiation as defined in clause 9.9.2.

## 7.4.7 NSCE-OAM

The interface between the NSCE server and the OAM system are generically referred to as NSCE-OAM reference point. This reference point supports provisioning of management service as defined in clause 6.1, 3GPP TS 28.531 [8].

NOTE: The NSCE-OAM reference point is out of scope of this specification, and is defined by SA5.

## 7.4.8 SEAL-X

The interactions between the NSCE servers and other SEAL servers are generically referred to as SEAL-X reference point. The specific SEAL server interactions corresponding to SEAL-X are described in 3GPP TS 23.434 [2].

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# 8 Identities and commonly used values

## 8.1 General

The common identities for SEAL refer to TS 23.434[2]. The following clauses list the additional identities and commonly used values for Network Slice Capability Enablement.

## 8.2 NSCE server ID

The NSCE server ID uniquely identifies the Network Slice Capability enablement server.

## 8.3 NSCE client ID

The Network Slice Capability enablement client ID identifies a particular NSCE client.

## 8.4 Network Slice related Identifier

The network slice related identifier identifies the network slice, which is mapped to the VAL application.

The identifier of the network slice is either S-NSSAI defined in 5.15.2.1 TS 23.501[16], or External Network Slice Information (ENSI) defined in TS 33.501[14].

Based on the operator's policy, if the service applies for a certain network slice instance, the identifier of Network Slice instance is used, i.e. NSI ID as defined in TS 23.501 or ENSI. If used, the NSI ID is associated with S-NSSAI.

## 8.5 Slice coverage area

The slice coverage area is the area where the network slice is available in the whole PLMN or in one or more Tracking Areas of the PLMN. The slice coverage area can be expressed as a Topological Service Area (e.g. a list of TA), a Geographical Service Area (e.g. geographical coordinates) or both.

## 8.6 NSCE service area

The NSCE service area is the area where the Network Slice Capability Enablement server owner provides its services. It is equal to the collection of coverage area of slices it can enable.

The NSCE service area can be expressed as a Topological Service Area (e.g. a list of TA), a Geographical Service Area (e.g. geographical coordinates) or both.

NOTE: The NSCE server service area shall not smaller than the collection of slice(s) coverage area(s) the NSCE server can enable.

## 9 Procedures and information flows

### 9.1 General

#### 9.1.1 Common Information Elements

##### 9.1.1.1 General

This clause provides descriptions for Information Elements which are commonly used in several procedures.

##### 9.1.1.2 Service requirement

The service requirement indicates the VAL application requirements pertaining to the slice(s).

**Table 9.1.1.2-1: Service requirement**

Information element	Status	Description
VAL service ID	M	The identification of the application ID related with the service requirement.
VAL service KPIs	O	KPIs including application QoS requirements (latency, error rates, throughput, jitter,...)
Network slice related identifier(s)	M	Identifier of network slice for which the request applies
Application layer Service Profile	O	The properties of network slice related requirement. If Service Profile is known by the VAL server, it can be provided to the NSCE server. The GST defined by GSMA (see clause 2.2 in [5]) and the performance requirements defined in clause 7 TS 22.261 [6] are all considered as input for it.
Area of interest	O	The service area for which the requirement applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).

## 9.2 Registration

For registration of the VAL server to be a recognized user of the CAPIF, the VAL server triggers the CAPIF Onboarding the API invoker procedure defined in 3GPP TS 23.222[3] clause 8.1. The NSCE server could be deployed with CAPIF core function.

**NOTE:** What additional information is needed, and if needed, whether it is specific for NSCE service or generally applicable for CAPIF is not specified in this release.

For de-registration of the VAL server, the VAL server triggers the CAPIF Offboarding the API invoker procedure defined in 3GPP TS 23.222[3] clause 8.2.

## 9.3 Slice API configuration and translation

### 9.3.1 General

This functionality is a service related to the translation of the service API as invoked by the end applications to slice APIs based on the API configuration and application to slice mapping. Slice APIs can be defined as customized/tailored sets of service APIs (which can be either NEF northbound APIs or OAM provided APIs or enabler layer/SEAL provided APIs) and can be mapped to particular slice instances. The slice APIs can be a bundled or combined API comprising of different types of APIs, which will be used to expose the telco (5GS/SEAL)-provided services as needed by the applications of the slice customer. Each slice API may be configured per network slice instance.



## 9.3.2 Procedure

### 9.3.2.1 Procedures on slice API configuration

#### 9.3.2.1.1 General

In the Initial Configuration procedure, the VAL server initially provides an application requirement to enabler server including the service KPIs and the subscribed/preferred slices. Then, the slice enabler configures the mapping of the VAL application to a slice API which is a combination/bundling of northbound APIs (from both management and control plane). In particular, a slice API consists of telco-provided/platform dependent service APIs (e.g., NEF, OAM, SEAL, etc), and provides an abstraction/simplification on top of them. The VAL server-initiated Configuration Update procedure covers the scenario where a trigger event occurs (e.g., QoS degradation, slice load) and the mapping configuration or the slice API configuration needed to be changed. In this scenario, the slice enabler updates the configuration of the API and provides a notification to the VAL server.

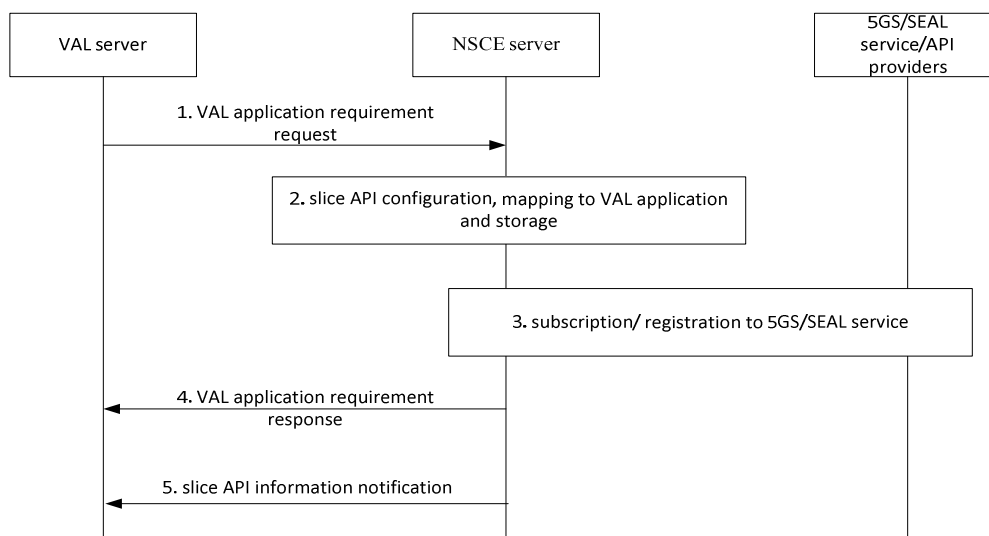
These two procedures for the initial configuration and the configuration update are covered in 9.3.2.1 and 9.3.2.2 respectively.

#### 9.3.2.1.2 Initial Configuration

Figure 9.3.2.1.2-1 illustrates the procedure of the initial slice API configuration.

Pre-conditions:

1. The VAL server has registered to receive NSCE services.



**Figure 9.3.2.1.2-1: Initial Slice API configuration**

1. The VAL server sends a VAL application requirement request to the NSCE server.
2. The NSCE server maps the VAL application requirement to a slice API which includes a list of APIs which is needed to be consumed as part of this service capability exposure.

The NSCE server may also store the mapping of the slice API to the service API list and per service API information (e.g. data encoding, transport technology, API protocol and versions)

3. The NSCE server registers to consume the corresponding APIs from the 5GS (NEF and OAM) and SEAL service producers. The NSCE server registers to the following:
  - to consume NEF monitoring events as specified in 3GPP TS 29.522 clause 5 e.g., network monitoring, slice status, analytics exposure, etc
  - to consume PM services and KPI monitoring from OAM

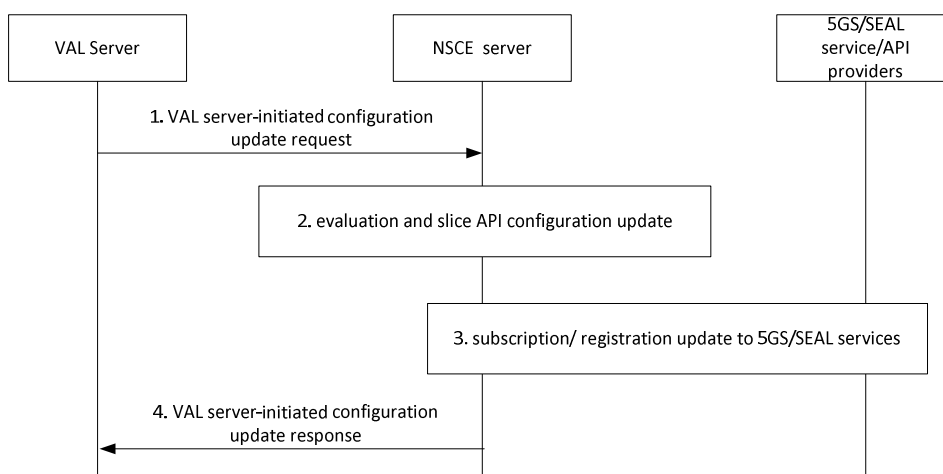
- to consume SEAL services based on 3GPP TS 23.434
- 4. The NSCE server sends a VAL application requirement response to notify on the result of the request and indicate whether the configuration of slice API is possible or not.
- 5. The NSCE server sends the slice API information notification to the VAL server.

### 9.3.2.1.3 VAL server-initiated Configuration Update

Figure 9.3.2.1.3-1 illustrates the procedure of the slice API configuration updated based on a trigger event.

Pre-conditions:

1. Initial configuration of the slice API has been completed successfully.
2. A trigger event, which may result the need of a slice configuration change, is captured by the VAL server (application server relocation to different EDN/DN, UE mobility to different EDN, application change of behaviour).



**Figure 9.3.2.1.3-1: Slice API configuration update**

1. The VAL server sends a VAL server-initiated configuration update request to the NSCE server.
2. The NSCE server processes the trigger event and checks the feasibility of such change and updates the mapping of service APIs to the slice APIs. One criterion for the update of the mapping is, if possible, to avoid changing the slice API configuration, which can be achieved by the re-mapping of the underlying service APIs
3. The NSCE server updates the subscription/registration to the underlying 5GS and SEAL service producers, if an update on the service APIs (e.g., NEF APIs, SEAL APIs, OAM provided APIs) is needed.
4. The NSCE server sends a VAL server-initiated configuration update response, containing the new slice API information, if an update has been carried out by the NSCE server.

### 9.3.2.2 Procedure on slice API translation

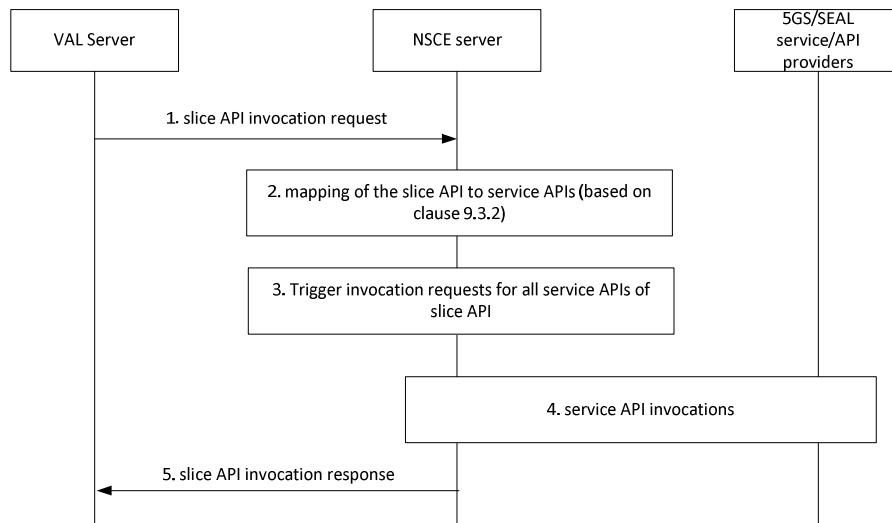
This procedure follows the 9.3.2.1 and aims to describe how the slice API invocation request is translated to service API invocations after the slice API configuration mapping. In this procedure, the NSCE server initially receives a slice API invocation request from the vertical application. Then, the NSCE server fetches the service APIs to be invoked based on the slice API configuration and performs invocation requests to the corresponding service API providers.

Figure 9.3.2.2-1 illustrates the procedure of the slice API translation based on the initial configuration.

Pre-conditions:

1. The VAL server has registered to receive NSCE services.

2. The slice API mapping to the VAL server has been performed based on 9.3.2.1.2 step 2 and the slice API information is provided to the VAL server based on 9.3.2.1.2 step 5.



**Figure 9.3.2.2-1: Slice API translation**

1. The VAL server sends a slice API invocation request to the NSCE server
2. The NSCE server checks that the user is authenticated and authorized to perform the slice API invocation and maps the requested slice API to a service APIs. If CAPIF is used, the NSCE server acts as AEF, and the authorization is obtained by CCF.
3. The NSCE server generates a trigger for service API invocation requests to all the service APIs within the slice API.
4. The NSCE server performs the corresponding service API invocation procedures based on CAPIF or via performing requests to the corresponding service API providers, which are mapped to the slice API. If CAPIF is used, the requests are sent to the corresponding AEFs of the API provider's domain, and the authorization is obtained by CCF.
5. The NSCE server sends a slice API invocation response to the VAL server, based on the result of the service API invocation response(s) of step 4.

## 9.3.3 Information flows

### 9.3.3.1 General

The following information elements are specified for slice API translation and configuration specified in clause 9.3.2.1 and 9.3.2.2.

### 9.3.3.2 VAL application requirement request

Table 9.3.3.2-1 describes information elements for the VAL application requirement request from the VAL server to the NSCE server.

This request provides the service requirements / KPIs, the capability exposure requirements and a preferred/subscribed slice identification (e.g., S-NSSAI or ENSI).

**Table 9.3.3.2-1: VAL application requirement request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
List of service requirement(s)	M	The VAL application requirements pertaining to the slice(s) as defined in table 9.1.1.1-1
Time validity	O	The time validity of the request
NOTE: One of this shall be present		

### 9.3.3.3 VAL application requirement response

Table 9.3.3.3-1 describes information elements for the VAL application requirement response from the NSCE server to the VAL server.

**Table 9.3.3.3-1: VAL application requirement response**

Information element	Status	Description
Result	M	Indicates the success or failure of the VAL application requirements request.
>Cause	O (see NOTE)	Indicates the cause of failure
NOTE : May only be present if the result is failure.		

### 9.3.3.4 Slice API information notify

Table 9.3.3.4-1 describes information elements for the Slice API information notification from the NSCE server to the VAL server. The Slice API information notification is used by NSCE server to send Slice API information to VAL server in the Initial Configuration and Configuration Update procedures.

**Table 9.3.3.4-1: Slice API information notify**

Information element	Status	Description
Slice API info	M	The information for the configured slice API

### 9.3.3.5 VAL server-initiated configuration update request

Table 9.3.3.5-1 describes information elements of the VAL server-initiated configuration update request sent by the VAL server to the NSCE server.

**Table 9.3.3.5-1: VAL server-initiated configuration update request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
Network slice ID	O	Identifier of the network slice for which the API configuration update is requested
Trigger Event Details	M	The trigger event details can be included, providing the cause for the need slice API configuration adaptation. Such trigger event can be: <ul style="list-style-type: none"> <li>- the UE mobility to a different service area (outside the original area of interest),</li> <li>- application server migration to different edge/cloud platform,</li> <li>- service API unavailability,</li> <li>- VAL application QoS requirements change</li> </ul>

### 9.3.3.6 VAL server-initiated configuration update response

Table 9.3.3.6-1 describes information elements of the VAL server-initiated configuration update response sent by the NSCE server to the VAL server.

**Table 9.3.3.6-1: VAL server-initiated configuration update response**

Information element	Status	Description
Configuration changed	O (see NOTE)	Indicates that the slice configuration has been changed.
> Updated slice API information	M	The information for the updated slice API
Configuration not changed	O (see NOTE)	The trigger event details can be included, providing the cause for the need slice API configuration adaptation. Such trigger event can be
> Cause	M	Indicates the reason for not changing the slice configuration. The reason may be that no change was needed, failure of changing in 5GS/SEAL or other (e.g. server internal error).
NOTE: Only one of these IEs is present in the message.		

### 9.3.3.7 slice API invocation request

Table 9.3.3.7-1 describes information elements for the slice API invocation request from the VAL server to the NSCE server.

**Table 9.3.3.7-1: slice API invocation request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
Authorization information	O	The authorization information obtained before initiating the slice API invocation request
Slice API identification	M	The identification information of the slice API for which invocation is requested. The slice API identification is part of the specific slice API invocation request.

### 9.3.3.8 slice API invocation response

Table 9.3.3.8-1 describes information elements for the slice API invocation response from the NSCE server to the VAL server.

**Table 9.3.3.8-1: slice API invocation response**

Information element	Status	Description
Result	M	Indicates the success or failure of slice API invocation request.
>Cause	O (see NOTE)	Indicates the cause of failure
NOTE: May only be present if the result is failure.		

## 9.3.4 APIs

### 9.3.4.1 General

Table 9.3.4.1-1 illustrates the NSCE APIs for the slice API configuration and translation feature.

**Table 9.3.4.1-1: List of APIs for slice API configuration and translation feature**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_NSCE_SliceApiConfiguration	Slice_API_configuration	VAL server	Request /Response
	Slice_API_configuration_update	VAL server	Request /Response
	Slice_API_information_notify	VAL server	Notify
SS_NSCE_Slice_ApiInvocation	Slice_API_invocation	VAL server	Request /Response

### 9.3.4.2 SS\_NSCE\_SliceApiConfiguration API

#### 9.3.4.2.1 General

**API description:** This API enables the VAL server to communicate with the NSCE server for the initial configuration of the slice API and possible subsequent slice API configuration update(s).

#### 9.3.4.2.2 SS\_NSCE\_Slice\_API\_configuration

**API operation name:** Slice\_API\_configuration

**Description:** Providing for VAL\_Application\_requirement to the NSCE server.

**Known Consumers:** VAL server

**Inputs:** See subclause 9.3.3.2

**Outputs:** See subclause 9.3.3.3

#### 9.3.4.2.3 SS\_NSCE\_Slice\_API\_configuration\_update

**API operation name:** Slice\_API\_configuration\_update

**Description:** VAL server providing trigger event information to the NSCE server that may potentially invoke slice API configuration change(s).

**Known Consumers:** VAL server

**Inputs:** See subclause 9.3.3.5

**Outputs:** See subclause 9.3.3.6

#### 9.3.4.2.4 SS\_NSCE\_Slice\_API\_information\_notify

**API operation name:** Slice\_API\_information\_notify

**Description:** Notifying the slice API information

**Known Consumers:** VAL server

**Inputs:** See subclause 9.3.3.4

**Outputs:** None

### 9.3.4.3 SS\_NSCE\_Slice\_ApiInvocation API

#### 9.3.4.3.1 General

**API description:** This API enables the VAL server to communicate with the NSCE server for invoking the slice API over NSCE-S.

#### 9.3.4.3.2 SS\_NSCE\_Slice\_API\_invocation

**API operation name:** Slice\_API\_invocation

**Description:** Requesting slice API invocation from NSCE server.

**Known Consumers:** VAL server

**Inputs:** See subclause 9.3.3.7

**Outputs:** See subclause 9.3.3.8

## 9.4 Application layer network slice lifecycle management

### 9.4.1 General

When NSCE receives a request for application layer network slice lifecycle management (AppLayer\_NS\_LCM) from VAL server, the NSCE server performs the service operations including subscribing the event which may trigger the management system to do the network slice lifecycle management, making the network slice lifecycle management recommendation/decision, triggering the network slice lifecycle management operations, notifying the consumer about the network slice information.

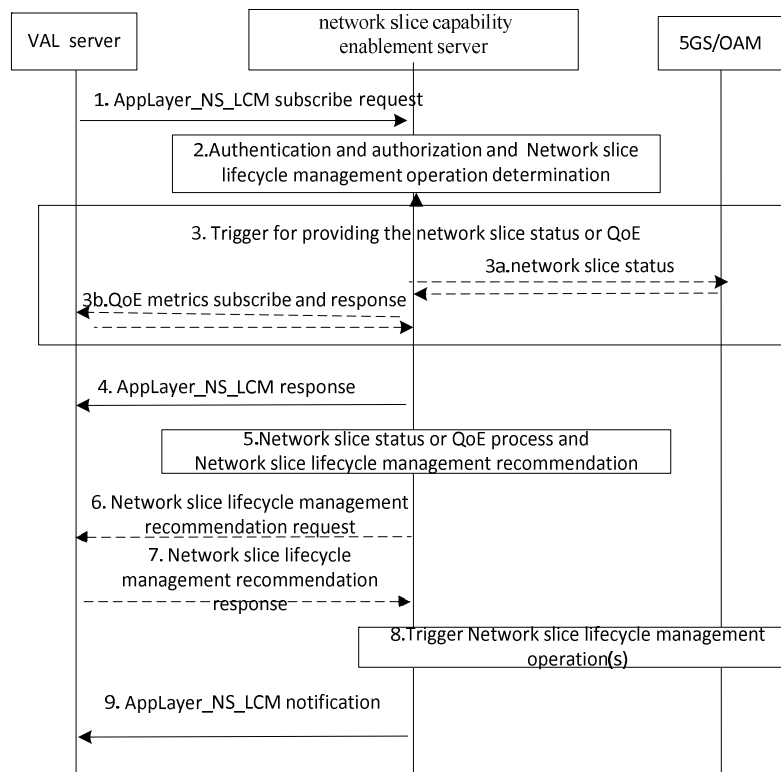
### 9.4.2 Procedure

#### 9.4.2.1 Procedures on slice lifecycle management

Figure 9.4.2.1-1 illustrates a procedure of application layer network slice lifecycle management based on network slice related data and QoE collected from application layer.

Pre-conditions:

1. The NSCE server has authenticated and authorized to the capabilities to collect current network slice from 5GS.
2. The NSCE server has authenticated and authorized to the capabilities trigger the network slice LCM operations.
3. There is signed contract for LCM between the entities using VAL server and entities using NSCE.



**Figure 9.4.2.1-1: Application layer network slice lifecycle management**

1. The VAL server sends the application layer network slice lifecycle management (AppLayer-NS-LCM) subscribe request to NSCE server, with network slice requirements from VAL server/consumer (e.g. delay, throughput, load, the maximum number of users supported, etc.). The request can indicate whether the notification is needed before performing the AppLayer-NS-LCM. The request can also indicate the trigger conditions, such as by providing the monitored parameters and the corresponding thresholds as described in clause 9.4.3.2.
2. After receiving the request, the NSCE server checks that the user is authenticated and authorized to perform the corresponding AppLayer-NS-LCM operations, and filters the unauthorized requests, if any.
3. According to network slice requirements and/or the trigger conditions, NSCE server triggers the provision of network slice status and QoE metrics. If the trigger conditions are not indicated in the subscription, the NSCE server can help to configure an appropriate trigger condition, such as report period or thresholds.
- 3a. The network slice status could be collected through subscribing or requesting to 5GS. List of network slice status parameters to be collected are:
  - Network Slice load statistics information, and/or Network Slice load predictions information from NWDAF/NEF as defined in TS 23.288 Table 6.3.3A.
  - Performance metric in the performance data file from OAM as defined in clause 11.3 of TS 28.532 [7].
- 3b. Also, the NSCE server could get the information of QoE metrics from the application layer domain by QoE metric subscribe as described in clause 9.4.3.5.
4. Once authenticated and authorized, the NSCE server sends the AppLayer-NS-LCM response to the VAL server.
5. The NSCE server may process and combine the collected network slice status and QoE metrics, if needed. The NSCE server may process and combine the parameters in the trigger conditions, if multiple trigger conditions were provided. Once the trigger condition or the combination of trigger conditions are met which indicating the network slice requirements from VAL server is not satisfied, the NSCE server determines whether and what network slice LCM operations should be taken based on requirements from VAL server/consumer and network slice status and QoE metrics, and makes the decision(s)/recommendation(s), such as modifyNsi/AllocateNsi/DeallocateNsi request as specified in TS 28.531 [8].



6. Optionally, if it is indicated in the request to notify the VAL server/consumer before performing the AppLayer-NS-LCM, the NSCE sends the network slice LCM recommendation(s) with network slice information to VAL server, to see whether takes the recommendation(s) or not.
7. Optionally, the VAL server sends the response to NSCE server.
8. Based on decision made by VAL server or NSCE server, the NSCE server sends the network slice LCM request to the OAM.
9. According to the corresponding operation(s) result, the NSCE server sends the response to the VAL server.

### 9.4.3 Information flows

#### 9.4.3.1 General

The following information flows are specified for AppLayer\_NS\_LCM:

- AppLayer\_NS\_LCM subscribe, response and notification;
- QoE metrics subscribe, response and notification;
- Network slice LCM recommendation request and response;

#### 9.4.3.2 Application layer network slice lifecycle management subscribe request

Table 9.4.3.2-1 describes information elements for the application layer network slice lifecycle management subscribe request from the VAL server to the NSCE server.

**Table 9.4.3.2-1: AppLayer-NS-LCM Subscribe**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. VAL server ID).
Security credentials	M	Security credentials resulting from a successful authorization for the NSCE service.
Service requirement	M	The VAL application requirements pertaining to the slice as defined in table 9.1.1.1-1
AppLayer-NS-LCM notification indication	M	Indicates whether to notify the VAL server/consumer about the AppLayer-NS-LCM
>AppLayer-NS-LCM notification address (see NOTE)	O	The address (e.g. URL) of the consumer that can receive the AppLayer-NS-LCM notification
Trigger condition	O	Indicates the monitored parameters and the corresponding thresholds which could trigger the AppLayer-NS-LCM.  The supported trigger conditions are: - The Network Slice load exceeds the threshold. - The collected Network Slice performance exceeds the threshold; - The collected QoE exceeds the threshold.
Proposed expiration time	O	Proposed expiration time for the subscription
NOTE: When the AppLayer-NS-LCM recommendation notification is needed, AppLayer-NS-LCM notification indication should be provided.		

#### 9.4.3.3 Application layer network slice lifecycle management response

The information elements specified in the Table 9.4.3.3-1 is used for the application layer network slice lifecycle management response sent from the NSCE server to the VAL server.

**Table 9.4.3.3-1: AppLayer-NS-LCM Response**

Information element	Status	Description
Result	M	Indicates that the success or failure.
> Cause	O (see NOTE)	Indicates the cause of AppLayer-NS-LCM request failure
NOTE: May only be present if the result is failure.		

#### 9.4.3.4 Application layer network slice lifecycle management notification

The information elements specified in the Table 9.4.3.4-1 is used for the application layer network slice lifecycle management notification sent from the NSCE server to the VAL server.

**Table 9.4.3.4-1: AppLayer-NS-LCM Notification**

Information element	Status	Description
Successful response (see NOTE)	O	Indicates that the AppLayer-NS-LCM request was successful.
>network slice information	M	Network slice information (i.e. NEST) with network slice identifier(i.e. S-NSSAI)
Failure response (see NOTE)	O	Indicates that the AppLayer-NS-LCM request failed.
> Cause	O	Indicates the cause of AppLayer-NS-LCM request failure
NOTE: One of these IEs shall be present in the message.		

#### 9.4.3.5 QoE metrics subscribe

Table 9.4.3.5-1 describes information elements for the QoE metrics subscribe from the NSCE server to the VAL server.

**Table 9.4.3.5-1: QoE metrics Subscribe**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. NSCE server ID).
Security credentials	M	Security credentials resulting from a successful authorization.
Notification Target Address	O	The Notification Target Address (e.g. URL) where the notifications destined for the requestor should be sent to.
Subscription ID	M	Identifier of the subscription.
Event Filter	M	The associated filter on a network slice to be notified
> Network slice related Identifier(s)	M	Identifier of the interested network slice
> VAL service ID	O	Indicator of the interested application (i.e. App ID)
>QoE type indicator	M	QoE metric type including latency, throughput, jitter, etc.
Event Reporting information	M	Information indicates how the notification is supposed to be sent, threshold based or the notification is periodical or the Immediate reporting is requested
>Threshold	O	Threshold of QoE metrics
>Reporting period	O	Indicating the metrics reporting period
>Immediate reporting flag	O	Indicating the request needs immediate reporting or not
Proposed expiration time	O	Proposed expiration time for the subscribe

### 9.4.3.6 QoE metrics response

Table 9.4.3.6-1 describes the information elements for the QoE metrics response from the VAL server to the NSCE server.

**Table 9.4.3.6-1: QoE metrics Response**

Information element	Status	Description
Result	M	Indicates the success or failure of the QoE metrics request.
> Subscription ID	O (see NOTE1)	Subscription identifier corresponding to the subscription.
>QoE metrics report	O (see NOTE2)	List of result values for the observed or computed QoE metrics value if the immediate reporting is needed.
> Cause	O (see NOTE3)	Indicates the cause of QoE metrics request failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: May only be present if the result is success.		
NOTE 3: May only be present if the result is failure.		

### 9.4.3.7 QoE metrics notification

Table 9.4.3.7-1 describes the information elements for the QoE metrics notification from the VAL server to the NSCE server.

**Table 9.4.3.7-1: QoE metrics Notify**

Information element	Status	Description
Subscription ID	M	Indicates that the QoE metrics request was successful.
QoE metrics report	M	List of result values for the observed or computed QoE metrics value.

### 9.4.3.8 Network slice LCM recommendation request

Table 9.4.3.8-1 describes information elements for the Network slice LCM recommendation request from the NSCE server to the VAL server.

**Table 9.4.3.8-1: Network slice LCM recommendation Request**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. NSCE server ID).
Security credentials	M	Security credentials resulting from a successful authorization.
Network slice LCM recommendation	M	Recommended network slice lifecycle management operation
> Network slice related Identifier(s)	M	Identifier of the network slice
>Recommend network slice LCM action	M	Recommend network slice LCM action(i.e. modifying the configuration, allocating a network slice)
>Network slice information	O	Network slice information if the action is taken(i.e. NEST)

### 9.4.3.9 Network slice LCM recommendation response

Table 9.4.3.9-1 describes the information elements for the Network slice LCM recommendation response from the VAL server to the NSCE server.

**Table 9.4.3.9-1: Network slice LCM recommendation Response**

Information element	Status	Description
Result	M	Indicates that the Network slice LCM recommendation request was accepted or not.
> Cause	O (see NOTE)	Indicates the cause of failure.
NOTE: May only be present if the result is failure.		

## 9.4.4 APIs

### 9.4.4.1 General

Table 9.4.4.1-1 illustrates the API for application layer network slice lifecycle management.

**Table 9.4.4.1-1: API for application layer network slice lifecycle management**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_AppLayerNSLCM	Subscribe	Subscribe/Response	VAL server
	Notify	Notify	VAL server
SS_NSCE_Val_QoEMetrics	Subscribe	Subscribe/Response	NSCE
	Notify	Notify	NSCE
SS_NSCE_Val_NSLCMRecommendation	Subscribe	Subscribe/Response	NSCE

#### 9.4.4.2 SS\_NSCE\_AppLayerNSLCM\_Subscribe operation

**API operation name:** AppLayerNSLCM\_Request

**Description:** The consumer subscribes for AppLayer\_NS\_LCM.

**Inputs:** See clause 9.4.3.2.

**Outputs:** See clause 9.4.3.3.

See clause 9.4.2 for details of usage of this operation.

#### 9.4.4.3 SS\_NSCE\_AppLayerNSLCM\_Notify operation

**API operation name:** AppLayerNSLCM\_Notify

**Description:** The consumer is notified with result of AppLayer\_NS\_LCM.

**Inputs:** See clause 9.4.3.4.

**Outputs:** None

See clause 9.4.2 for details of usage of this operation.

#### 9.4.4.4 SS\_NSCE\_Val\_QoEMetrics\_Subscribe operation

**API operation name:** QoEMetrics\_Subscribe

**Description:** The consumer subscribes for the QoE metrics.

**Inputs:** See clause 9.4.3.5.

**Outputs:** See clause 9.4.3.6.

See clause 9.4.2 for details of usage of this operation.

### 9.4.4.5 SS\_NSCE\_Val\_QoEMetrics\_Notify operation

**API operation name:** QoEMetrics\_Notify

**Description:** The consumer is notified with the QoE metrics.

**Inputs:** See clause 9.4.3.7.

**Outputs:** None

See clause 9.4.2 for details of usage of this operation.

### 9.4.4.6 SS\_NSCE\_Val\_NSLCMRecommendation\_Request operation

**API operation name:** NSLCMRecommendation\_Request

**Description:** The consumer request for whether to take the recommendation of the AppLayer\_NS\_LCM.

**Inputs:** See clause 9.4.3.8.

**Outputs:** See clause 9.4.3.9.

See clause 9.4.2 for details of usage of this operation.

## 9.5 Network slice optimization based on VAL server policy

### 9.5.1 General

Based on policy from the vertical applications (e.g., to trigger some network slice operations when the pre-configured thresholds are met), the network slice parameters for the vertical applications could be optimized by triggering the slice modification. The slice optimization can be triggered by OAM, data/prediction retrieved from NWDAF via NEF, and NSCE server itself as describe in 9.5.2.2.

### 9.5.2 Procedure

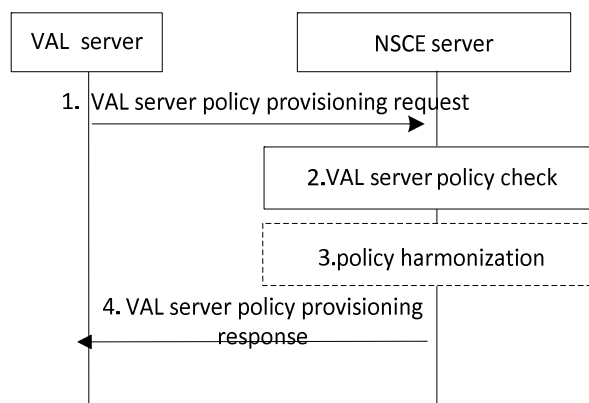
#### 9.5.2.1 VAL server policy management

##### 9.5.2.1.1 VAL server policy provisioning

Figure 9.5.2.1.1 illustrates the procedure of VAL server policy provisioning from the VAL server to the NSCE server.

Pre-conditions:

1. The NSCE server has information about the existing slice/slice profile/slice services which VAL server is using.



**Figure 9.5.2.1.1: VAL server policy provisioning**

1. VAL server sends VAL server policy provisioning request to NSCE server. The request contains the policy, VAL server ID, Default policy indication, and S-NSSAI. Optionally, the request contains the indicator of policy harmonization.

The VAL server can request the NSCE server to mark the provisioned policy as the default policy using the Default policy indication. The default policy should serve as a VAL server policy for the slices provisioned without any policy. Either the policy or default policy indication can be provided by the VAL server.

The VAL server policy is in form of a policy profile which contains list of trigger events associated with the parameters and expected actions. It contains priority and scheduling information with pre-emption capability for the policies. The scheduling information schedules the policy by defining the schedule (start and end time) for the policy. The pre-emption capability provides another, already successfully provisioned policy to pre-empt the scheduled policy in the scheduled period.

The supported policies are:

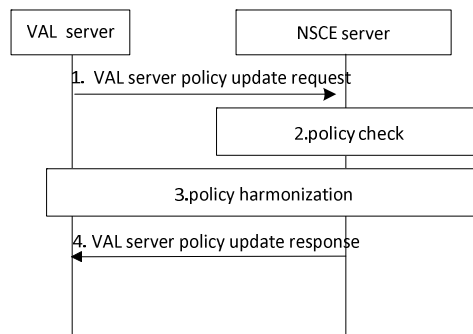
- Based on monitored performance metric from OAM, when the max number of PDU sessions or max number of UE is reached, trigger the slice modification with expected parameters.
  - Based on monitored Network Slice load from NSACF, when the number of PDU sessions or number of UE exceeds the threshold, trigger the slice modification with expected parameters.
  - Based on monitored Network Slice load predictions from NWDAF, when Network Slice load predictions (Predicted Number of PDU Session establishments at the Network Slice) exceeds the threshold with high confidence, trigger the slice modification with expected parameters.
  - Based on the monitored the time period, when getting to a certain time period (e.g. summer vacation, spring festival etc.), trigger the slice modification with expected parameters.
  - Based on the monitored time period, when getting to a certain time period, trigger the slice modification based on the expected QoS per UE. QoS is mapped/calculated by NSCE to specific parameters of the slice such as the dLThptPerUE, uLThptPerUE, dLThptPerSliceSubnet, uLThptPerSliceSubnet, delayTolerance, dLLatency, uLLatency.
2. The NSCE server checks whether the policy is conflict with the MNO policies or NSPP. One criterion is to translate the network slice parameters in the service profile to see whether it is conflict with that in the VAL provided policy. If policy harmonization is not requested and policies conflict then the request could be rejected. The NSCE server also checks the validity of the policy (policy is valid for the specified time period or until the specified threshold count of trigger events is achieved) to avoid a ping-pong effect of slice modification. If the policy is invalid, the request could be rejected.
  3. If the policy harmonization is requested, the NSCE server can harmonize the policy as per clause 9.5.2.1.4 and this may result in the changes to the current VAL server policy under provisioning.
  4. NSCE server sends the VAL server policy provisioning response to the VAL server to indicate whether the request is successful or not. If it is successful, policy ID is provided to VAL server.

#### 9.5.2.1.2 VAL server policy Update

Figure 9.5.2.1.2-1 illustrates the VAL server policy update procedure.

Pre-conditions:

1. The NSCE server has information about the existing slice/slice profile/slice services that the VAL server is using.
2. The VAL server has created policies in NSCE server using the procedure defined in clause 9.5.2.1.1.



**Figure 9.5.2.1.2-1: VAL server policy update**

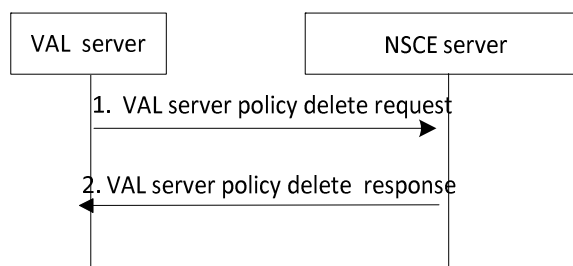
1. VAL server sends VAL server policy update request to NSCE server. The request shall contain the policy ID and policy modification details for updating the policy in the NSCE server. The request can update the existing default policy or specify a new default policy for the mentioned slice in the request. The policy update procedure can update the scheduling and pre-emption information for the policy.
2. The NSCE server checks whether the policy is conflict with the MNO policies or NSPP.
3. If authorized, the NSCE server can harmonize the policy as per clause 9.5.2.1.4 and this may result in the changes to the current VAL server policy under update process.
4. If the VAL server is authorized to update the VAL server policy, the NSCE server checks the modification with existing policies to avoid conflict and provides the response to the VAL server.

### 9.5.2.1.3 VAL server policy Delete

Figure 9.5.2.1.3-1 illustrates the VAL server policy delete procedure.

Pre-conditions:

1. The NSCE server has information about the existing slice/slice profile/slice services that the VAL server is using.
2. The VAL server has created one or more policies in NSCE server using the procedure defined in clause 9.5.2.1.1.



**Figure 9.5.2.1.3-1: VAL server policy delete**

1. VAL server sends VAL server policy delete request to NSCE server. The request contains the policy ID, and optionally default policy indication. The default policy indicates the update of the default policy in the case of a delete request for the default policy. The policy delete procedure can be used to delete one or more policies.
2. If the VAL server is authorized to delete the VAL server policy, the NSCE server deletes the policy. In the case of a default policy delete request, the NSCE server first updates the default policy with the policy mentioned in the delete request and then deletes the old default policy. The NSCE server reports the outcome of the deletion of the requested policy with policy ID and priority for the new default policy.

9.5.2.1.4 Policy harmonization

Policy harmonization is to make sure the VAL server Policy (from VAL Provider/ slice customer/ASP) is compatible with the MNO policies and NSCE service provider policy for the same service or slice. The policy harmonization could be requested through the policy provisioning/update service.

Figure 9.5.2.1.4-1 illustrates the procedure for policy harmonization.

Pre-conditions:

1. The NSCE service provider policy (NSPP) and MNO policy is available at the NSCE Server.
2. The VAL server is authorized to receive NSCE services.

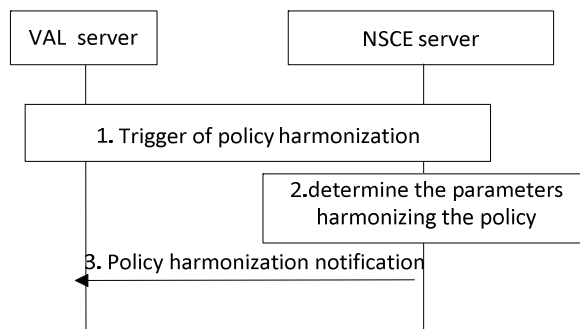


Figure 9.5.2.1.4-1: Policy harmonization

1. When receiving the policy provisioning, or policy update request, and the result of policy check turn out the policy is conflict, the policy harmonization is triggered.
2. The NSCE server determines parameters harmonizing the policy, if previously authorized.
3. NSCE server sends the VAL server a notification providing parameters values that allow the policies to be harmonized. Then the VAL server would decide whether to accept the provided optional parameters values. If they are accepted, the VAL server may invoke VAL server policy provisioning/ VAL server policy update procedure defined in clause 9.5.2.1.1, 9.5.2.1.2 with harmonized parameters values.

9.5.2.1.5 VAL server policy Usage Reporting data

Figure 9.5.2.1.5-1 illustrates the VAL server policy usage reporting data procedure.

Pre-conditions:

1. The NSCE server has information about the existing slice/slice profile/slice services which VAL server is using.
2. The VAL server has created one or more policies using in the NSCE server the procedure defined in clause 9.5.2.1.1.

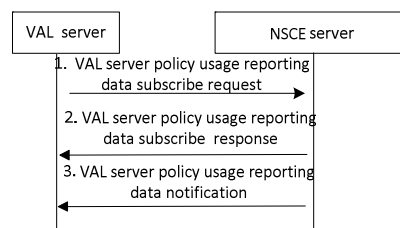


Figure 9.5.2.1.5-1: VAL server policy usage reporting data

1. VAL server sends VAL server policy usage reporting data subscribe request to NSCE server. The request contains the policy ID, reporting interval, and the required duration of the data.



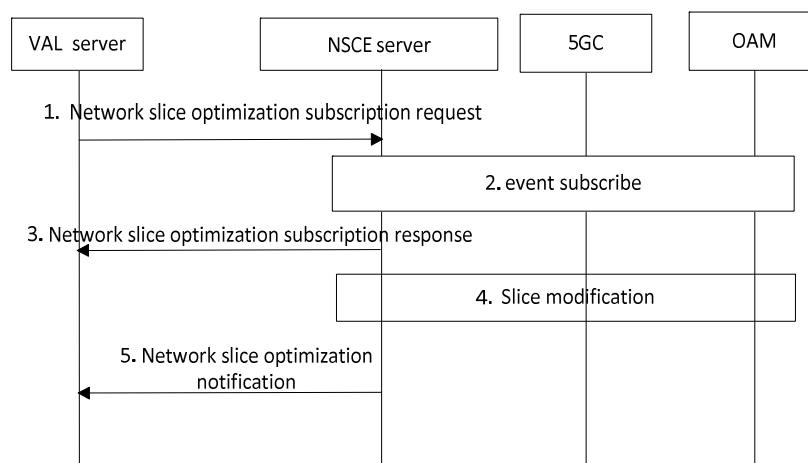
2. The NSCE server responds with a VAL server policy usage reporting data subscribe response message indicating the success or failure of the subscription.
3. The NSCE server reports the policy reporting data containing the number of times the policy has been used and the duration for which the policy was active in the requested duration and details of the preemption of policies. The reporting interval enables the periodic reporting of the requested report.

### 9.5.2.2 Network slice optimization based on VAL server policy

Figure 9.5.2.2-1 illustrates the procedure of network slice optimization based on VAL server policy.

Pre-conditions:

1. The NSCE server is authorized to get network slice management data notification from OAM, and/or NWDAF via NEF.
2. The VAL server is authorized to the NSCE server for network slice optimization.
3. There is enough network capacity when the expected action is to expand the network slice.
4. The VAL server policy has been pre-configured on the VAL server.
5. The VAL server policy has been provided to the NSCE server as specified in clause 9.5.2.1.



**Figure 9.5.2.2-1: Network slice optimization based on VAL server policy**

1. VAL server sends network slice optimization subscription request to NSCE server. The request contains the policy ID indicating the different policies. Optionally the request contains the Secondary policy ID indicating the fallback policy to be used for the failed network slice optimization. The NSCE server retries the network slice optimization using a Secondary policy in the case of a failed optimization.
2. The NSCE server translates the trigger event to service API(s) with necessary parameters, and subscribe to the related service if needed.
  - To get the monitored performance metric from OAM, the notifyThresholdCrossing as defined in TS 28.532[7] clause 11.3.1.3 which is filled in with corresponding S-NSSAI in objectInstance could be used.
  - To obtain the Network Slice load predictions from NWDAF, the NSCE server subscribes to the NWDAF prediction by invoking Nnef\_AnalyticsExposure\_Subscribe or Nnef\_AnalyticsExposure\_Fetch as defined in TS 23.288[4] clauses 6.1.1.2, and 6.1.1.2.
  - To monitor the Network Slice load (e.g. the number of UEs or the number of PDU Sessions) from NSACF, the NSCE server subscribes to the NSACF by using the Nnef\_EventExposure\_Subscribe Request or Nnsacf\_SliceEventExposure\_Subscribe\_Request as defined in clause 4.15.3.2.10 of TS 23.502 [12], and the APIs defined in clause 6.2 of TS 29.536 [13] can be utilized.
  - To monitor the time period, the NSCE server setup the timer.

3. NSCE server sends the network slice optimization subscription response to the VAL server to confirm the subscription of network slice optimization.
4. Upon receiving the notification which indicating the trigger event is met, i.e., the monitored information reaches the threshold or specific time period is arrived, the NSCE server performs the expected action by triggering the slice modification as specified in the VAL server policy. The network slice modification could be triggered by consuming the Network Slice Provisioning service with the modifyMOIAttributes operation as specified in TS 28.531 [8]. The OAM responds back to NSCE server that the requested slice modification was successful or not. The slice modification requests contain the parameters need to be updated to fit the requirement of network slice (e.g., scale in or scale out the network slice capability), including at least one of the following, uLThptPerSlice, dLThptPerSlice, dLThptPerUE, uLThptPerUE, dLThptPerSliceSubnet, uLThptPerSliceSubnet, delayTolerance, dLLatency, uLLatency, maximum number of UEs, maximum number of PDU session as specified in TS 28.541 [10].

NOTE 1: The slice modification could be done by application layer network slice lifecycle management as defined in clause 9.4.

5. The NSCE server provides a network slice optimization notification to the VAL server. The successful response optionally includes the Optimization time and the Enforced policy ID. The optimization time indicates the time the NSCE server has taken to optimize the slice. The Enforced policy ID indicates which secondary policy is used by the NSCE server for slice optimization in the case of a failed attempt for network slice optimization.

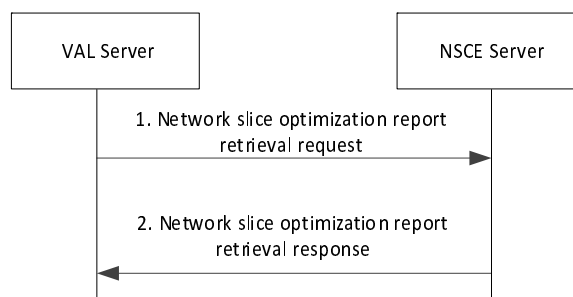
NOTE 2: There is no expectation to have constant and exact mapping between slice configuration parameters and actual traffic load of the same slice.

### 9.5.2.3 Network slice optimization report retrieval

Figure 9.5.2.3-1 illustrates the Network slice optimization report retrieval procedure.

Pre-conditions:

1. The NSCE server has information about the existing slice/slice profile/slice services that the VAL server is using.
2. The VAL server has the created policies using the procedure defined in clause 9.5.2.1.1.
3. The VAL server has subscribed for the network slice optimization using the procedure defined in clause 9.5.2.2.



**Figure 9.5.2.3-1: Network slice optimization report retrieval**

1. The VAL server sends a Network slice optimization report request to the NSCE server. The request shall contain the subscription ID, optimization result window, and optional elements like optimization result filters, sorting rules, and result size. The VAL server creates a filter using the optimization result filter for the NSCE server requesting filtered successful or failed responses. The VAL server can create additional sorting rules for the NSCE server to request sorted results based on optimization time or policy ID or slice optimization event time in ascending or descending order. The result size indicates the number of results or responses for the report.
2. The NSCE server provides the report to the VAL server as per the request of the VAL server containing optimization response, optimization time, policy ID, and Enforced Policy information.

## 9.5.3 Information flows

### 9.5.3.1 General

The following information flows are specified:

- VAL server policy provisioning request and response;
- Network slice optimization subscription, response and notification;
- VAL server policy update request and response;
- VAL server policy delete request and response;
- VAL server policy usage reporting data subscribe request, response, and notification; and
- Network slice optimization report retrieval request and response.
- Policy harmonization notify.

### 9.5.3.2 VAL server policy provisioning request

Table 9.5.3.2-1 describes information elements for the VAL server policy provisioning request from the VAL server to the NSCE server.

**Table 9.5.3.2-1: VAL server policy provisioning Request**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. VAL server ID).
Security credentials	M	Security credentials resulting from a successful authorization.
Network slice related Identifier(s)	O	Identifier of the network slice.
Requested DNN	O	Indication of the DNN which is requested.
Indicator of policy harmonization	O	Indicating whether the policy harmonization is requested.
Policy	O	The policy profile is defined in Table 9.5.3.2-2. The supported VAL server policies are listed in Table 9.5.3.2-3 to Table 9.5.3.2-5.
Default policy indication	O	Indicates the policy in the request to mark as a default policy for slices provisioned without any policy.

Table 9.5.3.2-2 describes Policy profile of the VAL server policy provisioning request.

**Table 9.5.3.2-2: Policy profile**

Information element	Status	Description
Policy	O	The name of VAL server policy.
>Area of interest	M	The service area for which the policy profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
>Trigger event	M	Indicating the event that should be monitored, associated with the threshold of the monitored parameter.
>Expected action	M	Indicating the expected actions associated with the updated parameter.
Lifetime or number of events	M	Time duration or number of times the policy can take action.
Priority	O	Indicates the priority of the policy.
Scheduling period	O	Indicates the scheduling of policy in terms of time.
>Start time	M	Indicates the scheduled start time.
>End time	M	Indicates the scheduled end time.
Preemption	O	Indicates the pre-empt capability of the policy.

Table 9.5.3.2-3 to Table 9.5.3.2-6 list the supported policies.

**Table 9.5.3.2-3: Policy of Max number of PDU sessions/ max number of UEs**

Information element	Status	Description
Policy	O	Max number of PDU sessions/ max number of UEs
>Area of interest	M	The service area for which the policy profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
>Trigger event	M	Threshold information, i.e. reached utilization of available capacity in (%), or number of PDU sessions request/ UEs reached the threshold
>Expected action	M	Modification of PDU sessions / max number of UEs (step for increase in %)
Lifetime or number of events	M	Time duration or number of times the policy can take action.
Priority	O	Indicates the priority of the policy.
Scheduling period	O	Indicates the scheduling of policy in terms of time.
>Start time	M	Indicates the scheduled start time.
>End time	M	Indicates the scheduled end time.
Preemption	O	Indicates the pre-empt capability of the policy.

**Table 9.5.3.2-4: Policy of Network slice load prediction**

Information element	Status	Description
Policy	O	Network slice load prediction
>Area of interest	M	The service area for which the policy profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
>Trigger event	M	Network Slice load predictions information from NWDAF as defined in TS 23.288 [4] clause 6.1.1 (exceeding utilization of available capacity in %)
>Expected action	M	Modification of related network slice parameters (step for increase in %)
Lifetime or number of events	M	Time duration or number of times the policy can take action.
Priority	O	Indicates the priority of the policy.
Scheduling period	O	Indicates the scheduling of policy in terms of time.
>Start time	M	Indicates the scheduled start time.
>End time	M	Indicates the scheduled end time.
Preemption	O	Indicates the pre-empt capability of the policy.

**Table 9.5.3.2-5: Policy of Time period and average QoS per UE**

Information element	Status	Description
Policy	O	Time period and average QoS per UE
>Area of interest	M	The service area for which the policy profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
>Trigger event	M	Time/day configuration where specific network slice capacity /QoS per UE is expected, average QoS per UE requested
>Expected action	M	Modification of slice capacity to the requested needs
Lifetime or number of events	M	Time duration or number of times the policy can take action.
Priority	O	Indicates the priority of the policy.
Scheduling period	O	Indicates the scheduling of policy in terms of time.
>Start time	M	Indicates the scheduled start time.
>End time	M	Indicates the scheduled end time.
Preemption	O	Indicates the pre-empt capability of the policy.

**Table 9.5.3.2-6: Policy of needed minimum QoS per UE**

Information element	Status	Description
Policy	O	Minimum QoS per UE
Area of interest	M	The service area for which the policy profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
>Trigger event	M	Time/day where minimum QoS per UE is expected, minimum QoS per UE requested
>Expected action	M	Modification of slice capacity to have the needed QoS per UE
Lifetime or number of events	M	Time duration or number of times the policy can take action.
Priority	O	Indicates the priority of the policy.
Scheduling period	O	Indicates the scheduling of policy in terms of time.
>Start time	M	Indicates the scheduled start time.
>End time	M	Indicates the scheduled end time.
Preemption	O	Indicates the pre-empt capability of the policy.

### 9.5.3.3 VAL server policy provisioning response

Table 9.5.3.3-1 describes the information elements for the VAL server policy provisioning response from the NSCE server to the VAL server.

**Table 9.5.3.3-1: VAL server policy provisioning Response**

Information element	Status	Description
Result	M	Indicates the success or failure of the VAL server policy provisioning request.
> Policy ID	O (see NOTE1)	Identifies the provided policy.
> Cause	O (see NOTE2)	Indicates the cause of VAL server policy provisioning request failure.
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise.		

### 9.5.3.4 VAL server policy update request

Table 9.5.3.4-1 describes the information elements for the VAL server policy update request from the VAL server to the NSCE server.

**Table 9.5.3.4-1: VAL server policy update request**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. VAL server ID).
Requested slice information	M	Indication of the slice which is requested.
Policy ID	M	Identifies the provided policy.
Policy modification details (see NOTE)	O	Describe the details for the policy update. The policy profile is defined in Table 9.5.3.2-2. The supported VAL server policies are listed in Table 9.5.3.2-3 to Table 9.5.3.2-5.
Priority (see NOTE)	O	Indicates the priority of the policy.
Default policy indication (see NOTE)	O	Indicates the default policy for slices provisioned without any policy.
NOTE: At least one of these information elements shall be present.		

### 9.5.3.5 VAL server policy update response

Table 9.5.3.5-1 describes the information elements for the VAL server policy update response from the NSCE server to the VAL server.

**Table 9.5.3.5-1: VAL server policy update response**

Information element	Status	Description
Result	M	Indicates the success or failure of the VAL server policy update request.
>Policy ID	O (see NOTE 1)	Identifies the provided policy.
>Updated Default policy indication	O (see NOTE 2)	Indicates the update of default policy.
>Cause	O (see NOTE 3)	Indicates the cause of the failure.
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: May only be present if the result is success.		
NOTE 3: May only be present if the result is failure.		

### 9.5.3.6 VAL server policy delete request

Table 9.5.3.6-1 describes the information elements for the VAL server policy delete request from the VAL server to the NSCE server.

**Table 9.5.3.6-1: VAL server policy delete request**

Information element	Status	Description
Policy ID	M	Identifies the provided policy for delete.
Update Default policy indication	O	Indicates the update of default policy.
>Policy ID	M	Identifies the provided policy.

### 9.5.3.7 VAL server policy delete response

Table 9.5.3.7-1 describes the information elements for the VAL server policy delete response from the NSCE server to the VAL server.

**Table 9.5.3.7-1: VAL server policy delete response**

Information element	Status	Description
Result	M	Indicates the success or failure of the VAL server policy delete request.
>Updated default policy	O (see NOTE 1)	Policies with updated priority values.
>>Policy ID	M	Identifies the provided policy.
>>Priority	O	Indicates the updated priority values.
>Cause	O (see NOTE 2)	Indicates the cause of the failure.
NOTE 1: May only be present if the result is success.		
NOTE 2: May only be present if the result is failure.		

### 9.5.3.8 VAL server policy usage reporting data subscribe request

Table 9.5.3.8-1 describes information elements for the VAL server policy usage reporting data subscribe request from the VAL server to the NSCE server.

**Table 9.5.3.8-1: VAL server policy usage reporting data subscribe request**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. VAL server ID).
Requested slice information	M	Indication of the slice which is requested.
Requested policy reporting data	M	Indicates the request for policy reporting data.
>Policy ID	M	Identifies the provided policy.
>Start time	M	Indicates start time for the policy reporting data.
>End time	M	Indicates end time for the policy reporting data.
Reporting interval	O	Indicates the policy report data reporting interval.

### 9.5.3.9 VAL server policy usage reporting data subscribe response

Table 9.5.3.9-1 describes information elements for the VAL server policy usage reporting data subscribe response from the NSCE server to the VAL server.

**Table 9.5.3.9-1: VAL server policy usage reporting data subscribe response**

Information element	Status	Description
Result	M	Indicates the success or failure of the VAL server policy usage reporting data subscribe request.
>Subscribe ID	O (see NOTE 1)	Identifies the VAL server policy reporting subscribe event.
>Cause	O (see NOTE 2)	Indicates the cause of the failure.
NOTE 1: Shall be present if the result is success and shall not be present otherwise		
NOTE 2: May only be present if the result is failure.		

### 9.5.3.10 VAL server policy usage reporting data notification

Table 9.5.3.10-1 describes information elements for the VAL server policy usage reporting data notification from the NSCE server to the VAL server.



**Table 9.5.3.10-1: VAL server policy usage reporting data notification**

Information element	Status	Description
Subscribe ID	M	Identifies the VAL server policy usage reporting subscribe request.
Policy reporting data	M	Indicates the requested VAL server policy reporting data.
>Policy ID	M	Identifies the provided policy.
>Policy count	M	Indicates the number of times the policy is active.
>Policy time spent	M	Indicates the duration for usage of policy.
>Pre-empt count	O	Indicates the number of times the policy is preempt with another policy.
>Pre-empt policy ID	O	Indicates the policy used for pre-emption.

### 9.5.3.11 Network slice optimization subscription request

Table 9.5.3.11-1 describes information elements for the Network slice optimization subscription request from the VAL server to the NSCE server.

**Table 9.5.3.11-1: Network slice optimization subscription request**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. VAL server ID).
Security credentials	M	Security credentials resulting from a successful authorization for the NSCE service.
Notification Target Address	O	The Notification Target Address (e.g. URL) where the notifications destined for the requestor should be sent to.
Network slice related Identifier(s)	O	Identifier of the network slice.
Requested DNN	O	Indication of the DNN which is requested.
Policy ID	O	Identifies the VAL server policy.
Proposed expiration time	O	Proposed expiration time for the subscription.
Secondary policy ID	O	Secondary policy act as a fallback policy for the network slice optimization in the case of a failed network slice optimization.

### 9.5.3.12 Network slice optimization subscription response

The information elements specified in the table 9.5.3.12-1 is used for the Network slice optimization subscription response sent from the NSCE server to the VAL server.

**Table 9.5.3.12-1: Network slice optimization subscription Response**

Information element	Status	Description
Result	M	Indicates the success or failure of the Network slice optimization subscription request.
> Subscribe ID	O (see NOTE 1)	Identifies the Network slice optimization subscribe event.
> Cause	O (see NOTE 2)	Indicates the cause of Network slice optimization subscription request failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise.		

### 9.5.3.13 Network slice optimization notification

The information elements specified in the table 9.5.3.13-1 is used for the Network slice optimization notification sent from the NSCE server to the VAL server.

**Table 9.5.3.13-1: Network slice optimization Notification**

Information element	Status	Description
> Subscribe ID	M	Identifies the Network slice optimization subscribe event.
>Network slice information	M	Network slice information (i.e. NEST) with network slice identifier(i.e. S-NSSAI)
>Optimization time	O	Indicates time spent for slice optimization by the NSCE Server.
>Enforced policy ID	O	Indicates the policy used for slice optimization in the case of the failed network slice optimization.
NOTE: One of these IEs shall be present in the message.		

### 9.5.3.14 Network slice optimization report retrieval request

Table 9.5.3.14-1 describes information elements for the Network slice optimization report retrieval request from the VAL server to the NSCE server.

**Table 9.5.3.14-1: Network slice optimization report retrieval request**

Information element	Status	Description
Subscribe ID	M	Identifies the Network slice optimization subscribe event.
Optimization result filter	O	Filter for network slice optimization responses (successful or failure). The default value is successful responses.
Optimization result sort	O	Sort optimization results based on slice optimization event time or optimization time, or policy ID. The default value is Optimization time.
>Sort type	O	Indicate sort type (ascending or descending). The default value is ascending.
>Optimization result size	O	Indicate the number of results of network slice optimization responses. The default value is 1.
Optimization result window	M	Indicates the time duration window for the report.
>Start time	M	Indicates the start time for generating the report.
>End time	M	Indicates the end time to finish the capture of the report.

### 9.5.3.15 Network slice optimization report retrieval response

Table 9.5.3.15-1 describes information elements for the Network slice optimization report retrieval response from the NSCE server to the VAL server.

**Table 9.5.3.15-1: Network slice optimization report retrieval response**

Information element	Status	Description
Optimization report results	M	Report results based on the network slice optimization request.
>Subscribe ID	M	Identifies the Network slice optimization subscribe event.
>Optimization response	M	Indicates network slice optimization response as per the filter in the request.
>Optimization time	M	Indicates time spent for slice optimization by the NSCE Server.
>Policy ID	O	Identifies the VAL server policy.
>Enforced policy ID	O	Indicates the policy used for slice optimization in the case of the failed network slice optimization.

### 9.5.3.16 Policy harmonization subscribe notify

Table 9.5.3.16-1 describes information elements for the Policy harmonization subscribe notify from the NSCE server to the VAL server.

**Table 9.5.3.16-1: Policy harmonization subscribe notify**

Information element	Status	Description
Policy ID	M	Identifies of the harmonized policy.
>harmonized policy	M	Pairs of policy attribute and harmonized parameter

## 9.5.4 APIs

### 9.5.4.1 General

Table 9.5.4.1-1 illustrates the API for Network slice optimization based on VAL server policy.

**Table 9.5.4.1-1: Network slice optimization based on VAL server policy**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_PolicyManagement	Policy_Provisioning	Request/Response	VAL server
	Policy_Update	Request/Response	
	Policy_Delete	Request/Response	
	Policy_Usage_Reporting_Data_Subscribe	Subscribe/Notify	
	Policy_Usage_Reporting_Data_Notification		
SS_NSCE_NSOptimization	NS_Optimization_Subscription	Subscribe/Notify	VAL server
	NS_Optimization_Notification		
	NS_Optimization_Report_Retrieval	Request/Response	
SS_NSCE_Policy_harmonization	Policy_harmonization_Notify	Notify	VAL server

#### 9.5.4.2 SS\_NSCE\_Policy\_Provisioning operation

**API operation name:** Policy\_Provisioning\_Request

**Description:** The consumer subscribes for VAL server policy Provisioning.

**Inputs:** See clause 9.5.3.2.

**Outputs:** See clause 9.5.3.3.

See clause 9.5.2.1.1 for details of usage of this operation.

#### 9.5.4.3 SS\_NSCE\_Policy\_Update operation

**API operation name:** Policy\_Update

**Description:** Providing the policy update to the NSCE server.

**Inputs:** Refer subclause 9.5.3.4.

**Outputs:** Refer subclause 9.5.3.5.

See subclause 9.5.2.1.2 for details of the usage of this operation.

#### 9.5.4.4 SS\_NSCE\_Policy\_Delete operation

**API operation name:** Policy\_Delete

**Description:** Requesting policy delete to the NSCE server.

**Inputs:** Refer subclause 9.5.3.6.

**Outputs:** Refer subclause 9.5.3.7.

See subclause 9.5.2.1.3 for details of the usage of this operation.

#### 9.5.4.5 SS\_NSCE\_Policy\_harmonization Notify\_operation

**API operation name:** Policy\_harmonization\_Notify

**Description:** The consumer is notified with result of Policy harmonization .

**Inputs:** See clause 9.5.3.16

**Outputs:** None

See clause 9.5.2.1.4 for details of usage of this operation.

#### 9.5.4.6 SS\_NSCE\_Policy\_Usage\_Reporting\_Data\_Subscribe operation

**API operation name:** Policy\_Usage\_Reporting\_Data\_Subscribe

**Description:** Subscription to the VAL server policy usage reporting data.

**Inputs:** Refer subclause 9.5.3.8.

**Outputs:** Refer subclause 9.5.3.9.

See subclause 9.5.2.1.5 for details of the usage of this operation.

#### 9.5.4.7 SS\_NSCE\_Policy\_Usage\_Reporting\_Data\_Notification operation

**API operation name:** Policy\_Usage\_Reporting\_Data\_Notification

**Description:** VAL server policy usage reporting data notification to the existing subscription.

**Inputs:** Refer subclause 9.5.3.10.

**Outputs:** None

See subclause 9.5.2.1.5 for details of the usage of this operation.

#### 9.5.4.8 SS\_NSCE\_NS\_Optimization\_Report\_Retrieval operation

**API operation name:** NSOptimizationReportRetrieval

**Description:** Providing the network slice optimization report to the VAL server.

**Inputs:** Refer subclause 9.5.3.14.

**Outputs:** Refer subclause 9.5.3.15.

See subclause 9.5.2.3 for details of the usage of this operation.

#### 9.5.4.9 SS\_NSCE\_NSOptimization\_Subscribe Request operation

**API operation name:** Ensce\_NSOptimization\_Subscribe

**Description:** The consumer request for Network Slice Optimization.

**Inputs:** See clause 9.5.3.11.

**Outputs:** See clause 9.5.3.12.

See clause 9.5.2.2 for details of usage of this operation.

#### 9.5.4.10 SS\_NSCE\_NSOptimization\_Notification operation

**API operation name:** Ensce\_NSOptimization\_Notification

**Description:** The consumer is notified with result of Network Slice Optimization.

**Inputs:** See clause 9.5.3.13.

**Outputs:** None

See clause 9.5.2.2 for details of usage of this operation.

## 9.6 Discovery of management service exposure

### 9.6.1 General

A Management Domain (MD) feature/capability is anything of use offered by the management system to the 3<sup>rd</sup> party application. Therefore, a new feature could be a managed entity, a MnS or management API, any software, hardware, or other functionality – for example, new technology support, new coverage area, new network slice type or instance, new NFs or new network slice subnet type or instance. To be able to utilise capabilities/features of the management system the applications must be made aware of existence of such features and capabilities. All MD features/capabilities come with a pre-configured exposure, where this can be configured by the operator for a given slice. This exposure is used to decide which application can see which information regarding the capability/feature. Exposure refers to the permissions that the 3<sup>rd</sup> party entity has gained over its use of the management service, e.g., the ability to read, or execute or modify or delete can be considered as different sorts of exposure.

The first procedure (9.6.2.1) provides the NSCE server support for translating the VAL server request to a MnS requirement and the exposure of service/management data related to his request. The second procedure (9.6.2.2) supports the notification to the VAL server, based on a new/modified MnS / capability for a target slice.

### 9.6.2 Procedure

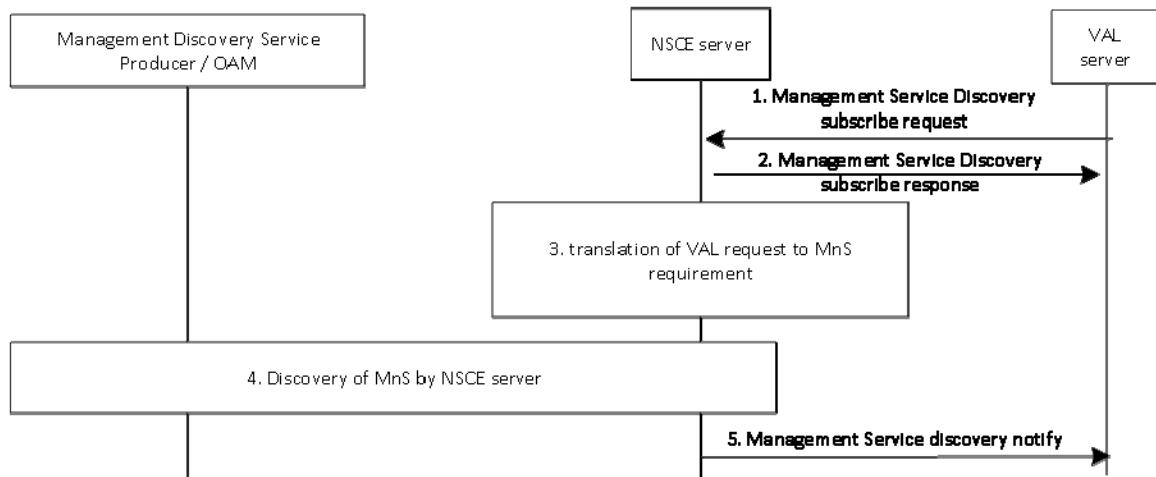
#### 9.6.2.1 VAL-triggered MnS discovery procedure

In this procedure, the VAL server initially requests the new MnS which are supported by a target slice and based on this request the NSCE server requests from the OAM/MnS registry the MnS discovery. Then, the OAM/MnS registry derives the details to be exposed based on the NSCE server/VAL server permissions and provides the list of MnS for the given slice and the access details via the NSCE server to the VAL server.

Pre-conditions:

1. The VAL server has registered to receive NSCE services.
2. The NSCE server is trusted by the OAM, and a contract has been signed between the MNO and NSCE server provider to allow OAM interfaces and/or network slice information exposure.
3. MnS registry at OAM is aware of the allowed MnS and the permissions for a given slice.

Figure 9.6.2.1-1 illustrates a solution for the MnS discovery support.



**Figure 9.6.2.1-1: MnS discovery support**

The steps of this procedure are as follows:

1. The VAL server sends a Management Service Discovery subscribe request message to NSCE server to indicate a requirement for receiving the expected exposure capability type and the related permissions for a target slice or for a given VAL application.
2. The NSCE server sends a response to the subscription request, indicating a success or failure of the subscription request.

NOTE 1: If CAPIF is used, the API interactions for the MnS discovery subscription shall be compliant with CAPIF as specified in 3GPP TS 23.222.

3. The NSCE server translates the requirement based on the subscription, and in particular identifies the needed exposure capability type and translates it to a MnS exposure requirement. Such translation of the requirement includes the mapping to a list of MnSs (specified in TS 28.532) which are needed for the given slice and VAL server permissions.
4. The NSCE server coordinates with the 5GS and discovers the related network service(s), by triggering the MnS service discovery as specified in TS 28.537[9], clause 5.2.1.3. In particular, NSCE server acts as MnS discovery service consumer (for all MnS needed for a target slice based on VAL requirement) requests from MnS discovery service producer(s) at OAM the discovery of MnS information for the MnS related to the target slice or VAL application. The 5GS, MnS discovery service producer(s) sends the discovery result including related exposure information such as management service identifier, management service information and management service producer information to the NSCE server.

NOTE 2: The actual connectivity in step 4 (e.g., exposure of MnS via CAPIF or EGMF) follows the mechanism defined in SA5.

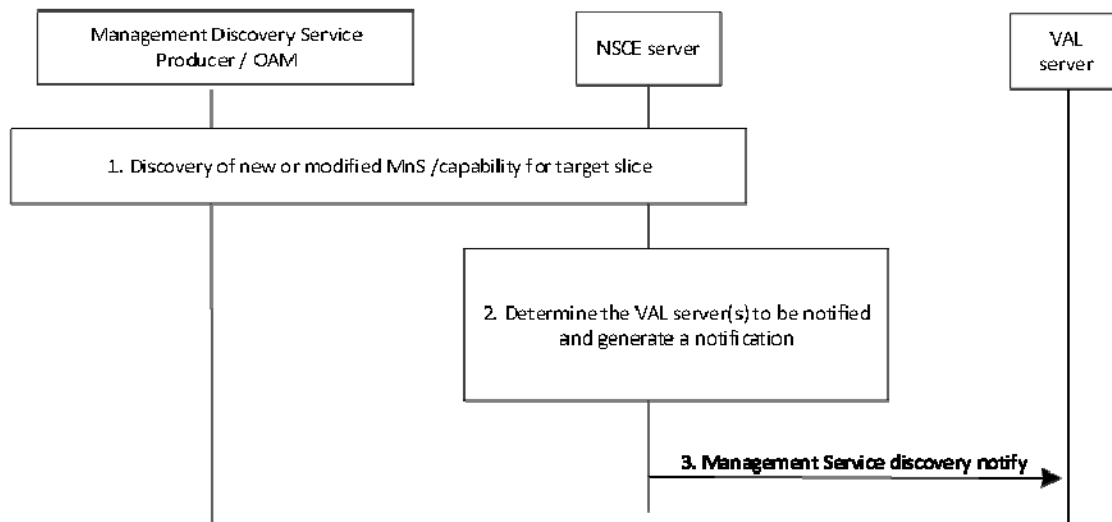
5. The NSCE server sends a management service discovery subscription notify message to provide the service/management data based on step 4, including the list of MnS and the corresponding exposure details to the VAL server.

### 9.6.2.2 OAM-triggered new/modified MnS discovery

This procedure includes the case when a new/modified MnS is deployed at the MD for the given slice, and the OAM/MnS registry provides this information directly to VAL server (assuming that VAL server has registered to the MD).

Pre-conditions:

1. VAL server is registered to NSCE server based on clause 9.2.
2. NSCE server has subscribed to OAM / MnS discovery service registry.



**Figure 9.6.2.2-1: OAM-triggered new/modified MnS discovery**

1. The MnS registry may discover new or modified MnS in the 3GPP MD. Such changes may be due to new/modified management service producers, new managed entities (such as new radio, new technology or new NFs), new/modified technical support (such as support in a new geography or coverage area), availability of new management data, e.g., related to slice performance. An example procedure related to the addition of a new MnS producer is provided in TS 28.537 clause 5.2.1.1.

The MnS discovery service producer when capturing new or modified capability (e.g. new MnS producer) related to the target slice or VAL application identifies the NSCE server which needs to be informed (based on the subscription) on the new/modified capability and derives the details to be exposed to the VAL server (via the NSCE server). Then, the MnS registry sends to the NSCE server the new / modified MnS.

NOTE: The actual connectivity in step 4 (e.g., exposure of MnS via CAPIF or EGMF) follows the mechanism defined in SA5.

2. The NSCE server determines the VAL server(s) that needs to be notified on the new or modified MnS / MD capability based on their registrations. Then, NSCE server generates and sends a notification with the required information to be provided to the VAL server.
3. The information on the discovered new/modified MnS is sent as a management service discovery notification message from the NSCE server to VAL server.

## 9.6.3 Information flows

### 9.6.3.1 General

The following information flows are specified for the MnS discovery support based on 9.6.2 and 9.6.3.

### 9.6.3.2 Management service discovery subscribe request

Table 9.6.4.2-1 describes information elements for the Management service discovery subscribe request from the VAL server to the NSCE server.

**Table 9.6.3.2-1: Management service discovery subscribe request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	The identifier of the VAL service for which the MnS discovery request applies
Network slice related Identifier(s)	O	The slice identifier, if known by the VAL server
Exposure capability requirement	O	The requirement includes indication of the requested permissions for exposing information related to the target slice. Also, the requirement may include the exposure capability type which is supported (e.g. via EGMF or directly to MnS producer)

### 9.6.3.3 Management service discovery subscribe response

Table 9.6.3.3-1 describes information elements for the Management service discovery subscribe response from the NSCE server to the VAL server.

**Table 9.6.3.3-1: Management service discovery subscribe response**

Information element	Status	Description
Result	M	The result of the subscription request (positive or negative acknowledgement)
> Cause	O (see NOTE)	Indicates the cause of failure.
NOTE: May only be present if the result is failure.		

### 9.6.3.4 Management service discovery notify

Table 9.6.3.4-1 describes information elements for the Management service discovery notify message from the NSCE server to the VAL server.

**Table 9.6.3.4-1: Management service discovery notify**

Information element	Status	Description
VAL service ID	M	The identifier of the VAL application
Management Domain/System ID	M	The identifier of the management system/domain of interest
List of MnS IDs / MnS producer IDs	M	The list of identifiers of the needed MnSs / MnS producers
>MnS capability	M	The capability per needed MnS. Such capability may related to the managed elements such as considerations for radio, technology, coverage or NFs
>MnS permissions	O	Allowed permissions of the VAL server over the MnS, e.g. whether it is allowed to read, write, delete, and/or update.
Network slice related Identifier(s)	O	The slice identifier which is mapped to the VAL application and the list of MnSs.

## 9.6.4 APIs

### 9.6.4.1 General

Table 9.6.4.1-1 illustrates the NSCE APIs for the MnS discovery feature.



**Table 9.6.4.1-1: List of APIs for the MnS discovery feature**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_NSCE_Management_Service_Discovery	Management_Service Discovery	VAL server	Subscribe/Notify

## 9.6.4.2 SS\_NSCE\_Management\_Service Discovery

### 9.6.4.2.1 General

**API description:** This API enables the VAL server to communicate with the network slice capability enablement server for requesting management service discovery over NSCE-S.

### 9.6.4.2.2 SS\_NSCE\_Management\_Service Discovery

**API operation name:** Management\_Service Discovery

**Description:** Providing for Management\_Service Discovery subscribe to the NSCE server and receiving a confirmation.

**Known Consumers:** VAL server.

**Inputs:** See subclause 9.6.2.1 (step 1)

**Outputs:** See subclause 9.6.2.1 (step 4), 9.6.2.2 (step 3)

## 9.7 Network slice related performance and analytics monitoring

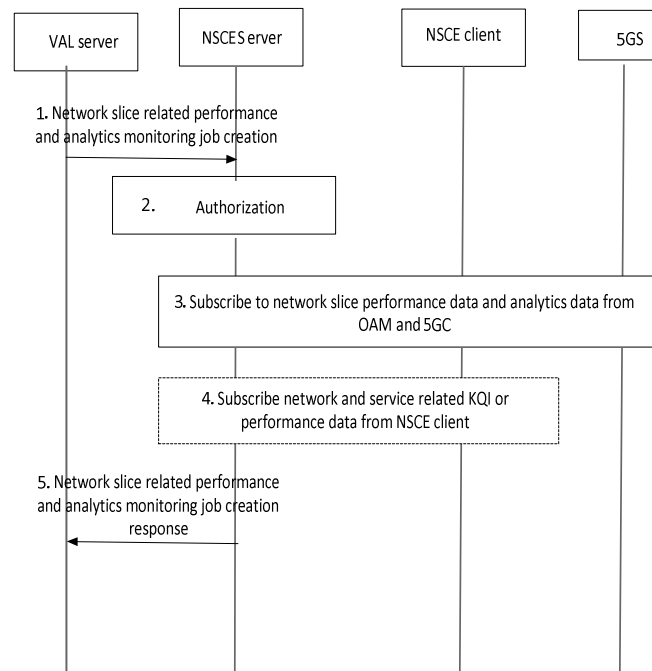
### 9.7.1 General

The NSCE server supports the end to end network slice related performance and analytic monitoring capability exposure. The NSCE server identifies which data are needed, collects the data from different data sources (e.g., the OAM system, the Core Network or the VAL end users), performs the data organizations and aggregations and expose the processed data to VAL servers for monitoring. Following clauses are for the procedures, information flows and APIs for Network slice related performance and analytics monitoring request and Network slice related performance and analytics reporting respectively. The procedure in clause 9.7.2.1 is for task creation of the network slice performance and analytics monitoring. The procedure in clause 9.7.2.2 is for the performance and analytics data retrieving when the data is available. The procedure in clause 9.7.2.3 is for multiple network slices performance and analytics consolidated report.

### 9.7.2 Procedure

#### 9.7.2.1 Network slice related performance and analytics monitoring job creation request

For network slice related performance and analytics monitoring job creation capabilities exposed to the VAL server, the VAL server triggers the procedure by sending the network slice related performance and analytics monitoring job creation request to NSCE server as Figure 9.7.2.2-1 shows:



**Figure 9.7.2.1-1: Request Network slice related performance and analytics job creation monitoring**

1. The VAL server sends a request to NSCE server to create the Network slice related performance and analytics monitoring job to collect the desired service/VAL service specific performance and analytics data, the detailed content of the reported data depends on the type of the VAL services. The required end-to-end network slice related data performance data are indicated by *Perflist* IE as described in table 9.7.3.2-1.
2. The NSCE server shall check if the VAL server is authorized to request the network slice performance and analytics data monitoring job creation.
3. NSCE server determines the requested data needed to collect from network side and collects the performance measurements and analytics data of network slice from 5GS. For OAM system, the APIs defined in clause 11.3, TS 28.532[7] is utilized, e.g., packet delay, radio resource utilization. For CN functions, the APIs of *Nnwdaf\_AnalyticsInfo* service defined in clause 7.3, TS 23.288 [4] is utilized, e.g., slice load level related network data analytics, slice load level related network data analytics.
4. Optionally, NSCE server retrieves the KQI data of services, the QoE data and the end user's information from NSCE client.

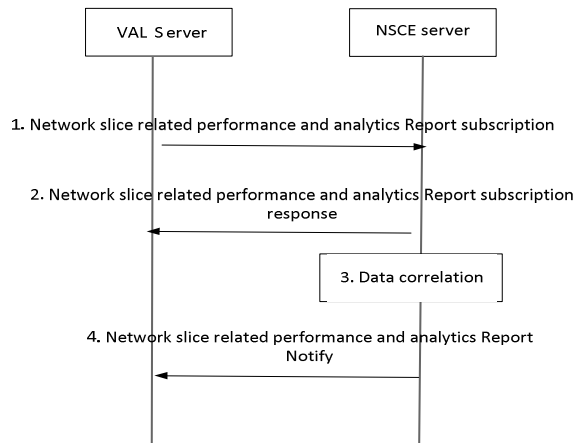
NOTE 1: The Data collection from NSCE client follows the mechanism defined in SA4 EVEX in TS 26.531 clause 5.6.

NOTE 2: How the collected data is stored in the NSCE server is implementation based.

5. NSCE server responds to VAL server to inform the VAL server if the monitoring request is succeed.

### 9.7.2.2 Network slice related performance and analytics report subscription and report

For network slice related performance and analytics result subscription and report, the VAL server triggers the procedure by sending the network slice related performance and analytics report subscription to NSCE server, the NSCE server reports the performance and analytics report after the subscription is succeed, as Figure 9.7.2.2-1 shows:



**Figure 9.7.2.2-1: Network slice related performance and analytics report subscription and report**

1. The VAL server subscribes to the required performance and analytics report.
2. The NSCE server response to the VAL server to indicate whether the report is successfully generated and ready.
3. NSCE server correlates the performance data of network slice instance, the analytics data of group of UEs and the KQI/QoE data to generate the performance data and analytics data report as required by VAL server.
4. NSCE server sends the performance report Notify to VAL server if the report is ready.

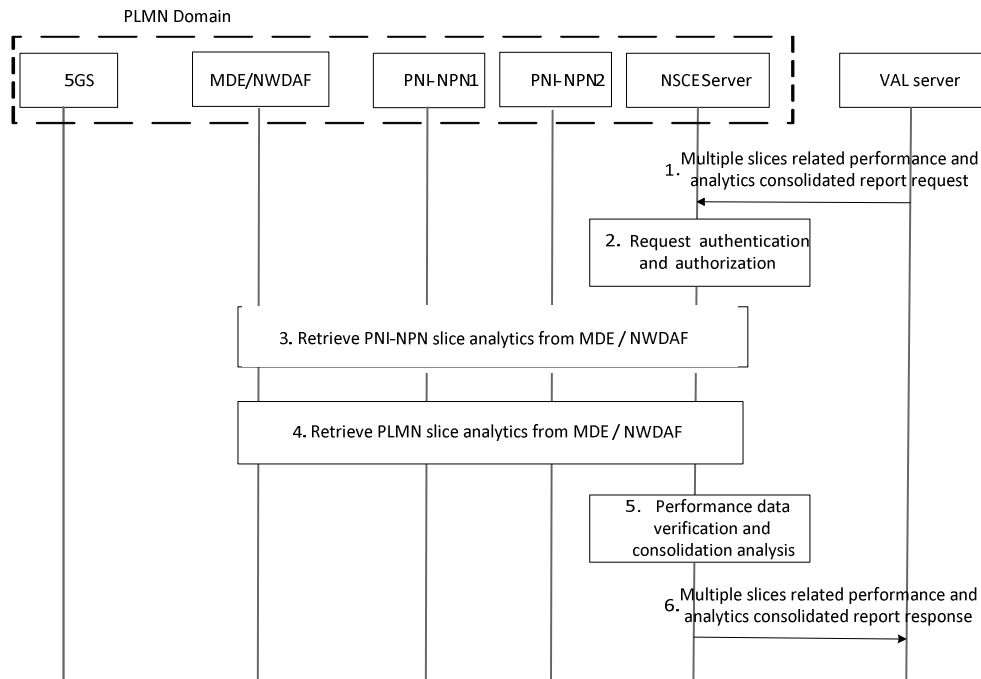
### 9.7.2.3 Multiple slices related performance and analytics consolidated report request

Based on preferred performance report request from the vertical applications, the consolidated performance report for dedicated service from multiple slices (PNI-NPN slice and PLMN slice of one network) can be offered to trusted third-party AF.

Figure 9.7.2.3-1 illustrates the procedure of multiple slices coordinated performance and analytics report service from VAL server to NSCE server.

Pre-conditions:

1. The network slice enabler layer is capable to interact with PLMN 5GC or OAM system to handle slices of PLMN and its PNI-NPNs.
2. PNI-NPNs are deployed as network slices of the PLMN.
3. NSCE server has subscribed for MDE and NWDAF analytics for the managed slices of PLMN and PNI-NPN.



**Figure 9.7.2.3 -1: Multiple slices performance and analytics consolidated report process**

1. The VAL server initiates multiple slices related performance and analytics consolidated report request towards the NSCE server. The request includes VAL server ID, VAL service ID. The message also includes application key performance indicator (such as end-to-end delay, throughput, etc.) list and monitoring period.
2. Upon receiving the request from the VAL server to manage the network slice QoS monitoring report, the NSCE server makes authentication and authorization of the VAL server and if VAL server is not authorized, the NSCE server replies with failure response.
3. The NSCE server makes mapping from application ID that received from VAL server to slice identities (S-NSSAIs allocated in each network) and retrieves the PNI-NPN slice related status information from MDE/NWDAF, i.e. analytics data specified in 3GPP TS 28.104 [21] and TS 23.288 [4].
4. The NSCE server retrieves the PLMN slice related performance information from MDE/NWDAF. The services of Nnwdafl\_AnalyticsInfo service defined in clause 7.3 of TS 23.288 [4] and analytics data as specified in 3GPP TS 28.104 [21] can be utilized.
5. The NSCE server verifies and analyses analytics data of network slice instances that is received from MDE/NWDAF about both PNI-NPN and PLMN slices, then NSCE server makes consolidated performance report among different kinds of network slices in specific period of time/location zone.
6. The NSCE server sends the multiple slices related performance and analytics consolidated report response towards VAL server including application key performance indicator (such as end-to-end delay, throughput, etc.) list and monitoring period.

## 9.7.3 Information flows

### 9.7.3.1 General

The following information flows are specified for Network slice related performance and analytics monitoring:

- Network slice related performance and analytics monitoring job creation request and response
- Network slice related performance and analytics monitoring report subscription

- Network slice related performance and analytics monitoring report Notify
- Multiple slices related performance and analytics consolidated report request and response

### 9.7.3.2 Network slice related performance and analytics monitoring job creation request and response

Table 9.7.3.2-1 and Table 9.7.3.2-2 describe information elements for the network slice related performance and analytics monitoring job creation request and response between the VAL server and the NSCE server.

**Table 9.7.3.2-1: Network slice related performance and analytics monitoring job creation request**

Information element	Status	Description
VAL information	M	The information of the VAL server
Performance Monitoring Request ID	M	Identifier of the performance and analytics monitoring job
Performance and analytics monitoring metrics	M	The information of performance and analytics monitoring
> VAL service identity	M	Identifier of the VAL service to be monitored
>PerfList	M	The list of performance to be monitored
>> PerfName	M	The name of the performance to be reported, e.g., the end to end round-trip time or the end to end network slice load.
> Network slice related Identifier(s)	O	Identifier(s) of the network slice to be monitored
>StartTime	M	The start time point of the performance and analytics monitoring
>EndTime	O	The end time point of the performance and analytics monitoring, If the EndTime IE is not included, it indicates that the performance and analytics monitoring will not stop until the monitoring request is released or updated.

**Table 9.7.3.2-2: Network slice related performance and analytics monitoring job creation response**

Information element	Status	Description
Result	M	Indicates the success or failure of the performance and analytics monitoring request
> Performance Monitoring Request ID	O (see NOTE 1)	Identifier of the performance and analytics monitoring job
>StartTime	O (see NOTE 1)	The start time point of the performance and analytics monitoring
>EndTime	O (see NOTE 2)	The end time point of the performance and analytics monitoring, If the EndTime IE is not included, it indicates that the performance and analytics monitoring will not stop until the monitoring request is released or updated.
>Cause	O (see NOTE 3)	Indicates the cause of VAL performance and analytics monitoring request failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: May only be present if the result is success.		
NOTE 3: Shall be present if the result is failure and shall not be present otherwise.		

### 9.7.3.3 Network slice related performance and analytics report subscription

Table 9.7.3.3-1 and 9.7.3.3-2 describe information elements for Network slice related performance and analytics report subscription from the NSCE server to the VAL server.

**Table 9.7.3.3-1: Network slice related performance and analytics report subscription**

Information element	Status	Description
VAL information	M	The information of the VAL server
>VAL server ID	M	The identifier of the VAL server
Report ID	M	Identifier of performance and analytics results the report
Report Information	M	The information of performance and analytics report retrieving
> VAL service identity	M	Identifier of the VAL service of which the performance and analytics results are required
> Network slice related Identifier(s)	O	Identifier(s) of the network slice
>StartTime	M	The start time point of the performance and analytics report
>EndTime	M	The end time point of the performance and analytics report
>Notification time interval	O	The time interval that the network slice related performance and analytics report are supposed to be notified
>PerfList	M	The list of performance to be reported
>>PerfName	M	The name of the performance to be reported

**Table 9.7.3.3-2: Response of Network slice related performance and analytics report subscription**

Information element	Status	Description
Result	M	Indicates the success or failure of the performance and analytics subscription
>Report ID	O (see NOTE 1)	Identifier of the performance and analytics report Id
>Cause	O (see NOTE 2)	Indicates the cause of VAL performance and analytics subscription failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise.		

#### 9.7.3.4 Network slice related performance and analytics report Notify

Table 9.7.3.4-1 and 9.7.3.4-2 describe information elements for Network slice related performance and analytics report Notify from the NSCE server to the VAL server.

**Table 9.7.3.4-1: Network slice related performance and analytics report Notify**

Information element	Status	Description
VAL information	M	The information of the VAL server
>VAL server ID	M	The identifier of the VAL server
>Network slice related performance and analytics report	M	Network slice related performance and analytics report as defined in Table 9.7.3.4-2

**Table 9.7.3.4-2: Network slice related performance and analytics report**

Information element	Status	Description
Report ID	M	Identifier of the report
PerfResultFile	CM (see NOTE 1)	PerfResultFile contains one or more PerfResult
>PerfResult	CM	Information element containing the VAL service identity or S-NSSAI followed by a list of result values for the aggregated or analyzed network slice related performance
>VAL service identity	M	Identifier of the VAL service of which the performance and analytics results are reported
> Network slice related Identifier(s)	O	Identifier(s) of the network slice
>ResultsValueList		List of ResultsValue
>>ResultsValue	M	Information element containing the perfName and perfValue.
>>>PerfName	M	The name of the performance to be reported
>>>PerfValue	M	The corresponding value of the monitored performance
Failure response	CM (see NOTE 2)	Indicates that network slice related performance and analytics results reporting failed.
>Cause	CM (see NOTE 2)	Indicates the cause of network slice related performance and analytics results report failure
NOTE 1: Information element shall be present when the network slice related performance and analytics results retrieving is successful.		
NOTE 2: Information element shall be present when the network slice related performance and analytics results retrieving is failure.		

### 9.7.3.5 Multiple slices related performance and analytics consolidated report request and response

Table 9.7.3.x-1 and Table 9.7.3.x-2 describe information elements for the multiple slices related performance and analytics consolidated report request and response between the VAL server and the NSCE server.

**Table 9.7.3.5-1: Multiple slices related performance and analytics consolidated report request**

Information element	Status	Description
VAL information	M	The information of the VAL server
Performance Monitoring Request ID	M	Identifier of the performance and analytics monitoring
Performance and analytics monitoring metrics	M	The information of performance and analytics monitoring
> VAL service identity	M	Identifier of the VAL service to be monitored
>PerfList	M	The list of performance to be monitored
>> PerfName	M	The name of the performance to be reported, e.g., the end to end round-trip time or the end to end network slice load.
> Network slice related Identifier(s)	O	Identifier(s) of the network slice to be monitored
>StartTime	M	The start time point of the performance and analytics monitoring
>EndTime	M	The end time point of the performance and analytics monitoring.
> Report ID	M	Identifier of performance and analytics report.

**Table 9.7.3.5-2: Multiple slices related performance and analytics consolidated report response**

Information element	Status	Description
Result	M	Indicates the success or failure of the performance and analytics monitoring request
>StartTime	O (see NOTE 1)	The start time point of the performance and analytics monitoring
>EndTime	O (see NOTE 1)	The end time point of the performance and analytics monitoring. If the EndTime IE is not included, it indicates that the performance and analytics monitoring will not stop until the monitoring request is released or updated.
>Report ID	O (see NOTE 1)	Identifier of the report
>VAL service identity	O (see NOTE 1)	Identifier of the VAL service of which the performance and analytics results are reported
>>Network slice related Identifier	O (see NOTE 1)	Identifier of the network slice. One VAL service can be offered on one or more network slices
>>>ResultsValue	O (see NOTE 1)	Information element containing the perfName and perfValue
>>>>PerfName	O (see NOTE 1)	The name of the performance to be reported
>>>>PerfValue	O (see NOTE 1)	The corresponding value of the monitored performance
>Cause	O (see NOTE 2)	Indicates the cause of VAL performance and analytics monitoring request failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise.		

## 9.7.4 APIs

### 9.7.4.1 General

Table 9.7.4.1-1 and 9.7.4.1-2 illustrate the API for network slice related performance and analytics monitoring.

**Table 9.7.4.1-1: SS\_NSCE\_PerfMonitoring API**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_PerfMonitoring	Perf_Monitoring_Request	Request /Response	VAL server

**Table 9.7.4.1-2 SS\_NSCE\_PerfResultReport API**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE__PerfReportSubscription	Perf_PerfReport_Subscription	Subscription/response	VAL Server

**Table 9.7.4.1-3: SS\_NSCE\_PerfReport API**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_PerfReporting	Perf_Report	Notify	VAL Server



**Table 9.7.4.1-4: SS\_NSCE\_MultiSlicePerfReport API**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_MultiSlicePerfReport	Multi_Slice_Perf_Report	Request /Response	VAL Server

#### 9.7.4.2 SS\_NSCE\_PerfMonitoring API

**API operation name:** Perf\_Monitoring

**Description:** The consumer requests to monitor network slice related performance and analytics.

**Known Consumers:** VAL server.

**Inputs:** See table 9.7.3.2-1.

**Outputs:** See table 9.7.2.2-2.

See clause 9.7.2.1 for details of usage of this operation.

#### 9.7.4.3 SS\_NSCE\_PerfReportSubscription API

**API operation name:** Perf\_Result\_Reporting

**Description:** The consumer requests to report network slice related performance and analytics.

**Known Consumers:** VAL server.

**Inputs:** See table 9.7.3.3-1.

**Outputs:** See table 9.7.3.3-2.

See clause 9.7.2.2 for details of usage of this operation.

#### 9.7.4.4 SS\_NSCE\_PerfReport API

**API operation name:** Perf\_Report

**Description:** The consumer get notify of network slice related performance and analytics report.

**Known Consumers:** VAL server.

**Inputs:** See table 9.7.3.4-1.

**Outputs:** See table 9.7.3.4-2.

See clause 9.7.2.2 for details of usage of this operation.

#### 9.7.4.5 SS\_NSCE\_MultiSlicePerfReport API

**API operation name:** Multi\_Slice\_Perf\_Report

**Description:** The consumer requests to get multiple slices related performance and analytics consolidated report.

**Known Consumers:** VAL server.

**Inputs:** See table 9.7.3.5-1.

**Outputs:** See table 9.7.3.5-2.

See clause 9.7.2.3 for details of usage of this operation.

## 9.8 Information collection from NSCE server(s)

### 9.8.1 General

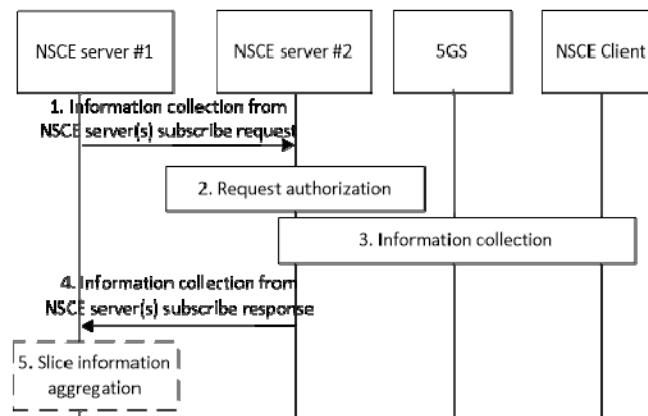
The collected information by NSCE server could be exposed to other NSCE server(s) to optimize network resource allocation, based on the agreement among the NSCE servers. Then the NSCE server providing network slice related information acts as the producer, while the NSCE server obtaining network slice related information is the consumer.

### 9.8.2 Procedure

#### 9.8.2.1 Information collection from NSCE server(s) subscribe request and response

Pre-condition:

1. The producer NSCE server #2 has agreement with consumer NSCE server #1 to provide the collected slice information.



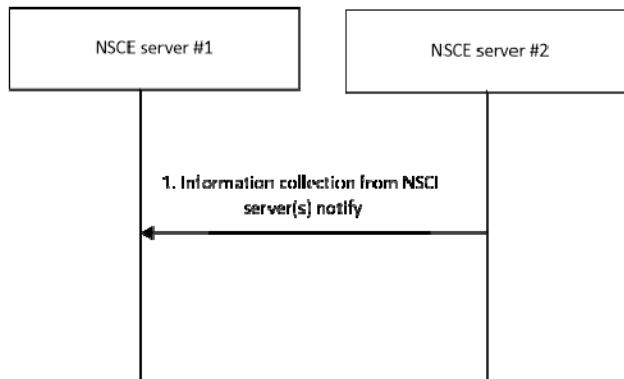
**Figure 9.8.2.1-1: Information collection from NSCE server(s) subscribe request and response**

1. The NSCE server#1 sends out the information collection subscribe request with expected period and interested slice ID, e.g., List of SNSSAI. This step could be done by pre-configuration.
2. The NSCE server #2 shall check if the NSCE server #1 is authorized to get the network slice information.
3. After authentication, the NSCE server #2 collects slice information as defined in clause 9.7.2.1 step3, step4.

NOTE: When the producer NCSE server is edge NSCE server, only local information is collected and provided.

4. The NSCE server #2 sends collected slice information to NSCE server #1.
5. The NSCE server #1 may process the collected slice information (such as information aggregation), if needed.

### 9.8.2.2 Information collection from NSCE server(s) Notify



**Figure 9.8.2.2-1: Information collection from NSCE server(s) Notify**

1. Once the reporting period is reached or the threshold is crossed, the NSCE server #2 sends information collection notify to NSCE server #1.

## 9.8.3 Information flows

### 9.8.3.1 General

The following information flows are specified for Information collection from NSCE server(s):

- Information collection from NSCE server(s) subscribe request, response and notify;

### 9.8.3.2 Information collection from NSCE server(s) subscribe request

Table 9.8.3.2-1 describes information elements for the Information collection from NSCE server(s) subscribe request from the consumer NSCE server to the producer NSCE server(s).

**Table 9.8.3.2-1: Information collection from NSCE server(s) subscribe request**

Information element	Status	Description
Requester Identifier	M	Unique identifier of the requester (i.e. NSCE server ID).
Security credentials	M	Security credentials resulting from a successful authorization for the NSCE service.
Notification Target Address	O	The Notification Target Address (e.g. URL) where the notifications destined for the requester should be sent to.
List of S-NSSAI(s)	M	Identifier of the interested network slice
>QoS type indicator	O	QoS metric type including latency, throughput, jitter, etc.
>Threshold	O	Threshold of QoS metrics
>Reporting period	O	Indicating the metrics reporting period
>Immediate reporting flag	O	Indicating the request needs immediate reporting or not
Proposed expiration time	O	Proposed expiration time for the subscription

### 9.8.3.3 Information collection from NSCE server(s) subscribe response

The information elements specified in the Table 9.8.3.3-1 is used for the Information collection from NSCE server(s) subscribe response sent from the producer NSCE server to the consumer NSCE server.

**Table 9.8.3.3-1: Information collection from NSCE server(s) subscribe Response**

Information element	Status	Description
Result	M	Indicates the success or failure of the performance and analytics subscription.
> Subscription ID	O (see NOTE 1)	Subscription identifier corresponding to the subscription.
>Network slice related performance and analytics report	O (see NOTE 2)	Network slice related performance and analytics report as defined in Table 9.7.3.4-2
> Cause	O (see NOTE 3)	Indicates the cause of request failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: May only be present if the result is success.		
NOTE 3: May only be present if the result is failure.		

### 9.8.3.4 Information collection from NSCE server(s) notify

The information elements specified in Table 9.8.3.4-1 are used for the information collection from NSCE server(s) notify sent from the producer NSCE server to the consumer NSCE server.

**Table 9.8.3.4-1: Information collection from NSCE server(s) Notify**

Information element	Status	Description
Subscription ID	M	Subscription identifier corresponding to the subscription.
>Network slice related performance and analytics report	M	Network slice performance and analytics (i.e. slice load) with network slice identifier(i.e. S-NSSAI)

## 9.8.4 APIs

### 9.8.4.1 General

Table 9.8.4.1-1 illustrates the API for information collection from NSCE server(s).

**Table 9.8.4.1-1: API for Information collection from NSCE server(s)**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_InfoCollection	Subscribe	Subscribe/Response	NSCE server
	Notify	Notify	NSCE server

### 9.8.4.2 SS\_NSCE\_InfoCollection\_Subscribe operation

**API operation name:** InfoCollection\_Subscribe

**Description:** The consumer subscribes for Information collection from NSCE server(s).

**Inputs:** See clause 9.8.3.2.

**Outputs:** See clause 9.8.3.3.

See clause 9.8.2.1 for details of usage of this operation.

### 9.8.4.3 SS\_NSCE\_InfoCollection\_Notify operation

**API operation name:** InfoCollection\_Notify

**Description:** The consumer is notified with result of information collection from NSCE server(s).

**Inputs:** See clause 9.8.3.4

**Outputs:** None

See clause 9.8.2.2 for details of usage of this operation.

## 9.9 Predictive slice modification in edge based NSCE deployments

### 9.9.1 General

In this feature, the NSCE server initially receives an expected/predicted UE location/mobility change request outside an EDN service area for one or more UEs within the VAL application session (e.g. such session can be an indirect V2V session or a multiplayer gaming session). Then, the source NSCE server checks with 5GS (OAM, 5GC) whether the serving slice is available and can offer the same performance at the target EDN. Thereafter, NSCE server evaluates the need for a slice modification (e.g. a slice lifecycle related trigger change) e.g. a slice subnet resource adaptation to allow for optimizing the application performance at the target area. Based on this decision/recommendation, it provides the action to the OAM and supports the re-mapping of NSCE server for the NSCE client proactively, before UE mobility happens.

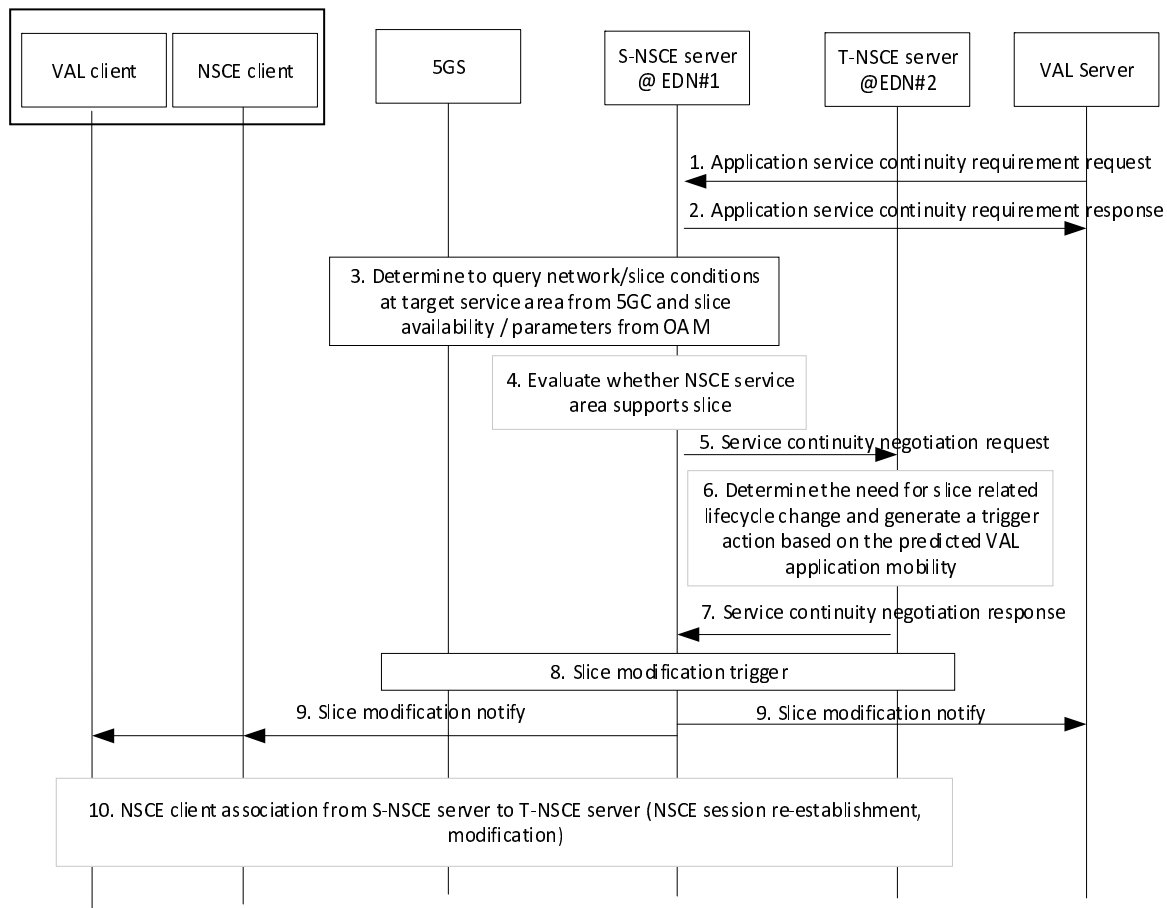
### 9.9.2 Procedure

#### 9.9.2.1 Procedures on predictive slice modification in edge based NSCE deployments

In the procedure shown in Figure 9.9.2.1-1, a mechanism is provided to allow for slice modification when a vertical application of single or group of VAL UEs migrates (or is expected/predicted to migrate) to a different EDN supported by different NSCE server.

Pre-conditions:

1. The VAL server has subscribed to the network slice capability enablement server
2. The VAL client of VAL UE is mapped to Slice#1, and NSCE client of VAL UE has established a connection to NSCE server#1 (S-NSCE server).
3. The S-NSCE server has already discovered the T-NSCE server and its area of coverage.
4. The VAL server is subscribed to and received prediction of UE location change.



**Figure 9.9.2.1-1: Support for predictive slice modification in distributed NSCE server deployments**

1. The VAL server sends to S-NSCE server an application service continuity requirement request due to predicted/expected UE or group UE mobility to a target service area covered by a different EDN.

NOTE: Such UE predicted mobility at the VAL server can be based on UE mobility analytics received by NWDAF or can be predicted by the VAL layer (VAL server or VAL UE).

2. S-NSCE server sends an application service continuity requirement response to the VAL server as positive or negative acknowledgement.
3. S-NSCE server determines to query the underlying 3GPP system on the slice availability and conditions at the target service area (based on step 1 requirement). Such query may be in form of a request/response and include:
  - a. S-NSCE server interacting with 5GC to query the UE specific information (location, UE connection capabilities) as well as network conditions (network monitoring from NEF) and/or slice related analytics on the slice load (from NWDAF as specified in TS 23.288 [4]).
  - b. S-NSCE server may also interact with OAM to query on the target slice availability and the up-to-date configured slice parameters e.g. slice RRM policies, modification of the NSI/NSSI resources (see TS 28.531 [8], 5.1.12) at the target service area and measurements for the slice at the target area.
4. S-NSCE server evaluates whether new NSCE service area supports slice #1 and if slice #1 offers similar performance in target area.
5. If the current slice doesn't fulfil these requirements, S-NSCE sends to the T-NSCE server (covering the target area) a service continuity negotiation request (including the VAL application service continuity requirement and optionally a proposed action) to negotiate on the trigger action.
6. T-NSCE server determines the need for a slice lifecycle change at the target area and translates this to a trigger action. This trigger action can be based on the proposed action in step 5 and can be a requested slice modification or the slice #1 creation/instantiation at the target area (this may happen if a group of UEs are moving to the target area and use slice #1, so it may be beneficial to create slice #1 at the target area).

7. T-NSCE server sends to the S-NSCE server a service continuity negotiation response including the determined trigger action.
8. The S- or T-NSCE server may send the trigger action as a slice modification trigger request to the slice provisioning MnS producer at OAM (e.g. slice modification for network slice) to extend slice availability to the target service area based on the expected/predicted VAL UE or VAL group mobility. As response to the trigger action, the provisioning MnS producer provides a slice modification trigger response to the corresponding NSCE server with a positive or negative result.
9. After the slice lifecycle change execution (based on the indication in step 5), the S-NSCE server sends a notification to the VAL server and optionally to the VAL client via S-NSCE client
10. If the NSCE client needs to be remapped to different NSCE server (due to the expected change of UE location), the NSCE client establishes a new connection with T-NSCE and terminates the one with S-NSCE (in case of subscription-based interaction), or in case of request-based interaction, it updates the mapping at the client side, and maintains the new NSCE server address / ID for the target NSCE area.

### 9.9.3 Information flows

#### 9.9.3.1 General

The following information flows are specified for the predictive slice modification support based on 9.9.2.

#### 9.9.3.2 Application service continuity requirement request

Table 9.9.3.2-1 describes information elements for the Application service continuity requirement request from the VAL server to the NSCE server.

**Table 9.9.3.2-1: Application service continuity requirement request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
Security credentials	M	Security credentials resulting from a successful authorization.
VAL service ID	M	The identifier of the VAL service for which the requirement request applies
VAL UE ID list	O	The list of VAL UE IDs for which the requirement request applies
Service Continuity Requirement	M	The service continuity requirement which can be the expected or predicted migration of the VAL application or a list of VAL UEs within the application to a target area.
Slice identifier	O	The slice identifier (S-NSSAI, NSI ID or ENSI) which is mapped to the VAL application, if known by the VAL server
Target Service Area	O	The target area can be represented as the geographical coordinates / set of waypoints outside the original service area, where the VAL application/ UE(s) is expected or predicted to move.
Application QoS requirements	O	The QoS requirements / KPIs for the VAL service

#### 9.9.3.3 Application service continuity requirement response

Table 9.9.3.3-1 describes information elements for the Application service continuity requirement response from the NSCE server to the VAL server.

**Table 9.9.3.3-1: Application service continuity requirement response**

Information element	Status	Description
Result	M	The result of the request (positive or negative acknowledgement)

### 9.9.3.4 Service continuity negotiation request

Table 9.9.3.4-1 describes information elements for the service continuity negotiation request from the S-NSCE server to the T-NSCE server.

**Table 9.9.3.4-1: service continuity negotiation request**

Information element	Status	Description
S-NSCE server ID	M	The identifier of the source NSCE server
VAL service ID	M	The identifier of the VAL service for which the request applies
VAL UE ID list	O	The list of VAL UE IDs for which the request applies
Service Continuity Requirement	M	The service continuity requirement which can be the expected or predicted migration of the VAL application or a list of VAL UEs within the application to a target area.
Proposed Trigger Action	O	The proposed slice lifecycle change for the target VAL UE or VAL application
Slice identifier	M	The slice identifier (S-NSSAI, NSI ID or ENSI) which is mapped to the VAL application, if known by the VAL server
Application QoS requirements	O	The QoS requirements / KPIs for the VAL service

### 9.9.3.5 Service continuity negotiation response

Table 9.9.3.5-1 describes information elements for the service continuity negotiation response from the T-NSCE server to the S-NSCE server.

**Table 9.9.3.5-1: service continuity negotiation response**

Information element	Status	Description
Result	M	The result of the request (positive or negative acknowledgement)
Trigger Action	O	The determined trigger action which can be the slice lifecycle change for the target VAL UE or VAL application

### 9.9.3.6 Slice modification notify

Table 9.9.3.6-1 describes information elements for the slice modification notify message from the NSCE server to the VAL server or the VAL client (via NSCE client).



**Table 9.9.4.6-1: slice modification notify**

Information element	Status	Description
VAL service ID	M	The identifier of the VAL application which is expected to be impacted by the slice modification
VAL UE ID list	O	The identifiers of the VAL UEs which are expected to be impacted by the slice modification
Slice identifier	M	The slice identifier (S-NSSAI, NSI ID or ENSI) which is expected or predicted to modify to extend slice availability to the target service area
Target NSCE server ID and address	M	The identifier and address of the target NSCE server
Target Service Area	M	The target area can be represented as the edge service area (including the target DNN/DNAI) or the topological area (e.g. list of cells/TAs) for which the slice modification applies.

## 9.9.4 APIs

### 9.9.4.1 General

Table 9.9.4.1-1 illustrates the NSCE APIs for the predictive slice modification support feature.

**Table 9.9.4.1-1: List of APIs for the predictive slice modification support feature**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_NSCE_Service_Continuity_Requirement	Service_Continuity_Requirement	VAL server	Request / Response
SS_NSCE_Service_Continuity_Negotiation	Service_Continuity_Negotiation	NSCE server	Request / Response
SS_NSCE_Slice_Modification_Notify	Slice_Modification_Notify	VAL server or VAL client	Notify

### 9.9.4.2 SS\_NSCE\_Service\_Continuity\_Requirement

#### 9.9.4.2.1 General

**API description:** This API enables the VAL server to communicate with the network slice capability enablement server for requesting a service continuity requirement over NSCE-S.

#### 9.9.4.2.2 Service\_Continuity\_Requirement

**API operation name:** Service\_Continuity\_Requirement

**Description:** Providing for Service\_Continuity\_Requirement to the NSCE server and receiving a response / result.

**Known Consumers:** VAL server.

**Inputs:** See table 9.9.3.2-1

**Outputs:** See table 9.9.3.3-1

### 9.9.4.3 SS\_NSCE\_Service\_Continuity\_Negotiation

#### 9.9.4.3.1 General

**API description:** This API enables the S-NSCE server to communicate with the T-NSCE server for requesting a service continuity negotiation over NSCE-X.

#### 9.9.4.3.2 Service\_Continuity\_Negotiation

**API operation name:** Service\_Continuity\_Negotiation

**Description:** Providing for Service\_Continuity\_Negotiation to the T-NSCE server and receiving a response / result.

**Known Consumers:** S-NSCE server.

**Inputs:** See table 9.9.3.4-1

**Outputs:** See table 9.9.3.5-1

#### 9.9.4.4 SS\_NSCE\_Slice\_Modification\_Notify

##### 9.9.4.4.1 General

**API description:** This API enables the network slice capability enablement server to communicate with the VAL server or VAL UE (NSCE client or VAL client) for notifying the slice modification to extend to the target service area.

##### 9.9.4.4.2 Slice\_Modification\_Notify

**API operation name:** Slice\_Modification\_Notify

**Description:** Notifying about the slice modification to extend to the target area.

**Known Consumers:** VAL server.

**Inputs:** See table 9.9.3.6-1

**Outputs:** None

## 9.10 Multiple slices coordinated resource optimization

### 9.10.1 General

Based on preferred QoS request from the vertical applications, the performance monitoring of multiple slices of one network (PNI-NPN slice and PLMN slice) and resource adjustment between different slices can be made to realize optimized and efficient resource usage.

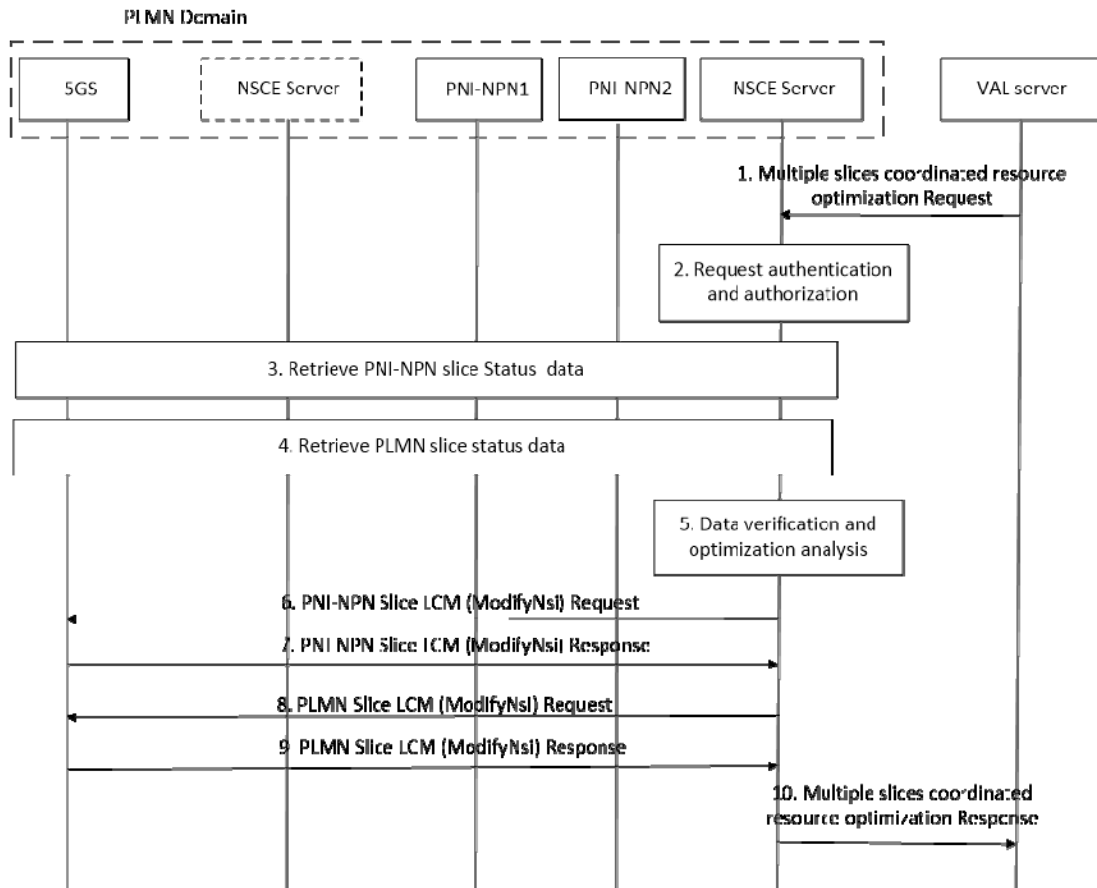
### 9.10.2 Procedure

#### 9.10.2.1 Procedure on multiple slices coordinated resource optimization

Figure 9.10.2.1-1 illustrates the procedure of multiple slices coordinated resource optimization service from VAL server to NSCE server.

Pre-conditions:

1. The network slice enabler layer is capable to interact with PLMN 5GC or OAM system to handle slices of PLMN and its PNI-NPNs.
2. PNI-NPNs are deployed as network slices of the PLMN.



**Figure 9.10.2.1-1: Multiple slices coordinated resource optimization process**

1. The VAL server initiates multiple slices coordinated resource optimization request towards the NSCE server. The request includes VAL server ID, VAL service ID. The message also includes preferred optimization zone.
2. Upon receiving the request from the VAL server to make the network slice resource optimization, the NSCE server makes authentication and authorization of the VAL server and if VAL server is not authorized to send multiple slices coordinated resource optimization request, the NSCE server replies with failure response.
3. The NSCE server makes mapping from VAL service ID that received from VAL server to slice identities (S-NSSAIs allocated in multiple networks) and retrieves the network slice related status information from 5GC or OAM of PLMN for PNI-NPN slices, such as NF(s) load in 5GC and network utilization in access network as defined in TS 28.535 [11].
4. The NSCE server retrieves the network slice related status information for PLMN from 5GC or OAM of PLMN networks for PLMN slices, such as NF(s) load in 5GC and network utilization in access network as defined in TS 28.535 [11]. The PLMN operator can choose to deploy NSCE-Server acting as single entry of PLMN capability exposure which can be optional.
5. The NSCE server verifies and analyses status data of network slices instance as well as network slice performance monitoring response (optional), then NSCE server makes resource optimization (e.g. shared radio resources, etc.) decision among different kinds of slices in specific location zone.
- 6-7. The NSCE server determines whether and what network slice LCM operations should be taken and makes the decision(s)/recommendation(s), such as modifyNsi request as specified in TS 28.531 [8] to PNI-NPN slice. Based on decision made by NSCE server, the network slice management entity (such as NSMF) performs the corresponding operation(s) and sends LCM response including slice resource adjustment result.
- 8-9. The NSCE server determines whether and what network slice LCM operations should be taken and makes the decision(s)/recommendation(s), such as modifyNsi request as specified in TS 28.531 [8] to PLMN slice. Based on decision made by NSCE server, the network slice management entity (such as NSMF) performs the corresponding operation(s) and sends LCM response including slice resource adjustment result. The PLMN

operator can choose to deploy NSCE-S acting as single entry of PLMN capability exposure which can be optional.

10. The NSCE server sends the multiple slices coordinated resource optimization response towards VAL server.

### 9.10.3 Information flows

#### 9.10.3.1 General

The following information flows are specified:

- Multiple slices coordinated resource optimization request and response.

#### 9.10.3.2 Multiple slices coordinated resource optimization request

Table 9.10.3.2-1 describes information elements for the multiple slices coordinated resource optimization request from the VAL server to the NSCE server.

**Table 9.10.3.2-1: Multiple slices coordinated resource optimization request**

Information element	Status	Description
Requestor Identifier	M	Unique identifier of the requestor (i.e. VAL server ID).
Security credentials	M	Security credentials resulting from a successful authorization.
VAL service identity	M	Identifier of the VAL service application to be monitored.
Optimization Zone	O	The preferred location area of the performance monitoring and optimization.
Requested S-NSSAI(s)	O	Indication of the S-NSSAI(s) which are requested.

#### 9.10.3.3 Multiple slices coordinated resource optimization response

Table 9.10.3.3-1 describes the information elements for the multiple slices coordinated resource optimization response from the NSCE server to the VAL server.

**Table 9.10.3.3-1: Multiple slices coordinated resource optimization response**

Information element	Status	Description
Result	M	Indicates the success or failure of the multiple slices resource optimization request.
> VAL service identity	O (see NOTE 1)	Identifier of the VAL service application to be monitored.
> Cause	O (see NOTE 2)	Indicates the cause of multiple slices resource optimization request failure.
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise.		

### 9.10.4 APIs

#### 9.10.4.1 General

Table 9.10.4.1-1 illustrates the API for multiple slices coordinated resource optimization.

**Table 9.10.4.1-1: Multiple slices coordinated resource optimization**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_NSCE_MultiSlices_Optimization	MultiSlices_Optimization	VAL server	Request /Response

### 9.10.4.2 SS\_NSCE\_MultiSlices\_Optimization operation

**API operation name:** SS\_NSCE\_MultiSlices\_Optimization\_Request

**Description:** The consumer subscribes for multiple slices coordinated resource optimization .

**Inputs:** See clause 9.10.3.2.

**Outputs:** See clause 9.10.3.3.

See clause 9.10.2 for details of usage of this operation.

## 9.11 Network slice adaptation for VAL application

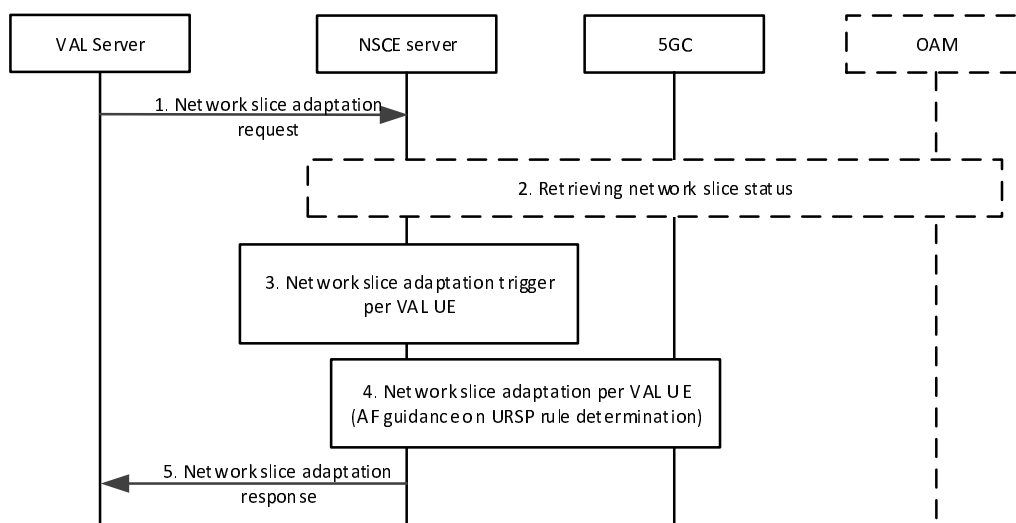
### 9.11.1 General

This subclause describes the procedure for network slice adaptation at the Network Slice Capability Enablement (NSCE) server, based on a request from a VAL server to adapt the network slice for the VAL application. This request is handled between the NSCE server and the NSCE client per each VAL UE of the VAL application. Such adaptation assumes that the UE is subscribed to more than one slice and is done via providing a guidance to update the URSP rules at the 5GS (denoted in clause 9.11.2.1 as network-based mechanism).

### 9.11.2 Procedures

#### 9.11.2.1 Procedure for VAL server-triggered and network-based network slice adaptation for VAL application- request and response model

Figure 9.11.2.1-1 illustrates the VAL server-triggered and network-based procedure where the NSCE server supports the network slice adaptation with the underlying 3GPP system for the VAL UEs of the VAL application.



**Figure 9.11.2.1-1: Network slice adaptation for VAL application**

1. The VAL server sends a network slice adaptation request to the NSCE server for the VAL application (and the VAL UEs within the VAL application). This request may be in the form of exact requested network slice (and

optionally DNN) for all the VAL UEs of the VAL application; or indication that the VAL application needs to be remapped to a different network slice (and optionally DNN). The request optionally includes the adaptation threshold of network slice adaptation as defined in Table 9.11.3.1-1.

2. [Optional]NSCE server collects the network slice status information, including network slice performance measurements in clause 5.1.1.1, clause 5.1.1.2, clause 5.1.1.3, in 3GPP TS 28.552 [19] and key performance indicators in clause 6.3, in 3GPP TS 28.554 [20], and network slice related E2E latency analytics report in clause 8.4.2.4.3, in 3GPP TS 28.104 [21] from network slice management functions by utilizing MnS of create MOI operation defined in clause 11.1 and MnS of streaming data reporting service or file data reporting service defined in clause 11.5 and 11.6, 3GPP TS 28.532 [7].
3. The NSCE server processes the request and triggers the network slice configuration per VAL UE within the VAL Application. If network slice status from step 2 is considered, the NSCE server analyses the network slice status information before triggering the network slice configuration. If the threshold is crossed for the current network slice of adaptation and the objective network slice satisfy the requests, NSCE server triggers the network slice configuration per VAL UE within the VAL Application.
4. The NSCE server acting as AF provides the updated S-NSSAI and DNN per VAL UE. In particular, NSCE server sends this information to the PCF via NEF as part of the AF-driven guidance for URSP determination to 5G system (as specified in 3GPP TS 23.502 [12] clause 4.15.6.10, 3GPP TS 23.503 [17] clause 6.6.2.2, 3GPP TS 23.548 [18] clause 6.2.4). This guidance may update the route selection parameters to indicate different sets of PDU Session information (DNN, S-NSSAI) that can be associated with applications matching the application traffic.

NOTE: NSCE server provides the updated S-NSSAI/DNN as a suggestion/guidance to PCF; however it is up to PCF to decide whether to perform the slice/DNN re-mapping

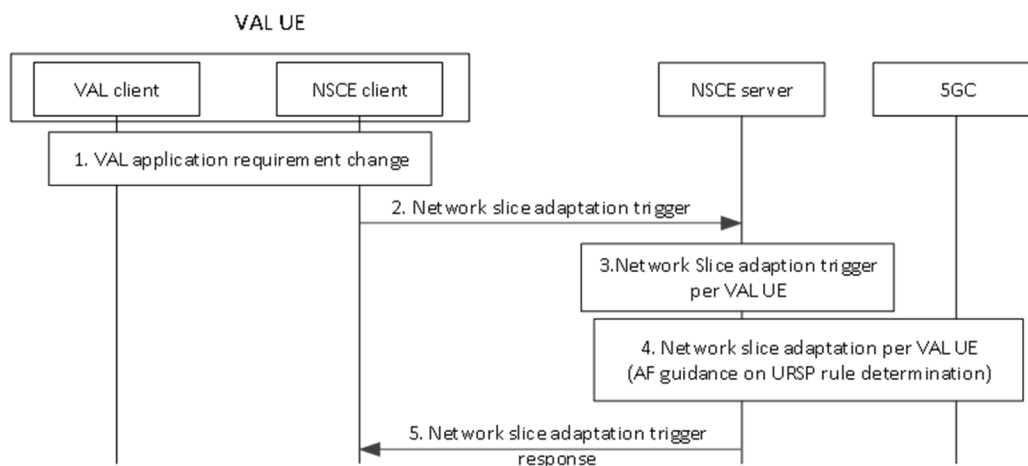
5. Upon successful adaptation of the route selection parameters, the NSCE server provides a network slice adaptation response to the VAL server, providing information on the fulfilment of the network slice adaptation request per VAL application.

### 9.11.2.2 Procedure for VAL UE-triggered and network-based network slice adaptation for VAL application - request and response model

Figure 9.11.2.2-1 illustrates the VAL UE-triggered and network-based procedure where the NSCE server supports the network slice adaptation with the underlying 3GPP system for the VAL UEs of the VAL application.

Pre-condition:

- The NSCE client has connected to the NSCE server;



**Figure 9.11.2.2-1: Network slice adaptation for VAL application**

1. The VAL client provides a new application requirement to the NSCE client, indicating a new service profile for the VAL application. This may be in the form of a change at the application QoS requirements, location

requirements, time window requirement, access type preference (e.g., 3GPP, non-3GPP or multi access) service operation change, or other application-related parameters.

- The NSCE client sends a network slice adaptation trigger to the NSCE server for the VAL application. This trigger may be in the form of exact requested network slice (and optionally DNN) for the VAL UE of the VAL application; or indication that the VAL application needs to be remapped to a different network slice (and optionally DNN). The trigger may also include additional application requirements based on step1, e.g., the requested location criteria, time window.

NOTE 1 : How the requested network slice is known by the NSCE client is out of scope of this release.

- The NSCE server processes the request and triggers the network slice configuration per VAL UE within the VAL Application.

NOTE 2: Whether and how the NSCE server triggers the network slice adaptation for all the VAL UEs within the VAL Application is out of scope of this release.

NOTE 3: How the NSCE server decides to trigger the network slice configuration is implementation dependent.

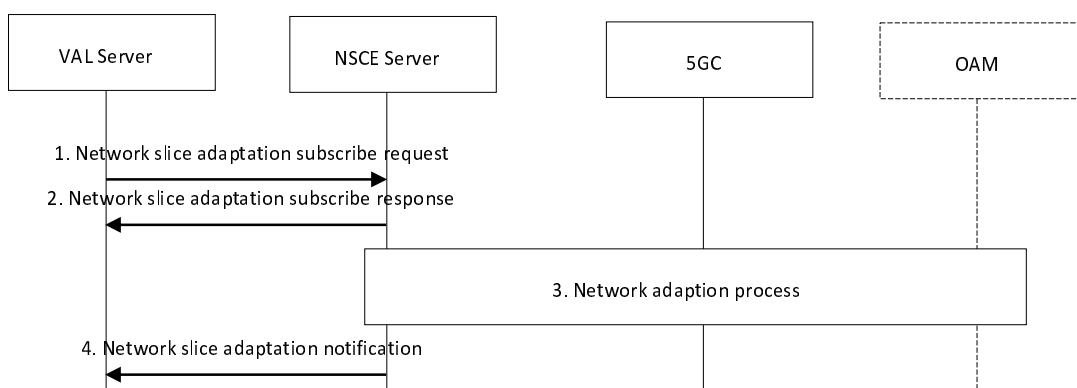
- The NSCE server acting as AF provides the updated S-NSSAI, application requirements and DNN per VAL UE. In particular, NSCE server sends this information to the PCF via NEF as part of the AF-driven guidance for URSP determination to 5G system (as specified in 3GPP TS 23.502 [12] clause 4.15.6.10, 3GPP TS 23.503 [17] clause 6.6.2.2, 3GPP TS 23.548 [18] clause 6.2.4). This guidance may update the route selection parameters to indicate different sets of PDU Session information (DNN, S-NSSAI, application requirements) that can be associated with applications matching the application traffic. 5GC uses this information to update the URSP to the affected UE(s).

NOTE 4: NSCE server provides the updated S-NSSAI/DNN as a suggestion/guidance to PCF; however it is up to PCF to decide whether to perform the slice/DNN re-mapping

- The NSCE server sends the response to the NSCE client indicating success or failure.

### 9.11.2.3 Procedure for VAL server-triggered and network-based network slice adaptation for VAL application – subscribe and notify model

Figure 9.11.2.3-1 illustrates the VAL server-triggered and network-based procedure with subscribe and notify model where the NSCE server supports the network slice adaptation with the underlying 3GPP system for the VAL UEs of the VAL application.



**Figure 9.11.2.3-1: Network slice adaptation for VAL application**

- The VAL server sends a network slice adaptation subscribe request to the NSCE server for the VAL application (and the VAL UEs within the VAL application). This request may be in the form of exact requested network slice (and optionally DNN) for all the VAL UEs of the VAL application; or indication that the VAL application needs to be remapped to a different network slice (and optionally DNN). The request optionally includes the adaptation threshold of network slice adaptation as defined in Table 9.11.3.1-1.
- The NSCE server confirms the subscription and returns the network slice adaptation subscribe response.

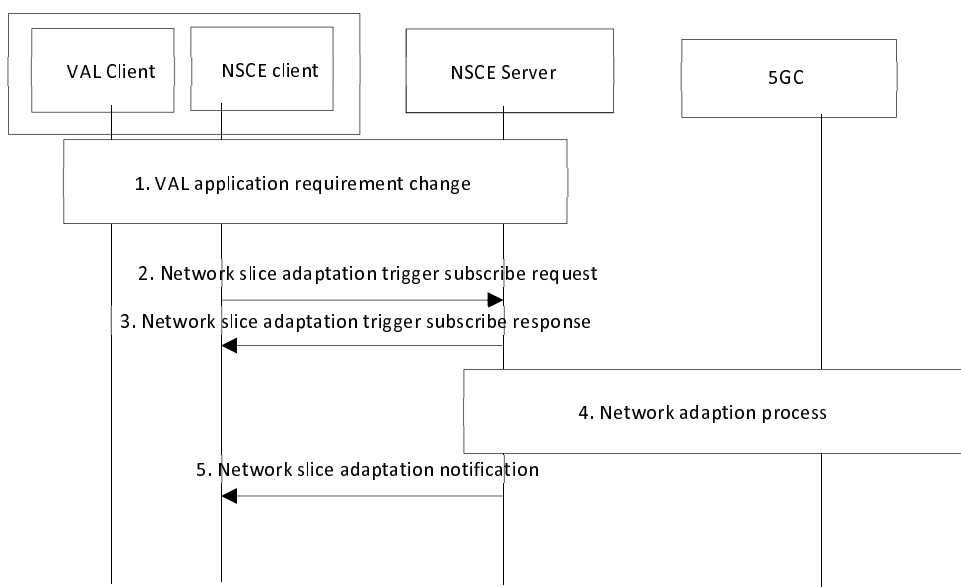
3. The NSCE server may interact with the 5GC and OAM to collect the network slice status and perform the network network slice adaptation per VAL UE as described in step 2- step 4 in clause 9.11.2.1.
4. When the network slice adaptation completes, and the adaptation result comes out and available, the NSCE server provides the network slice adaptation notification to the VAL server.

#### 9.11.2.4 Procedure for VAL UE-triggered and network-based network slice adaptation for VAL application - subscribe and notify model

Figure 9.11.2.4-1 illustrates the VAL UE-triggered and network-based procedure with subscribe and notify model where the NSCE server supports the network slice adaptation with the underlying 3GPP system for the VAL UEs of the VAL application.

Pre-condition:

- The NSCE client has connected to the NSCE server;



**Figure 9.11.2.4-1: Network slice adaptation for VAL application**

1. The VAL client provides a new application requirement to the NSCE client, indicating a new service profile for the VAL application. This may be in the form of a change at the application QoS requirements, location requirements, time window requirement, access type preference (e.g., 3GPP, non-3GPP or multi access) service operation change, or other application-related parameters.
2. The NSCE client sends a network slice adaptation trigger subscribe request to the NSCE server for the VAL application. This trigger may be in the form of exact requested network slice (and optionally DNN) for the VAL UE of the VAL application; or indication that the VAL application needs to be remapped to a different network slice (and optionally DNN). The trigger may also include additional application requirements based on step 1, e.g., the requested location criteria, time window.

NOTE 1 : How the requested network slice is known by the NSCE client is out of scope of this release.

3. The NSCE server confirms the subscription and responds with a network slice adaptation trigger subscribe response.
4. The NSCE server performs the network slice adaptation per VAL UE as described in step 3- step 4 in clause 9.11.2.2.
5. When the network slice adaptation completes, and the adaptation result comes out and available, the NSCE server provides the network slice adaptation notification to the NSCE client.



## 9.11.3 Information flows

### 9.11.3.1 Network slice adaptation request

Table 9.11.3.1-1 describes the information flow network slice adaptation request from the VAL server to the NSCE server.

**Table 9.11.3.1-1: Network slice adaptation request**

Information element	Status	Description
VAL service ID	M	The VAL service ID of the VAL application for which the network slice adaptation may corresponds to.
List of VAL UE IDs	M	List of the VAL UE IDs within the VAL service for which the slice adaptation request corresponds
Requested Network slice related identifier(s)	O	Identifier of network slice for which the VAL server requests to use for adaptation
Requested monitored Network slice related identifier(s)	O (see NOTE 1)	Identifier of the provisioned network slice(s) which are provisioned for the listed UE(s) and requested to be monitored by NSCE server
Requested DNN	O	Indication of the new DNN which is requested.
Requested Adaptation threshold	O (see NOTE 2)	The threshold of network slice adaptation
>Requested adaptation threshold of the delay of network slice	O	The network slice delay defined clause 5.1.1.1, 5.1.1.2, 5.1.1.3, in 3GPP TS 28.552 [19] and key performance indicators in clause 6.3, in TS 28.554 [20], and network slice related analytics report in clause 8.4.2.4.3, in 3GPP TS 28.104 [21].
NOTE 1: If this IE is not present then the NSCE server monitors all the slices provisioned for the listed UE(s) mentioned in this request. If this IE is present, the NSCE server monitors the network slice(s) only indicated by the identifier(s).		
NOTE 2: The NSCE is requested to adapt UE to the requested network slice only when the status of the provisioned network slice for the listed UE(s) crosses the requested threshold.		

### 9.11.3.2 Network slice adaptation response

Table 9.11.3.2-1 describes the information flow network slice adaptation response from the NSCE server to the VAL server.

**Table 9.11.3.2-1: Network slice adaptation response**

Information element	Status	Description
Result	M	Result includes success or failure of the network slice adaptation with the underlying network.
Cause	O	Indicates the cause of failure

### 9.11.3.3 Network slice adaptation trigger

Table 9.11.3.3-1 describes the information flow Network slice adaptation trigger from the NSCE client to the NSCE server.

**Table 9.11.3.3-1: Network slice adaptation trigger**

Information element	Status	Description
VAL UE ID(s)	M	The VAL UE ID(s) within the VAL service, for which the network slice adaptation trigger applies
VAL service ID	M	The VAL service ID of the VAL application for which the network slice configuration may corresponds to.
Requested S-NSSAI	M	Indication of the new S-NSSAI which is requested.
Requested DNN	O	Indication of the new DNN which is requested.
Request application requirements	O	The application-related request parameters
>Requested time window	O	Indication of the new scheduled time window that is requested
>Requested location criteria	O	Indication of the new location criteria that is requested
>Requested access type preference	O	Indication of the new access type (3GPP, non-3GPP or multi-access) preference that is requested.

#### 9.11.3.4 Network slice adaptation trigger response

Table 9.11.3.4-1 describes the information flow network slice adaptation trigger response from the NSCE server to the NSCE client and optionally to the VAL client.

**Table 9.11.3.4-1: Network slice adaptation trigger response**

Information element	Status	Description
Result	M	Result includes success or failure of the network slice adaptation.
Cause	O	Indicates the cause of failure

#### 9.11.3.5 Network slice adaptation subscribe request

Table 9.11.3.5-1 describes the information flow network slice adaptation subscribe request from the VAL server to the NSCE server.

**Table 9.11.3.5-1: Network slice adaptation subscribe request**

Information element	Status	Description
VAL service ID	M	The VAL service ID of the VAL application for which the network slice adaptation may correspond to.
List of VAL UE IDs	M	List of the VAL UE IDs within the VAL service for which the slice adaptation request corresponds
Requested Network slice related identifier(s)	O	Identifier of network slice for which the VAL server requests to use for adaptation
Requested monitored Network slice related identifier(s)	O (see NOTE 1)	Identifier of the provisioned network slice(s) which are provisioned for the listed UE(s) and requested to be monitored by NSCE server
Requested DNN	O	Indication of the new DNN which is requested.
Requested Adaptation threshold	O (see NOTE 2)	The threshold of network slice adaptation
>Requested adaptation threshold of the delay of network slice	O	The network slice delay defined clause 5.1.1.1, 5.1.1.2, 5.1.1.3, in 3GPP TS 28.552 [19] and key performance indicators in clause 6.3, in TS 28.554 [20], and network slice related analytics report in clause 8.4.2.4.3, in 3GPP TS 28.104 [21].
NOTE 1: If this IE is not present then the NSCE server monitors all the slices provisioned for the listed UE(s) mentioned in this request. If this IE is present, the NSCE server monitors the network slice(s) only indicated by the identifier(s).		
NOTE 2: The NSCE is requested to adapt UE to the requested network slice only when the status of the provisioned network slice for the listed UE(s) crosses the requested threshold.		

### 9.11.3.6 Network slice adaptation subscribe response

Table 9.11.3.6-1 describes the information flow network slice adaptation subscribe response from the NSCE server to the VAL server.

**Table 9.11.3.6-1: Network slice adaptation subscribe response**

Information element	Status	Description
Subscription ID	M (see NOTE)	Identifier of the subscription
Result	M	Result includes success or failure of subscription
Cause	O	Indicates the cause of failure
NOTE: Only present if the result is success.		

### 9.11.3.7 Network slice adaptation trigger subscribe request

Table 9.11.3.7-1 describes the information flow Network slice adaptation trigger subscribe request from the NSCE client to the NSCE server.

**Table 9.11.3.7-1: Network slice adaptation trigger subscribe request**

Information element	Status	Description
VAL UE ID(s)	M	The VAL UE ID(s) within the VAL service, for which the network slice adaptation trigger applies
VAL service ID	M	The VAL service ID of the VAL application for which the network slice configuration may corresponds to.
Requested S-NSSAI	M	Indication of the new S-NSSAI which is requested.
Requested DNN	O	Indication of the new DNN which is requested.
Request application requirements	O	The application-related request parameters
>Requested time window	O	Indication of the new scheduled time window that is requested
>Requested location criteria	O	Indication of the new location criteria that is requested
>Requested access type reference	O	Indication of the new access type (3GPP, non-3GPP or multi-access) preference that is requested.

### 9.11.3.8 Network slice adaptation trigger subscribe response

Table 9.11.3.8-1 describes the information flow network slice adaptation trigger subscribe response from the NSCE server to the NSCE client and optionally to the VAL client.

**Table 9.11.3.8-1: Network slice adaptation trigger subscribe response**

Information element	Status	Description
Subscription ID	M (see NOTE)	Identifier of the subscription
Result	M	Result includes success or failure of subscription
Cause	O	Indicates the cause of failure
NOTE: Only present if the result is success.		

### 9.11.3.9 Network slice adaptation notification

Table 9.11.3.9-1 describes the information flow network slice adaptation notification from the NSCE server to the VAL server or to the NSCE client.

**Table 9.11.3.9-1: Network slice adaptation notification**

Information element	Status	Description
Subscription ID	M (NOTE)	Identifier of the subscription
Adaption result	M	Result includes success or failure of the network slice adaptation with the underlying network.
Cause	O	Indicates the cause of failure

## 9.11.4 APIs

### 9.11.4.1 General

Table 9.11.4.1-1 illustrates the APIs for VAL server-triggered and network-based network slice adaptation.

**Table 9.11.4.1-1: List of APIs for network slice adaptation**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_ NSCE_NetworkSliceAdaptation	Network_slice_adaptation	VAL server	Request /Response

Table 9.11.4.1-2 illustrates the APIs for VAL UE-triggered and network-based network slice adaptation

**Table 9.11.4.1-2: List of APIs for network slice capability adaptation trigger**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_ NSCE_NetworkSliceAdaptationTrigger	Network_slice_adaptation_trigger	VAL server	Request /Response

## 9.11.4.2 SS\_NSCE\_NetworkSliceAdaptation API

### 9.11.4.2.1 General

**API description:** This API enables the VAL server to communicate with the network slice capability enablement server for network slice adaptation over NSCE-S.

### 9.11.4.2.2 Network\_Slice\_Adaptation

**API operation name:** Network\_Slice\_Adaptation

**Description:** Requesting for network slice adaptation.

**Known Consumers:** VAL server.

**Inputs:** See subclause 9.11.3.1

**Outputs:** See subclause 9.11.3.2

See subclause 9.11.2.1 for the details of usage of this API operation.

## 9.12 Slice related communication service lifecycle management exposure

### 9.12.1 General

The NSCE server supports the slice related communication service lifecycle management exposure to VAL server. The NSCE server acquires the application services related requirements for a specific VAL service from the vertical industry perspective, evaluates these requirements and then determines the network slice by pre-configured industry mapping relations or by KQI-KPI translation algorithms. After the network slice requirements are determined the NSCE server allocate proper network slice resources to support the application services. The NSCE server also enables the VAL server to reconfigure or disengage the slice related communication services for the application. The procedures in clause 9.12.2 are for creation, reconfiguration and disengagement of slice related communication service respectively.

### 9.12.2 Procedure

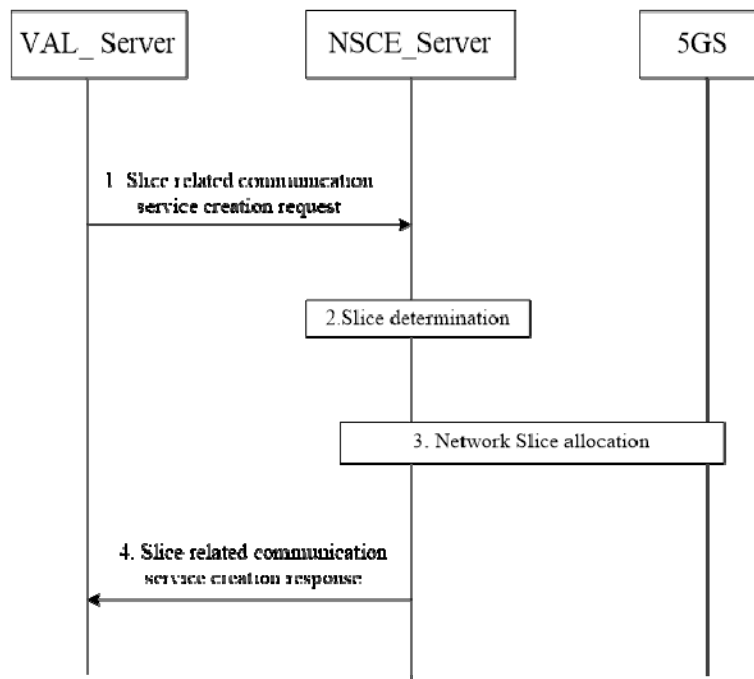
#### 9.12.2.1 Procedures on slice related communication service lifecycle management exposure

##### 9.12.2.1.1 Slice related Communication Service Creation

Figure 9.12.2.1.1-1 illustrates the procedure of slice related communication service creation. The NSCE helps to allocate network slice resources to support the application service required by the verticals.

Pre-conditions:

1. The VAL server has registered to receive NSCE services.



**Figure 9.12.2.1. 1–1: Slice related communication service creation**

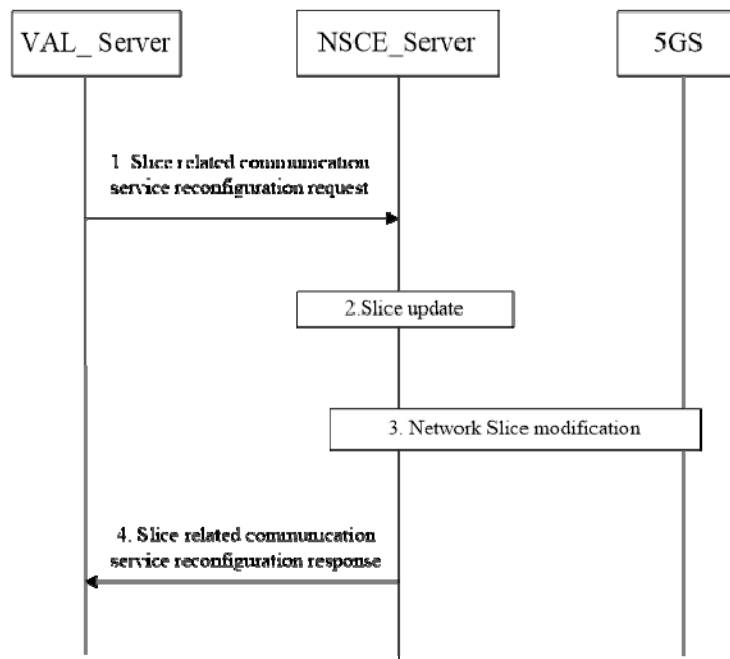
1. The VAL server sends a request to NSCE server to create a slice related communication service to support a specific application service, e.g., the VAL server wants to create a video streaming service in a future factory, the slice related communication service creation request carries the identifier of the video streaming service and the corresponding service attributes.
2. NSCE server translates the application service requirements (e.g., for a video streaming service, the service location and the resolution of the video) and then perform slice determination (e.g., dLtThptPerSlice, uLtThptPerSlice, latency as defined in serviceProfile TS 28.541[14]). The NSCE may perform the translation by pre-configured industry profiles or by KQI-KPI translation algorithms which are out scope of standard. The procedures of APIs translation defined in clause 9.3 are referred to.
3. NSCE server initiates the Slice Service subscription procedures by utilizing the management service of network slice creation as defined in clause 6.1, TS 28.531[5] exposed by EGMF defined in SA5. The slice creation request may fail due to the shortage of network resources or other causes.
4. NCSE server sends the slice related communication service creation response to VAL server. If the slice creation is succeeded in step3, then the response from NSCE server should include the attributes and the values of network slice determined by NSCE server. If the slice creation failed in step3, the NSCE server shall indicate the cause of the creation failure, e.g. the shortage of network slice resources.

#### 9.12.2.1. 2 Slice related Communication Service Reconfiguration

Figure 9.12.2.1.2-1 illustrates the procedure of slice related communication service reconfiguration to support the application service. The NSCE server provides the APIs to enable the VAL server to reconfigure the application service related requirements in case the current application service is not satisfied or application service is adjusted.

Pre-conditions:

1. The VAL server has registered to receive NSCE services.
2. The VAL server has requested the NSCE server to create a slice related communication service to support the application service.



**Figure 9.12.2.1. 2-1: Slice related communication service reconfiguration**

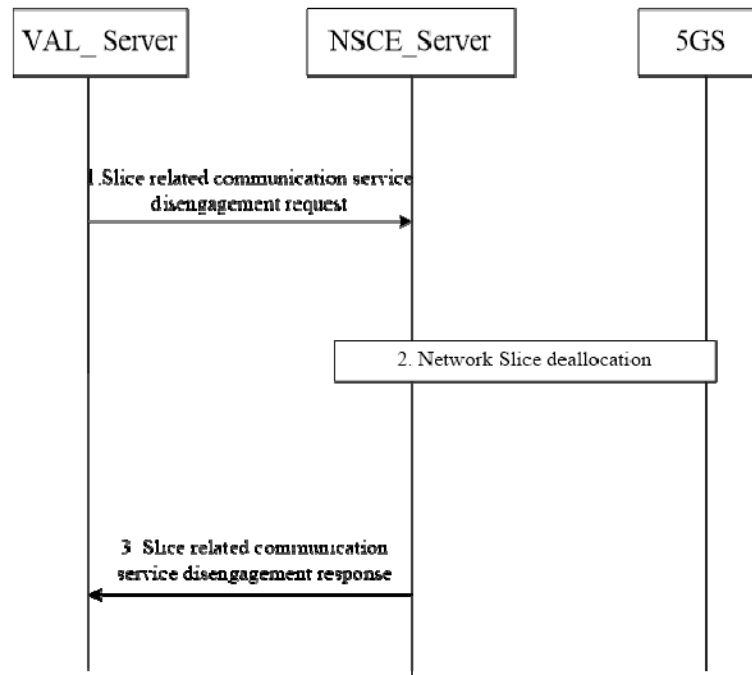
1. VAL server sends the slice related communication service reconfiguration request to the NSCE server to reconfigure the properties of the application service (e.g., In case there is a downgrade/upgrade of the application service where the application service profile is changed).
2. NSCE server translates the application requirements according to the reconfigured application properties then updates the requested network slice.
3. NSCE server initiates the Slice Service update procedures by utilize the management service of network slice modification as defined in clause 6.1, TS 28.531[5] exposed by EGMF defined in SA5.
4. NCSE server sends the slice related communication service modification response to VAL server.

### 9.12.2.1. 3 Slice related Communication Service disengagement

Figure 9.12.2.1.3-1 illustrates the procedure of slice related communication service disengagement. The NSCE server provides the APIs to enable the VAL server to terminate an application service.

Pre-conditions:

1. The VAL server has registered to receive NSCE services.
2. The VAL server has requested the NSCE server to create a slice related communication service to support the application service.



**Figure 9.12.2.1. 3-1: Slice related Communication service disengagement**

1. The VAL server sends a request to NSCE server to disengage the slice related communication service when the application service is to be terminated.
2. NSCE server initiates the Slice Service de-allocation procedures by utilizing the management service of network slice de-allocation as defined in clause 6.1, TS 28.531[5] exposed by EGMF defined in SA5.
3. NCSE server sends the slice related communication service disengagement response to VAL server.

## 9.12.3 Information flows

### 9.12.3.1 General

The following information flows are specified for slice related communication service lifecycle management:

- slice related communication service creation
- slice related communication service reconfiguration
- slice related communication service disengagement

### 9.12.3.2 Slice related communication service creation

Table 9.12.3.2-1 and Table 9.12.3.2-2 describe information elements for slice related communication service creation request and response between the VAL server and the NSCE server.



**Table 9.12.3.2-1: Slice related communication service creation request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service name	M	The name of the application service to be supported by the created slice related communication service, the value can be as followings: V2X service; Video streaming service; Remote control service; ...
VAL service ID	M	Identifier of the application service
Area of interest	M	The service area for which the application service profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
Application service profile	M	The list of the requirements of the corresponding application service
> ReqInfo	M	The element containing the reqName and reqValue
>>ReqName	M	The name of the application service requirement, the value of this IE can be as followings: the resolution of a video service, the end user numbers, the latency, ...
>>ReqValue	M	The corresponding value of the application service requirement

**Table 9.12.3.2-2: Slice related communication service creation response**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	Identifier of the application service to be supported by the created slice related communication service.
Result	M	Indicates the success or failure of the slice related communication service creation
Network slice info List	O (see NOTE 1)	The list of the network slice info determined by NSCE
> Network slice info	O (see NOTE 1)	The network slice info which includes the attributes and the corresponding values of network slice
>>S-NSSAI	O (see NOTE 1)	The identifier of network slice
>>attributes of network slice	O (see NOTE 1)	The list of attributes of the serviceProfile e.g, <i>dLtThptPerSlice</i> or latencies of network slice as defined in <i>serviceProfile</i> TS 28.541[10]
>>AttributeValues	O (see NOTE 1)	The corresponding values of the attributes of the service profiles that determined by the NSCE server
Cause	O (see NOTE 2)	Indicates the cause of creation failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise		

### 9.12.3.3 Slice related communication service reconfiguration

Table 9.12.3.3-1 and Table 9.12.3.3-2 describe information elements for slice related communication service reconfiguration request and response between the VAL server and the NSCE server.

**Table 9.12.3.3-1: Slice related communication service reconfiguration request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service name	M	The name of the application service to be upgrade/downgrade which requires the reconfiguration of the slice related communication service, the value can be as followings: V2X service; Video streaming service; Remote control service; ...
VAL service ID	M	Identifier of the application service
Area of interest	M	The service area for which the application profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
Application service profile	M	The list of the requirements of the corresponding application service to be changed
> ReqInfo	M	The element containing the reqName and reqValue
>>ReqName	M	The name of the application service requirement, the value of this IE can be as followings: the resolution of a video service, the end user numbers, the latency, ...
>>ReqValue	M	The corresponding updated value of the application service requirement

**Table 9.12.3.3-2: Slice related communication service reconfiguration response**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	Identifier of the application service
Result	M	Indicates the success or failure of the slice related communication service reconfiguration
Network slice info List	O (see NOTE 1)	The list of the network slice info updated by NSCE
> Network slice info	O (see NOTE 1)	The network slice info which includes the attributes and the corresponding values of network slice
>>S-NSSAI	O (see NOTE 1)	The identifier of network slice
>>Attributes of network slice	O (see NOTE 1)	The list of attributes of the serviceProfile e.g., <i>dLtThptPerSlice</i> or latencies of network slice as defined in <i>serviceProfile</i> TS 28.541[10]
>>AttributeValues	O (see NOTE 1)	The corresponding values of the attributes of the service profiles that updated by the NSCE server
Cause	O (see NOTE 2)	Indicates the cause of reconfiguration failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise		

## 9.12.3.4 Slice related communication service disengagement

**Table 9.12.3.4-1: Slice related communication service disengagement request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service name	M	The name of the application service to be terminated which requires the disengagement of the slice related communication service, the value can be as followings: V2X service; Video streaming service; Remote control service; ...
VAL service ID	M	Identifier of the application service

**Table 9.12.3.4-2: Slice related communication service disengagement response**

Information element	Status	Description
Result	M	Indicates the success or failure of the slice related communication service disengagement request
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	Identifier of the application service
Cause	O(see NOTE)	Indicates the cause of disengagement failure
NOTE: Shall be present if the result is failure and shall not be present otherwise		

## 9.12.4 APIs

## 9.12.4.1 General

Table 9.12.4.1-1 and 9.12.4.1-2 illustrate the API for slice related communication service lifecycle management exposure.

**Table 9.12.4.1-1: SS\_NSCE\_SliceCommServiceCreation**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_SliceCommService_Creation	SliceCommService_Creation_Request	Request /Response	VAL server

**Table 9.12.4.1-2 SS\_NSCE\_SliceCommServiceReconfiguration**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_SliceCommService_Reconfiguration	SliceCommService_Reconfiguration_Request	Request /Response	VAL Server

**Table 9.12.4.1-3: SS\_NSCE\_SliceCommServiceDisengagement**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_SliceCommService_Disengagement	SliceCommService_Disengagement_Request	Request /Response	VAL Server

## 9.12.4.2 SS\_NSCE\_SliceCommService\_Creation API

**API operation name:** SliceCommService\_Creation

**Description:** The consumer requests to create the slice related communication service

**Known Consumers:** VAL server.

**Inputs:** See table 9.12.3.2-1.

**Outputs:** See table 9.12.3.2-2.

See clause 9.12.2.1.1 for details of usage of this operation.

### 9.12.4.3 SS\_NSCE\_SliceCommService\_Reconfiguration API

**API operation name:** SliceCommService\_Reconfiguration

**Description:** The consumer requests to report reconfigure the slice related communication service.

**Known Consumers:** VAL server.

**Inputs:** See table 9.12.3.3-1.

**Outputs:** See table 9.12.3.3-2.

See clause 9.12.2.1.2 for details of usage of this operation.

### 9.12.4.4 SS\_NSCE\_SliceCommService\_Disengagement API

**API operation name:** SliceCommService\_Disengagement

**Description:** The consumer requests to disengagement the slice related communication service.

**Known Consumers:** VAL server.

**Inputs:** See table 9.12.3.4-1.

**Outputs:** See table 9.12.3.4-2.

See clause 9.12.2.1.3 for details of usage of this operation.

## 9.13 Predictive slice modification in Inter-PLMN based slice service continuity

### 9.13.1 General

This feature applies to the specific deployment where NSCE service provider provides its services when connected to two PLMNs and has SLA with them (i.e. deployment shown in 3GPP TS 23.434 [2] Figure 8.2.2-2). In this feature, the NSCE server initially receives an expected/predicted UE location/mobility change request outside a PLMN1 slice service area for one or more UEs within the VAL application session (e.g. such session can be a V2X session). Then, the NSCE server checks with 5GS (OAM, 5GC) whether the serving slice is available and can offer the same performance at the target PLMN. The NSCE server evaluates the need for a slice modification (e.g. a slice lifecycle related trigger change). Based on this decision/recommendation, it provides the action to the OAM of PLMN2 proactively, before UE mobility happens.

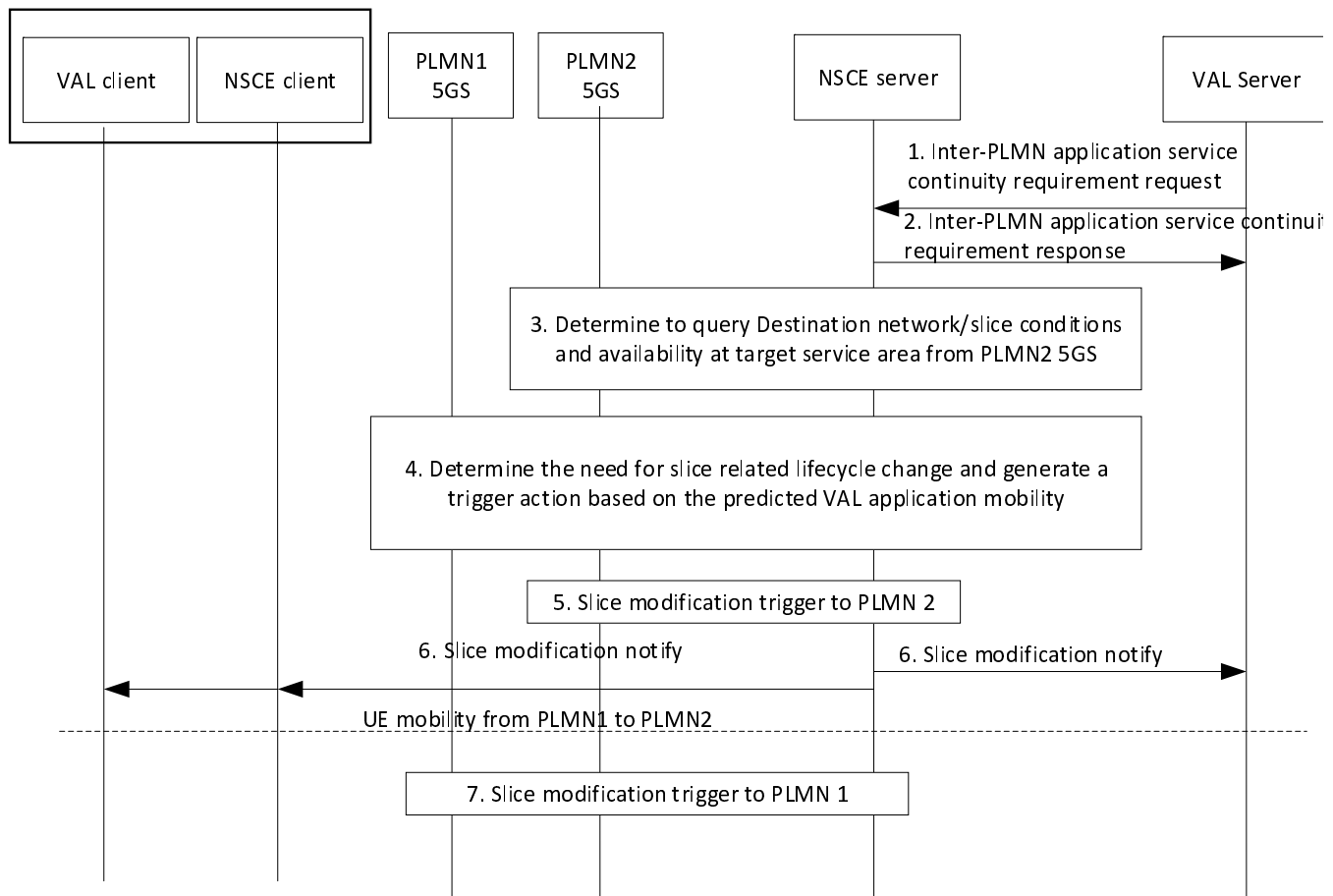
### 9.13.2 Procedure

In the procedure shown in Figure 9.13.2-1, a mechanism is provided to allow for slice modification when a vertical application of single or group of VAL UEs migrates (or is expected/predicted to migrate) to a different PLMN supported by the same NSCE server.

Pre-conditions:

1. Enterprise hosting the VAL server has SLA for slice services with NSCE service provider.

2. The VAL server has subscribed to the network slice capability enablement server managing slice services from PLMN1 and PLMN2.
3. The VAL client of VAL UE is mapped to Slice#1, and NSCE client of VAL UE has established a connection to PLMN1.
4. The NSCE server is connected to 5GS of PLMN1 and PLMN2.
5. The VAL server is subscribed to and received mobility predictions of UE location change (according to 6.7.2.3 of 3GPP TS 23.288 [4]) from PLMN1 and/or PLMN2 in advance before the actual event. . The VAL server correlated received mobility predictions and determined PLMN change.



**Figure 9.13.2-1: Predictive Inter-PLMN slice service continuity**

1. The VAL server sends to NSCE server an Inter-PLMN application service continuity requirement request due to predicted/expected UE or group UE mobility from source service area of slice1 in PLMN1 to a target service area covered by a different slice service area in slice#2/PLMN2.

NOTE: Such UE predicted mobility at the VAL server can be available before the event based on UE mobility analytics received by NWDAF or can be predicted by the VAL layer (VAL server or VAL UE).

2. NSCE server sends an Inter-PLMN application service continuity requirement response to the VAL server as positive or negative acknowledgement depending on its capability to provide such service serving both areas/slices in both PLMNs and available resources.
3. NSCE server determines to query the underlying 5G system on the slice availability and conditions at the target service area/slice2/PLMN2 (based on step 1 requirement). Such query may be in form of a request/response and include:

- a. NSCE server interacting with 5GS/PLMN2 to query the UEs specific information (location, UEs connection capabilities) as well as network conditions, slice related analytics (from NWDAF as specified in 3GPP TS 23.288 [4]).
  - b. NSCE server may also interact with 5GS/PLMN2 to query on the target slice availability and the up-to-date configured slice parameters e.g. slice RRM policies, modification of the NSI/NSSI resources (see TS 28.531 [8], 5.1.12) at the target service area and measurements for the slice at the target area.
4. NSCE server determines the need for a slice lifecycle change at the slice target area and translates this to a trigger action. This trigger action can be based on the outcome of step 3 and can be a requested slice modification (slice2/PLMN2) or creation/instantiation of new slice at the target area (this may happen if a group of UEs are moving to the target area and the requested slice2 is missing in the target area).
  5. The NSCE server may send the trigger action as a slice modification trigger request to the slice provisioning MnS producer at OAM/PLMN2 (e.g. slice modification for network slice) to extend slice availability to the target service area based on the expected/predicted VAL UE or VAL group mobility. As response to the trigger action, the provisioning MnS producer provides a slice modification trigger response with a positive or negative result.
  6. After the slice lifecycle change execution (based on the indication in step 5), the NSCE server sends a notification to the VAL server and optionally to the VAL client containing the positive or negative result from step5.
  7. If big number of UEs is migrating from PLMN1 to PLMN2, there might be a need to further modify/reduce the respective slice resources of PLMN1. NSCE sends trigger request to the slice provisioning MnS producer at OAM/PLMN1 (e.g. slice modification for network slice) to decrease slice availability to the source area after the UEs have migrated.

### 9.13.3 Information flows

#### 9.13.3.1 General

The following information flows are specified for predictive inter-PLMN slice service continuity:

- Inter-PLMN application service continuity requirement
- Slice modification notification

#### 9.13.3.2 Inter-PLMN application service continuity requirement request

Table 9.13.3.2-1 and Table 9.13.3.2-2 describe information elements inter-PLMN application service continuity requirement request and response between the VAL server and the NSCE server.

**Table 9.13.3.2-1: Inter-PLMN application service continuity requirement request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
Security credentials	M	Security credentials resulting from a successful authorization.
VAL service ID	M	The identifier of the VAL service for which the requirement request applies
VAL UE ID list	O	The list of VAL UE IDs for which the requirement request applies
Service Continuity Requirement	M	The service continuity requirement which can be the expected or predicted migration of the VAL application or a list of VAL UEs within the application to a target area.
Target PLMN ID	M	PLMN identifier of the target PLMN
Slice identifier	O (see NOTE)	The slice identifier (S-NSSAI, NSI ID or ENSI) which is mapped to the VAL application, if known by the VAL server
Target Service Area	O	The target area can be represented as the geographical coordinates / set of waypoints outside the original service area, where the VAL application/ UE(s) is expected or predicted to move.
Application QoS requirements	O	The QoS requirements / KPIs for the VAL service
NOTE: Slice info can be available based on SLA between VAL service provider and network operator.		

**Table 9.13.3.2-2: Inter-PLMN application service continuity requirement response**

Information element	Status	Description
Result	M	The result of the request (positive or negative acknowledgement)

### 9.13.3.3 Inter-PLMN slice modification notify

Table 9.13.3.3-1 describes information elements for the inter-PLMN slice modification notify message from the NSCE server to the VAL server or the VAL client (via NSCE client).

**Table 9.13.3.3-1: Inter-PLMN slice modification notify**

Information element	Status	Description
VAL service ID	M	The identifier of the VAL application which is impacted by the slice modification
VAL UE ID list	O	The identifiers of the VAL UEs which are impacted by the slice modification
Slice identifier	M	The slice identifier (S-NSSAI, NSI ID or ENSI) which is used and/or modified to extend slice availability to the target service area
PLMN ID	M	PLMN identifier of the PLMN where modification was performed
Target Service Area	M	The target area, can be represented as the geographical coordinates / set of waypoints outside the original service area, for which the modification applies.

## 9.13.4 APIs

### 9.13.4.1 General

Table 9.13.4.1-1 illustrates the API for inter-PLMN application service continuity exposure.

**Table 9.13.4.1-1: Inter-PLMN application service continuity requirement**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_InterPLMN_Continuity	Inter-PLMN_Continuity_Requirement	Request /Response	VAL server
SS_NSCE_InterPLMN_Slice_Modification_Notify	Inter-PLMN_Slice_Modification_Notify	Notify	VAL server or VAL client

### 9.13.4.2 SS\_NSCE\_Inter-PLMN\_Continuity API

**API operation name:** Inter-PLMN\_Continuity\_Requirement

**Description:** The consumer requests to have inter-PLMN slice service continuity

**Known Consumers:** VAL server.

**Inputs:** See table 9.13.3.2-1.

**Outputs:** See table 9.13.3.2-2.

See clause 9.13.2 for details of usage of this operation.

### 9.13.4.3 SS\_NSCE\_Inter-PLMN\_slice modification notify API

**API operation name:** Inter-PLMN\_Slice\_Modification\_Notify

**Description:** The NSCE notifies about slice modification

**Known Consumers:** VAL server.

**Inputs:** See table 9.13.3.3-1

**Outputs:** None

See clause 9.13.2 for details of usage of this operation.

## 9.14 Network slice diagnostics

### 9.14.1 General

Network slice diagnostics provides possibility for the vertical/ASP using VAL server to receive information about the specific event(s) related to service experience. The vertical/ASP using the VAL server has estimated bad QoE for a mobile user or service – either reported from a mobile user or service or detected by application and can initiate a check with NSCE. The NSCE server can provide details related to the identified event.

### 9.14.2 Procedure

#### 9.14.2.1 Network slice diagnostics procedure

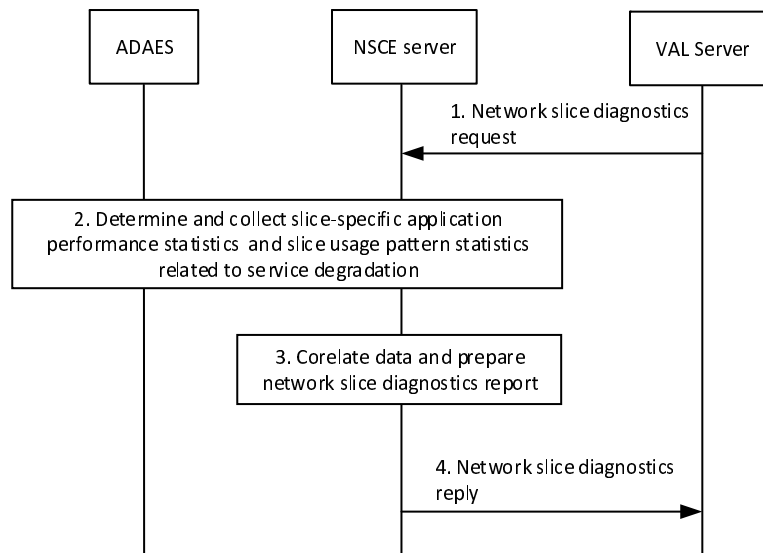
In the procedure shown in Figure 9.14.2.1-1, a mechanism is provided to allow for vertical/ASP using VAL server to initiate request for network slice diagnostics and receive all the relevant information about specific events.

Pre-conditions:

1. Enterprise hosting the VAL server has SLA for slice services with NSCE service provider.
2. The VAL server has subscribed to the network slice capability enablement server managing slice services.



3. The NSCE server has initiated monitoring and gathering statistical data about its managed slices from ADAES according to TS 23.436 clause 8.3 and 8.7.
4. The VAL server has identified there is specific event where the application has experienced service degradation (reported errors from VAL client for degraded service (bad quality), reported errors from application (downgrade of communication, detected communication errors)).



**Figure 9.14.2.1-1: Network slice diagnostics procedure**

1. The VAL server sends to NSCE server a network slice diagnostics request containing information about detected service degradation.
2. NSCE server determines which specific statistics to request from ADAES based on the indicated service degradation. If the service degradation is related to detected communication error, then slice usage pattern statistics are needed. If bad quality is reported from the VAL client slice-specific application performance statistics are needed. NSCE server collects the needed statistics based on the procedure described in TS23.436 clause 8.7.3.
3. Based on the received statistics information and input from VAL server, the NSCE server correlated data and prepares network slice diagnostics report about the needed diagnostics.
4. NSCE server sends network slice diagnostics reply to VAL server.

## 9.14.3 Information flows

### 9.14.3.1 General

The following information flows are specified for Network slice diagnostics:

- Network slice diagnostics request and response

### 9.14.3.2 Network slice diagnostics request and response

Table 9.14.3.2-1 and Table 9.14.3.2-2 describe information elements for the network slice diagnostics request and response between the VAL server and the NSCE server.

**Table 9.14.3.2-1: Network slice diagnostics request**

Information element	Status	Description
VAL information	M	The information of the VAL server.
Network Slice Diagnostics ID	M	Identifier of the network slice diagnostics.
Service degradation type	M	The information of service degradation.
> VAL service identity	M	Identifier of the VAL service to be monitored.
>ErrorsList	M	The list of registered errors by VAL server.
>> ErrorName	M	The name of the reported error: detected communication error; RTT above limit; QoS downgrade.
>> Network slice related Identifier(s)	M	Identifier(s) of the network slice to be checked.
>> UE(s) related Identifier(s)	O	Identifier(s) of the related UE(s).
>> Area of interest	O	The service area for which the requirement applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
>>StartTime	M	The start time point of the registered service degradation.
>>EndTime	M	The end time point of the registered service degradation.

**Table 9.14.3.2-2: Network slice diagnostics response**

Information element	Status	Description
Result	M	Indicates the success or failure of network slice diagnostics request.
> Network slice Diagnostics ID	O (see NOTE 1)	Identifier of the network slice diagnostics.
>StartTime	O (see NOTE 1)	The start time point of the available data for network slice service degradation.
>EndTime	O (see NOTE 1)	The start time point of the available data for network slice service degradation.
>Data type	O (see NOTE 1)	The type of the reported data samples (UE data, network data, application data).
>Data output	O (see NOTE 1)	The reported data related to the reported error(s) in the network slice diagnostics request.
>Cause	O (see NOTE 2)	Indicates the cause of the network slice diagnostics request failure.
NOTE 1: Shall be present if the result is success. NOTE 2: Shall be present if the result is failure.		

## 9.14.4 APIs

### 9.14.4.1 General

Table 9.14.3.2-1 and 9.14.3.2-2 illustrate the API for network slice diagnostics.

**Table 9.14.4.1-1: List of APIs for the network slice diagnostics feature**

API Name	API Operations	Known Consumer(s)	Communication Type
SS_NSCE_Network Slice Diagnostics	Network Slice Diagnostics	VAL server	Request / Response

## 9.14.4.2 SS\_NSCE\_Network\_Slice\_Diagnostics

### 9.14.4.2.1 General

**API description:** This API enables the VAL server to communicate with the network slice capability enablement server for requesting network slice diagnostics over NSCE-S.

### 9.14.4.2.2 Network\_Slice\_Diagnostics

**API operation name:** Network\_Slice\_Diagnostics

**Description:** Request for Network\_Slice\_Diagnostics to the NSCE server and receiving a response / result.

**Known Consumers:** VAL server.

**Inputs:** See table 9.14.3.2-1.

**Outputs:** See table 9.14.3.2-2.

## 9.15 Network slice fault management capability exposure

### 9.15.1 General

5GS is required to provide suitable APIs to allow a trusted third-party to monitor the network slice used for the third-party according to operator policies. And network diagnostics is of key importance that helps with scanning, diagnosing and identifying problems within a network. Diagnostics includes gathering data and continuously providing sufficient fault diagnosis results that characterize the quality of the network connections and services. Exposure of relevant (and possibly aggregated) performance parameters ensures a quick reaction in case of failure as well as identifying network connectivity, performance and other related problems. Also, the alarm data from different sources (e.g., OAM, VAL server, NSCE client) can be used to help the third-party to diagnose the fault problem of the services, locate the fault causes, and to be aware of the potential fault. In TS 28.545 [23], the fault supervision management services are standardized by which the alarm of the network slice instance from network resource aspects can be subscribed and reported. This alarm information together with the application function's fault report and communication service related knowledge can be utilized by the NSCE to diagnose the cause of the service performance deterioration, locate the fault of the communication services, and expose the fault report to the third-party.

For example, if the status of the required communication is not correct, the SEAL/NSCE derives this alarm information from application functions. In this case, it is the SEAL/NSCE's responsibility to detect whether this fault is caused by the 5GS network or not and exposed the fault report to the third-party. If it is, then the SEAL/NSCE may inform the management functions the location of the fault and ask for the maintenance of the managed functions to clear the fault.

This service provides a possible procedure to illustrate the network slice fault management capability exposed by NSCE server. The performance data and alarm data from multiple sources is helpful to characterize the quality of the network connection.

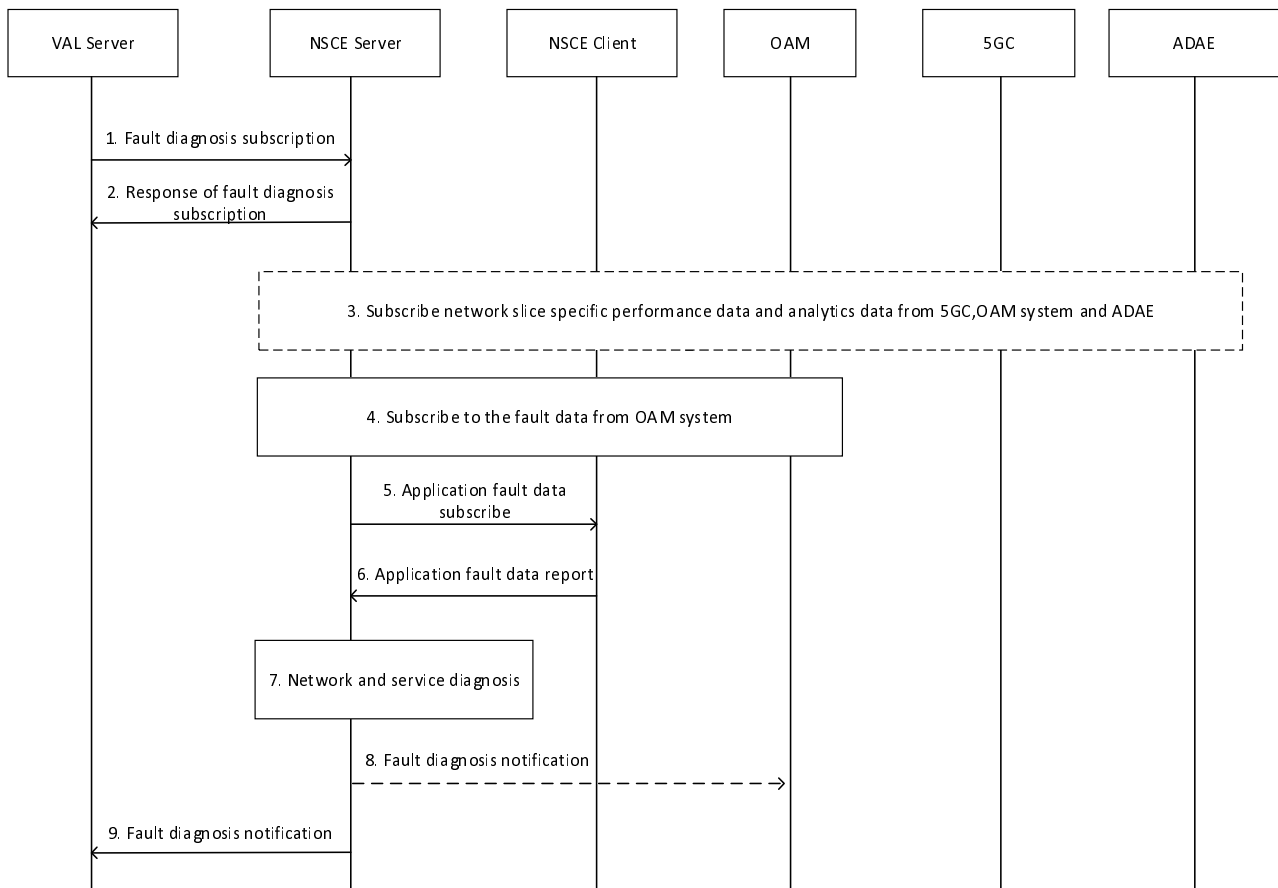
### 9.15.2 Procedure

#### 9.15.2.1 Procedures on network slice fault management capability exposure

Figure 9.15.2.1-1 illustrates the network slice fault management process to address the key issue 4 of network slice fault management.

Pre-conditions:

1. The network slice enabler layer is capable to interact with NEF and OAM system.
2. The VAL server has checked the status of application layer.



**Figure 9.15.2.1-1: Support for predictive slice modification in distributed NSCE server deployments**

1. The VAL server sends a subscription to NSCE server to subscribe the fault diagnosis of the applications and networks. This request may be triggered by the errors of the applications detected by the VAL server itself, or the VAL server may periodically collect the fault diagnostic report subscribing to the NSCE.
2. NSCE server sends the response of the subscription to VAL server.
3. Optionally, on receiving the request from VAL server, NSCE server subscribes the performance data of network slice from 5GS. For OAM system, the APIs defined in clause 11.3, TS 28.532[7] is utilized. For CN functions, the APIs of Nnwdaf\_AnalyticsInfo service defined in clause 7.3, TS 23.288[4] can be utilized.

The analytics data defined in clause 6.3 to clause 6.14, TS 23.288[4], network slice instance related performance data defined in clause 5, TS 28.552[19] and network analytics data in clause 8.3 and clause 8.4 TS 28.104[21] exposed by OAM system may be acquired. Also, the analytics result of slice-specific performance and slice usage analytics defined in TS 23.436[26] can be utilized.

4. NSCE server subscribes the alarms of network slice instances from OAM system via the procedures defined in clause 6.1, TS 28.545[23], and the alarms are defined in clause 4.1.1.1, TS 32.111-1 [24], e.g., the fault of communication, environmental, equipment, processing error, QoS for device/resource/file/functionality/smallest.
5. NSCE server may subscribe the alarm information (e.g., the 5GS network is not work or the required performance is under the threshold which leads the service's problem) collected by NSCE client if possible. The information collected by the NSCE client depends on the third-parties' requirements and implementation.
6. NSCE client report the requested fault information to NSCE server.

Note: The collection of fault data from NSCE client follows the mechanism defined in EVEX in SA4.

7. Every time the notifications from the OAM, NSCE client or ADAEs are received, NSCE server correlates this data, diagnoses the causes of the fault of the applications or services by analysing the fault information from different sources and prepares report for the VAL to be notified about the respective fault event. For example, the RAN function of the slice instance which is utilized to support the service of the smart grid application, for a certain time duration, the smart grid suffered the bad experience caused by Service Availability Failure Events,

and in the RAN function is detected continuously to report an alarm of environmental fault in the same time duration, then the environment fault may be the root cause of the Service Availability Failure and should be prioritized to be solved. The fault may be identified with "critical", "major", "minor", "ignore" to show its prioritization.

8. If the NSCE server detects that the application/service error (reported from NSCE client) is caused by the 5GS, the VAL server may send the fault diagnosis report to OAM system to indicate the server fault which causes the application/service failure by utilizing the NSCE-OAM interface.

NOTE: The APIs utilized to send the fault diagnosis report to OAM will re-utilize the fault management services in TS 28.532[7] exposed by EGMF as defined in TS 28.533[25].

9. NSCE server send a notification to VAL server with the fault diagnostics report prepared in step 7.

### 9.15.3 Information flows

#### 9.15.3.1 General

The following information flows are specified for the network slice fault management capability exposure.

#### 9.15.3.2 Fault diagnosis subscription request

Table 9.15.3.2-1 describes information elements for fault diagnosis subscription.

**Table 9.15.3.2-1: Fault diagnosis subscription**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	The identifier of the VAL service for which the request applies
VAL UE ID list	O	The list of VAL UE IDs for which the request applies
Fault diagnosis information	O	Indicate what kind of fault is need for the subscription, e.g., time, specific problem, etc.
Network slice related Identifier(s)	O	Identifier(s) of the network slice to be monitored

#### 9.15.3.3 Response of fault diagnosis subscription

Table 9.15.3.3-1 describes information elements for response of fault diagnosis subscription.

**Table 9.15.3.3-1: Response of fault diagnosis subscription**

Information element	Status	Description
Subscription ID	M	Subscription identifier corresponding to the subscription
Result	M	The result of the request (positive or negative acknowledgement)

#### 9.15.3.4 Fault diagnosis notification

Table 9.15.3.4-1 describes information elements for fault diagnosis notification.

**Table 9.15.3.3-4: Fault diagnosis notification**

Information element	Status	Description
Subscription ID	M	Subscription identifier corresponding to the subscription
Fault Report ID	M	Identifier of the fault Report
FaultReport	M	The report of the fault diagnosis
>CorrelatedAlarmList	M	The list of the correlated alarms
>>CorrelatedAlarm	M	The correlated alarms
>rootCause	M	The root cause of the fault

## 9.15.4 APIs

### 9.15.4.1 General

Table 9.15.4.1-1 illustrates the APIs for the network slice fault management capability exposure.

**Table 9.15.4.1-1: fault diagnosis request.**

API Name	API Operations	Communication Type	Consumer(s)
SS_NSCE_FaultDiagnosis	Fault_Diagnosis_Subscribe	subscription / notification	VAL server
	Fault_Diagnosis_Notification		

### 9.15.4.2 SS\_NSCE\_FaultDiagnosis API

#### 9.15.4.2.1 General

**API description:** This API enables the VAL server to communicate with the network slice capability enablement server to request the fault diagnosis over NSCE-S.

#### 9.15.4.2.2 Fault\_Diagnosis\_Subscribe

**API operation name:** Fault\_Diagnosis\_Subscribe

**Description:** The consumer subscribes to the network slice fault diagnosis

**Known Consumers:** VAL server

**Inputs:** See table 9.15.3.2-1

**Outputs:** See table 9.15.3.3-1

#### 9.15.4.2.3 Fault\_Diagnosis\_Notification

**API operation name:** Fault\_Diagnosis\_Notification

**Description:** The consumer notifies the network slice fault diagnosis results

**Known Consumers:** VAL server

**Inputs:** None

**Outputs:** See table 9.15.3.4-1

## 9.16 Slice requirements verification and alignment capability exposure

### 9.16.1 General

Verticals can compare the QoS achieved by the provider with the QoS/slice requirements and its own experience of the QoS to verify if the QoS/Slice requirements are reasonably configured. To order a slice with certain slice requirements parameters and their values, the verticals will put their best effort into slice requirements translation. However, they are not able to guarantee that all the potential factors will be considered to generate the optimal slice requirements parameters on the first try.

In some cases, there may be some unforeseen exceptions (e.g., unexpected traffic changes) and the current configured slice requirements parameters are not able to fulfil the verticals requirements (e.g., more resources are required to address the exceptions), the VAL client may also suffer unsatisfied experience. Or in some other cases, when the service is executed on the required slice, the slice may not fully match the service real-time running conditions, for example, maybe only 60% of the slice resource is used to support the service, and rest of the slice resource is always idle, or the slice resource is insufficient due to under-provisioning.

Hence, NSCE is able to provide the capability of comparing the QoS achievement status together with the OAM QoS data versus real customer QoS data (e.g., Mean Opinion Score) collected from VAL client to check whether the existing QoS/Slice related data is able to satisfy the VAL clients and send periodically alignment notifications to VAL server for the slice requirements.

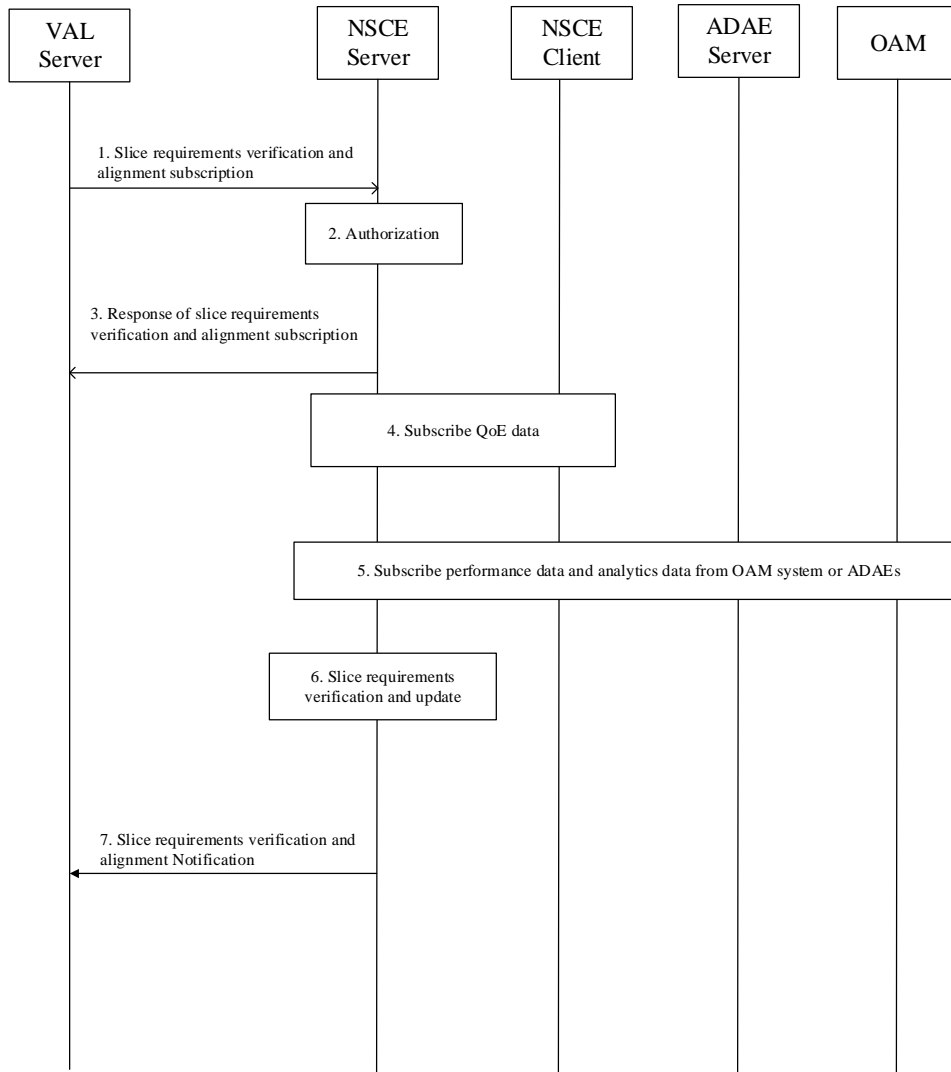
### 9.16.2 Procedure

#### 9.16.2.1 Procedures on slice requirements verification and alignment capability exposure

Figure 9.16.2.1-1 provides a possible procedure of slice requirements verification and alignment capability exposure.

Pre-conditions:

1. The NSCE Server has subscribed to the service of network slice performance management provided by EGMF.



**Figure 9.16.2.1-1: Slice requirements verification and alignment process**

1. The VAL server sends slice requirements verification and alignment subscription NSCE server to require the NSCE server to check whether the slice requirements (by configuring the attributes of *serviceProfile*) matches the real network slice usage status, the request may include the S-NSSAI, the ID of the VAL server, the slice requirements parameters (attributes of *serviceProfile*) which is requested to be aligned.
2. The NSCE server checks if the VAL server is authorized to trigger the service of slice requirements alignment.
3. The NSCE server response to VAL server with the result of slice requirements verification and alignment request, e.g., the slice requirements alignment request is accepted.
4. The NSCE server may optionally subscribe the QoE data from the NSCE client. The QoE data can refer to the data defined in clause 16, TS 26.114[27]. Note: The QoE data collection from NSCE client follows the mechanism defined in EVEX work in SA4.
5. The NSCE server subscribes the network slice related performance data and KPIs (e.g., the average PRB usage, the distribution of the PRB usage) defined in TS 28.552[19]. The NSCE server can also subscribe the analytics data (both statistics and predictions) from MDAS and ADAEs.
6. NSCE server periodically receives the subscribed data (from steps 4 and 5) and compares the slice requirement parameters of network slice (the values of attributes of *serviceProfile*, e.g., radioSpectrum, the maxNumberOfUEs) with network slice performance statistics (e.g., active number of users, the average PRB usage, the distribution of the PRB usage of the S-NSSAI) to generate the optimal slice requirements for the required service (represented by S-NSSAI) of the vertical. This step depends on implementation (e.g., if in



implementation specific time window the VAL client experience is satisfied while the network slice resources are with low utilization, the resources required in the slice requirements could be reduced based on predictions and statistics).

7. Based on the analysis in step 6, the NSCE server periodically sends notifications to VAL server to inform the recommended changes of the slice requirements parameters.

### 9.16.3 Information flows

#### 9.16.3.1 General

The following information flows are specified for slice requirements verification and alignment capability exposure.

#### 9.16.3.2 Slice requirements verification and alignment subscription

Table 9.16.3.2-1 describes information elements for slice requirements verification and alignment subscription.

**Table 9.16.3.2-1: Slice requirements verification and alignment subscription**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	The identifier of the VAL service for which the requirement request applies
VAL UE ID list	O	The list of VAL UE IDs for which the requirement request applies
Slice identifier	M	The slice identifier (S-NSSAI, NSI ID or ENSI) which is mapped to the VAL application, if known by the VAL server
Slice Requirements List	M	The list of the slice requirements which need to be aligned.
>sliceRequirement	M	The requirement which need to be aligned, this parameter refers to the attribute of serviceProfile defined in TS 28.531[5]

#### 9.16.3.3 Response of slice requirements verification and alignment subscription

Table 9.16.3.3-1 describes information elements for response of slice requirements verification and alignment subscription.

**Table 9.16.3.3-1: Response of slice requirements verification and alignment subscription**

Information element	Status	Description
Result	M	The result of the subscription (positive or negative acknowledgement)

#### 9.16.3.4 Slice requirements verification and alignment notification

Table 9.16.3.4-1 describes information elements for slice requirements verification and alignment notification.

**Table 9.16.3.4-1: Slice requirements verification and alignment notification**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	The identifier of the VAL service for which the requirement request applies
VAL UE ID list	O	The list of VAL UE IDs for which the requirement request applies
Slice identifier	M	The slice identifier (S-NSSAI, NSI ID or ENSI) which is mapped to the VAL application, if known by the VAL server
Updated Slice requirements info	M	The attributes and values of slice requirements

## 9.16.4 APIs

### 9.16.4.1 General

Table 9.16.4.1-1 illustrates the APIs for the network slice verification and alignment capability exposure.

**Table 9.16.4.1-1: List of APIs for network slice verification and alignment**

API Name	API Operations	Communication Type	Consumer(s)
SS_NSCE_SliceReq_VerifyAndAlign	SliceReq_VerifyAndAlign_Subscribe	Subscription/Notification	VAL server
	SliceReq_VerifyAndAlign_Notification		

### 9.16.4.2 SS\_NSCE\_SliceReq\_VerifyAndAlign API

#### 9.16.4.2.1 General

**API description:** This API enables the VAL server to communicate with the network slice capability enablement server to consume the network slice requirements verification and alignment service.

#### 9.16.4.2.2 SliceReq\_VerifyAndAlign\_Subscribe

**API operation name:** SliceReq\_VerifyAndAlign

**Description:** The consumer subscribe to the network slice requirements verification and alignment.

**Known Consumers:** VAL server

**Inputs:** See table 9.16.3.2-1

**Outputs:** See table 9.16.3.3-1

#### 9.16.4.2.3 SliceReq\_VerifyAndAlign\_Notification

**API operation name:** SliceReq\_VerifyAndAlign\_Notification

**Description:** The consumer is notified with the updated network slice requirements information according to the slice requirements verification and alignment.

**Known Consumers:** VAL server

**Inputs:** None

**Outputs:** See table 9.16.3.4-1

## 9.17 Network Slice Information delivery

### 9.17.1 General

The NSCE layer provides the feature of Network Slice information delivery. The Network Slice information is necessary for the VAL server to manage the network slice for their service such as preparation, creation, activation and termination (tear-down) of network slice.

The Network Slice information that is delivered to the VAL server depends upon network operator policy. The network slice capabilities and management options offered to the customer are determined by a business agreement prior to and outside of the scope of 3GPP standards.

The NSCE server performs the below.

- Retrieval of Network Slice ServiceProfile in 5GS (e.g., NSMF) as specified in 3GPP TS 28.532 [7]
- Conversion of Network Slice ServiceProfile (specified in 3GPP TS 28.541 [10]) to Network Slice Information
- Creation of Network Slice Information
- Storing of Network Slice Information
- Delivery of Network Slice Information to VAL server that the Network Slice Customer is authorized to use.

NOTE: The Network Slice Information provided to the VAL server depends on service agreements.

The VAL server as a Network Slice consumer makes use of the delivered Network Slice information for the Network Slice Lifecycle management for its service.

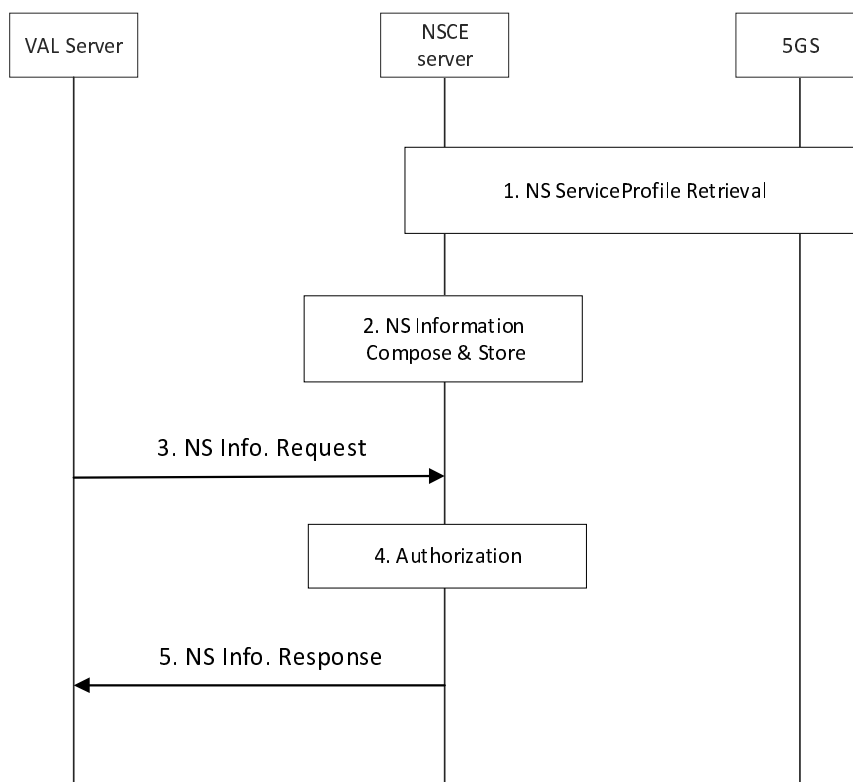
### 9.17.2 Procedure

#### 9.17.2.1 Network Slice Information delivery request

This subclause depicts the procedure of the Network Slice Information delivery to the VAL server via NSCE server, when the VAL server requests the Network Slice Information after registration.

Pre-condition:

1. The NSCE server should have the agreement with MNO (NOP) for retrieval of ServiceProfile, if the NSCE server is the external entity.



**Figure 9.17.2.1-1: Network Slice Information delivery request**

1. The NSCE server retrieves the Network Slice ServiceProfile from 5GS (e.g., NSMF) when the NSCE server acting as a NSP prepares a Network Slice to be provided. The NSCE server follows the procedure to request/receive the Network Slice Service Profile with 'getMOIAttributes' operation as specified in 3GPP TS 28.532[7].

**NOTE:** If NSCE server and NSMF are in same operator, then the NSCE server gets access directly to NSMF. The delivered Network Slice Service Profile contains the values of attributes such as PLMN, S-NSSAI, SST, maximum number of UEs, maximum number of PDU sessions, Slice Coverage Area, Latency, and, Data volume, which specify the Network Slice characteristics, as specified in clause of ServiceProfile in 3GPP TS 28.541 [10].

2. The NSCE server, as Network Slice as a Service, creates and stores the Network Slice information. When NSCE server retrieves the Network Slice Information, it is necessary for NSCE server to convert the attributes in Network Slice ServiceProfile to the Network Slice information for readable information and to compose the Network Slice information, according to the NSP's policy.

In order to reduce to request often the Network Slice Information Retrieval, the NSCE server stores the Network Slice information.

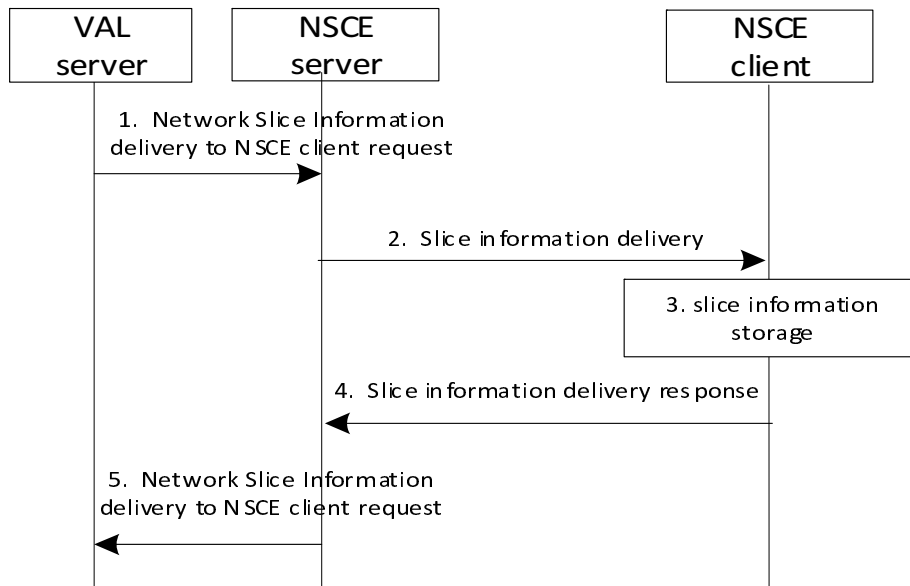
3. The VAL server requests the Network Slice Information to the NSCE server. If the VAL server needs to know the specific attribute value for its service, then the attribute name of Network Slice Information (e.g., S-NSSAI, SST, Slice Coverage Area, etc.) can be added in the Request message.
4. The NSCE server performs to check whether the requesting VAL server is registered or not. The NSCE server identifies which the Network Slice Customer is authorized to use.
5. The NSCE server sends the Network Slice Information, if the VAL server is registered and authorized. The NSCE server rejects to the request of the Network Slice Information, if not registered.

### 9.17.2.2 Network Slice Information delivery to NSCE client request

This subclause depicts the procedure of the Network Slice Information delivery to the NSCE client via NSCE server.

Pre-condition:

1. The network slice has been allocated/created to VAL server.



**Figure 9.17.2.2-1: Network Slice Information delivery to NSCE client**

1. The VAL server sends a request to NSCE server to deliver the Network Slice Information to the NSCE Clients. The request includes the network slice information and indication of the UE notification with VAL UE's ID List.
2. The NSCE server delivers the Network Slice Information to the NSCE Clients of VAL UEs based on the VAL UE's ID list from step 1, in case the Network Slice Allocation is successful, if the NSCE server does not perform AF-driven guidance for URSP determination to 5GS.

The Network Slice Information contains the VAL service ID, S-NSSAI, and DNN.

3. The NSCE client stores and applies the Network Slice Information.

**NOTE:** If the UE is provisioned with URSP rules by the network operator, the UE handles the precedence between the delivered network slice info via NSCE layer info and URSP rules as defined in clause 6.1.2.2.1 of 3GPP TS 23.503 [17]. How the UE uses the Network Slice info delivered via NSCE layer in relation to the URSP is implementation dependent.

4. The NSCE client sends the Network Slice Allocation Information response to the NSCE server.
5. The NSCE server sends the response to the Network Slice Information delivery to NSCE client request.

### 9.17.3 Information flows

#### 9.17.3.1 Network Slice Information delivery request

Table 9.17.3.1-1 describes the information flows for Network Slice Information delivery from the VAL server to the NSCE server.

**Table 9.17.3.1-1: Network Slice Information delivery request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
Security credentials	M	Security credentials resulting from a successful authorization.
VAL service ID	M	The VAL service ID of the VAL application
Requested network slice information list	O	Network slice information that is requested by the VAL server
> S-NSSAI information request	O	Indicates to request S-NSSAI
> SST information request	O	Indicates SST
> Slice Coverage Area information request	O	Indicates slice coverage area

### 9.17.3.2 Network Slice Information delivery response

Table 9.17.3.2-1 describes the information flows for Network Slice Information delivery response from the NSCE server to the VAL server.

**Table 9.17.3.2-1: Network slice information response**

Information element	Status	Description
Result	M	Result includes success or failure of the Network Slice Information delivery request
> Network slice Information	O (see NOTE 1)	Network slice information
>> S-NSSAI	O	S-NSSAI
>> SST	O	Slice/Service Type
>> Slice Coverage Area	O	Coverage area of the network slice
> Cause	O (see NOTE 2)	Indicates the cause of Network Slice Information delivery request failure.
NOTE 1: Shall be present if the result is success and shall not be present otherwise.		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise.		

### 9.17.3.3 Slice Information delivery to NSCE client

Table 9.17.3.3-1 describes information elements for the Slice Information delivery to NSCE client request between the NSCE server and the NSCE client.

**Table 9.17.3.3-1: Slice Information delivery to NSCE client request**

Information element	Status	Description
VAL service ID	M	The identifier of the VAL service
NSCE server ID and address	M	The identifier and address of the NSCE server
VAL UE ID list	O	The identifiers of the VAL UEs which are impacted by the slice modification
>Network slice information	M	Network slice information
>> Network Slice related Identifier	M	The allocated slice identifier
>>DNN	O	The allocated DNN

### 9.17.3.4 Slice Information delivery to NSCE client

Table 9.17.3.4-1 describes information elements for the Slice Information delivery to NSCE client response between the NSCE server and the NSCE client.

**Table 9.17.3.4-1: Slice Information delivery to NSCE client response**

Information element	Status	Description
Result	M	Indicates the success or failure of the Slice Information delivery.
> Cause	O (see NOTE)	Indicates the cause of Slice Information delivery request failure.
NOTE: Shall be present if the result is failure and shall not be present otherwise.		

## 9.17.4 APIs

### 9.17.4.1 General

Table 9.17.4.1-1 illustrates the APIs for the Network Slice Information delivery.

**Table 9.17.4.1-1: List of APIs for Network Slice Information delivery**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_NSInfoDelivery	NSInfoDelivery_request	Request/Response	VAL Server

Table 9.17.4.1-2 illustrates the APIs for the Network Slice Information delivery to NSCE client.

**Table 9.17.4.1-2: List of APIs for Network Slice Information delivery to NSCE client**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_NSInfoDelivery_Client	NSInfoDelivery_Client	Request/Response	VAL Server

### 9.17.4.2 SS\_NSCE\_NSInfoDelivery Get operation

**API operation name:** SS\_NSCE\_NSInfoDelivery Get

**Description:** The consumer requests to get Network Slice Information.

**Inputs:** See clause 9.17.3.1.

**Outputs:** See clause 9.17.3.2.

See clause 9.17.2.1 for details of usage of this operation.

### 9.17.4.3 SS\_NSCE\_NSInfoDelivery\_Client Request operation

**API operation name:** SS\_NSCE\_NSInfoDelivery\_Client Request

**Description:** The consumer requests to deliver the network slice information to NSCE client.

**Inputs:** See table 9.17.3.3-1.

**Outputs:** See table 9.17.3.4-1.

See clause 9.17.2.2 for details of usage of this operation.

## 9.18 Network Slice Allocation in NSaaS model

### 9.18.1 General

When in NSaaS model, the NSCE server performs the Network Slice allocation operation on behalf of the VAL server. The non-trusted 3<sup>rd</sup> party application (i.e., VAL server) cannot access to the 5GS management system directly. So, the

NSCE server needs to perform the authentication and authorization for the registration of VAL server on behalf of 5G MnS.

The Network Slice creation that is triggered by the VAL server depends upon network operator policy. The network slice capabilities and management options offered to the customer are determined by a business agreement prior to and outside of the scope of 3GPP standards.

The VAL server can identify the Network slice in Network Slice creation request with the Network Slice indicator (e.g., S-NSSAI).

Upon network slice allocation, the NSCE server acts as the network slice provisioning MnS consumer. The NSCE server requests 'AllocatedNsi' operation to the network slice provisioning MnS producer as specified in 3GPP TS 28.531 [8]. When the 'AllocatedNsi' operation is received, the network slice provisioning MnS Producer in 5GS performs charging mechanism as specified in 3GPP TS 28.202 [28].

The NSCE server sends the allocated Network Slice information (e.g., S-NSSAI) to the NSCE Client, after the Network Slice allocation to the VAL server is successful.

With the above regards, the NSCE server performs the below for the Network Slice Allocation for the VAL server.

- Network Slice Allocation operation on behalf of VAL Server as specified in TS 28.531 [8]
- Delivery of the Network Slice Allocation result
- Delivery of the allocated Network Slice Information to NSCE client

The VAL server as a Network Slice consumer makes use of the APIs provided from NSCE server to allocate the Network Slice for the Network Slice Lifecycle management for its service.

## 9.18.2 Procedure

### 9.18.2.1 Network Slice Allocation in NSaaS model

This subclause depicts the procedure of the Network Slice Allocation in NSaaS model, when the VAL server needs to allocate the Network Slice, interaction with 5GS via the NSCE server.

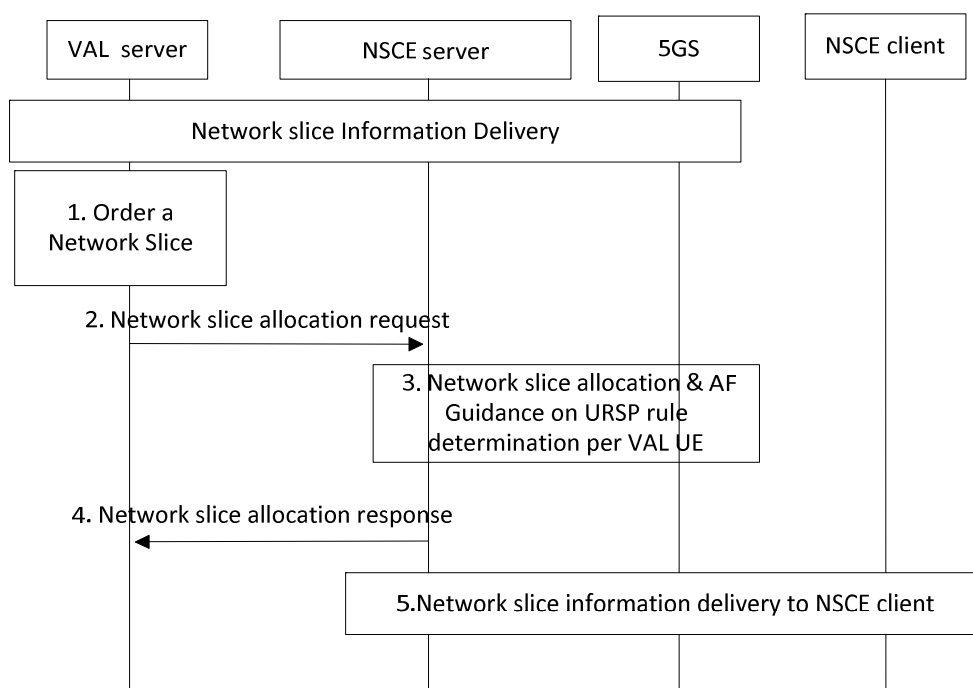


Figure 9.18.2.1-1: Network Slice Allocation in NSaaS model



1. The VAL server makes a request to order the Network Slice. The VAL server specifies the Network Slice requirements for the VAL service. The Network Slice requirement at the VAL server may be specified with the attributes of GST (which results in NEST) as specified in GSMA NG.116.
2. The VAL server requests the Network Slice allocation with the Network Slice requirements. The Network Slice allocation request includes the VAL Service ID, VAL UE's ID List, and S-NSSAI.
3. The NSCE server performs the Network Slice Allocation. If the NSCE server act as NSaaS provider, and the existing allocated network slice could satisfied the Network Slice requirements, the NSCE server allocates the existing network slice to the VAL. Otherwise, the NSCE server as network slice provisioning MnS consumer requests of 'AllocatedNsi' operation as specified in 3GPP TS 28.531 [8].

When the 'AllocatedNsi' operation is received, the network slice provisioning MnS Producer performs charging mechanism as specified in 3GPP TS 28.202 [28].

The NSCE server performs AF-driven guidance for URSP determination to 5GS per VAL UE.

NOTE 1: According to the network operator policy, the NSCE server acting as AF may send the created network slice information to the PCF via NEF as part of the AF-driven guidance for URSP determination to 5G system (as specified in TS 23.501 [16]). This guidance may create the new route selection parameters to indicate sets of PDU Session information (DNN, S-NSSAI) that can be associated with applications matching the application traffic.

4. The NSCE server sends the result of Network Slice Allocation to the VAL server.
5. The NSCE server delivers the Network Slice Allocation Information to the NSCE Clients of VAL UEs based on the VAL UE's ID list from step 2, using the procedure defined in 9.17.2.2 step 2 – step 4, in case the Network Slice Allocation is successful, if the NSCE server does not perform AF-driven guidance for URSP determination to 5GS in step 3. The Network Slice Allocation Information contains the VAL service ID, S-NSSAI, and DNN.

NOTE 2: If the UE is provisioned with URSP rules by the network operator, the UE handles the precedence between the delivered network slice info via NSCE layer info and URSP rules as defined in clause 6.1.2.2.1 of 3GPP TS 23.503 [17]. How the UE uses the Network Slice info delivered via NSCE layer in relation to the URSP is implementation dependent.

## 9.18.3 Information flows

### 9.18.3.1 General

The following information flows are specified for Network Slice Allocation:

- Network Slice Allocation request and response.

### 9.18.3.2 Network Slice Allocation

Table 9.18.3.2-1 and Table 9.18.3.2-2 describe information elements for Network Slice Allocation request and response between the VAL server and the NSCE server.

**Table 9.18.3.2-1: Network Slice Allocation request**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	Identifier of the application service
VAL UE's ID List	O	The list of VAL UE IDs for which the request applies
Area of interest	M	The service area for which the application service profile applies, which can be expressed as a geographical area (e.g. geographical coordinates), or a topological area (e.g. a list of TA).
Network slice related Identifier(s)	O	The slice identifier
Network Slice requirements	O	The properties of network slice related requirement. If Service Profile is known by the VAL server, it can be provided to the NSCE server. The GST defined by GSMA (see clause 2.2 in [5]) and the performance requirements defined in clause 7 TS 22.261 [6] are all considered as input for it.

**Table 9.18.3.2-2: Network Slice Allocation response**

Information element	Status	Description
VAL server ID	M	The identifier of the VAL server
VAL service ID	M	Identifier of the application service to be supported by the created slice related communication service.
Result	M	Indicates the success or failure of the slice related communication service creation
Network slice info List	O (see NOTE 1)	The list of the network slice info allocated by NSCE
> Network slice info	O (see NOTE 1)	The network slice info which includes the attributes and the corresponding values of network slice
>>S-NSSAI	O (see NOTE 1)	The identifier of network slice
>>attributes of network slice	O (see NOTE 1)	The list of attributes of the serviceProfile e.g, <i>dLtThptPerSlice</i> or latencies of network slice as defined in <i>serviceProfile</i> TS 28.541[10]
>>AttributeValues	O (see NOTE 1)	The corresponding values of the attributes of the service profiles that determined by the NSCE server
Cause	O (see NOTE 2)	Indicates the cause of creation failure
NOTE 1: Shall be present if the result is success and shall not be present otherwise		
NOTE 2: Shall be present if the result is failure and shall not be present otherwise		

## 9.18.4 APIs

### 9.18.4.1 General

Table 9.18.4.1-1 illustrates the API for Network Slice Allocation.

**Table 9.18.4.1-1: SS\_NSCE\_NSAllocation**

API Name	API Operations	Operation Semantics	Consumer(s)
SS_NSCE_NSAllocation	NSAllocation_Request /Response	Request /Response	VAL server

### 9.18.4.2 SS\_NSCE\_NSAllocation\_Request /Response operation

**API operation name:** SS\_NSCE\_NSAllocation\_Request /Response

**Description:** The consumer requests the network slice allocation.

**Inputs:** See table 9.18.3.2-1.

**Outputs:** See table 9.18.3.2-2.

See clause 9.18.2.1 for details of usage of this operation.

## 9.19 Authorization and authentication

VAL server authorization and authentication are specified in 3GPP TS 33.434 [22], clause 5.1.1.8.

## Annex A (informative): Deployment models

### A.1 Deployment scenarios

#### A.1.1 General

Based on the network slicing capability of the S-NSSAI granularity provided by SA2 and the network slicing capability of the NSI/S-NSSAI granularity provided by SA5, the NSCE service is provides network slicing management and control capabilities in the S-NSSAI granularity for vertical industries.

A network slice can have only one owner and one NSCE service provider. NSCE service provider and slice owner can be different. For example the slice owner is VAL server, but the NSCE service provider is MNO.

This clause describes examples of deployment models with respect to different deployment scenarios as follows.

#### A.1.2 Centralized NSCE deployment

Figure A.1.2 provides a example of centralized deployment of NSCE server whose service area covering the whole PLMN. It is also possible slice coverage area to be smaller than the NSCE service area.

The network slice capability enablement service is provided with the view of whole PLMN in this scenario.

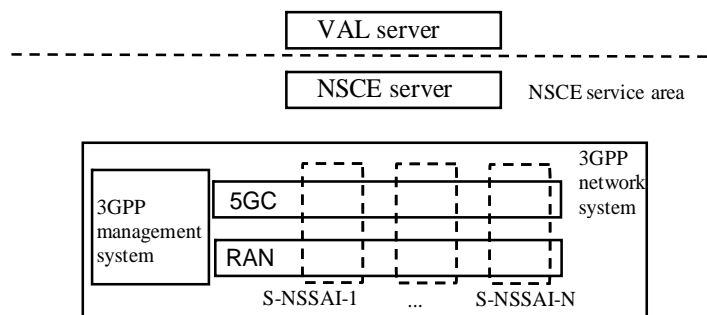
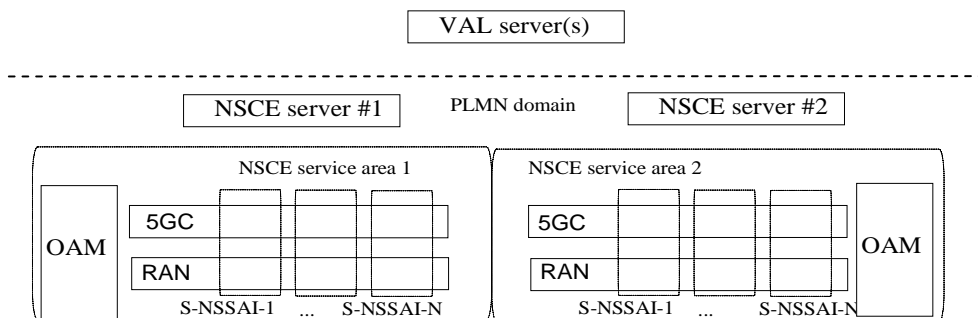


Figure A.1.2: Illustration of centralized NSCE deployment

#### A.1.3 Distributed NSCE deployment

The distributed deployment refers to the deployment model in which multiple NSCE servers are deployed by same provider, whose service area only covers some specific areas as shown below (based on geographical coordinates or TA list(s)).



**Figure A.1.3: Illustration of distributed NSCE deployment**

When there are multiple NSCE servers managed by same provider, NSCE server(s) can be subscribed for providing the network slice statistics to another NSCE server to provide a global view.

There can be two use cases to provide the NSCE service in the distributed deployment:

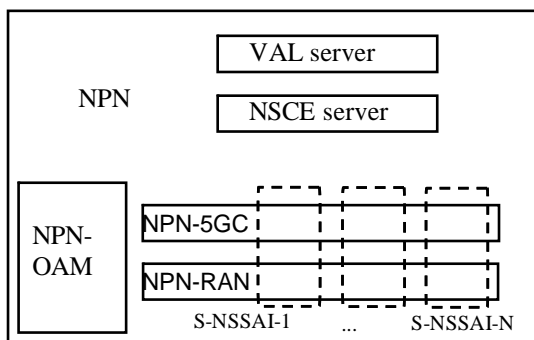
One use case is that the distributed deployed NSCE is about a slice service area which is equivalent to the edge/NPN’s service area. For this scenario, if the distributed deployed NSCE wants to access the NEF/NWDAF/NSACF services or to receive policies from OAM, it needs to interact to the global NSCE.

A further use case could be that some NSCE services (e.g. MnS discovery) are locally provided to VAL servers (for example as a micro-service), whereas other capabilities are provided for the whole PLMN area. So, the distributed NSCE includes a subset of capabilities which are edge native. The local deployment of such capabilities can allow for more efficient services to the VAL servers (e.g. for QoS verification, the edge deployed NSCE can receive more timely KQI/QoE measurements and can process them locally before triggering an event).

### A.1.4 NPN NSCE deployment

The NSCE architecture supports the deployment that NSCE server is deployed in NPN.

Figure A.1.4 shows a deployment example of NSCE server deployment in the NPN. This case is valid if a geographical match between slice coverage area, NPN coverage area and NSCE service area is pre-configured. The matching may be pre-configured in the NSCE server by network operator based on the TA list or geographical coordinates. The NSCE server is deployed in Non-public network to provide the network slice capabilities exposure application service based on the interaction with NPN-5GC and NPN management system.



**Figure A.1.4: Illustration of NPN NSCE deployment**

## A.1.5 Edge NSCE deployment

The NSCE architecture supports the deployment that the NSCE server is deployed in EDN as an EAS to provide the network slice capabilities exposure application service, based on the interaction with 5GS pertaining the network slice, and edge computing management system.

Figure A.1.5 shows the edge NSCE deployment cases when the NSCE server is deployed in the EDN using LADNs as described in Annex A.2.4 of TS 23.558 [22]. This case is valid if a geographical match between slice coverage area, LADN service area (which is EDN service area) and NSCE service area is pre-configured in the NSCE server. The matching can be based on the TA list or geographical coordinates.

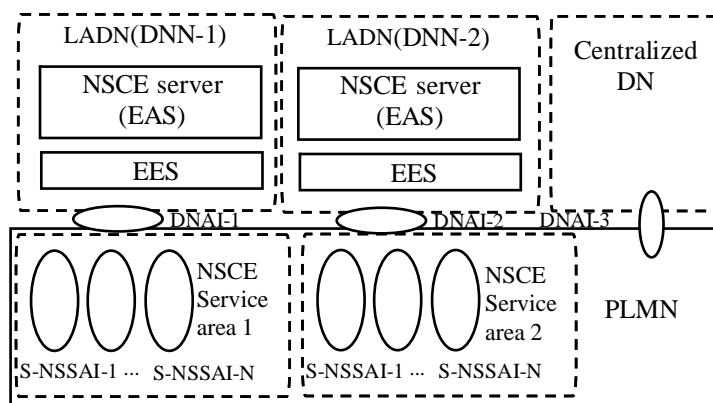


Figure A.1.5: Illustration of edge NSCE deployment

## A.2 Deployment of NSCE server(s) in relation to VAL server and 3GPP system

To support the centralized/distributed deployment, the NSCE server(s) will have different deployment models and different relation with VAL server and 3GPP system.

### A.2.1 Centralized NSCE deployment

The NSCE server can be deployed in single PLMN operator domain (as a SEAL server as specified in Figure 8.2.1-1 TS 23.434), deployed in VAL service provider domain by vertical (as a SEAL server as specified in Figure 8.2.2-1 TS 23.434), or deployed outside of both the VAL service provider domain and PLMN operator domain i.e. in 3<sup>rd</sup> party domain (as a SEAL server as specified in Figure 8.2.3-1 TS 23.434).

The deployment of NSCE server(s), with connections to 3GPP network systems in multiple PLMN operator domains (as a SEAL server as specified in Figure 8.2.2-2) is also supported. When the vertical consumer wants to get NSCE services in two countries which are operated by two different MNOs, the NSCE service provider has to interact with two 3GPP network systems. The NSCE server is either deployed in the VAL service provider domain or deployed separately in the 3<sup>rd</sup> party domain.

### A.2.2 Distributed NSCE deployment

The NSCE servers can be distributed in multiple PLMN domains (as a SEAL server as specified in TS 23.434 Figure 8.2.1-2, Figure 8.2.1-3), or distributed in single PLMN operator domain (as a SEAL server as specified in TS 23.434 Figure 8.2.1-4). The NSCE servers can also be distributed in VAL service provider domain by vertical (as a SEAL server as specified in TS 23.434 Figure 8.2.2-3), or distributed deployed in 3<sup>rd</sup> party domain by 3<sup>rd</sup> party. The VAL server

can communicate with multiple NSCE servers via NSCE-S as long as other NSCE servers are discovered and accessible. Or, the VAL server can communicate with other NSCE servers via NSCE-E if needed.

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## A.3 Deployment of NSCE server(s) in relation to SEAL

The NSCE server(s) supports standalone deployment independent with other SEAL services, it can interact with other SEAL service(s) via SEAL-X interface as specified in Clause 6.2 TS 23.434, .

The NSCE service(s) supports combined deployment with other SEAL services, it can interact with other SEAL service via service API as specified in clause 15 TS 23.434.

## Annex B (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2022-06	SA6#49-bis-e					TS skeleton	0.0.0
2022-07	SA6#49-bis-e					TS Skeleton agreed in SA6#49-bis-e: S6-221640, Implemented pCRs approved in SA6#49-bis-e: S6-221641, S6-221642, S6-221643, S6-221822, S6-221818.	0.1.0
2022-09	SA6#50-e					Implemented pCRs approved in SA6#50: S6-222146, S6-222197, S6-222407 Editorial changes by the rapporteur.	0.2.0
2022-10	SA6#51-e					Implemented pCRs approved in SA6#51: S6-223036, S6-223035, <a href="#">S6-222901</a> , S6-222764. Editorial changes by the rapporteur.	0.3.0
2022-11	SA6#52					Implemented pCRs approved in SA6#51: S6-223449, S6-223517, S6-223595, S6-223557, S6-223207, S6-223477 Editorial changes by the rapporteur.	0.4.0
2023-01	SA6#52-bis-e					Implemented pCRs approved in SA6#52-bis-e: S6-230053, S6-230054, S6-230353, S6-230467, S6-230355, S6-230359, S6-230379, S6-230397, S6-230459, S6-230360, S6-230460, S6-230352, S6-230403, S6-230136, S6-230417, S6-230419, S6-230420, S6-230421, S6-230422, S6-230461 Editorial changes by the rapporteur.	0.5.0
2023-03	SA6#53					Implemented pCRs approved in SA6#53: S6-230960, S6-230961, S6-230616, S6-231027, S6-231028, S6-230997, S6-231069, S6-230967, S6-231009, S6-230968, S6-230598 Editorial changes by the rapporteur.	0.6.0
2023-03	SA#99	SP-230272				Presentation for information at SA#99	1.0.0
2023-03	SA#99	SP-230346				Correction of implementation of pCR S6-231009 and presentation for information at SA#99	1.1.0
2023-04	SA6#54					Implemented pCRs approved in SA6#54: S6-231499, S6-231616, S6-231617, S6-231618, S6-231619, S6-231467, S6-231259, S6-231258, S6-231620, S6-231338, S6-231445, S6-231621 Editorial changes by the rapporteur.	1.2.0
2023-05	SA6#55					Implemented pCRs approved in SA6#55: S6-232092, S6-231800, S6-231802, S6-231803, S6-232093, S6-231805, S6-231806, S6-232094, S6-232095, S6-232096. Editorial changes by the rapporteur.	1.3.0
2023-06	SA#100	SP-230686				Presentation for approval at SA#100	2.0.0
2023-06	SA#100	SP-230686				MCC Editorial update for publication after TSG SA approval (SA#100)	18.0.0
2023-12	SA#102	SP-231561	0002	2	F	Solve the EN in registration	18.1.0
2024-03	SA#103	SP-240307	0007	1	F	IE Name and Reference Corrections	18.2.0
2024-03	SA#103	SP-240307	0008	2	F	Fault diagnosis subscription request	18.2.0
2024-03	SA#103	SP-240307	0010	3	F	Add late notification to the network slice adaptation procedures	18.2.0
2024-03	SA#103	SP-240307	0012	2	F	Correction of Area of interest	18.2.0
2024-06	SA#104	SP-240760	0020		F	Correction of Procedure name	18.3.0
2024-06	SA#104	SP-240760	0023	3	F	Update on predictive slice modification in Inter-PLMN based slice service continuity	18.3.0
2024-06	SA#104	SP-240760	0025	1	F	UE IP address preservation indicator deletion	18.3.0
2024-09	SA#105	SP-241215	0029	2	F	Adding a note on predictive slice modification in inter-PLMN based slice service continuity	18.4.0



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# History

<b>Document history</b>		
V18.2.0	April 2024	Publication
V18.3.0	July 2024	Publication
V18.4.0	October 2024	Publication