ETSI GS ZSM 003 V1.1.1 (2021-06)

GROUP SPECIFICATION

Zero-touch network and Service Management (ZSM); End-to-end management and orchestration of network slicing

Reference

DGS/ZSM-003ed111_Slicing

Keywords

network management, orchestration, service, slicing

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

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

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.
No recommendation as to products and services or vendors is made or should be implied.
No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.
In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Zero touch network and Service Management (ZSM).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1   Scope

The present document specifies the E2E network slicing management solutions and related management interfaces. The E2E network slicing including provisioning, performance assurance and fault management of an E2E slice instance across multiple management domains.

2   References

2.1   Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

> NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1]   ETSI TS 123 501 (V15.2.0): "5G; System Architecture for the 5G System (3GPP TS 23.501 version 15.2.0 Release 15)".

[2]   ETSI TS 123 502 (V15.2.0): "5G; Procedures for the 5G System (3GPP TS 23.502 version 15.2.0 Release 15)".

[3]   ETSI TS 123 503 (V15.2.0): "5G; Policy and Charging Control Framework for the 5G System; Stage 2 (3GPP TS 23.503 version 15.2.0 Release 15)".

[4]   ETSI TS 128 530 (V15.0.0): "5G; Management and orchestration; Concepts, use cases and requirements (3GPP TS 28.530 version 15.0.0 Release 15)".

[5]   ETSI TS 128 531 (V15.0.0): "5G; Management and orchestration; Provisioning (3GPP TS 28.531 version 15.0.0 Release 15)".

[6]   ETSI TS 128 550 (V16.7.0): "5G; Management and orchestration; Performance assurance (3GPP TS 28.550 version 16.7.0 Release 16)".

[7]   ETSI TS 128 541 (V15.0.1): "5G; Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3 (3GPP TS 28.541 version 15.0.1 Release 15)".

[8]   ETSI TS 128 552 (V15.0.0): "5G; Management and orchestration; 5G performance measurements (3GPP TS 28.552 version 15.0.0 Release 15)".

[9]   ETSI TS 128 554 (V15.0.1): "5G; Management and orchestration; 5G end to end Key Performance Indicators (KPI) (3GPP TS 28.554 version 15.0.1 Release 15)".

[10]   ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

[11]   ETSI GS ZSM 007: "Zero-touch network and Service Management (ZSM); Terminology for concepts in ZSM".

[12]   ETSI GS ZSM 002: "Zero-touch network and Service Management (ZSM); Reference Architecture".

[13]   ETSI TS 128 532 (V15.0.1): "5G; Management and orchestration; Generic management services (3GPP TS 28.532 version 15.0.1 Release 15)".

[14]   ETSI TS 128 545 (V15.0.0): "5G; Management and orchestration; Fault Supervision (FS) (3GPP TS 28.545 version 15.0.0 Release 15)".

[15]   ETSI TS 128 526 (V16.0.0): "LTE; Telecommunication management; Life Cycle Management (LCM) for mobile networks that include virtualized network functions; Procedures (3GPP TS 28.526 version 16.0.0 Release 16)".

[16]   GSMA PRD NG.116 v1.0 (2019-05): "Generic Network Slice Template", v1.0.

[17]   ETSI GS ZSM 001: "Zero-touch network and Service Management (ZSM); Requirements based on documented scenarios".

[18]   ETSI TS 133 501 (V16.4.0): "5G; Security architecture and procedures for 5G System (3GPP TS 33.501 version 16.4.0 Release 16)".

[19]   ETSI TS 128 622 (V16.7.1): "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS) (3GPP TS 28.622 version 16.7.1 Release 16)".

2.2   Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1]   3GPP TR 33.811 (V0.4.0) (2018-01): "Study on security aspects of 5G network slicing management".

[i.2]   GSMA: "5G Network Slicing Report: From Vertical Industry Requirements to Network Slice Characteristics".

[i.3]   ETSI GR NFV-EVE 012: "Network Functions Virtualisation (NFV) Release 3; Evolution and Ecosystem; Report on Network Slicing Support with ETSI NFV Architecture Framework".

[i.4]   TMF641: "Service Ordering API REST Specification".

[i.5]   TMF638: "Service Inventory Management API REST Specification".

[i.6]   TMF633: "Service Catalog Management API REST Specification".

[i.7]   TMF628: "Performance Management API REST Specification".

[i.8]   TMF642: "Alarm Management API REST Specification".

[i.9]   IETF RFC 8453: "Framework for Abstraction and Control of TE Networks (ACTN)".

[i.10]   IETF RFC 8632: "A YANG Data Model for Alarm Management", S. Vallin et al.

[i.11]   draft-ietf-teas-yang-te work in progress: "A YANG Data Model for Traffic Engineering Tunnels and Interfaces", T. Saad et al.

[i.12]   draft-ietf-teas-actn-pm-telemetry-autonomics work in progress: "YANG models for VN/TE Performance Monitoring Telemetry and Scaling Intent Autonomics", Y. Lee et al.

[i.13]   IETF RFC 8795: "YANG Data Model for TE Topologies".

[i.14]   draft-ietf-teas-enhanced-vpn work in progress: "A framework for Enhanced Virtual Private Networks (VPN+) Service", J. Dong et al.

[i.15]   draft-ietf-teas-ietf-network-slices-03: "Framework for IETF Network Slices".

[i.16]   IETF RFC 8466: "A YANG Data Model for Layer 2 Virtual Private Network (L2VPN) Service Delivery".

[i.17]   NGMN Alliance: "Description of Network Slicing Concept", September 2016.

[i.18]   NGMN Alliance: "5G E2E Architectural framework v2.0", February 2018.

[i.19]   IETF RFC 8299: "YANG Data Model for L3VPN Service Delivery".

3   Definition of terms, symbols and abbreviations

3.1   Terms

For the purposes of the present document, the terms given in ETSI GS ZSM 007 [11] and the following apply:

E2E network slicing: set of management and orchestration activities that allow the deployment and operation of network slices across multiple management domains

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

network slice subnet: representation of a set of network functions and the associated resources (e.g. compute, storage and networking resources) supporting network slice

3.2   Symbols

Void.

3.3   Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS ZSM 007 [11] and the following apply:

AAA	Authentication-Authorisation-Accounting
ACTN	Abstraction and Control of TE Networks
AI	Artificial Intelligence
AMF	Access and Mobility Management Function
AN	Access Network
API	Application Programming Interface
AS	Access Stratum
BBF	Broadband Forum
CMI	Customer Network Controller - Multi-Domain Service Coordinator Interface
CN	Core Network
CSC	Communication Service Customer
CSM	Communication Service Management
CSP	Communication Service Provider
DCN	Data Center Network
DL	DownLink
DN	Distinguished Name
DRB	Data Radio Bearer
DSL	Domain Specific Language
EVR	Evaluation Result
GSM	Global System for Mobile communications
GSMA	GSM Association
GST	Generic network Slice Template
IOC	Information Object Class
KPI	Key Performance Indicator

LCM	Life Cycle Management
MD	Management Domain
MDSC	Multi-Domain Service Coordinator
MEF	Metro Ethernet Forum
MNO	Mobile Network Operator
MnS	Management Service
MOI	Managed Object Instance
MPI	Main Path Interface
MPLS	Multiprotocol Label Switching
NBI	Northbound Interface
NEST	NEtwork Slice Type
NF	Network Function
NFVI	NFV Infrastructure
NFVO	NFV Orchestrator
NG	Next Generation
NGMN	Next Generation Mobile Networks
NG-RAN	NG Radio Access Network
NOP	Network Operator
NRM	Network Resource Model
NSC	Network Slice Controller
NSDT	Network Slice Design Team
NSE	Network Slice Endpoints
NSI	Network Slice Instance
NSM	Network Service Management
NSRE	Network Slice Realization Endpoints
NSS	Network Slice Subnet
NSSAI	Network Slice Selection Assistance Information
NSSI	Network Slice Subnet Instance
OAM	Operation, Administration and Maintenance
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PM	Performance Management
PNC	Provisioning Network Controller
PNF	Physical Network Function
PRB	Physical Resource Block
PRD	Permanent Reference Document
PSA	PDU session anchor
RAN	Radio Access Network
RRM	Radio Resource Management
SBI	SouthBound Interface
Serv-Orch	Service Orchestration service
SLA	Service Level Agreement
SLS	Service-Level Specification
SMF	Session Management Function
S-NSSAI	Single Network Slice Selection Assistance Information
TEAS	Traffic Engineering and Architecture Signaling
TM	Telecom Management
TN	Transport Network
T-NSSMF	Transport Network Slice Subnet Management Function
TSG	Technical Specification Group
UE	User Equipment
UL	UpLink
UPF	User Plane Function
VLAN	Virtual Local Area Network
VN	Virtualised Network
VNF	Virtualised Network Function
VPN	Virtual Private Network
WAN	Wide Area Network
YANG	Yet Another Next Generation

4   Concept of E2E network slicing management and orchestration

4.1   Roles in network slicing

In the context of 5G networks, responsibilities regarding network management operations have been defined and assigned to different roles, see clause 4.8 of ETSI TS 128 530 [4]. The ZSM Framework Consumer plays the role of Communication Service Customer (CSC) and uses communication services provided by Communication Service Provider (CSP). The communication provider in turn uses the network provided by the role network operator.

4.2   Communication service provided by network slice

The following diagram shows the relation between communication service instance, network slice instance and network slice subnet instance.
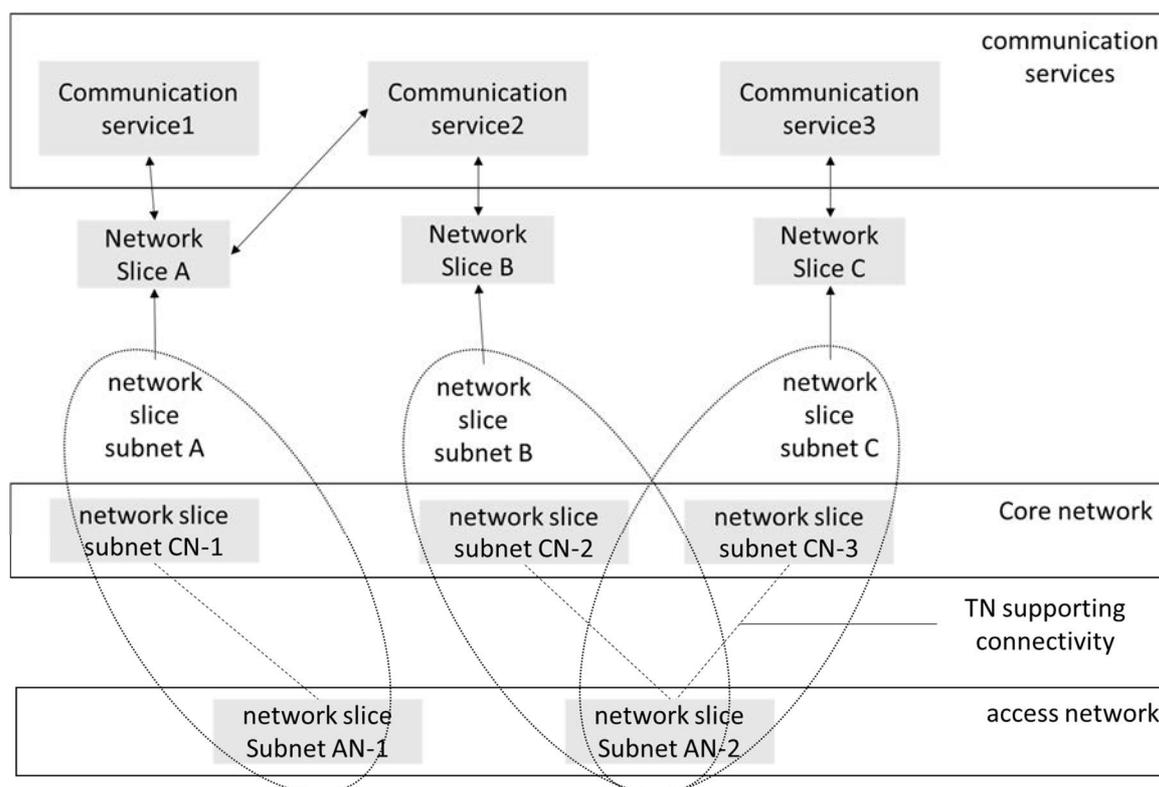
Figure 4.2-1: A variety of communication services provided by multiple network slices

A vertical may have multiple communication services and one or more communication services may be supported by one network slice instance as shown in ETSI TS 128 530 [4], clause 4.1.3.

  NOTE: The concepts of "vertical" and "vertical customer" are used interchangeably throughout the present document.

4.3   Typical scenarios of using network slicing

4.3.1   Overview

There are two scenarios for using network slicing, as specified in clauses 4.1.6 and 4.1.7 of ETSI TS 128 530 [4]:

- Network Slices as NOP internals.

- Network Slice as a Service (NSaaS).

4.3.2   Using "Network Slices as NOP internals"

In the "Network Slices as NOP internals" scenario, one entity takes both CSP and NOP roles and provides communication services to vertical customers, which take the role of CSCs. The network slice instances are not visible to the verticals. The entity decides whether the network slices instances or the network is used to support the communication services (e.g. for internal network resource utilization consideration, etc.). This scenario allows the vertical consumer to use the communication service and optionally allows the vertical to monitor the network status of the network that supports the communication service.

Figure 4.3.2-1 quoted from 3GPP (see ETSI TS 128 530 [4]) illustrates an example of how network slices can be utilized to deliver communication services based on the 3GPP defined roles.
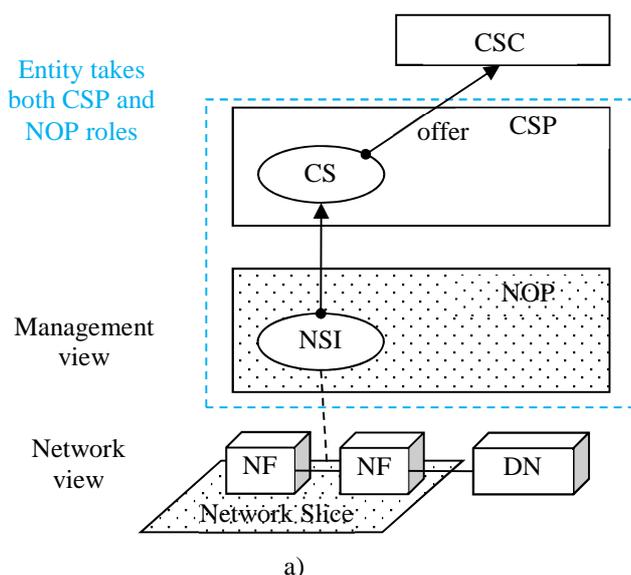
Figure 4.3.2-1: 3GPP example of Network Slice as NOP internals

Figure 4.3.2-2 illustrates an example of how network slices from business view can be utilized to deliver communication services in ZSM.

A network slice consists of a group of NFs. The business entity X (e.g. MNO) takes the role of both NOP and CSP and delivers communication services to vertical customers. Only the communication service is exposed to the vertical customer. The vertical should be able to monitor the communication service status (e.g. administrative status, operational status, etc.) and performance data via the exposed interfaces.
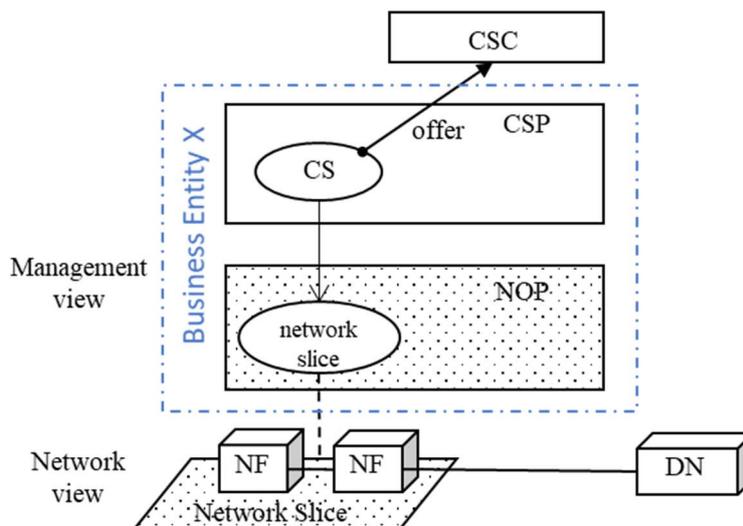
Figure 4.3.2-2: ZSM example of Network Slice as NOP internals

4.3.3   Adopting "Network Slices as a Service" model

In the "Network Slice as a Service" scenario, a network slice can be offered to vertical as a service. This scenario allows a vertical customer to use the network slice and optionally allows the vertical to manage the network slice instance via management exposure interface. In addition, verticals can offer their own services (e.g. communication services) that rely on the new network slice.

Figure 4.3.3-1 quoted from 3GPP (see [4]) illustrates an example of how network slices can be utilized to deliver communication services, including Network Slice as a Service reusing the 3GPP defined roles.
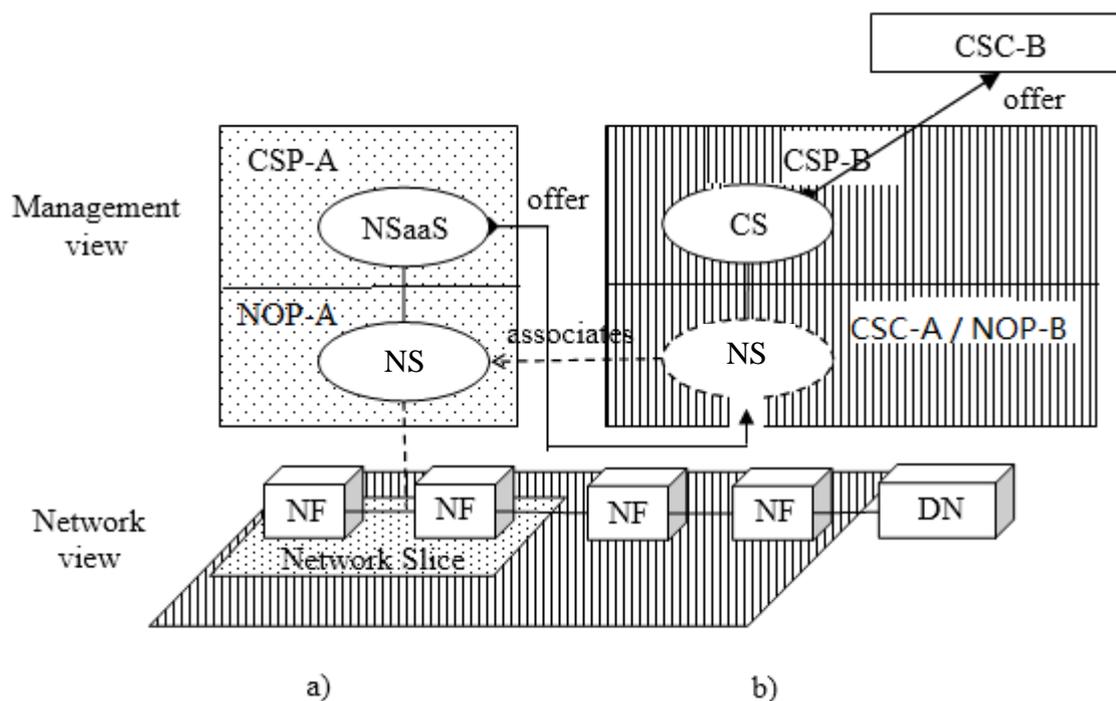
**Figure 4.3.3-1: 3GPP examples of Network Slice as a Service being utilized
to deliver communication services to customers**

Figure 4.3.3-2 illustrates an example of how network slices from a business view can be utilized to deliver communication services in ZSM.

In this example, CSP uses the network slice offered by NOP and its own network functions to deliver communication services to vertical customers (CSC). CSP and NOP corresponds to different business entities in this example.
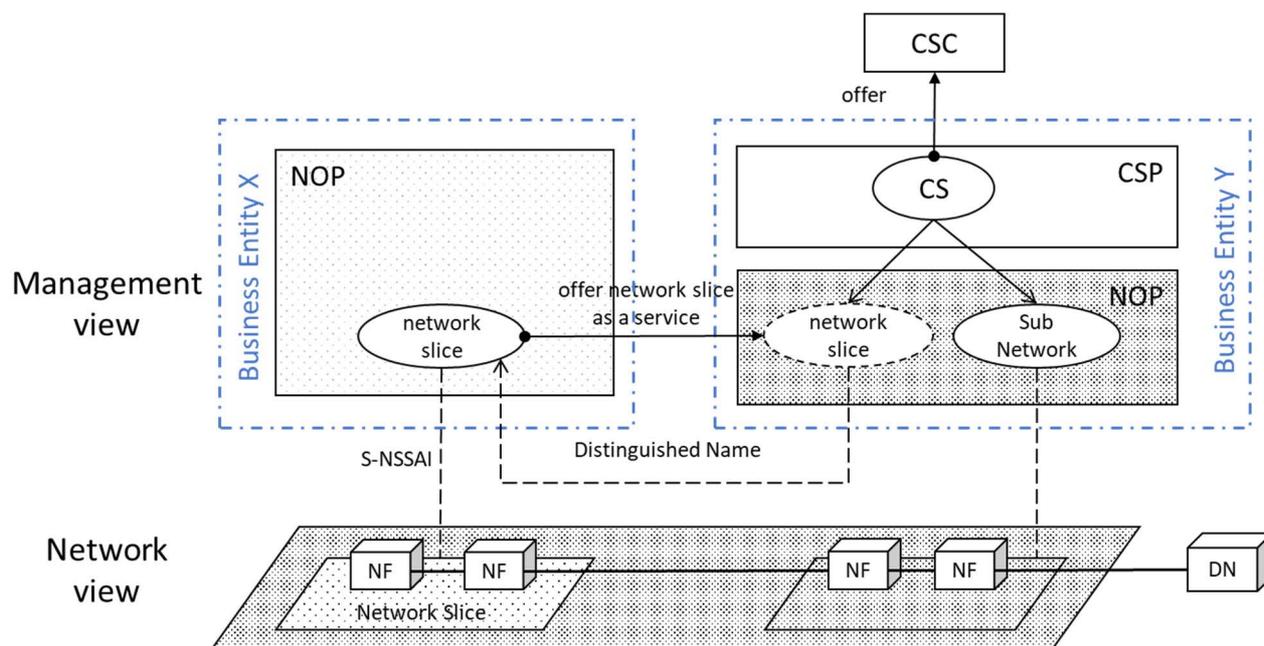
NOTE 1:   Network slice shown on the left side of Figure 4.3.3-2 is a managed object instance created by NOP of Business Entity X. It is offered as a network slice as a service to Business Entity Y as a network slice shown on the right side of the same figure. CSP of Business Entity Y uses Distinguished Name to refer to and access the network slice created in the NOP.
NOTE 2:   Depending on the use case, the business entity Y could represent a vertical customer or another MNO.

**Figure 4.3.3-2: ZSM example of Network Slice as a Service being utilized
to deliver communication services to customers**

In another example, as shown in Figure 4.3.3-3, CSP of Business Entity Y may use the network slice offered by NOP of Business Entity X and additional network functions to build a new network slice.
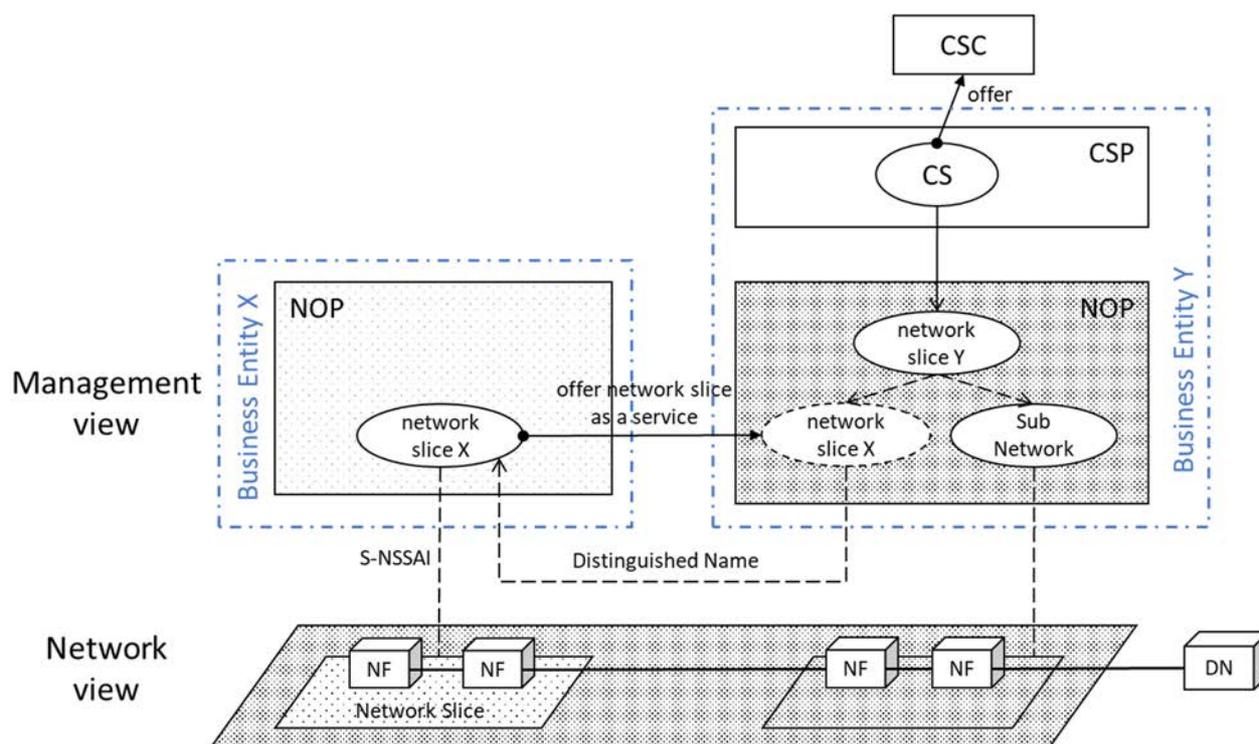
Figure 4.3.3-3: ZSM example of Network Slice as a Service being utilized to build a new network slice

5   E2E network slicing management and orchestration Architecture

5.1   Network slicing management architecture

Figure 5.1-1 describes an example of ZSM architecture deployment for network slicing management. In this scenario, the management domains for E2E Service, AN, CN and TN exist. The deployment is according to the architecture defined in ETSI GS ZSM 002 [12].
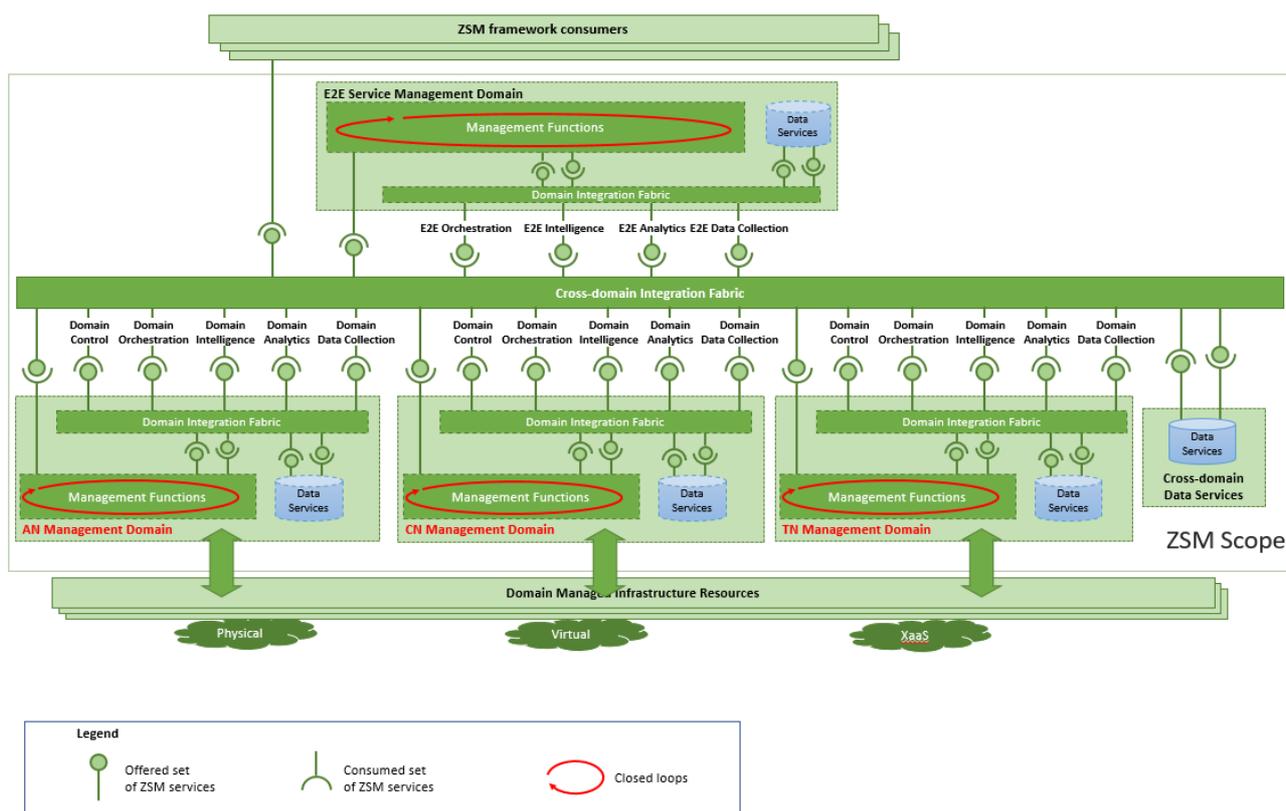
Figure 5.1-1: ZSM architecture deployment example for network slicing management

NOTE: This is one possible example shows how to deploy management domains.

The components of E2E network slicing architecture are described as follows:

- E2E Service MD (E2E Service Management Domain) is a provider of the E2E network slicing related management services based on Management Functions. E2E Service MD is also a consumer of the management services provided by AN MD, CN MD and TN MD.

- AN MD (Access Network Management Domain) is a provider of the AN slice subnet-related management services based on Management Functions.

- CN MD (Core Network Management Domain) is a provider of the CN slice subnet-related management services based on Management Functions.

- TN MD (Transport Network Management Domain) is a provider of the TN slice subnet-related management services based on Management Functions.

A network slice instance is composed of one E2E network slice subnet. One E2E network slice subnet is composed of one or more network slice subnets as shown in ETSI TS 128 541 [7], clause 6.2.1.

6   E2E network slicing management and orchestration solutions

6.1   E2E network slice management

6.1.1   Requirements for Network Slice

GSMA has provided information that capturing service requirements for a network slice. In GSMA PRD NG.116 [16], a Generic network Slice Template (GST) is defined as a set of attributes that can characterize a type of network slice/service. The value of each attribute is assigned to express a set of requirements to support a network slice customer's use case. The NEtwork Slice Type (NEST) is a GST filled with values. The NEST can be used as an input to the network slice preparation as depicted in Figure 6.1.1-1.

Different NESTs allow describing different types of network slices. For the network slices based on standardized service types, e.g. eMBB, uRLLC and mIoT, the network operator may have a set of the readymade, standardized NESTs. For the network slices addressing specific use cases, the network operator can create additional NESTs.
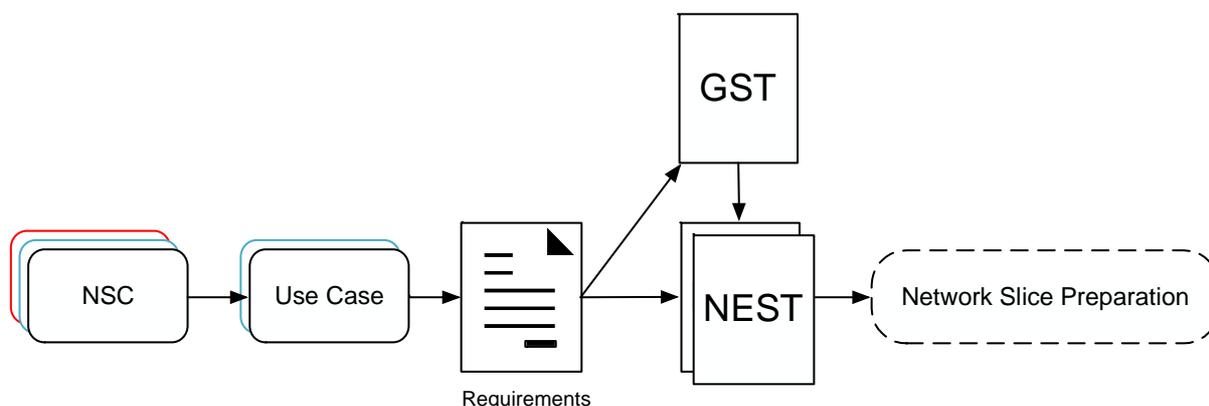
Figure 6.1.1-1: GST and NEST in context of the network slice lifecycle

GST attributes can be classified into two main categories:

- *Character attributes* - characterize a network slice. They can be further split into:

  - *performance-related attributes*, which specify the Key Performance Indicators (KPIs) supported by the network slice;

  - *functionality-related attributes,* which specify the functionality provided by the network slice;

  - *control and management-related attributes,* which specify what control and management capabilities are handed over to the vertical in order to operate the network slice.

- *Scalability attributes* - provide information about the scalability of the network slice.

6.1.2   Actions in LCM of network slicing

This clause describes the actions in the Life Cycle Management (LCM) of an E2E network slice instance, which is an overview of the E2E network slicing management and orchestration solutions.

As shown in ETSI TS 128 530 [4], Figure 4.3.1.1, the management of network slice instance contains four phases: Preparation, Commissioning, Operation and Decommissioning.
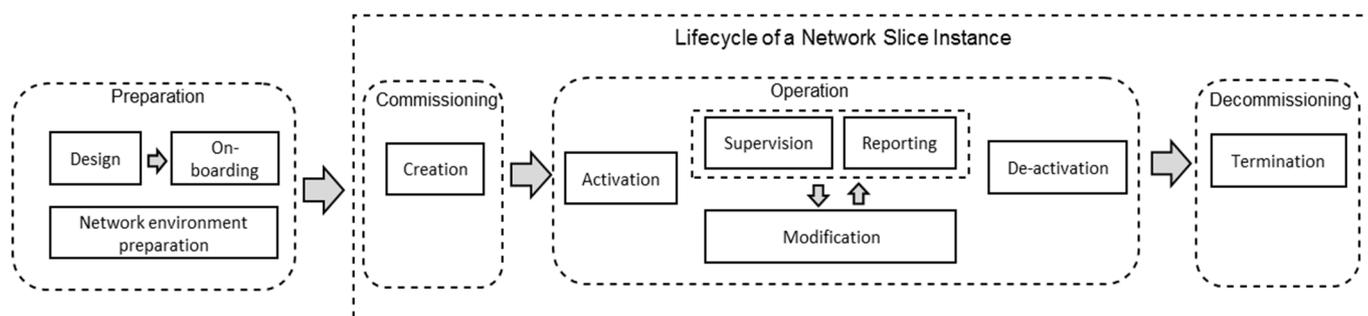
Figure 6.1.2-1: Lifecycle of network slice instance

During the Preparation phase, a capability check from the network environment is necessary.

During the Commissioning, Operation and Decommissioning phases, the following actions are necessary for the network slice instance provisioning:

- Creation
  For network slice instance allocation, the provider may create a new network slice instance or using an existing network slice instance to satisfy the request.

- Activation

- Modification

- De-activation

- Termination
  For network slice instance deallocation, the provider may terminate the network slice instance.

During the Operation phase, the following actions are necessary for fault and performance management:

- Supervision

- Reporting

6.2 Providing communication service in the scenario of network slice as NOP internals

6.2.1 Overall Description

In the scenario of network slice as NOP internals, the operator plays CSP and NOP roles simultaneously to provide communication services and network services.

The communication services provided by the operator may include such as eMBB, mIoT and critical communication.
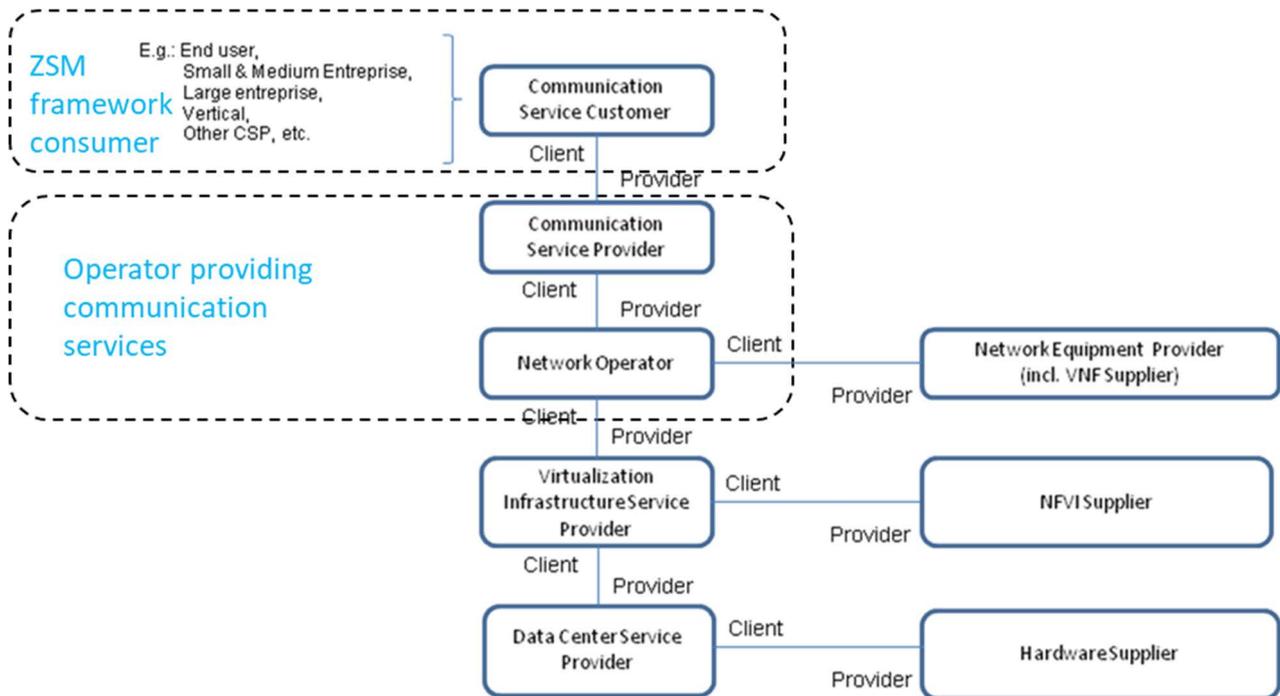
**Figure 6.2.1-1: High-level model of roles for network slice
as NOP internals based on ETSI TS 128 530 [4]**

In the "Network Slices as NOP internals" scenario, see clause 4.1.7 of ETSI TS 128 530 [4], the provisioning of the network is provided by E2E service management domain. For example, in the case of operator A operating the E2E service management domain, operator A provides communication services to vertical consumers to satisfy service-related requirements whilst the one or more network slice instances internally deployed by operator A are not visible to the vertical consumers.

Furthermore, as a consumer, E2E service management domain consumes the provisioning management service for network slice subnet instance provided by respective management domains, for example, AN management domain, CN management domain and TN management domain managed by vendors.

Optionally, the operator provides the management services to some vertical consumers who have requirements of acquiring some of the capabilities of service management. The E2E management services exposed by the operator may include capabilities such as monitoring of E2E service status, provisioning of E2E service.

6.2.2   E2E communication service provisioning

6.2.2.1   Overall Description

The management services (operations, notifications and information model) provided by E2E service management domain, management services provided by CN management domain and AN management domain should refer to ETSI TS 128 531 [5]. This clause provides the possible procedures for E2E network slicing management according to the example ZSM architecture deployment for network slicing in Figure 5.1-1.

6.2.2.2   Solution of E2E communication service provisioning

6.2.2.2.1   Solution of E2E communication service allocation

Figure 6.2.2.2.1-1 illustrates one of the possible solutions of allocating network with E2E network slice for communication services in the scenario of network slice as NOP internals. In the scenario of network slice as NOP internals, ZSM Framework Consumer (e.g. vertical customer) decides to deploy a service.

   NOTE: The sequence in this clause assumes a network structure consisting of AN/CN/TN MD.
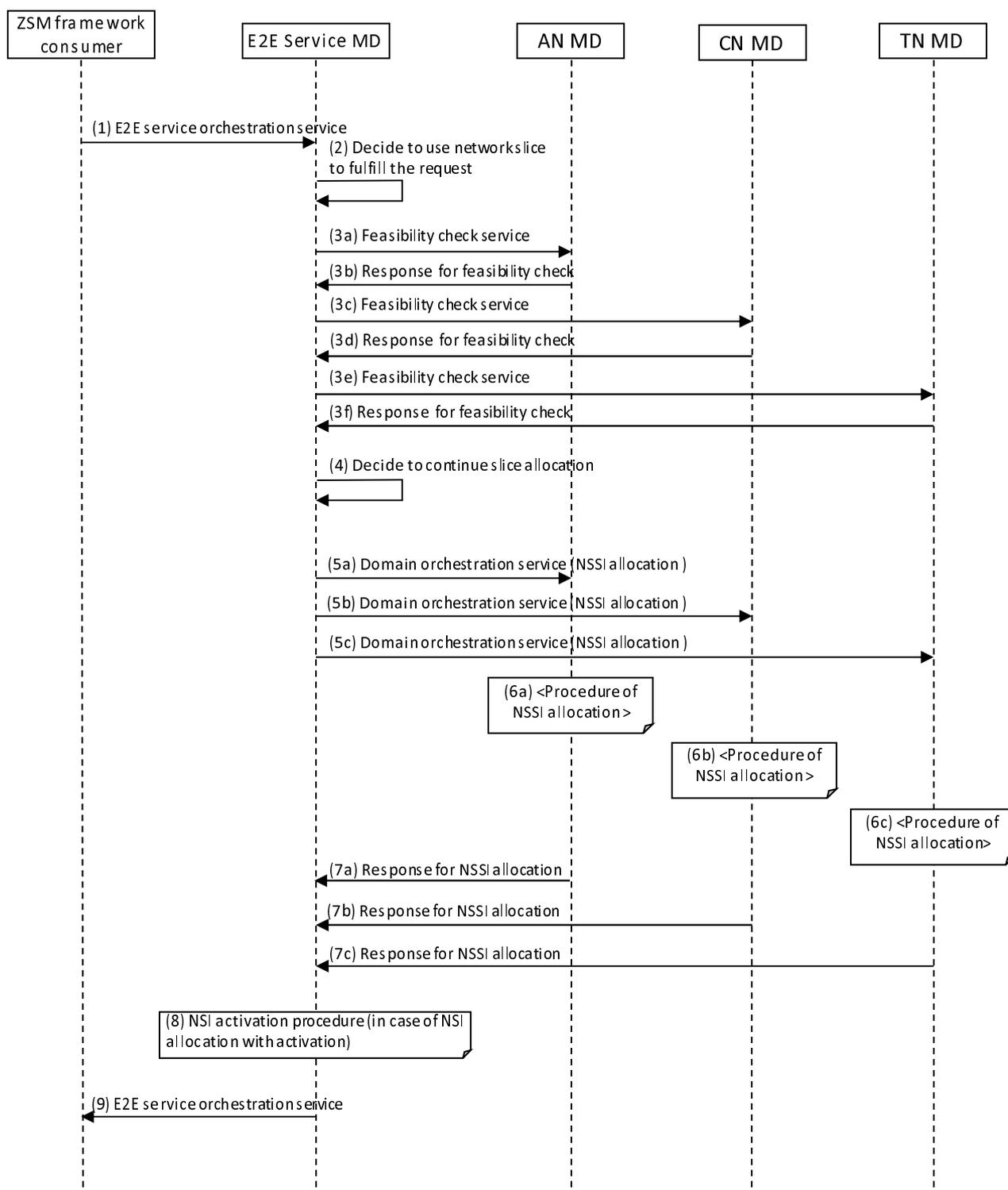
Figure 6.2.2.2.1-1: Allocating network with E2E network slice for communication services

1) E2E Service MD (E2E Service Management Domain) which includes the function of NSM (network service management) and CSM (communication service management), as communication service providers, acquires the service requirements on receiving the request from ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1, ETSI GS ZSM 002 [12] (the service may be implemented by TM Forum Open *API*, see API operation of Create Service in TMF638 [i.5]).

2) The E2E Service MD may decide to use network slice to fulfil the service-related requirements.

3a) The E2E Service MD derives the requirements for AN from the requirements received in step 1. Then, it sends a request to AN MD by utilizing feasibility check service in clause 6.5.5.2.2 of ETSI GS ZSM 002 [12] to check the feasibility of required resources and, if yes, reserves them. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period of time depending on the existing agreements with the consumer.

3b) The AN MD acknowledges the E2E Service MD. The response includes the success or failure of the request.

3c) The E2E Service MD derives the requirements for CN from the requirements received in step 1. Then, it sends a request to CN MD by utilizing feasibility check service in clause 6.5.5.2.2 of ETSI GS ZSM 002 [12] to check the feasibility of required resources and, if yes, reserves them. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period of time depending on the existing agreement with the consumer.

3d) The CN MD acknowledges the E2E Service MD. The response includes the success or failure of the request.

3e) The E2E Service MD derives the requirements for TN from the requirements received in step 1. Then, it sends a request to TN MD by utilizing feasibility check service in clause 6.5.5.2.2 of ETSI GS ZSM 002 [12] to check the feasibility of required resources and, if yes, reserves them. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period of time depending on the existing agreements with the consumer.

3f) The TN MD acknowledges the E2E Service MD. The response includes the success or failure of the request.

4)   If all the feasibility checks and reservations are successfully completed, the E2E Service MD decides to continue with slice allocation.

5a) E2E Service MD then requests AN MD to allocate the network slice subnet instance for AN by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be implemented by *AllocateNssi* operation in ETSI TS 128 531 [5]).

5b) E2E Service MD then requests CN MD to allocate the network slice subnet instance for CN by utilizing the E2E service orchestration service and the domain orchestration service in clauses 6.6.5.2.1 and 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be implemented by *AllocateNssi* operation in ETSI TS 128 531 [5]).

5c) E2E Service MD then requests TN MD to allocate the network slice subnet instance for TN. In the case of NFVO as a TN manager, the request can be implemented by utilizing the E2E service orchestration service and domain orchestration service in clauses 6.6.5.2.1 and 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be converted to *NFV Create service operation* in ETSI GS NFV-IFA 013 [10]. In other cases, the MDSC and PNC in the ACTN architecture (referring to [10]) can act as a TN manager, and the request can be carried by the CMI interface).

6a) On receiving the request from E2E Service MD, AN MD checks if the network slice subnet instance including network service instance needs to be allocated by utilizing the domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12]. If yes, the *network slice subnet allocation procedures* for AN follow.

6b) On receiving the request from E2E Service MD, CN MD checks if the network slice subnet instance including network service instance needs to be allocated by utilizing the domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12]. If yes, the *network slice subnet allocation procedures* for CN follow.

6c) On receiving the request from E2E Service MD, TN MD checks if the network slice subnet instance including network service instance needs to be allocated by utilizing the domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12]. If yes, the network slice subnet allocation procedures for TN follow. In the case of NFVO as a TN manager, the procedures refers to the procedure of *network slice Instance instantiation* (see clause 4.4.1 of ETSI TS 128 526 [15]). In other cases, the MDSC and PNC in the ACTN architecture (referring to [i.9]) can act as a TN manager, responsible to create the TN network slice subnet (i.e. to create a set of tunnels and form the Type 1 VN) in the underlying network through the MPI interface of ACTN architecture, referring to [i.12] and [i.11].

7a)   After completing the allocation of the AN network slice subnet, the AN MD sends a response to E2E Service MD by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

7b)   After completing the allocation of the CN network slice subnet, the CN MD sends a response to E2E Service MD by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

7c)   After completing the allocation of the TN network slice subnet, the TN MD sends a response to E2E Service MD by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the response can be converted to utilizing the *NFV Create service operation* in ETSI GS NFV-IFA 013 [10]. In other cases, the MDSC and PNC in the ACTN architecture (referring to IETF RFC 8453 [i.9]) can act as a TN manager, and the response can be carried by the CMI interface.

8)   If the NSI activation is requested with the NSI allocation request (step 1), the procedure in clause 6.2.2.2.4 is executed.

9)   After the E2E network slice has been allocated internally, the E2E Service MD sends the response to the ZSM Framework Consumer.

An example of a domain-level allocation sequence in AN MD.
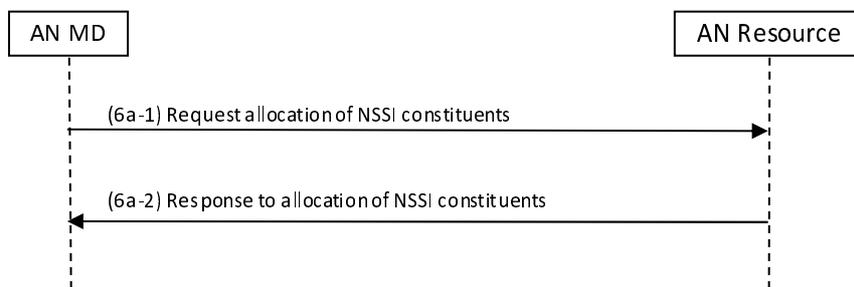
Figure 6.2.2.2.1-2: Example of a sequence of E2E network slice subnet allocation in AN MD

6a-1)   AN MD requests AN Resource to allocate the network slice subnet instance constituents by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be implemented by *AllocateNssi* operation in ETSI TS 128 531 [5]).

6a-2)   After completing the allocation of network slice subnet instance constituents, AN Resource sends the response to AN MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level allocation sequence for resource in CN MD.
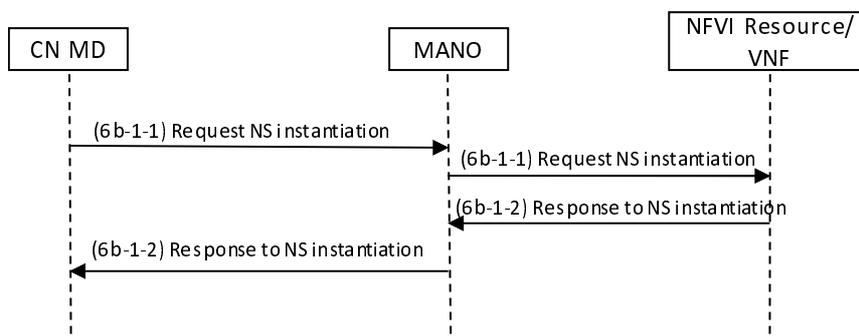
Figure 6.2.2.2.1-3: Example of a sequence of E2E network slice subnet allocation for resource in CN MD

6b-1-1)   CN MD requests network slice instantiation to NFVI Resource/VNF via MANO by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be implemented by *AllocateNssi* operation in ETSI TS 128 531 [5]).

6b-1-2)   After completing the network slice instantiation, MANO sends the response to CN MD, by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level allocation sequence for OAM application in CN MD.
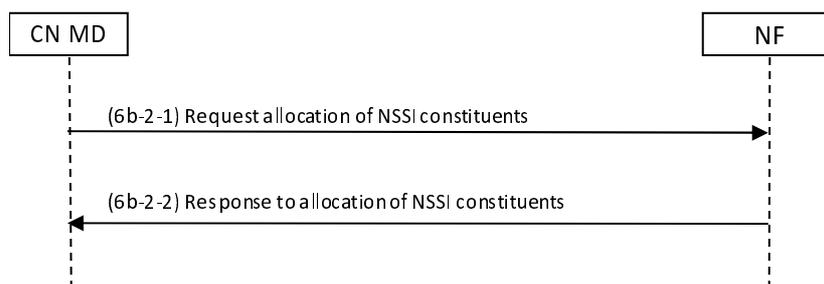
**Figure 6.2.2.2.1-4: Example of a sequence of E2E network slice subnet allocation
for OAM application in CN MD**

6b-2-1)   CN MD requests the allocation of network slice subnet instance constituents to NF by utilizing the
                 domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be
                 implemented by *AllocateNssi* operation in ETSI TS 128 531 [5]).

6b-2-2)   After completing the allocation of network slice subnet instance constituents, NF sends the
                 response to CN MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI
                 GS ZSM 002 [12].

An example of a domain-level allocation sequence in TN MD.
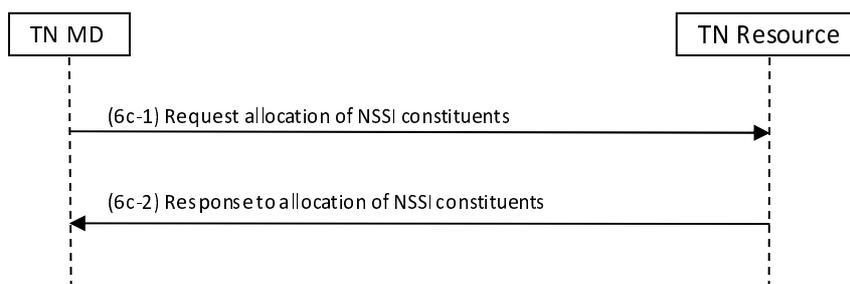
Figure 6.2.2.2.1-5: Example of a sequence of E2E network slice subnet Allocation in TN MD

6c-1)   TN MD requests the allocation of network slice subnet instance constituents to TN Resource by
                 utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this
                 service may be implemented by *AllocateNssi* operation in ETSI TS 128 531 [5]).

6c-2)   After completing the allocation of network slice subnet instance constituents, TN Resource sends
                 the response to TN MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI
                 GS ZSM 002 [12].

6.2.2.2.2   Solution of E2E communication service modification

Figure 6.2.2.2.2-1 illustrates one of the possible solutions of E2E network slice modification.
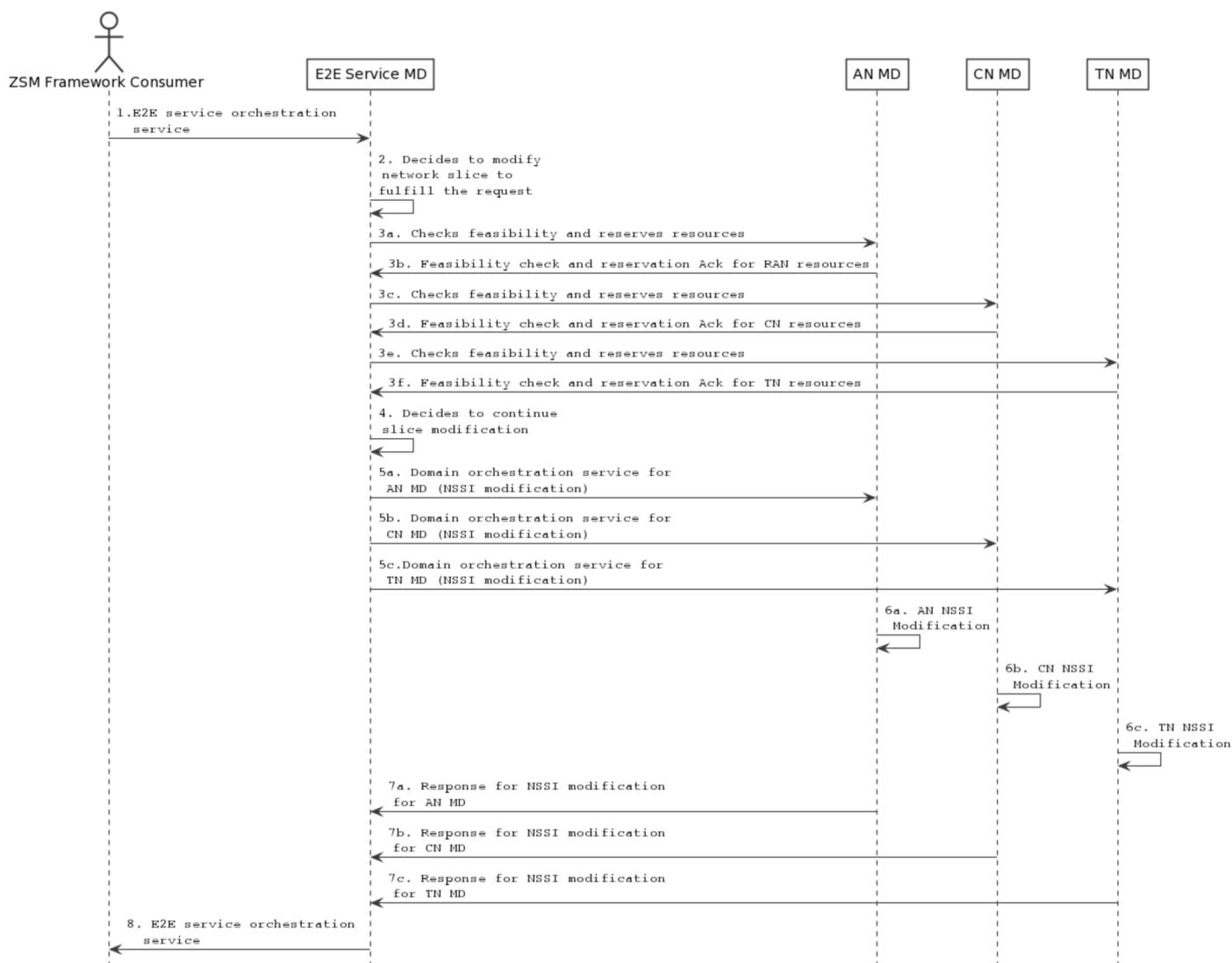
Figure 6.2.2.2.2-1: Modifying network with E2E network slice for communication services

1)   In the scenario of network slice as NOP internals, ZSM Framework Consumer (e.g. vertical industry) decides to modify a service. E2E Service MD (E2E Service Management Domain), as communication services providers, can get the service requirements update when receiving the request from ZSM Framework Consumer by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12] (the TM Forum API operation of *Patch service* in TMF638 [i.5] may be used for implementation).

2)   The E2E Service MD decides to modify the network slice to fulfil the service-related requirements.

3a) The E2E Service MD derives the requirements for AN from the requirements update received in step 1. If the modification in AN MD is needed, the E2E Service MD sends a request to AN MD to check the feasibility of required resources and, if yes, make the reservation of them. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period depending on the terms and conditions with the consumer.

3b) The AN MD sends Ack to E2E Service MD.

3c) The E2E Service MD derives the requirements for CN from the requirements update received in step 1. If the modification in CN MD is needed, the E2E Service MD sends a request to CN MD to check the feasibility of required resources and, if yes, make the reservation of them. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of feasibility check due to the other reservation requests. The reserved resources may be released after a period depending on the terms and conditions with the consumer.

3d)   The CN MD sends Ack to E2E Service MD.

3e)   The E2E Service MD derives the requirements for TN from the requirements update received in step 1). If the modification in TN MD is needed, the E2E Service MD sends a request to TN MD to check the feasibility of required resources and, if yes, make the reservation of them. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period depending on the terms and conditions with the consumer.

3f)   The TN MD sends Ack to E2E Service MD.

4)   If all the reservations are successfully completed, the E2E Service MD decides to continue the network slice modification.

5a)   E2E Service Management derived the new requirements for AN then request AN MD to modify the AN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (the *modifyMOIAttributes* operation defined in ETSI TS 128 532 [13] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] may be used for implementation).

5b)   E2E Service Management derived the new requirements for CN then request CN MD to modify the CN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (the *modifyMOIAttributes* operation defined in ETSI TS 128 532 [13] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] may be used for implementation).

5c)   E2E Service Management derived the new requirements for TN then request TN MD to modify TN related network slice subnet instance by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the request can be converted to utilizing NFV *Scale network service operation* or *Update network service Operation* in ETSI NFV IFA 013 [10].

6a)   On receiving the request from E2E Service MD, the NSSI modification procedures for AN part follow. In the case of AN domain, the *network slice subnet instance modification* procedures for RAN in ETSI TS 128 531 [5] may be referred to.

6b)   On receiving the request from E2E Service MD, the NSSI modification procedures for CN follows, the *network slice subnet instance modification* procedures for CN in ETSI TS 128 531 [5] may be referred to.

6c)   On receiving the request from E2E Service MD, the network slice subnet instance modification procedures for TN follows. In the case of NFVO as a TN manager, the procedures refer to the procedure of *network slice Instance updating* (see clause 4.4.5 of ETSI TS 128 526 [15]).

7a)   After completing the modification of the AN related network slice subnet instance, the AN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

7b)   After completing the modification of the CN related network slice subnet instance, the CN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

7c)   After completing the modification of the TN related network slice subnet instance, the TN MD sends a response to E2E Service MD domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the response can be converted to utilizing the NFV *Scale network service operation* or *Update network service Operation* in ETSI GS NFV-IFA 013 [10].

8)   After the E2E network slice has been modified internally, the E2E Service MD sends the response to the ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

6.2.2.2.3   Solution of E2E communication service deallocation

Figure 6.2.2.2.3-1 illustrates one of the possible solutions of deallocating network with E2E network slice for communication services in the scenario of network slice as NOP internals.
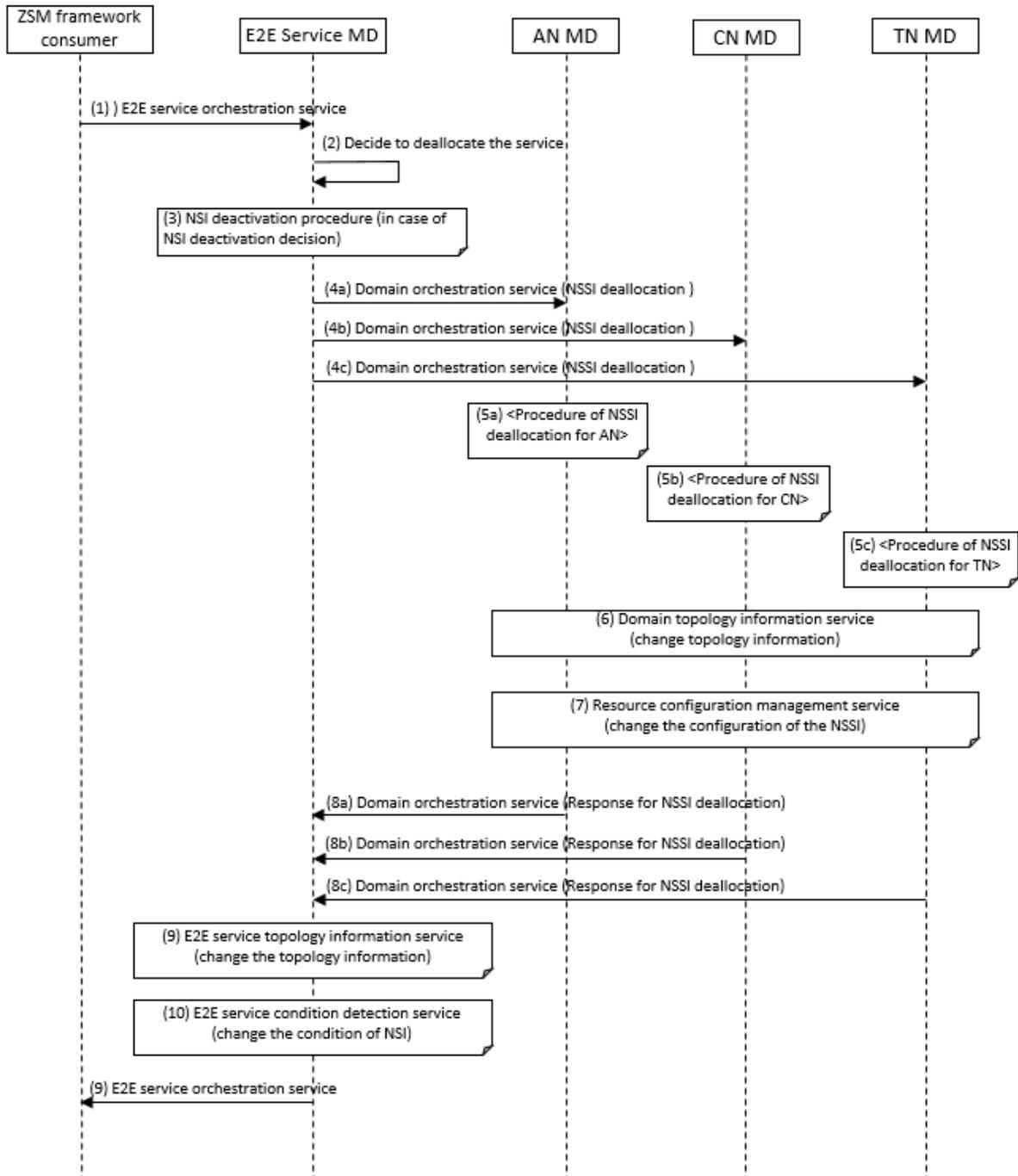
Figure 6.2.2.2.3-1: Deallocating network with E2E network slice for communication services

1) In the scenario of network slice as NOP internals, ZSM Framework Consumer (e.g. vertical customer) decides to terminate a service. E2E Service MD (E2E Service Management Domain), as communication service providers, can get the service termination requirements on receiving the request from ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12] (TM Forum API operation of *delete service* in TMF638 [i.5] may be utilized for implementation).

2) E2E Service MD may retrieve topology information of the network slice instance to check other services supported by the network slice instance. E2E Service MD decides to terminate the E2E service.

NOTE 1: Execute modification of the network slice instance or stop termination if there is another service supported by the network slice instance.

3) If the NSI deactivation is decided, the procedure in clause 6.2.2.2.5 is executed.

4a)   E2E Service MD requests AN MD to deallocate the AN related network slice subnet instance by utilizing
        domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (the de*allocateNssi* operation in
        ETSI TS 128 531 [5] may be utilized for implementation).

4b)   E2E Service MD requests CN MD to deallocate the CN related network slice subnet instance by utilizing
        domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (the de*allocateNssi* operation in
        ETSI TS 128 531 [5] may be utilized for implementation).

NOTE 2: For step a) and b), the de*allocateNssi* operation in ETSI TS 128 530 [4] is only applicable to the case that
         an AN/CN network slice subnet only support a single network slice.

4c)   E2E Service MD requests TN MD to deallocate the TN related network slice subnet instance by utilizing the
        E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN
        manager, the request can be converted to utilizing the NFV *Delete network service operation* or *Terminate
        network service operation* in ETSI GS NFV-IFA 013 [10].

5a)   On receiving the request from E2E Service MD, AN MD checks if the network slice subnet instance need to
        be terminated and network service instances are associated with the network slice subnet instance by utilizing
        the domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12]. If yes, the *network
        slice subnet deallocation procedures* for AN (see clause 7.5 of ETSI TS 128 531 [5]) follow.

5b)   On receiving the request from E2E Service MD, CN MD check if the network slice subnet instance need to be
        terminated and network service instances are associated with the network slice subnet instance by utilizing the
        domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12]. If yes, the *network slice
        subnet deallocation procedures* for CN (see clause 7.5 of ETSI TS 128 531 [5]) follow.

5c)   On receiving the request from E2E Service MD, TN MD check if the network slice subnet instance need to be
        terminated and network service instances are associated with the network slice subnet instance by utilizing the
        domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12]. If yes, the network slice
        subnet deallocation procedures for TN follows. In the case of NFVO as a TN manager, the procedure refers to
        the procedure of *network slice Instance termination* (see clause 4.4.2 of ETSI TS 128 526 [15]).

NOTE 3: At 5a), 5b) and 5c), network slice subnet instances/ network service instances update can be executed
         instead of termination. (The case of update will not be illustrated in this sequence.)

6)   CN MD, AN MD and TN MD may change the topology information by utilizing the domain topology
        information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12].

7)   CN MD, AN MD and TN MD may change the configuration of the network slice subnet instance by utilizing
        the resource configuration management service in clause 6.5.6.2.1 of ETSI GS ZSM 002 [12].

8a)   After completing the deallocation of the AN network slice subnet, the AN MD sends a response to E2E
        Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

8b)   After completing the deallocation of the CN network slice subnet, the CN MD sends a response to E2E
        Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

8c)   After completing the deallocation of the TN network slice subnet, the TN MD sends a response to E2E Service
        MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of
        NFVO as a TN manager, the response can be converted to utilizing the NFV *Delete network service operation*
        or *Terminate network service operation* in ETSI GS NFV-IFA 013 [10].

9)   E2E Service MD may change the topology information of the network slice instance by utilizing the E2E
        service topology information service in clause 6.6.5.2.7 of ETSI GS ZSM 002 [12].

10)   E2E Service MD may change the condition of the network slice instance by utilizing the E2E service condition
        detection service in clause 6.6.3.2.3 of ETSI GS ZSM 002 [12].

11)   After the E2E network slice has been deallocated internally, the E2E Service MD sends the response to the
        ZSM Framework Consumer by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI
        GS ZSM 002 [12].

An example of a domain-level sequence of network slice subnet deallocation in AN MD.
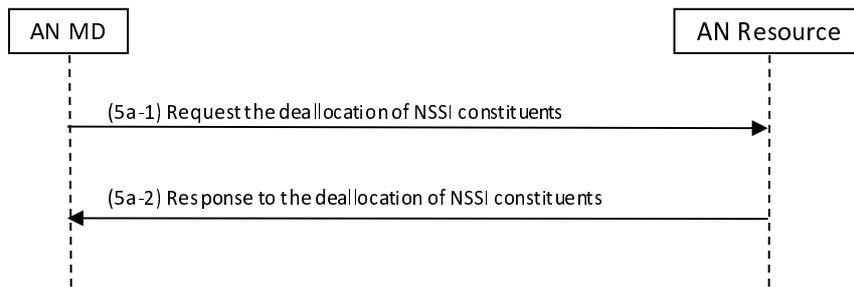
Figure 6.2.2.2.3-2: Example of a sequence of network slice subnet deallocation in AN MD

5a-1)   AN MD requests the deallocation of network slice subnet instance constituents to AN Resource by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

5a-2)   After completing the deallocation of AN Resource, AN Resource sends the response to AN MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of network slice subnet deallocation for resource in CN MD.
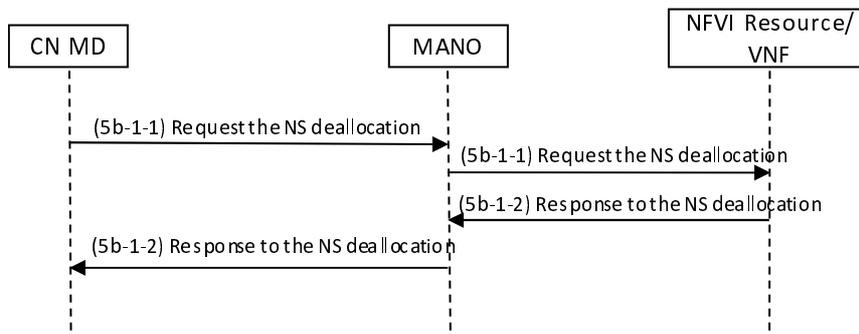
Figure 6.2.2.2.3-3: Example of a sequence of network slice subnet deallocation for resource in CN MD

5b-1-1)   CN MD requests network slice deallocation to NFVI Resource/VNF via MANO. (ref. Os-Ma-Nfvo and Venf-Vnfm).

5b-1-2)   After completing the network slice deallocation, MANO sends the response to CN MD. (ref. Os-Ma-Nfvo and Venf-Vnfm).

An example of a domain-level sequence of network slice subnet deallocation for OAM application in CN MD.
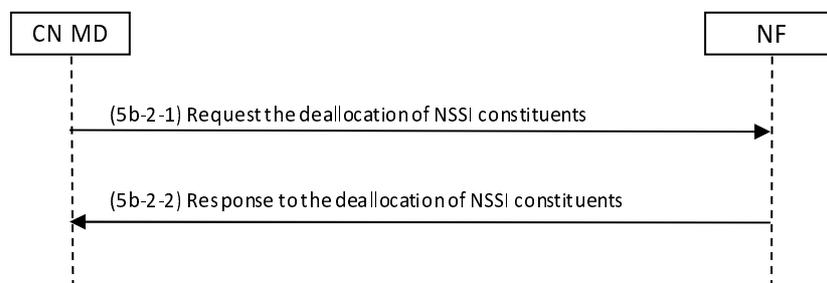
Figure 6.2.2.2.3-4: Example of a sequence of network slice subnet deallocation for OAM application in CN MD

5b-2-1)   CN MD requests the deallocation of network slice subnet instance constituents to NF by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (this service may be implemented by DeallocateNssi operation in ETSI TS 128 531 [5]).

5b-2-2)   After completing the allocation of network slice subnet instance constituents, NF sends the response to CN MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of network slice subnet deallocation in TN MD.
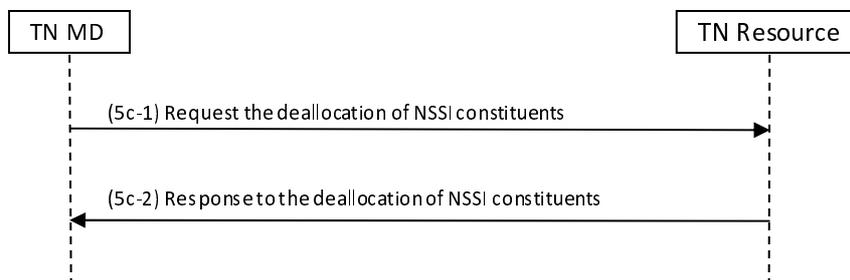
Figure 6.2.2.2.3-5: Example of a sequence of network slice subnet deallocation in TN MD

5c-1)   TN MD requests the deallocation of network slice subnet instance constituents to TN Resource by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

5c-2)   After completing the deallocation of TN Resource, TN Resource sends the response to TN MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

6.2.2.2.4   Solution of E2E communication service activation

Figure 6.2.2.2.4-1 illustrates one of the possible solutions of activating network with E2E network slice for communication services in the scenario of network slice as NOP internals.

Pre-condition: A network slice instance and network slice subnet instances have been created and their administrative states are "locked," see annex B (normative): Network slice instance and network slice subnet instance state handling of ETSI TS 128 541 [7].
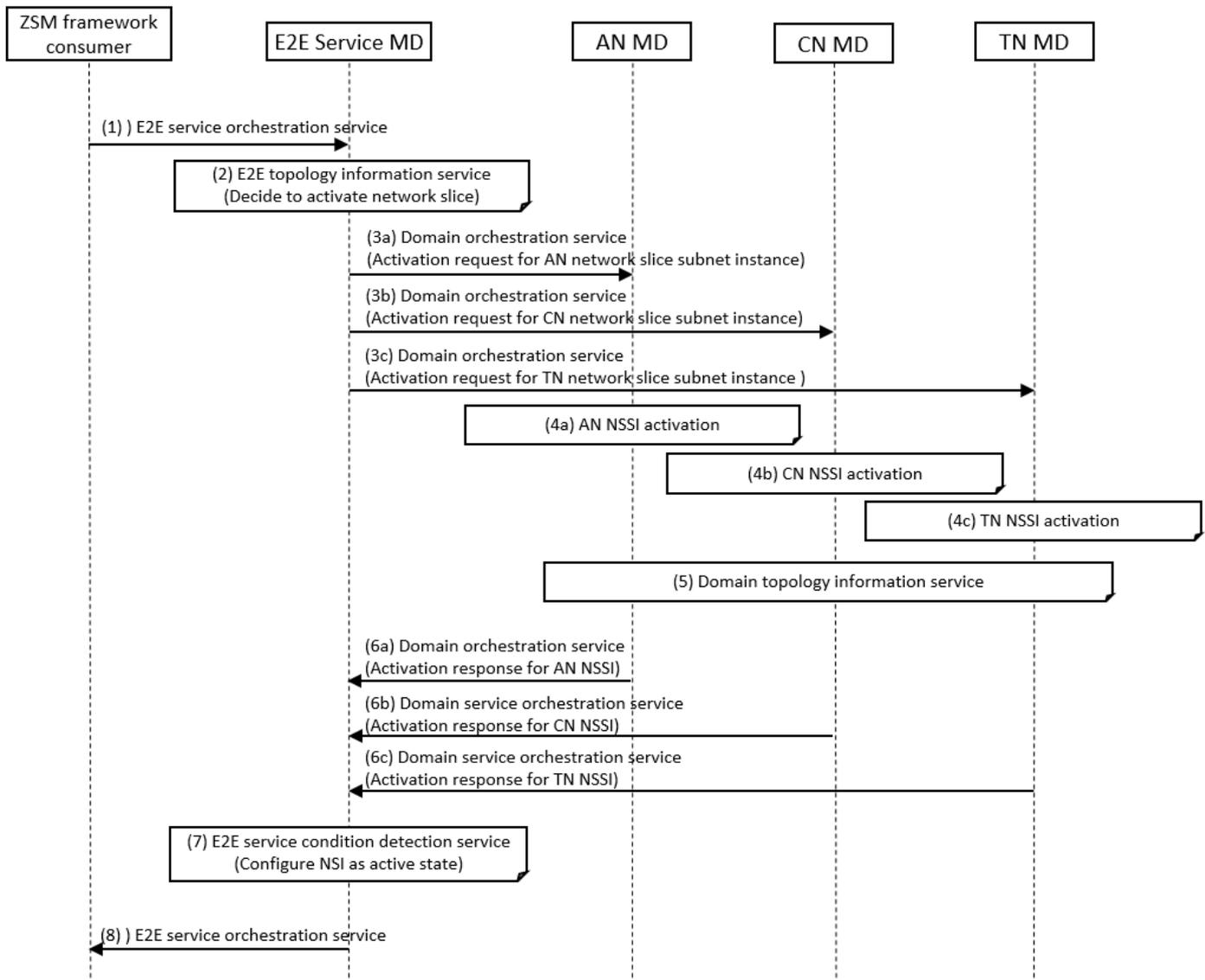
Figure 6.2.2.2.4-1: Activating network with E2E network slice for communication services

1) ZSM framework consumers (e.g. vertical customer) decides to activate a service by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12]. E2E Service MD (E2E Service Management Domain) which includes the function of NSM (network service management) and CSM (communication service management), as communication services providers, can get the service requirements on receiving the request from ZSM framework consumers.

NOTE 1: Activation may be requested with network slice allocation request mentioned in step1 of clause 6.2.2.2.1. In this case, network slice activation sequence is initiated after step 7 of clause 6.2.2.2.1 and step1 in this clause is skipped.

2) The E2E Service MD decides to activate the network slice to fulfil the network slice related requirements and may change its topology information by utilizing E2E service topology information service in clause 6.6.5.2.7 of ETSI GS ZSM 002 [12].

3a) E2E Service MD derives the requirements for AN, then requests AN MD to activate the AN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

3b) E2E Service MD derives the requirements for CN, then requests CN MD to activate the CN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

3c) E2E Service MD derives the requirements for TN, then requests TN MD to activate the TN related network slice subnet instance by utilizing domain orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

4a)   On receiving the request from E2E Service MD, AN MD executes the network slice subnet instance activation and changes a network slice subnet instance administrative state from "locked" to "unlocked" by utilizing the domain condition detection service in clause 6.5.3.2.2 of ETSI GS ZSM 002 [12].

4b)   On receiving the request from E2E Service MD, CN MD executes the network slice subnet instance activation and changes a network slice subnet instance administrative state from "locked" to "unlocked" by utilizing the domain condition detection service in clause 6.5.3.2.2 of ETSI GS ZSM 002 [12].

4c)   On receiving the request from E2E Service MD, the procedures of network slice subnet activation solution for TN is executed.

5)   CN MD, AN MD and TN MD may change the topology information of each MD by utilizing the domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12].

6a)   After completing the activation of the AN related network slice subnet, the AN MD sends the response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

6b)   After completing the activation of the CN related network slice subnet, the CN MD sends the response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

6c)   After completing the activation of the TN related network slice subnet, the TN MD sends the response to E2E Service MD by utilizing domain orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

7)   E2E Service MD configures the network slice instance as active state by utilizing E2E service condition detection service in clause 6.6.3.2.3 of ETSI GS ZSM 002 [12].

8)   After the E2E network slice has been activated internally, the E2E Service MD sends the response to the ZSM framework consumers.

NOTE 2:   In case that activation is requested with network slice allocation request in step1 of clause 6.2.2.2.1, step 9) in clause 6.2.2.2.1 is executed instead of step 8 of this clause.

An example of a domain-level sequence of activation in AN MD.
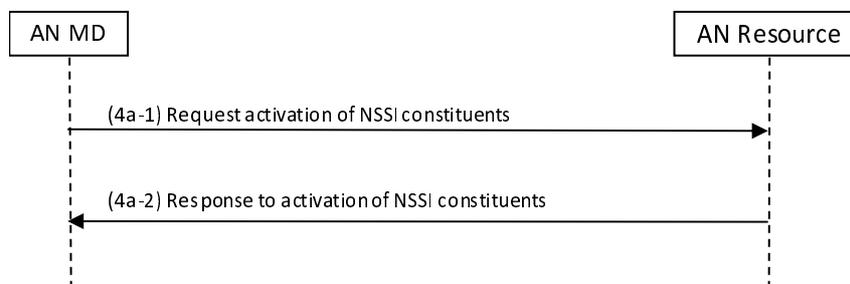
Figure 6.2.2.2.4-2: Example of a sequence of network slice subnet activation in AN MD

4a-1)   On receiving the request from E2E Service MD, AN MD requests the activation of the network slice subnet instance constituents in AN Resource by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

4a-2)   After completing the activation of AN Resource, AN Resource sends the response to AN MD by utilizing the performance measurements collection service/ fault events service in clauses 6.5.2.2.3 and 5.5.2.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of activation for resource in CN MD.
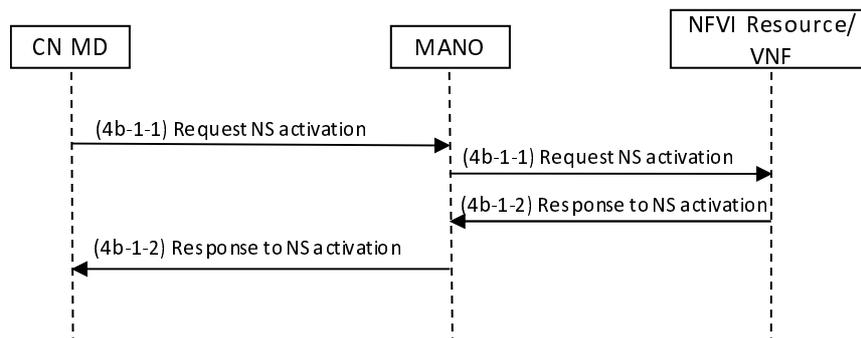
Figure 6.2.2.2.4-3: Example of a sequence of network slice subnet Activation for resource in CN MD

4b-1-1)   On receiving the request from E2E Service MD, CN MD requests network slice activation to NFVI Resource/VNF via MANO by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

4b-1-2)   After completing the activation of the network slice, the response to the request is sent from MANO to CN MD by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of activation for OAM application in CN MD.
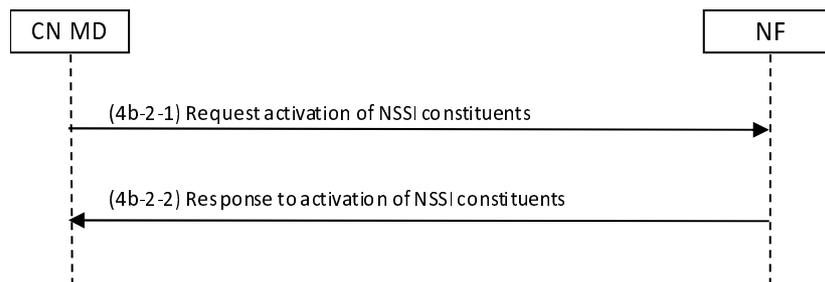
**Figure 6.2.2.2.4-4: Example of a sequence of network slice subnet
Activation for OAM application in CN MD**

4b-2-1)   On receiving the request from E2E Service MD, CN MD requests the activation of the network slice subnet instance constituents to NF by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

4b-2-2)   After completing the activation of the network slice subnet instance constituents, NF sends the response to CN MD by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of activation in TN MD.
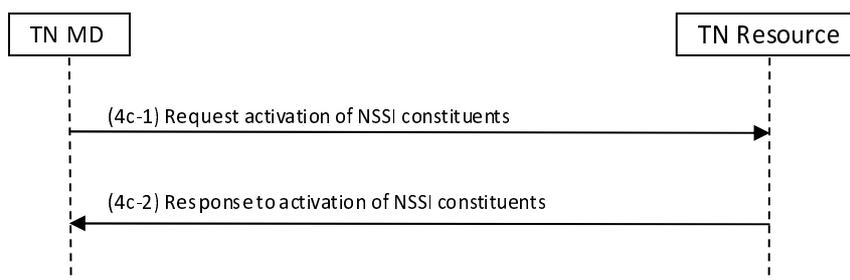
Figure 6.2.2.2.4-5: Example of a sequence of network slice subnet Activation in TN MD

4c-1)   On receiving the request from E2E Service MD, TN MD requests the activation of the network slice subnet instance constituents in TN Resource by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

4c-2)   After completing the activation of TN Resource, TN Resource sends the response to TN MD by utilizing the performance measurements collection service/fault events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

6.2.2.2.5   Solution of E2E communication service deactivation

Figure 6.2.2.2.5-1 illustrates one of the possible solutions of deactivating network with E2E network slice for communication services in the scenario of network slice as NOP internals.

Pre-condition: The administrative states of a network slice instance and network slice subnet instances are "unlocked," see annex B (normative): network slice instance and network slice subnet instance state handling of ETSI TS 128 541 [7].
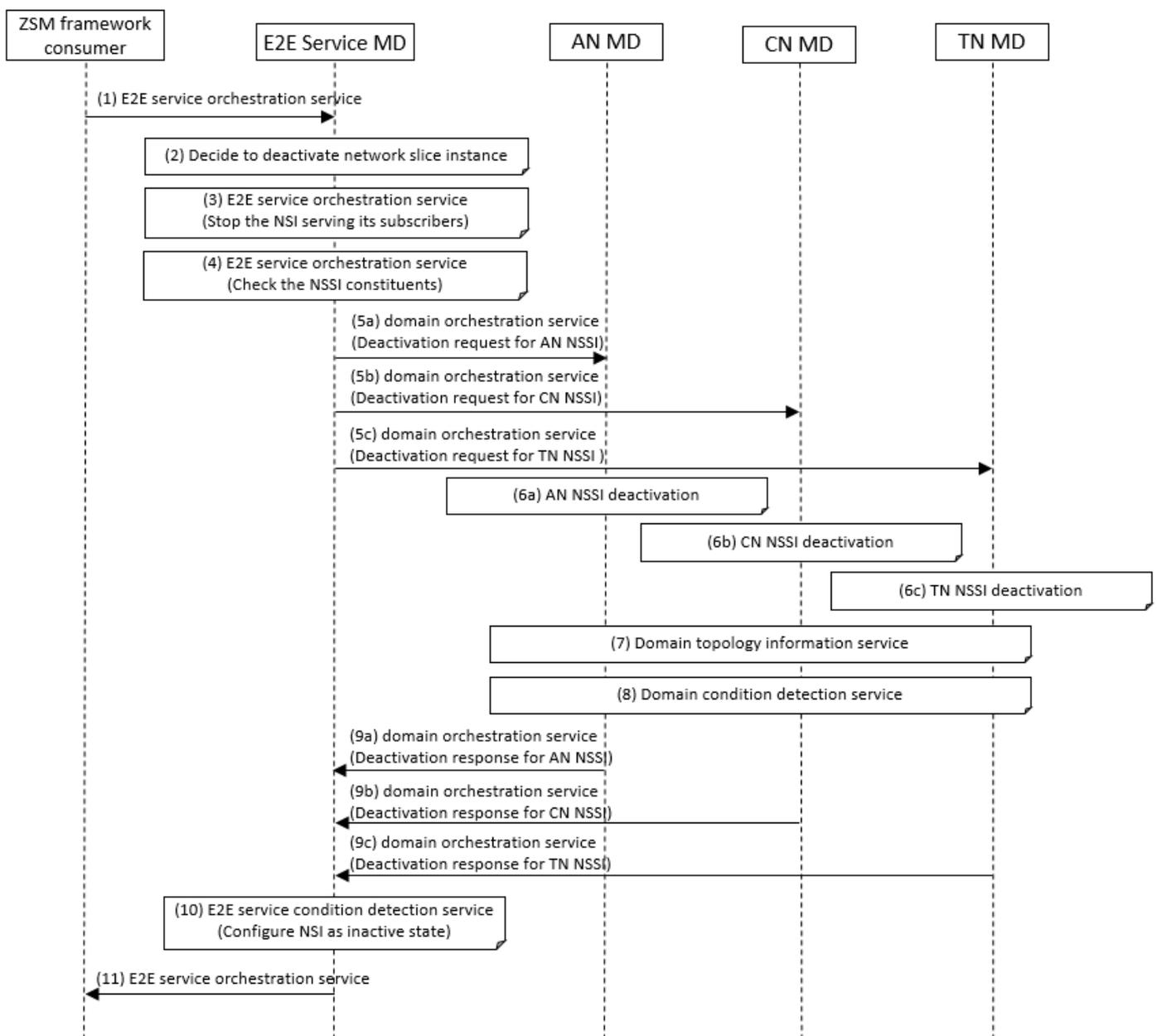

Figure 6.2.2.2.5-1: Deactivating network with E2E network slice for communication services

1)   In the scenario of network slice as NOP internals, ZSM framework consumers (e.g. vertical customer) decides to deactivate a service by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12]. E2E Service MD (E2E Service Management Domain) which includes the function of NSM (network service management) and CSM (communication service management), as communication services providers, can get the service requirements on receiving the request from ZSM framework consumers.

NOTE 1: The deactivation may be requested with the network slice deallocation mentioned in step 1 of clause 6.2.2.2.3. In this case, the network slice deactivation sequence is initiated after step 3 of clause 6.2.2.2.3 and step 1) of this clause is skipped.

2)   The E2E Service MD decides to deactivate the network slice to fulfil the network slice related requirements (see ServiceProfile defined in clause 6.3.3 of ETSI TS 128 541 [7]). Before this decision, the E2E Service MD may check that network slice instance is in active state by utilizing the E2E service condition detection service in clause 6.6.3.2.3 of ETSI GS ZSM 002 [12].

3)   E2E Service MD may stop the network slice instance serving its subscribers by utilizing the E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

4)   E2E Service MD may check if there are the network slice subnet instance constituents that need to be deactivated by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

NOTE 2: This sequence aims to express termination including deactivation of E2E network slice instance. Therefore, the steps below (4) are drawn assuming that there are the network slice subnet instance constituents that need to be deactivated.

5a)   E2E Service MD derives the requirements for AN, then requests AN MD to deactivate the AN related network slice subnet instance by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

5b)   E2E Service MD derives the requirements for CN, then requests CN MD to deactivate the CN related network slice subnet instance by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

5c)   E2E Service MD derives the requirements for TN, then requests TN MD to deactivate the TN related network slice subnet instance by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

6a)   On receiving the request from E2E Service MD, AN MD executes the network slice subnet instance deactivation and changes a network slice subnet instance administrative state from "unlocked" to "locked."

6b)   On receiving the request from E2E Service MD, CN MD executes the network slice subnet instance deactivation and changes a network slice subnet instance administrative state from "unlocked" to "locked."

6c)   On receiving the request from E2E Service MD, the procedures of network slice subnet deactivation solution for TN is executed.

7)   CN MD, AN MD and TN MD may change the topology information of each MD by utilizing the domain topology information service in clause 6.5.5.2.7 of ETSI GS ZSM 002 [12].

8)   CN MD, AN MD and TN MD may configure the network slice subnet instances as inactive state each by utilizing the domain condition detection service in clause 6.5.3.2.2 of ETSI GS ZSM 002 [12]

9a)   After completing the deactivation of the AN network slice subnet, the AN MD sends the response to E2E Service MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

9b)   After completing the deactivation of the CN network slice subnet, the CN MD sends the response to E2E Service MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

9c)   After completing the deactivation of the TN network slice subnet, the TN MD sends the response to E2E Service MD by utilizing the domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12].

10)   E2E Service MD configures the network slice instance as inactive state by utilizing the E2E service condition detection service in clause 6.6.3.2.3 of ETSI GS ZSM 002 [12]

11)   After the E2E network slice has been deactivated internally, the E2E Service MD sends the response to the ZSM framework consumers.

NOTE 3:   In case that deactivation is requested with the network slice deallocation request in step 1 of
          clause 6.2.2.2.3, steps after step 4) of clause 6.2.2.2.3 are executed instead of step 11) of this clause.

An example of a domain-level sequence of deactivation in AN MD.
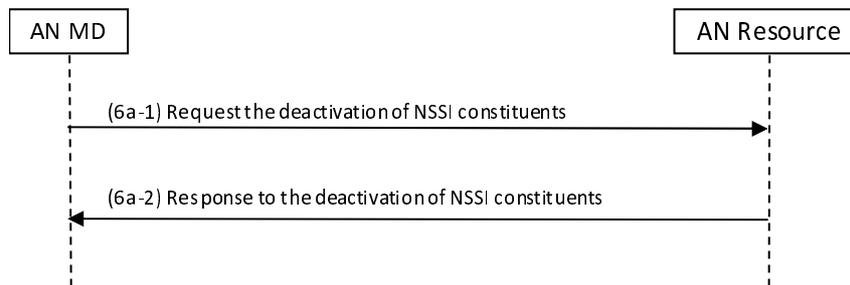
Figure 6.2.2.2.5-2: Example of a sequence of network slice subnet deactivation in AN MD

6a-1)   On receiving the request from E2E Service MD, AN MD requests the deactivation of the network
                 slice subnet instance constituents in AN Resource by utilizing the performance measurements
                 collection service/ faults events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI
   GS ZSM 002 [12].

6a-2)   After completing the deactivation of AN Resource, AN Resource sends the response to AN MD by
                 utilizing the performance measurements collection service/ faults events service in
   clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of deactivation for resource in CN MD.
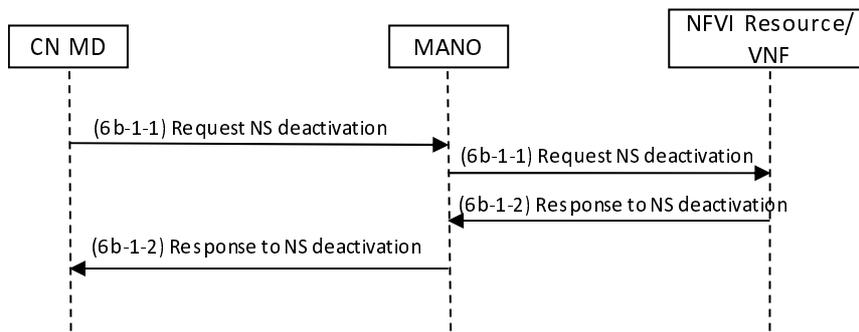
Figure 6.2.2.2.5-3: Example of a sequence of network slice subnet
Deactivation for resource in CN MD

6b-1-1)   On receiving the request from E2E Service MD, CN MD requests network slice deactivation to
                 NFVI Resource/VNF via MANO.

6b-1-2)   After completing the deactivation of network slice, the response to the request is sent to CN MD
                 via MANO.

An example of a domain-level sequence of deactivation for OAM application in CN MD.

```
  ┌────────┐                                          ┌────────┐
  │ CN MD  │                                          │   NF   │
  └────────┘                                          └────────┘
       │                                                   │
       │  (6b-2-1) Request the deactivation of NSSI constituents │
       │──────────────────────────────────────────────────>│
       │                                                   │
       │  (6b-2-2) Response to the deactivation of NSSI constituents │
       │<──────────────────────────────────────────────────│
       │                                                   │
```
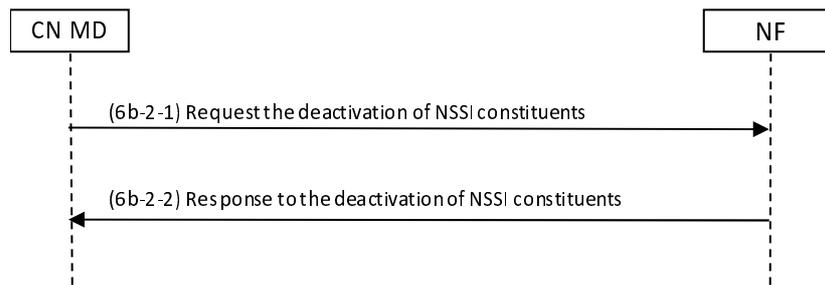
**Figure 6.2.2.2.5-4: Example of a sequence of network slice subnet
Deactivation for OAM application in CN MD**

6b-2-1)   On receiving the request from E2E Service MD, CN MD requests the deactivation of the network
               slice subnet instance constituents to NF by utilizing the performance measurements collection
               service/ faults events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

6b-2-2)   After completing the deactivation of the network slice instance constituents, NF sends the response
               to CN MD by utilizing the performance measurements collection service/ faults events service in
               clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

An example of a domain-level sequence of deactivation in TN MD.

```
  ┌────────┐                                          ┌─────────────┐
  │ TN MD  │                                          │ TN Resource │
  └────────┘                                          └─────────────┘
       │                                                   │
       │  (6c-1) Request the deactivation of NSSI constituents │
       │──────────────────────────────────────────────────>│
       │                                                   │
       │  (6c-2) Response to the deactivation of NSSI constituents │
       │<──────────────────────────────────────────────────│
       │                                                   │
```
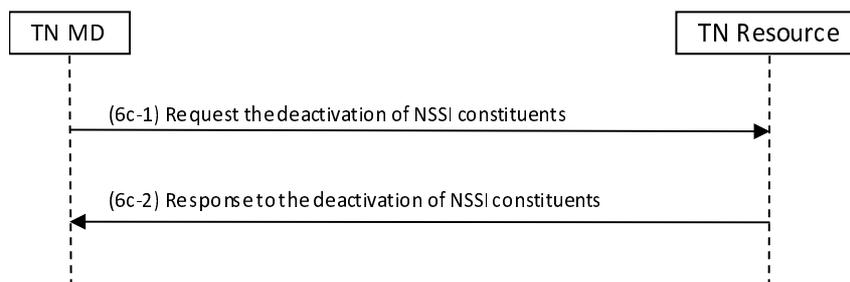
Figure 6.2.2.2.5-5: Example of a sequence of network slice subnet Deactivation in TN MD

6c-1)   On receiving the request from E2E Service MD, TN MD requests the deactivation of the network
               slice subnet instance constituents in TN Resource by utilizing the performance measurements
               collection service/ faults events service in clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI
               GS ZSM 002 [12].

6c-2)   After completing the deactivation of TN Resource, TN Resource sends the response to TN MD by
               utilizing the performance measurements collection service/ faults events service in
               clauses 6.5.2.2.3 and 6.5.2.2.1 of ETSI GS ZSM 002 [12].

6.2.2.2.6   Solution of E2E network slice instance feasibility check

The management service for service feasibility check in the E2E service management domain is used to check if a
particularly parameterized E2E network slice iis deployable corresponding to the proposed service-level specification
(SLS). This check ranges from simple location-based checks (e.g. radio coverage in RAN domain), to full configuration
parameter feasibility check of a network slice instance. It further includes checking the availability of the resources to
be allocated to the network slice instance.

Querying the different management domains to acquire accurate and current information about idle and allocated
resources might be a complex and time-consuming process. A simpler and quick check with respect to a selected set of
fundamental domain capabilities ("qualitative check") might be sufficient for, e.g. preliminary E2E network slice
instance feasibility check.

However, in such case, resource availability might be uncertain for selected management domains. Indication of
confidence values reflects such uncertainty in resource availability and could be part of the capabilities of the feasibility
check service.

Figure 6.2.2.2.6-1 illustrates one of the possible solutions of checking E2E network slice feasibility, using six more basic management services. The complete service execution can be separated into two parts. The first part checks for the qualitative network capabilities that the network slice instance requires, e.g. availability of a specific radio access technology or feasible network function configurations. This is expected to complete rather quickly and can therefore provide a quick reply in the case of a negative ("network slice instance infeasible") response. In case of a positive qualitative check, the second part quantitatively checks if sufficient resources, such as, processing, storage, throughput, but also radio resources, are available. It also calculates confidence values if resource availability is associated with statistical uncertainty, e.g. due to statistical fluctuations in resource consumption of already deployed slice instances.
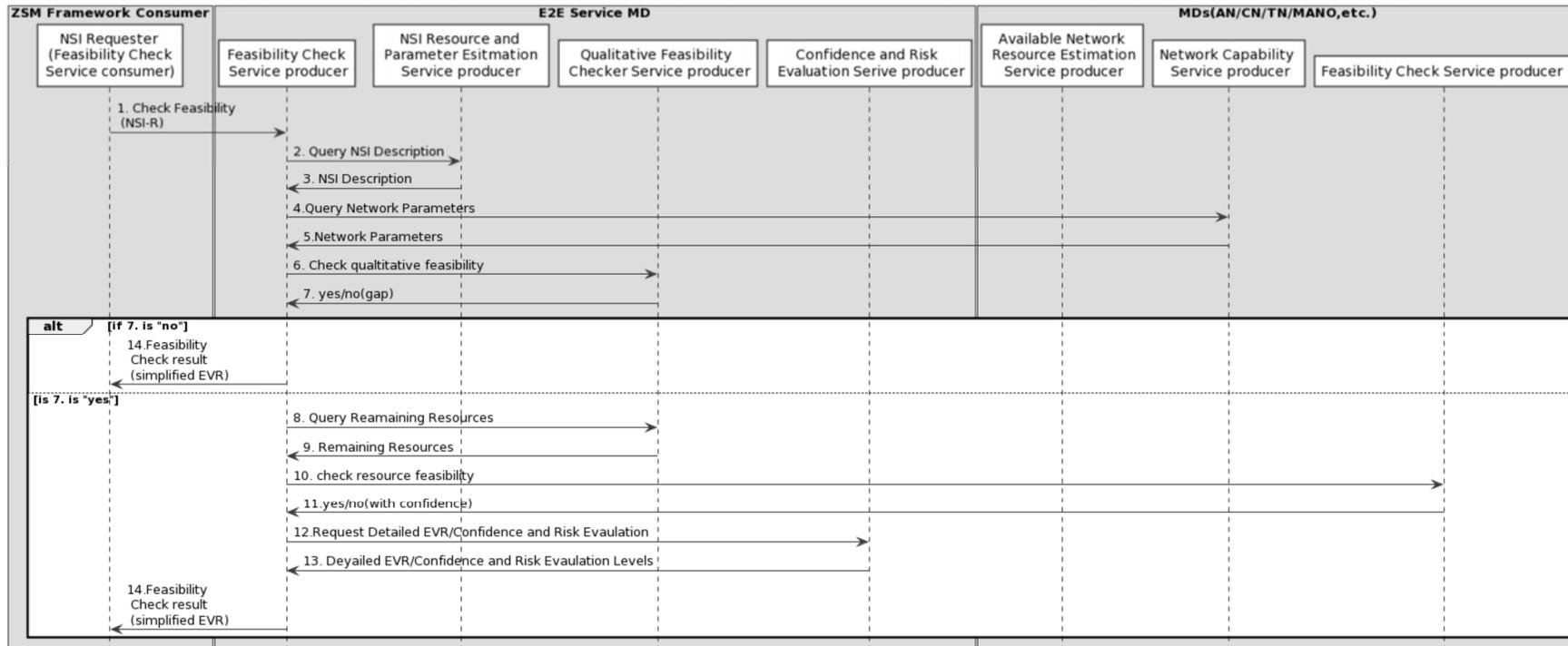
Figure 6.2.2.2.6-1: E2E network slice instance feasibility chec

NOTE: Not all the MnSs have been specified in ETSI GS ZSM 002 [12].

1)   The Feasibility Check Service consumer (i.e. the network slice instance Requester) sends a request to check the feasibility of a network slice instance Request (network slice instance-R) to the Feasibility Check Service producer in the E2E service management domain. The network slice instance-R is a customer-facing service description, provided via, e.g. ZSM framework consumers. The network slice instance-R may contain SLS parameters, such as those defined in GSMA PRD NG.116 [16], e.g. latency, coverage, bandwidth, traffic profile, performance reliability requirements, mobility.

2)   The Feasibility Check Service producer queries the network slice instance Description (network slice instance-D) for the requested, additional network slice instance from the network slice instance Resource and Parameter Estimation Service, providing the network slice instance-R of step 1). The network slice instance-D comprises a resource-facing service description of the network slice instance-R. It specifies requirements regarding resource and network capabilities. Typical parameters are, for instance: latency, throughput, computational power, memory capacities, availability and reliability.

3)   The network slice instance Resource and Parameter Estimation Service producer responds with the network slice instance-D for the requested network slice instance to the Feasibility Check Service producer.

4)   The Feasibility Check Service producer queries the Network Parameters from the Network Capability Service producer, optionally providing some filtering criteria (e.g. geographical scope of the network slice instance, specific network domain) to limit the scope of the requested network capabilities. The queried Network Parameters are selected features and configuration parameters from the network slice subnet domains, e.g. RAN technology, coverage, edge cloud availability, security features, service and session continuity parameters.

5)   The Network Capability Service producer responds with the Network Parameters to the Feasibility Check Service producer. The Network Parameters comprise a formal description of the network capabilities. If some filtering criteria have been provided in the previous step, only these Network Parameters that match the criteria are provided. The Network Parameters have the same level of abstraction as the information elements contained in the network slice instance-D.

6)   The Feasibility Check Service producer triggers the Qualitative Feasibility Checker Service, providing the network slice instance-D as well as the Network Parameters from steps 3) and 5), respectively.

7)   The Qualitative Feasibility Checker Service producer compares network slice instance-D and Network Parameters according to an internal logic and responds to the Feasibility Check Service producer with "yes/network slice instance preliminary feasible" or "no/network slice instance infeasible". It also includes potentially identified gaps to network slice instance requirements, e.g. lack of radio coverage in specific area. If the Qualitative Feasibility Checker Service producer answers "no/network slice instance infeasible" the process ends and the Feasibility Check Result (simplified EVR) is returned to the Feasibility Check Service consumer (step 14), otherwise the Feasibility Check Service continues with the quantitative resource evaluation.

8)   If the Qualitative Feasibility Checker Service producer(s) respond(s) with "yes", Feasibility Check Service producer queries the Remaining Resources from the Available Network Resource Estimation Service producer.

9)   The Available Network Resource Estimation Service producer reports the Remaining Resources to the Feasibility Check Service producer. That means a probabilistic model of resource utilization for the consumable resources that are part of the network slice instance-D.

10) The Feasibility Check Service producer triggers the Feasibility Check Service in the management domain(s), providing information regarding the Remaining Resources of step 9).

11) The Feasibility Check Service producer(s) respond(s) to the Feasibility Check Service producer with "yes" or "no" and Confidence Information per resource category.

12) The Feasibility Check Service producer triggers the Confidence and Risk Evaluation Service, providing the Remaining Resources of message 9 and the Confidence Information of step 11).

13)   Depending on its implementation, the Confidence and Risk Evaluation Service responds to the Feasibility
        Check Service producers with a detailed Evaluation Result (EVR) or only the Confidence and Risk Levels.
        The EVR includes for instance the confidence in SLS fulfilment and the risk of violation of the requirements.
        The Confidence and Risk Levels include the absolute value of expected resource overbooking, as well as a
        probabilistic model for each resource.

14)   The Feasibility Check Service prepares a Feasibility Check Result (i.e. a simplified EVR) based on the
        detailed EVR (or Confidence and Risk Levels, respectively) and/or on the Remaining Resources of message 9
        and the Confidence Information of message 11 and provides the same to the Feasibility Check Service
        consumer, in this case the network slice instance Requester.

6.2.2.3   Coordination with transport network for supporting of network slicing provisioning

End to End network slice instance which includes access network part, transport network part and core network part is
used to provide communication services. Transport network part which includes Data Center Network (DCN) and Wide
Area Network (WAN) provides transmission functionality. Different types of WAN (e.g. IP network, optical network)
may be used to support the End to End network slicing.

In order to manage an E2E network slice instance, network slice provider needs to translate the E2E network slice
related requirements into requirements for different transport network and coordination with transport network provider
to handle the corresponding requirements, e.g. TN SliceProfile described in clause 6.1.2. ZSM framework shall be able
to differentiate the transport types(e.g. IP network, optical network) according to different scenarios, and communicate
to the corresponding transport management system with the transport requirements.
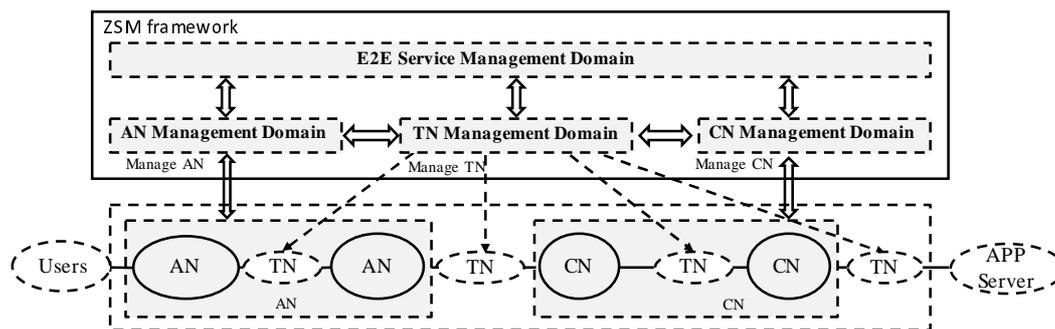
**Figure 6.2.2.3-1: Example of coordination between AN, CN and
TN management systems within ZSM framework**

As an example, 3GPP RAN and CN may provide the following requirements to transport management system:

- the topology requirement for the TN links (nodes to be connected by the transport link, e.g. including ports
  information, VLAN IDs, IP addresses);

- the latency requirement for the TN links;

- the bandwidth requirement for the TN links;

- the isolation requirement for the TN links.

NOTE: There may have more requirements depending on the GST mapping discussion progress between 3GPP
          SA5 and GSMA.

6.2.3   E2E network slicing performance management

6.2.3.1   Overall Description

In the scenario of ZSM architecture deployment example for network slicing management according to Figure 4.1-1.

Different services requirements are required by various service types such as eMBB, mIoT and critical communication from vertical industry. E2E service level KPIs and performance measurements to support the E2E service management should refer to the following 3GPP specifications.

Examples of the E2E KPIs and performance measurements for network slice are defined in ETSI TS 128 554 [9] and ETSI TS 128 552 [8] as the following two categories:

1) E2E KPIs related to SubNetwork, network slice and network slice subnet:

   - End-to-end latency of 5G network

   - DRB Accessibility for UE services

   - Upstream throughput for single network slice

   - Downstream throughput for single network slice

   - RAN UE throughput

   - Mean Number of PDU sessions of network and network slice

   - QoS flow Retainability

   - DRB Retainability

   - NG-RAN handover success rate

   - Mean Time of Inter-gNB handover Execution of network slice

   - Successful rate of mobility registration updates of single network slice

2) Performance measurements related to S-NSSAI:

   - Average delay DL in air-interface

   - DL/UL Total PRB Usage

   - Average DL/UL UE throughput in gNB

   - QoS flow release/setup related measurements

   - Registered subscribers measurements

   - Virtualized resource usage measurements

   - Round-trip packet delay between PSA UPF and UE

   - DL/UL packet delay between PSA UPF and UE

   - One way packet delay between NG-RAN and UE

To report the above performance measurement data, there are two available mechanisms as specified in 3GPP specification:

- Performance data file report management service (see ETSI TS 128 532 [13]).

- Performance data streaming management service (see ETSI TS 128 550 [6]).

This clause provides the procedures for E2E network slicing performance management according to the example ZSM architecture deployment for network slicing in Figure 4.1-1.

6.2.3.2   Solution of E2E network slice performance file-based reporting

To satisfy the requirements from ZSM Framework Consumer and prevent from performance deteriorations, KPIs and performance measurements defined in 3GPP SA5 should be monitored.

Figure 6.2.3.2-1 illustrates one of the possible solutions of performance file-based reporting for E2E network slice in the scenario of network slice as NOP internals
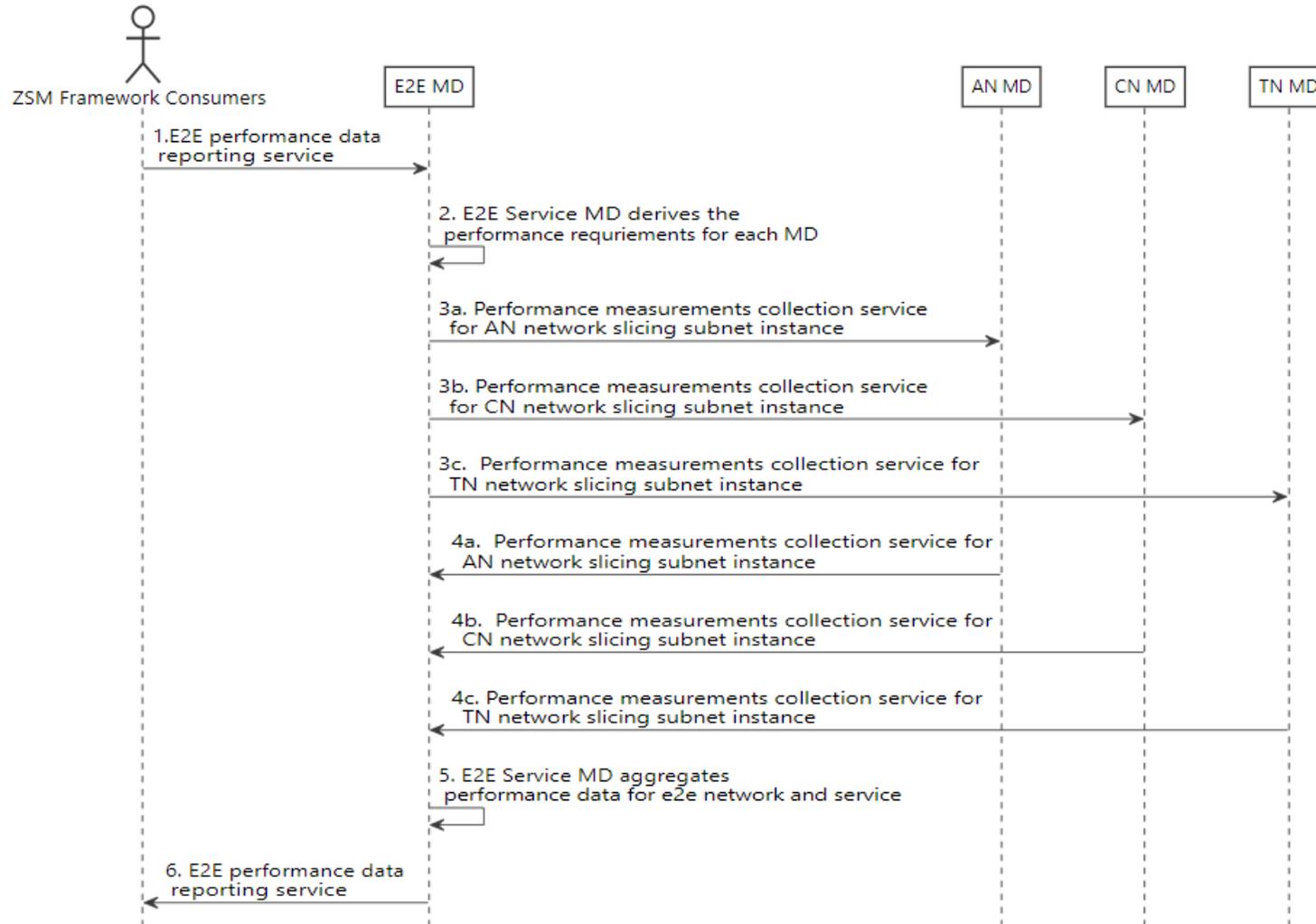
Figure 6.2.3.2-1: Network performance file-based reporting
with E2E network slice for communication services

1) In the scenario of network slice as NOP internals, ZSM Framework Consumer (e.g. vertical customer) needs to monitor the E2E network performance measurements or KPIs. Service MD (E2E Service Management Domain), as communication services providers, can get the requirements on receiving the request from ZSM Framework Consumer by utilizing E2E performance data reporting service in clause 6.6.2.2.1 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurement creation related operations in 3GPP SA5, e.g. *createMOI operation* in ETSI TS 128 532 [13] with *PerfMetricJob* IOC defined in TS 28.622, or *createMeasurementJob* operation defined in ETSI TS 128 550 [6]).

2) E2E Service MD derives the requirements for each management domain.

3a) E2E Service Management send a request to AN MD to request the performance and KPI data for AN related network slice subnet instance by utilizing performance measurements collection service in clause 6.5.2.2.3 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurement creation related operations in 3GPP SA5, e.g. *createMOI operation* in ETSI TS 128 532 [13] with *PerfMetricJob* IOC defined in ETSI TS 128 622 [19], or *createMeasurementJob* operation defined in ETSI TS 128 550 [6]).

3b) E2E Service Management send a request to CN MD to request the performance and KPI data for CN related network slice subnet instance by utilizing performance measurements collection service in clause 6.5.2.2.3 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurement creation related operations in 3GPP SA5, e.g. *createMOI operation* in ETSI TS 128 532 [13] with *PerfMetricJob* IOC defined in 3GPP TS 28.622 or *createMeasurementJob* operation defined in ETSI TS 128 550 [6]).

3c) E2E Service Management send a performance file-based reporting request to TN MD to reporting performance of TN related network slice subnet instance performance measurements collection service in clause 6.5.2.2.3 of ETSI GS ZSM 002 [12]. In the case of NFVO takes the role of collection performance measurements from TN MD, the request can be implemented by utilizing the NFV *Create PM Jobs operation* or *Subscribe operation* in ETSI GS NFV-IFA 013 [10].

4a) After the requested data file for AN network slice subnet instance is ready, the AN MD notifies E2E Service MD by utilizing performance measurements collection service in clause 6.5.2.2.3 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurements reporting related operations in 3GPP SA5, e.g. *notifyFileReady* notification in ETSI TS 128 532 [13]. The E2E service MD is able to fetch AN related PM data it subscribed.

4b) After the requested data file for CN network slice subnet instance is ready, the CN MD notifies E2E Service MD by utilizing performance measurements collection service in clause 6.5.2.2.3 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurements reporting related operations in 3GPP SA5, e.g. *notifyFileReady* notification in ETSI TS 128 532 [13]. The E2E service MD is able to fetch CN related PM data it subscribed.

4c) After the requested data file for TN network slice subnet instance is ready, the TN MD sends performance file-based reporting response to E2E Service MD performance measurements collection service in clause 6.5.2.2.3 of ETSI GS ZSM 002 [12]. In the case of NFVO takes the role of collection performance measurements from TN MD, the response can be implemented by utilizing NFV *Notify* in ETSI GS NFV-IFA 013 [10].

5) E2E Service MD aggregates the performance and KPIs for E2E network. The E2E service MD is able to fetch TN related PM data it subscribed.

6) After the requested data file for E2E network is ready, E2E Service MD can notify ZSM Framework Consumer by utilizing E2E performance data reporting service in clause 6.6.2.2.1 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurements reporting related operations in 3GPP SA5, e.g. *notifyFileReady* notification in ETSI TS 128 532 [13]. The ZSM Framework Consumer is able to fetch the E2E network related PM data it subscribed.

6.2.3.3   Solution of E2E network slice performance data streaming reporting

Figure 6.2.3.3-1 illustrates one of the possible solutions of performance data streaming reporting for E2E network slice in the scenario of network slice as NOP internals.
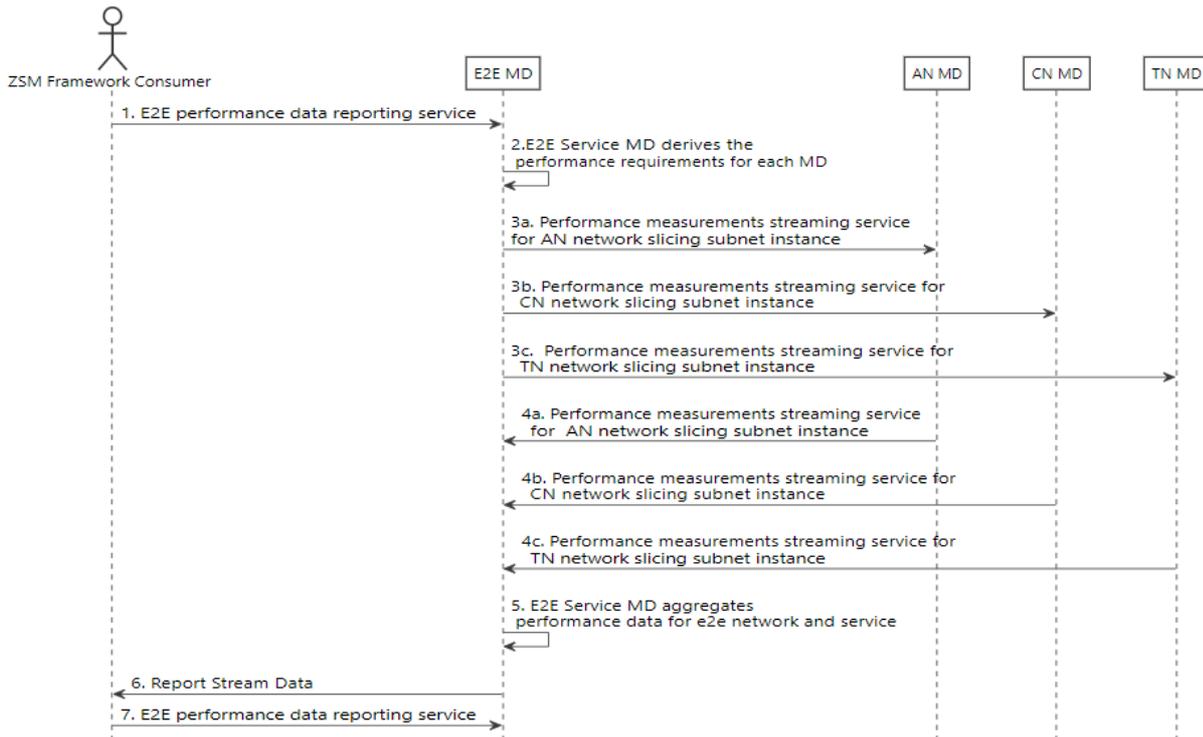
**Figure 6.2.3.3-1: Network performance data streaming reporting
with E2E network slice for communication services**

1) Service MD (E2E Service Management Domain) gets the requirements on receiving the request from ZSM Framework Consumers by E2E performance data reporting service in clause 6.6.2.2.1 of ETSI GS ZSM 002 [12], (this may be implemented by the performance measurement creation related operations in 3GPP SA5, e.g. *createMOI operation* in ETSI TS 128 532 [13] with *PerfMetricJob* IOC defined in 3GPP TS 28.622, or *createMeasurementJob* operation defined in ETSI TS 128 550 [6]).

2) E2E Service MD derives the requirements for each management domain.

3a) E2E Service Management send a request to AN MD to require the performance measurement and KPI data for AN related network slice subnet instance by utilizing performance measurements streaming service in clause 6.5.2.2.2 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurement creation related operations in 3GPP SA5, e.g. *createMOI operation* in ETSI TS 128 532 [13] with *PerfMetricJob* IOC defined in 3GPP TS 28.622, or *createMeasurementJob* operation defined in ETSI TS 128 550 [6]).

3b) E2E Service Management send a request to CN MD to require the performance measurement and KPI data for CN related network slice subnet instance by utilizing by utilizing performance measurements streaming service in clause 6.5.2.2.2 of ETSI GS ZSM 002 [12], (this service may be implemented by the performance measurement creation related operations in 3GPP SA5, e.g. *createMOI operation* in ETSI TS 128 532 [13] with *PerfMetricJob* IOC defined in 3GPP TS 28.622, or *createMeasurementJob* operation defined in ETSI TS 128 550 [6]).

3c) E2E Service Management send a request to TN MD to reporting performance data of TN related network slice subnet instance performance measurements streaming service in clause 6.5.2.2.2 of ETSI GS ZSM 002 [12].

4a) AN MD reports the requested performance data streaming to E2E Service MD by utilizing performance measurements streaming service in clause 6.5.2.2.2 of ETSI GS ZSM 002 [12], (this service may be implemented by the streaming reporting related operations in 3GPP SA5, e.g. *establishStreamingConnection operation* and *reportStreamData* operation in ETSI TS 128 532 [13]).

4b) CN MD reports the requested performance data streaming to E2E Service MD by utilizing performance measurements streaming service in clause 6.5.2.2.2 of ETSI GS ZSM 002 [12], (this service may be implemented by the streaming reporting related operations in 3GPP SA5, e.g. *establishStreamingConnection operation* and *reportStreamData* operation in ETSI TS 128 532 [13]).

4c)   TN MD sends the requested performance data streaming to E2E Service MD as a response by utilizing performance measurements streaming service in clause 6.5.2.2.2 of ETSI GS ZSM 002 [12].

5)   E2E Service MD aggregates the performance measurement and KPI data for E2E network.

6)   E2E service MD reports the E2E network related performance measurement and KPI data to ZSM Framework Consumers by reporting stream data, (this may be implemented by the streaming reporting related operations in 3GPP SA5, e.g. *establishStreamingConnection operation and reportStreamData* operation in ETSI TS 128 532 [13]).

7)   Once ZSM Framework Consumers decide to stop managing the E2E network performance, it sends a request to E2E Service MD to stop the performance management procedure by utilizing E2E performance data reporting service in clause 6.6.2.2.1 of ETSI GS ZSM 002 [12], (this may be implemented by performance measurement termination related operations in 3GPP SA5, e.g. *deleteMOI operation* defined in ETSI TS 128 532 [13] with DN of PerfMetricJob MOI defined in 3GPP TS 28.622, or s*topMeasurementJob* defined in ETSI TS 128 550 [6]).

6.2.3.4   Solution of E2E network slice performance assurance

Figure 6.2.3.4-1 illustrates one of the possible solutions of performance assurance for E2E network slice in the scenario of network slice as NOP internals.
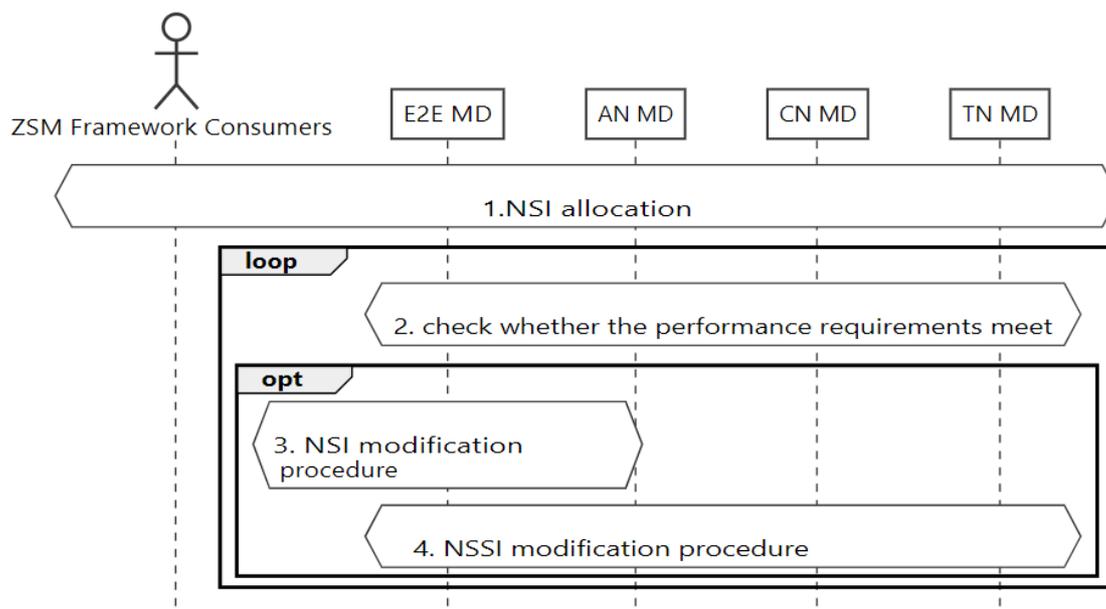
Figure 6.2.3.4-1: Network performance assurance with E2E network slice for communication services

1)   The ZSM Framework consumers request the E2E service management domain to allocate a new network slice instance to satisfy the service requirements. E2E service management domain decides to allocate the network slice instance to fulfil the requirements. The procedures of network slice allocation described in clause 6.3.2.2.1 are utilized.

2)   E2E service management domain monitors the performance of the E2E network slice instance and checks whether the performance requirements are satisfied. The procedures of E2E network slice performance reporting described in clauses 5.1.3.2 and 5.1.3.3 are utilized. This step is triggered periodically or by event. For each domain as AN MD, CN MD and TN MD, the corresponding MD checks whether the performance requirements can be met by the corresponding network slice subnet instance by utilizing the performance measurements defined in ETSI TS 128 552 [8] and KPIs defined in ETSI TS 128 554 [9].

3)   If the performance requirements of network slice instance are not satisfied, E2E service management domain triggers the procedures of network slice modification described in clause 6.3.2.2.2. E2E service management may modify the capacity of the network slice, or modify the network slice configuration to guarantee the performance requirements, see clause 4.a of clause H.2 of ETSI TS 128 550 [6].

4)   If the performance requirements of network slice subnet instances are not satisfied, the corresponding MD
     trigger the procedures of network slice subnet instance modification described in clause 6.3.2.2.2. CN MD
     may modify virtualized resources and the configuration of 5GC NFs to guarantee the performance
     requirements. RAN MD may reconfigure RRM Policy to optimize performance, see clause 4b of clause H.2 of
     ETSI TS 128 550 [6]).

6.2.4   E2E network slicing fault management

6.2.4.1   Overall Description

To keep ZSM network functioning properly, E2E service MD should have network slicing fault management services to
support notifying the fault alarm which refers to the 3GPP specifications (see clause 6 of ETSI TS 128 532 [13]). The
fault alarm data can be monitored in network slice instance or network slice subnet instance level for network slicing
fault management (see clause 4.1.1 of ETSI TS 128 545 [14]).

This clause provides the procedures for E2E network slice fault reporting according to the example of ZSM architecture
deployment for network slicing in Figure 4.1-1.

6.2.4.2   Example of E2E network slice fault notification

To satisfy the requirements from ZSM framework consumers and alleviate the impact of fault events, fault
measurements defined in 3GPP SA5 should be monitored.

Figure 6.2.4.2-1 illustrates one of the examples of fault notification for E2E network slice.
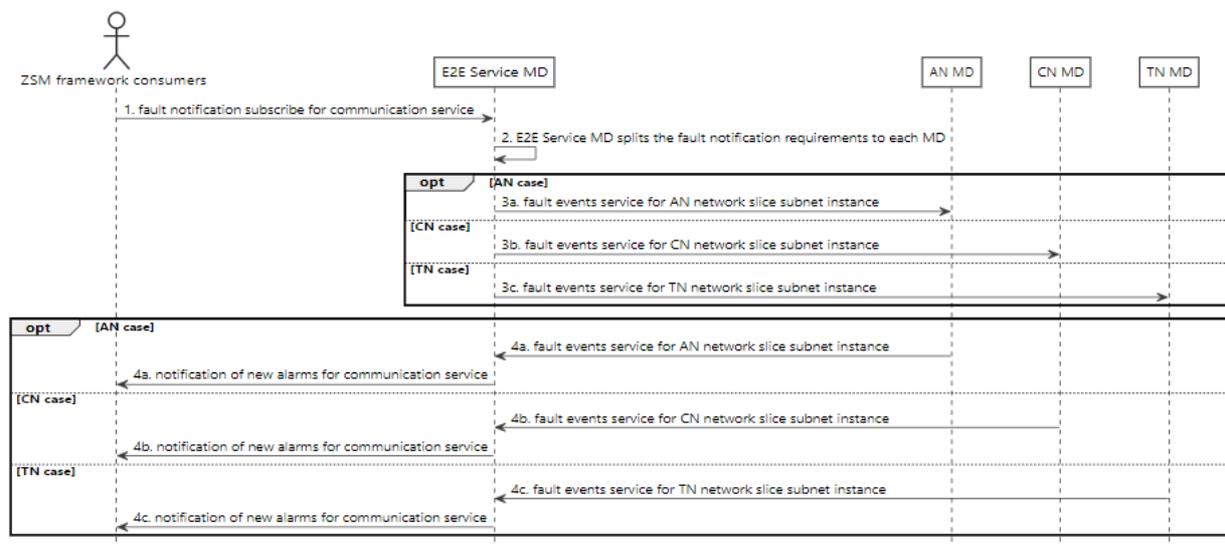
Figure 6.2.4.2-1: Example of E2E network slice fault notification

1)   In the scenario of network slice fault management, a ZSM framework consumer (e.g. vertical industry) decides
     to subscribe fault reporting. E2E Service MD (E2E Service Management Domain) which includes the function
     of NSM (network service management) and CSM (communication service management), as communication
     services providers, can get the service requirements on receiving the request from ZSM framework consumers
     via the subscription of fault notification for communication service, (the service may be implemented by fault
     subscription related operations in 3GPP SA5, e.g. *subscribe* operation for communication service defined in
     ETSI TS 128 532 [13]).

2)   E2E Service MD splits the fault notification requirements to each MD, and request concerned MD with
     following step 3), step 4).

3a)   E2E Service MD splits the requirements to each MD, then send requests to AN MD to subscribe the fault reporting of AN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12], (the service may be implemented by fault subscription related operations in 3GPP SA5, e.g. *subscribe* operation defined in ETSI TS 128 532 [13]).

3b)   E2E Service MD splits the requirements to each MD, then send requests to CN MD to subscribe the fault reporting of CN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12], (the service may be implemented by fault subscription related operations in 3GPP SA5, e.g. *subscribe* operation defined in ETSI TS 128 532 [13]).

3c)   E2E Service MD splits the requirements to each MD, then requests TN MD to subscribe the fault reporting of TN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12].

4a)   After completing the above steps, once new alarm occurs in the AN MD, it will be sent to E2E Service MD via the report of fault notification for AN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12], (the service may be implemented by fault reporting related operations in 3GPP SA5, e.g. *notifyNewAlarm* operation, which is defined in ETSI TS 128 532 [13]. After getting the new alarm notification from AN MD, E2E Service MD notifies the new alarm to the ZSM framework consumers.

4b)   After completing the above steps, once new alarm occurs in the CN MD, it will be sent to E2E Service MD via the report of fault notification for CN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12], (the service may be implemented by fault reporting related operations in 3GPP SA5, e.g. the *notifyNewAlarm* operation, which is defined in ETSI TS 128 532 [13]. After getting the new alarm notification from CN MD, E2E Service MD notifies the new alarm to the ZSM framework consumers.

4c)   After completing the above steps, once new alarm occurs in the TN MD, it will be sent to E2E Service MD via the report of fault notification for TN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12]. After getting the new alarm notification from TN MD, E2E Service MD notifies the new alarm to the ZSM framework consumers.

6.2.4.3   Example of getting E2E network slice alarm list

To offer the ZSM framework consumers the information when alarm occurs, the *getAlarmList* operation for communication service defined in 3GPP SA5 should be provided.
Figure 6.1.4.3-1 illustrates one of the examples of getting E2E network slice alarm list.
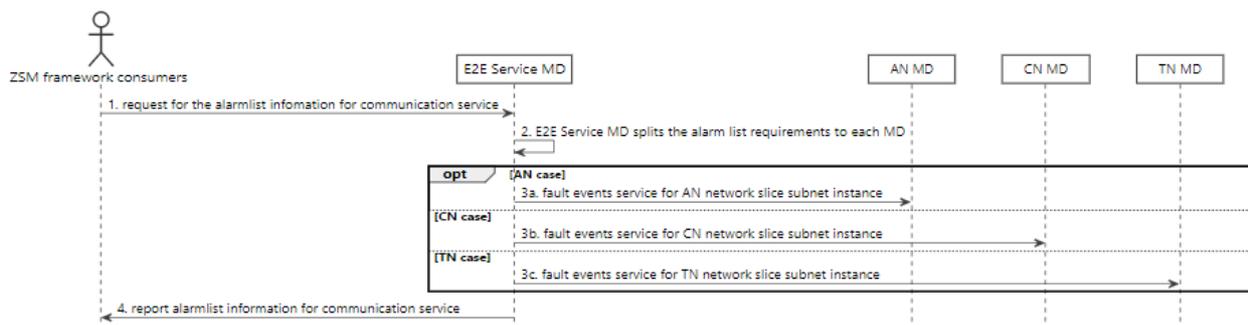
Figure 6.2.4.3-1: Example of getting E2E network slice alarm list

1)   In the scenario of network slice fault management, a ZSM framework consumer decides to get the list of all the alarms by requesting for the alarm list information for communication service, (the service may be implemented by alarm report related operations in 3GPP SA5, e.g. *getAlarmList* operation for communication service defined inETSI TS 128 532 [13]).

2)   E2E Service MD splits the alarm list requirements to each MD, and request concerned MD with following step 3a), step 3b), step 3c), step 4a), step 4b) and step 4c).

3a) E2E Service MD splits the requirements to each MD, then requests AN MD to get alarm list of AN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12], (the service may be implemented by alarm report related operations in 3GPP SA5, e.g. *getAlarmList* operation defined in ETSI TS 128 532 [13]).

3b) E2E Service MD splits the requirements to each MD, then requests CN MD to get alarm list of CN related network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12], (the may be implemented by alarm report related operations in 3GPP SA5, e.g. *getAlarmList* operation defined in ETSI TS 128 532 [13].

3c) E2E Service MD splits the requirements to each MD, then requests TN MD to get alarm list of TN network slice subnet instance by utilizing the fault events service in clause 6.5.2.2.1 of ETSI GS ZSM 002 [12].

4) After getting the alarm notification from each MD, E2E Service MD notifies the alarm list to the ZSM framework consumer.

6.3 Providing communication service in the scenario of network slice as a service (NsaaS)

6.3.1 Overall Description

Figure 6.3.1-1 gives the description of high-level model of roles in E2E networks providing services.

In network slice as a service scenarios, see clause 4.1.7 of ETSI TS 128 530 [4], Network Slice as a Service (NSaaS) can be offered to the vertical users in the form of a communication service. The entities provide communication services and network slice capabilities can be different.
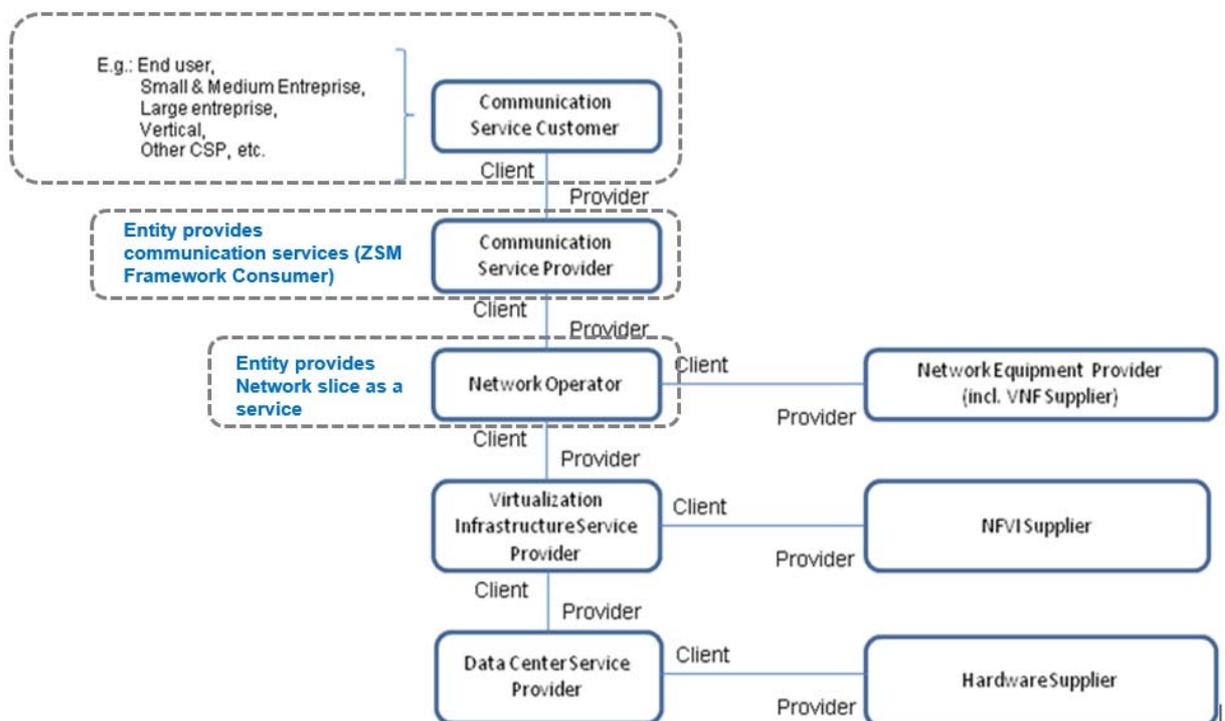
Figure 6.3.1-1: High-level model of roles for NSaaS

6.3.2   End-to-end network slicing provisioning

6.3.2.1   Introduction

ETSI TS 128 531 [5] has defined and implemented a series of management services (operations, notifications and information model). These management services can be utilized by AN and CN for E2E network slicing provisioning. The operations implemented by 3GPP SA5 can also been reused. To support E2E slicing procedures for the deployment ZSM architecture in Figure 4.1-1.

6.3.2.2   Solution of E2E network slicing provisioning

6.3.2.2.1   Solution of E2E network slice allocation with new network slice instance

Figure 6.3.2.2.1-1 illustrates one of the possible solutions of allocating network with E2E network slice for communication services in the NSaaS scenario. The main difference from the previous case in clause 5.1 is that in this case the consumer is directly able to request the allocation of a network slice instance. In this case the E2E Service MD decides to create *a new* network slice instance to satisfy the request.
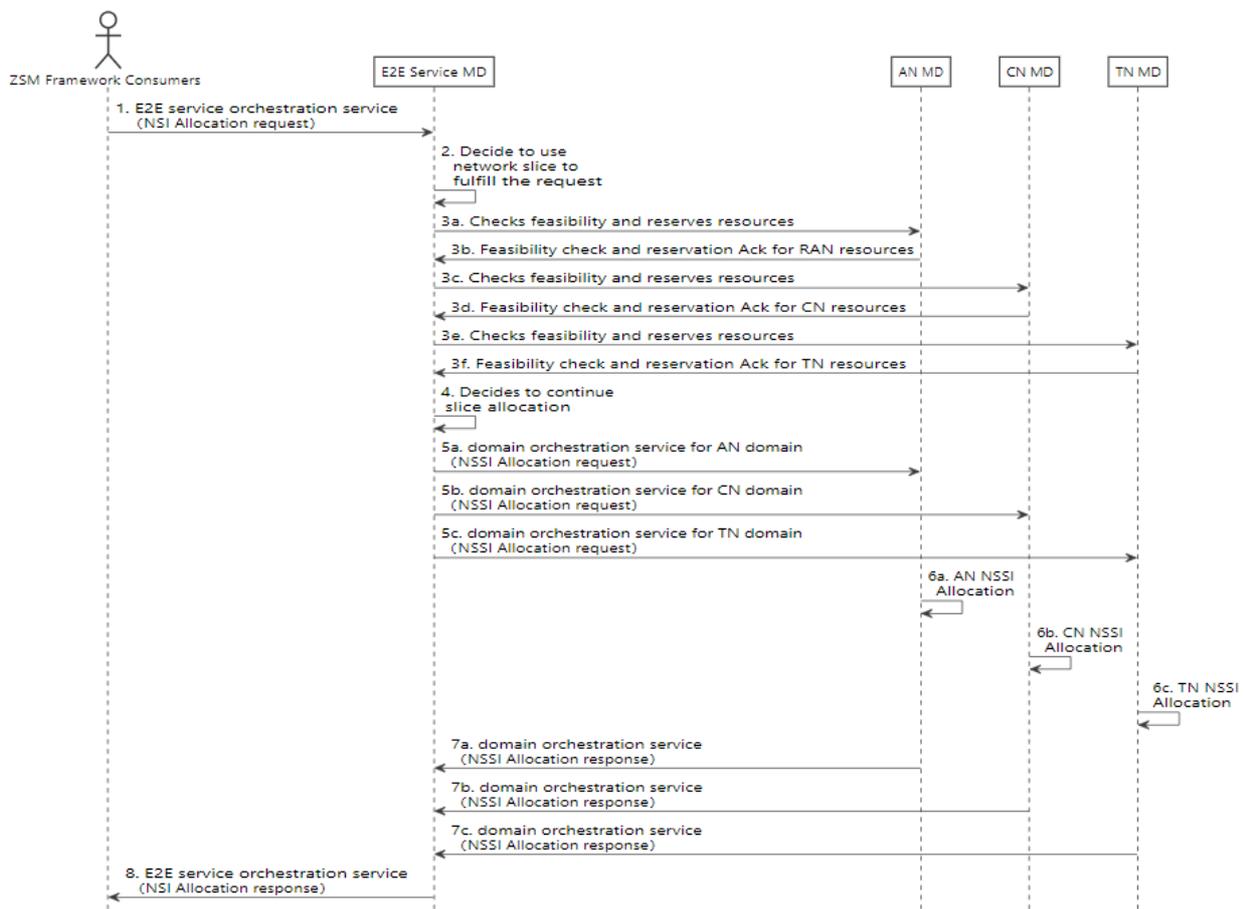
Figure 6.3.2.2.1-1: NSaaS case slice allocation solution option with new network slice instance

1)   Network Slice Management Service Provider (NSMS_Provider) in the E2E Service MD receives an AllocateNsi request by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12] (for example, the *AllocateNsi* operation defined in ETSI TS 128 531 [5] may be used for implementation) from the ZSM Framework Consumer with network slice related requirements (e.g. the attributes of *NetworkSlice* and *ServiceProfile* defined in clauses 6.3.1 and 6.3.3 in ETSI TS 128 541 [7]).

2)   Based on the requirements received in step 1) the E2E Service MD decides to use a new network slice to fulfil the network slice related requirements.

3) The E2E Service MD derives the requirements and sends requests to check the feasibility of required resources and, if yes, make the reservation of them to the specific MDs. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period depending on the terms and conditions with the consumer:

   a) The E2E Service MD sends a request to AN MD to check the feasibility of required resources and, if yes, make the reservation of them.

   b) The AN MD sends Ack to E2E Service MD.

   c) The E2E Service MD sends a request to CN MD to check the feasibility of required resources and, if yes, make the reservation of them.

   d) The CN MD sends Ack to E2E Service MD.

   e) The E2E Service MD sends a request to TN MD to check the feasibility of required resources and, if yes, make the reservation of them

   f) The TN MD sends Ack to E2E Service MD.

4) If all the reservations are successfully completed, the E2E Service MD decides to continue the slice allocation.

5) The E2E Service MD derives the requirements and send requests to allocate the management domain specific network slice subnet instances to the specific MDs, in particular to:

   a) The AN MD to allocate AN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *AllocateNssi* operation in ETSI TS 128 531 [5] may be utilized for implementation with the network slice subnet instance related requirements, e.g. the attributes of *NetworksliceSubnet* and *SliceProfile* defined in clauses 6.3.2 and 6.3.4 in ETSI TS 128 541 [7]).

   b) The CN MD to allocate CN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *AllocateNssi* operation in ETSI TS 128 531 [5] may be utilized for implementation with the network slice subnet instance related requirements, e.g. *NetworksliceSubnet* and *SliceProfile* defined in clauses 6.3.2 and 6.3.4 in ETSI TS 128 541 [7]).

   c) The TN MD to allocate TN related network slice subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the request can be converted to utilizing the *NFV Create network service operation* or *Create network service operation* in ETSI GS NFV-IFA 013 [10].

6) On receiving the request from E2E Service MD, individual MDs will begin procedures for network slice subnet instance allocation, in particular:

   a) AN MD initiates the network slice subnet allocation procedures for AN. In case of RAN, the network slice subnet allocation procedures in clause 7.3 of ETSI TS 128 531 [5] may be followed.

   b) The CN MD initiates the network slice subnet allocation procedures for CN, the network slice subnet allocation procedures for CN in clause 7.3 of ETSI TS 128 531 [5] may be followed.

   c) The TN MD initiates the network slice subnet allocation procedures for TN. In the case of NFVO as a TN manager, the procedures refer to the procedure of network slice Instance instantiation (see clause 4.4.1 of ETSI TS 128 526 [15]).

7) After completing the allocation of the respective network slice subnet instance each domain sends a response to the respective network slice subnet instance allocation request, in particular:

   a) The AN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (e.g. the *AllocateNssi* operation in ETSI TS 128 531 [5] may be used for implementation).

   b) The CN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12] (e.g. the *AllocateNssi* operation in ETSI TS 128 531 [5].

c)   The TN MD sends a response to the allocation of network slice subnet instance request to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the response can be implemented by utilizing the *NFV Create network service operation* in ETSI GS NFV-IFA 013 [10].

8)   Based on the reply from all the composing management domains the final response for network slice instance creation is sent back to the ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

6.3.2.2.2   Solution of E2E network slice modification

Figure 6.3.2.2.2-1 illustrates one of the possible solutions of modifying a network slice instance in the NSaaS scenario. In this case the E2E Service MD receives a network slice instance modification request from the NSaaS consumer.
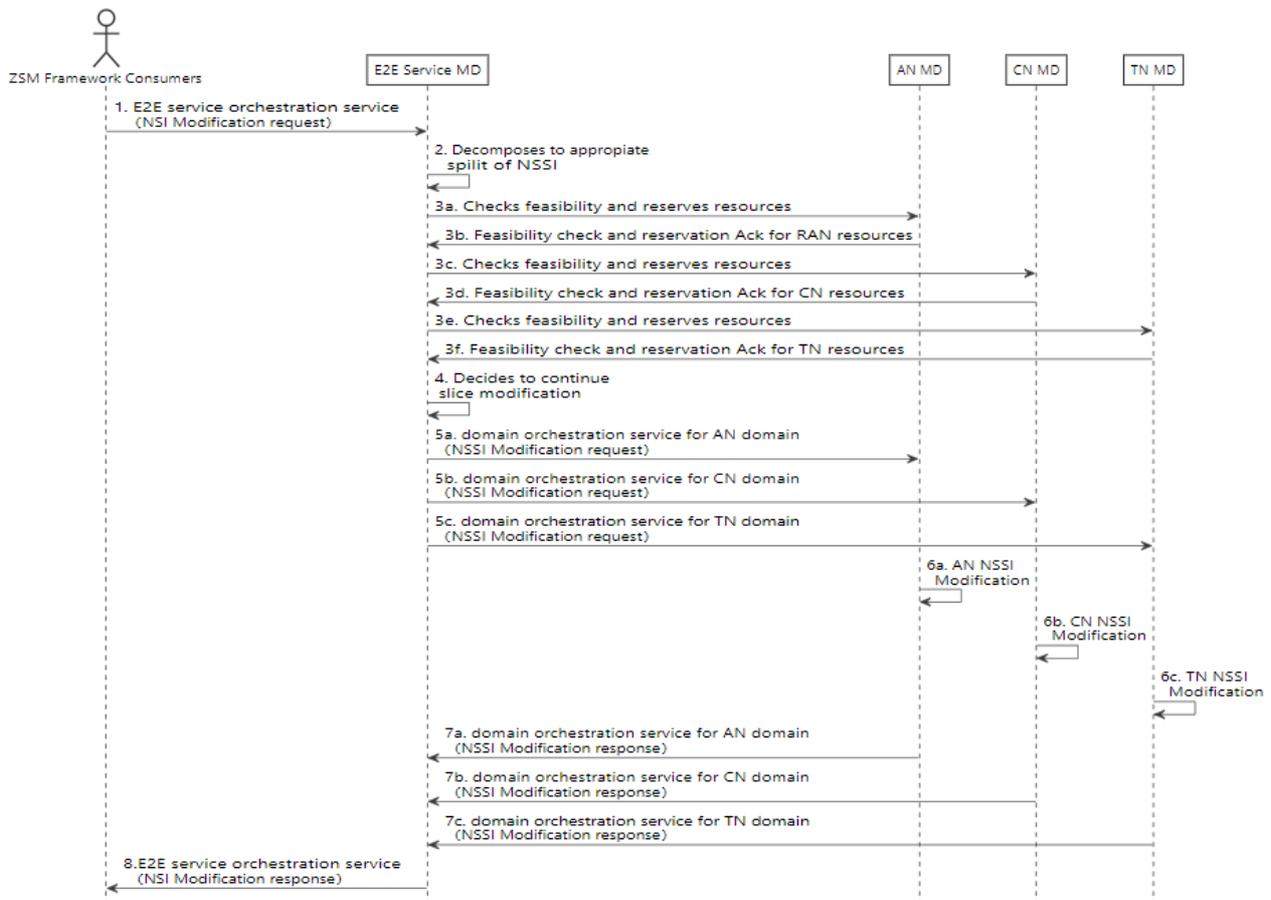
Figure 6.3.2.2.2-1: NSaaS case slice modification solution

1)   Network Slice Management Service Provider (NSMS_Provider) in the E2E Service MD receives NSI modification request by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12] (e.g. the modifyMOIAttributes operation defined in ETSI TS 128 532 [13] may be used for implementation) from the ZSM Framework Consumer with the management identifier of network slice instance and the new network slice related requirements (e.g. the attributes of NetworkSlice and ServiceProfile defined in clauses 6.3.1 and 6.3.3 in ETSI TS 128 541 [7] respectively).

2)   The E2E Service MD decomposes the modification to appropriate network slice subnet instances in the corresponding MDs. Decomposing refers to the split of the modification request of network slice instance to the respective network slice subnet instance modifications.

3) The E2E Service MD derives the new requirements and sends requests to check the feasibility of required resources and, if yes, make the reservation of them to the specific MDs where the modification is needed. The feasibility check and reservation shall be processed in the same transaction to avoid changing the result of the feasibility check due to the other reservation requests. The reserved resources may be released after a period depending on the terms and conditions with the consumer:

   a) The E2E Service MD sends a request to AN MD to check the feasibility of required resources and, if yes, make the reservation of them.

   b) The AN MD sends Ack to E2E Service MD.

   c) The E2E Service MD sends a request to CN MD to check the feasibility of required resources and, if yes, make the reservation of them.

   d) The CN MD sends Ack to E2E Service MD.

   e) The E2E Service MD sends a request to TN MD to check the feasibility of required resources and, if yes, make the reservation of them

   f) The TN MD sends Ack to E2E Service MD.

4) If all the reservations are successfully completed, the E2E Service MD decides to continue the slice modification.

5) The E2E Service MD derives the requirements and sends modification requests of the management domain specific network slice subnet instances to the respective MDs, in particular to:

   a) The AN MD to modify the RAN network slicing subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *modifyMOIAttributes* operation defined in ETSI TS 128 532 [13] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] may be used for implementation).

   b) The CN MD to modify CN network slicing subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *modifyMOIAttributes* operation defined in ETSI TS 128 532 [13] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] may be used for implementation).

   c) The TN MD to modify TN network slicing subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the request can be converted to utilizing NFV *Scale network service operation* or *Update network service Operation* in ETSI GS NFV-IFA 013 [10].

6) On receiving the request from E2E Service MD each individual MD will begin procedures for network slice subnet instance modification, in particular:

   a) AN MD initiates the network slice subnet modification procedures for AN, in case of RAN, the *network slice subnet instance modification* procedures for RAN in clause 7.7 of ETSI TS 128 531 [5] may be followed.

   b) The CN MD initiates the network slice subnet modification procedures for CN, the *network slice subnet instance modification* procedures for CN in clause 7.7 of ETSI TS 128 531 [5] may be followed.

   c) The TN MD initiates the network slice subnet instance modification procedures for TN. In the case of NFVO as a TN manager, the procedures refers to the procedure of *network slice Instance updating* (see clause 4.4.5 of ETSI TS 128 526 [15]).

7) After completing the allocation of the respective network slice subnet instance each domain sends a response to the respective network slice subnet instance allocation request, in particular:

   a) The AN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *modifyMOIAttributes* operation in ETSI TS 128 531 [5] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] may be utilized for implementation).

b) The CN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *modifyMOIAttributes* operation in ETSI TS 128 531 [5] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] and *NetworkSliceSubnet* IOC defined in ETSI TS 128 541 [7] may be utilized for implementation).

c) The TN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the response can be converted to utilizing the NFV *Scale network service operation* or *Update network service Operation* in ETSI GS NFV-IFA 013 [10].

8) Based on the reply from all the composing management domains the final response for network slice instance modification is sent back to the ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12].

6.3.2.2.3   Solution of E2E network slice deallocation

Figure 6.3.2.2.3-1 illustrates one of the possible solutions of deallocating network slice in the scenario of network slice as service.
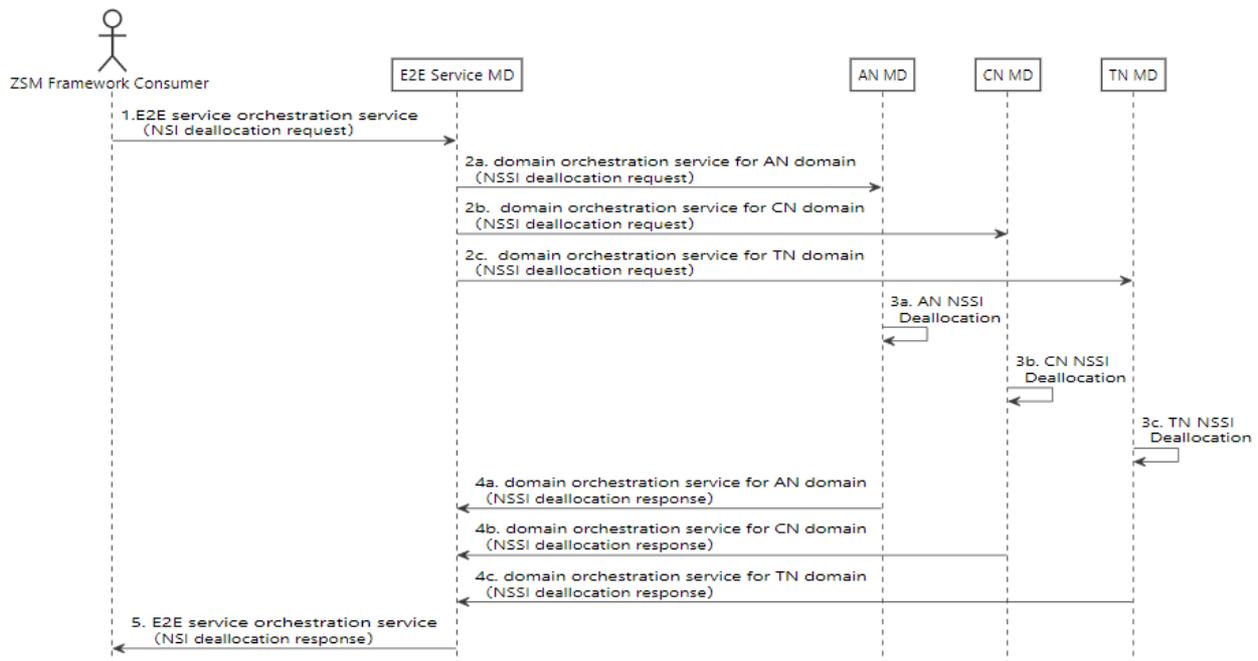
Figure 6.3.2.2.3-1: Deallocating network with E2E network slice for communication services

1) In the scenario of network slice as service, ZSM Framework Consumer (e.g. vertical industry) decides to release a network slice. E2E Service MD (E2E Service Management Domain), as communication services providers, can get the network slice termination requirements on receiving the request from ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12], the de*allocateNsi* operation in ETSI TS 128 531 [5].

2a) E2E Service Management request AN MD to deallocate AN network slicing subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the de*allocateNssi* operation in ETSI TS 128 531 [5] may be used for implementation).

2b) E2E Service Management request CN MD to deallocate CN network slicing subnet instance by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the de*allocateNssi* operation in ETSI TS 128 531 [5] may be used for implementation).

2c)   E2E Service Management request TN MD to deallocate TN network slicing subnet instance domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the request can be converted to utilizing the NFV *Delete network service operation* or *Terminate network service operation* in ETSI GS NFV-IFA 013 [10].

3a)   On receiving the request from E2E Service MD, AN MD initiates the network slice subnet deallocation procedures. In case of AN, the *network slice subnet deallocation procedures* for AN in clause 7.5 of ETSI TS 128 531 [5] may be followed.

3b)   On receiving the request from E2E Service MD, CN MD initiates the network slice subnet deallocation procedures. The *network slice subnet deallocation procedures* for CN in clause 7.5 of ETSI TS 128 531 [5] may be followed.

3c)   On receiving the request from E2E Service MD, the network slice subnet deallocation procedures for TN follows. In the case of NFVO as a TN manager, the procedure refers to the procedure of *network slice Instance termination* (see clause 4.4.2 of ETSI TS 128 526 [15]).

4a)   After completing the deallocation of the AN network slice subnet, the AN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *DeallocateNssi* operation in ETSI TS 128 531 [5] may be used for implementation).

4b)   After completing the deallocation of the CN network slice subnet, the CN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the *DeallocateNssi* operation in ETSI TS 128 531 [5] may be used for implementation).

4c)   After completing the deallocation of the TN network slice subnet, the TN MD sends a response to E2E Service MD by utilizing domain orchestration service in clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]. In the case of NFVO as a TN manager, the response can be converted to utilizing the NFV *Delete network service operation* or *Terminate network service operation* in ETSI GS NFV-IFA 013 [10].

5)   After the E2E network slice has been deallocated internally, the E2E Service MD sends the response to the ZSM Framework Consumer by utilizing E2E service orchestration service in clause 6.6.5.2.1 of ETSI GS ZSM 002 [12], (e.g. the de*allocateNsi* operation in ETSI TS 128 531 [5] may be used for implementation).

6.3.3   E2E network slicing performance management

6.3.3.1   Overall Description

In the scenario of ZSM architecture deployment example for network slicing management according to Figure 4.1-1 in the scenario of network slicing as a service.

A series of E2E KPIs and performance measurements related to network slicing are defined in 3GPP SA5 work group (see ETSI TS 128 554 [9] and ETSI TS 128 552 [8]). Some examples of performance measurements and KPIs refer to clause 6.2.3.1. This clause provides one of the possible solutions for E2E network slicing performance management in network as a service scenarios according to the example ZSM architecture deployment for network slicing in Figure 4.1-1.

6.3.3.2   Solution of E2E network slice performance reporting

See the procedures described in clause 6.2.3.

NOTE: The input parameter of *Filter* in *subscribe operation* is solution set dependent. In this scenario, the filter object is expected to be set with the set of S-NSSAI IDs.

6.4   Topology service for E2E network slicing services

The E2E network and service topology management requirement is proposed in ETSI GS ZSM 001 [17], and the E2E Service topology information service and Domain topology information service are defined in ETSI GS ZSM 002 [12]. The topology information of E2E network slice can be obtained from the E2E service topology information service provided by the E2E service management domain.

Below is the sequence diagram of querying E2E network slice topology.
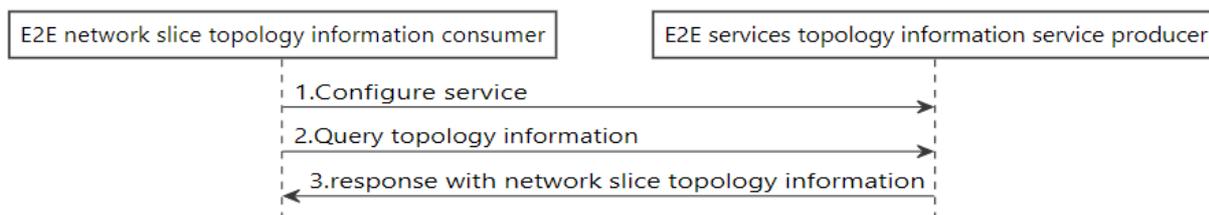
Figure 6.4-1: Query E2E network slice topology info

The network slice topology consumer may configure the service before query the network slice topology information by setting the abstraction policy to control the degree of detail of the provided topology information (which is defined in ETSI GS ZSM 002 [12]).

E2E services topology information service producer will provide the information about the topology of the infrastructure from the perspective of E2E network slice. This may include resources (and their utilization level), services, physical/virtualized nodes, physical and/or virtual links/network connections of E2E network slice.

Domain topology information service producer will provide the information about the topology of the infrastructure of domain network slice. This may include resources (and their utilization level), services, physical/virtualized nodes, physical and/or virtual links/network connections of domain network slice. The sequence of querying the domain network slice topology is similar as the E2E network slice topology querying sequence

7   Management exposure to vertical consumers

7.1   Network slice SLA/SLS

7.1.1   Network slice SLA/SLS in GSMA and 3GPP

SLA is an important part of the network slicing and is used to support the diverse service requirements from various vertical consumers. GSM NEST attribute values, which collectively define the SLA, are mapped into 3GPP ServiceProfile defined in ETSI TS 128 541 [7], clause 6.3.3, which defines the SLS.

In the E2E Service MD, some `ServiceProfile` parameters are translated into the configurable parameters for each domain (CN domain, AN domain, TN domain), while other ServiceProfile parameters are kept at the OAM domain. Figure 7.1.1-1 shows the whole process. The SliceProfile is defined in clause 6.3.4 of ETSI TS 128 541 [7].
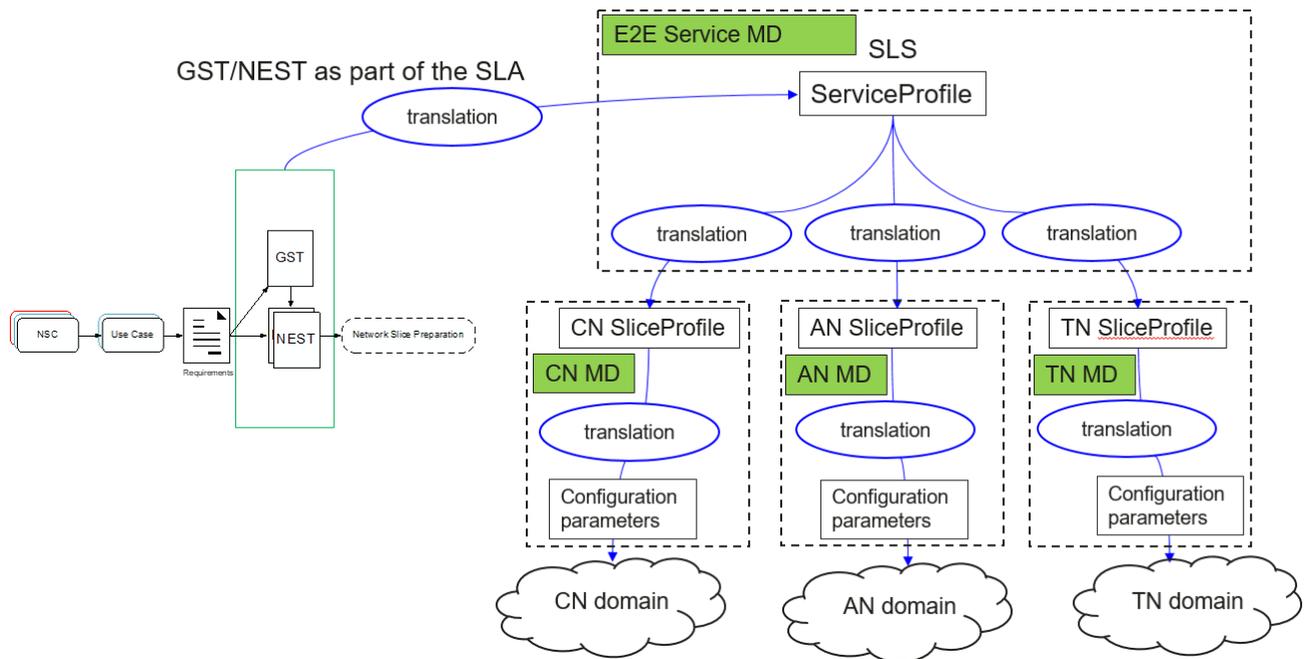
Figure 7.1.1-1: Relation between GSMA GST and 3GPP NRM ServiceProfile

7.1.2   Network slice SLA in ZSM

According to Figure 4.1-1 of the ZSM architecture for network slicing management, Figure 7.1.2-1 below shows the relations between SLA coming from GSMA GST, 3GPP NRM [7] ServiceProfile and SliceProfile of network slice subnet, e.g. AN SliceProfile, CN SliceProfile and TN SliceProfile.

The SLA requested by vertical consumers is translated and used as input for the attributes of ServiceProfile from the E2E management aspect. The E2E Service Management Domain is also responsible for the translation or decomposition of the ServiceProfile to the corresponding Management Domain requirements, e.g. CN SliceProfile, AN SliceProfile or TN SliceProfile. Each domain is able to schedule the resources to support the requirements of the corresponding SliceProfile.
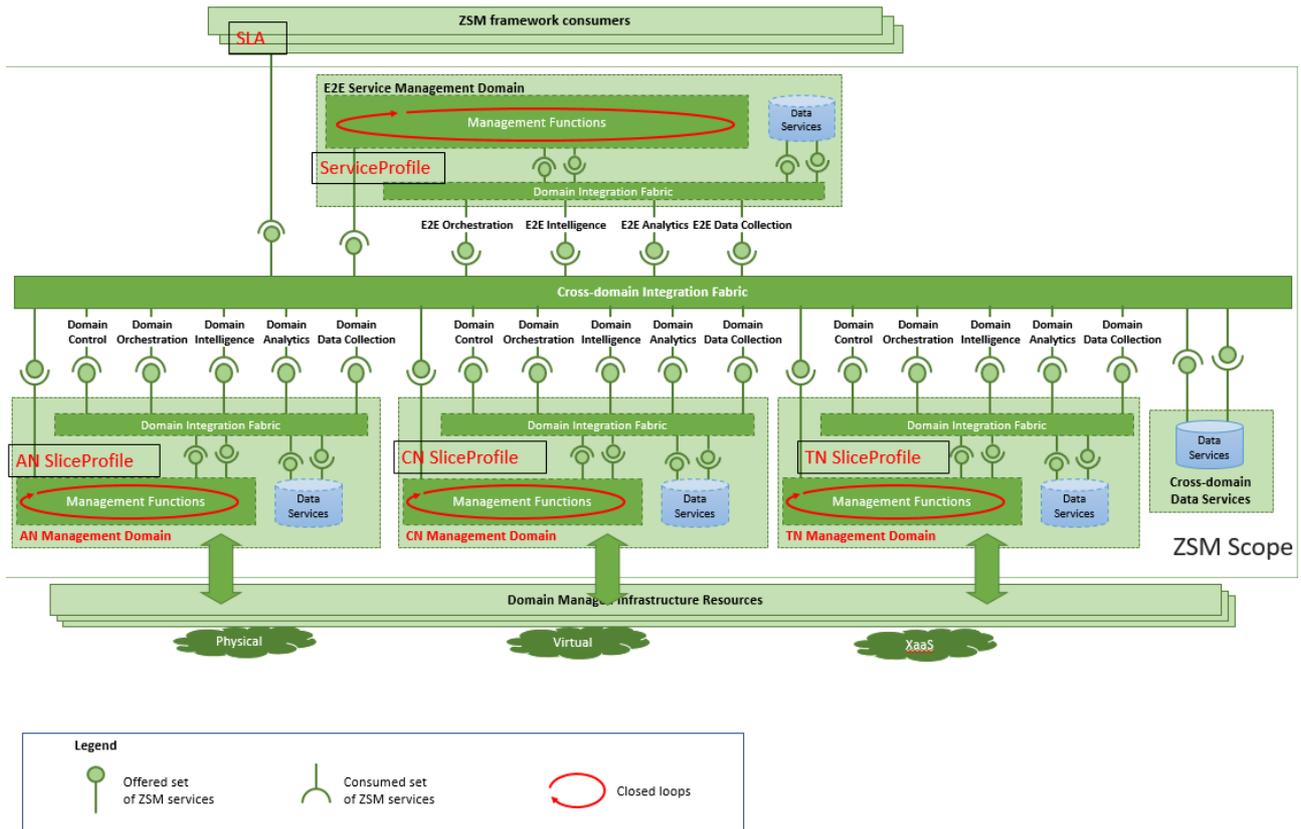
Figure 7.1.2-1: SLA translation to ServiceProfile and SliceProfile

7.1.3   Network slice management models

The network slice management models as defined in ETSI TS 128 541 [7] include NetworkSlice, NetworkSliceSubnet, ServiceProfile and SliceProfile models. The relations of the models are in Figure 7.1.3-1.
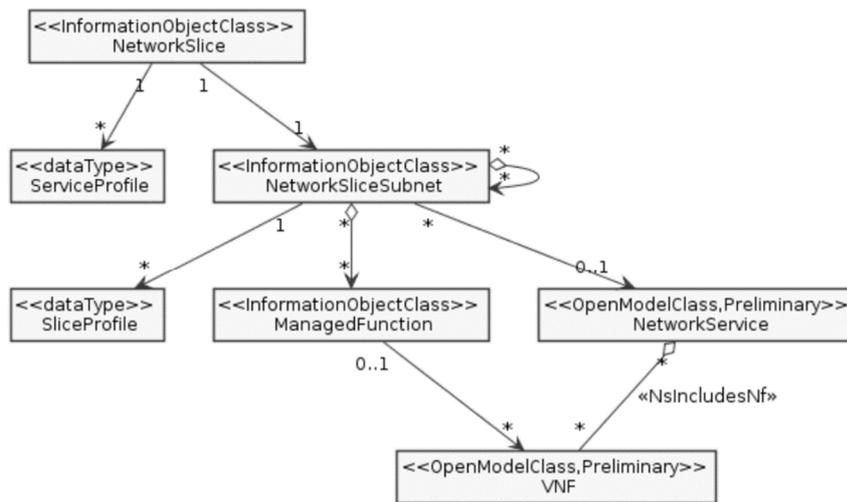
Figure 7.1.3-1: Network slice management models

7.2 Management exposure to vertical consumers in NOP Internal scenario

In the NOP Internal scenario, the vertical customers provide the communication service-related SLA requirements to operators. The slice information is invisible to vertical customers. These requirements specify SLS of requested communication services, together with other business-related information (e.g. communication service lifetime, communication service charging/accounting, etc.).

Operator as ZSM service provider provides the individual vertical customers with information on their running communication services, including SLA fulfilment and assurance information. Information on underlying network slices is not made available to vertical customers.

7.3 Management exposure to vertical consumers in NSaaS scenario

In the NSaaS scenario, a dedicated network slice can be offered to a vertical as a service. Unlike the NOP internal scenario, in this scenario the vertical customer is slicing aware. The operator allows the vertical to use the provided network slice instance and optionally manage it.

The vertical customers provide the network slice SLA requirements to operators. In addition to specifying the SLS of the requested network slice together with other business-related information (e.g. network slice lifetime, network slice charging/accounting, etc.), these SLA requirements include information on how much control the vertical customer can retain on the network slice. Different vertical customers might want to take different levels of management over their serving slices, depending on the needs of their particular use cases. To support this variety, the operator can expose different management and data services to different vertical customers.

NOTE: The management and data services offered to a given vertical customer allow defining the management capabilities it can get from the ZSM framework.

Operator as ZSM service provider provides individual vertical customers with information on their running network slice instances, including SLA fulfilment and assurance information. It also grants individual vertical customers access to agreed management and data services.

PNI-NPN (Public Network Integrated Non-Public Network) provisioning is an example of where management exposure could be applied. PNI-NPN can be deployed as an end-to-end network composed of two segments:

- A public segment, consisting of PLMN operator provided AN and 5GC network functions. These functions are deployed in the form of a network slice, using segregated public 5G resources.

- One private, consisting of vertical customer-provided network functions. These functions are deployed as an on-premise sub-network, using private 5G resources.

Figure 7.3-1 illustrates the applicability of this scenario to the ZSM architecture framework. As seen, the PLMN operator plays the role of *ZSM framework owner*, while the vertical customer plays the role of *ZSM framework consumer*. The PLMN operator relies on NSaaS to deliver network slice to the vertical customer, together with the ZSM management and data services associated to that network slice, according to the management exposure agreed between both parties. The vertical customer consumes the ZSM management and data services made available with NSaaS to attach the received network slice to the on-premise sub-network, thus forming the PNI-NPN.

PNI-NPNs for different vertical customers may require the PLMN operator to deliver NSaaS with different management capabilities. These management capabilities allow the vertical customers to consume the received slice as needed, i.e. according to the degree of control the vertical wants to take on the slice. In this regard, while there are verticals that only want to get aggregated KPIs for passive monitoring activities (e.g. SLA assurance), there are some other verticals that might want to get more advanced capabilities (e.g. change application layer configuration of individual NFs, modify slice capacity by triggering NFV scaling out operations, etc.).

ZSM management and data
services made available to ZSM
framework consumer, according to
agreed management exposure.

NSaaS

ZSM E2E Service Management Domain

Cross-Domain Integration Fabric

Management Domain

Management Domain

ZSM framework consumer

Network Slice O&M

Core Network Slice Subnet O&M

Access Network Slice Subnet O&M

Subnetwork O&M

Network Slice

AN

CN

NF

NF

NF

Data Network

Subnetwork

NF

NF

NF

NF

Vertical's premises

PLMN

PNI-NPN

Management View

Network View

Figure 7.3-1: Example of management exposure for PNI-NPN provisioning

Annex A (informative):
Available output from standard groups and open source groups on network slicing management

A.1   Telecommunication

A.1.1   3GPP TSG SA2

SA WG2 is in charge of Architecture and procedures for the 5G system, and network slicing related work are included in specifications ETSI TS 123 501 [1] and ETSI TS 123 502 [2].

Network slicing is described in ETSI TS 123 501 [1], clause 5.15.

ETSI TS 123 502 [2] contains the stage 2 procedures and flows for the 5G System architecture described in ETSI TS 123 501 [1] and for the policy and charging control framework described in ETSI TS 123 503 [3].

A.1.2   3GPP TSG SA3

SA WG3 focuses on the security aspects of 5G network slicing management. Key issues are included in 3GPP TR 33.811 [i.1].

SA3 ETSI TS 133 501 [18] captures the security aspects for network slices.

In clause 15 of [18], it focused on the management security for network slices. When the consumer resides outside the 3GPP operators' trust domain, the mutual authentication, protection of management interactions between the management service consumer and management service provider and the authorization of management service consumer's request should be performed before provisioning of Network Slice Instance.

In clause 16 of [18], it focused on security procedures for network slices, including authorization procedure for network slice access, network slice specific authentication and authorization procedure, AAA server triggered Network Slice-specific Re-authentication and Re-authorization procedure, AAA server triggered Slice-specific Authorization Revocation procedure.

A.1.3   3GPP TSG SA5

SA WG5 focuses on the management and orchestration of 5G for 3GPP systems which includes network slicing management.

ETSI TS 128 530 [4] specifies the concepts, use cases and requirements for management of network slicing in mobile network.

SA5 ETSI TS 128 531 [5] specifies use cases, requirements, management services and procedures for provisioning of 5G networks. In particular, the life cycle management of network slices as well as network slice subnets.

ETSI TS 128 550 [6] defines the stage 1, 2 and 3 of performance assurance related management services for 5G networks including network slicing.

ETSI TS 128 552 [8] specifies the performance measurements for 5G networks including network slicing.

ETSI TS 128 554 [9] specifies End to End Key Performance Indicators (KPIs) for the 5G network and network slicing.

ETSI TS 128 532 [13] specifies Management and orchestration; Generic management services.

ETSI TS 128 541 [7] specifies Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3.

ETSI TS 128 545 [14] specifies Management and orchestration; Fault Supervision.

A.1.4 NGMN

The concept of slicing was initially defined in the NGMN white paper [i.18].

In addition, NGMN in February 2018 released version 2 of their 5G End to End architecture paper [i.17] that demonstrates how to utilize the network slicing concept to release user/business services in the 5G telecommunication environment.

A.1.5 GSMA

GSMA published a white paper [i.2] on network slicing. It focuses on the business scenarios and derived requirements for network slicing from the view of vertical consumers.

GSMA published GSMA NG.116 [16] in which a Generic network Slice Template (GST) is defined as a set of attributes that can characterize a type of network slice/service.

A.1.6 ETSI NFV EVE012

ETSI NFV ISG is actually highlighting the relationship between NSs and Slices/Subnet_Slices [i.3]. This is important since the CSP is familiar and supports the network slice (and VNF) constructions. Figure A.1.6-1 presents the relationship between 3GPP and ETSI NFV data models. It can be observed that the virtualized resources for the slice subnet and their connectivity to physical resources can be represented by the nested network slice concept, or one or more VNFs and Physical Network Functions (PNF) are directly attached to the network slice used by the network slice. ETSI states that "an NFV Network Service (network slice) can thus be regarded as a resource-centric view of a network slice, for the cases where a network slice instance would contain at least one virtualized network function" [i.3].
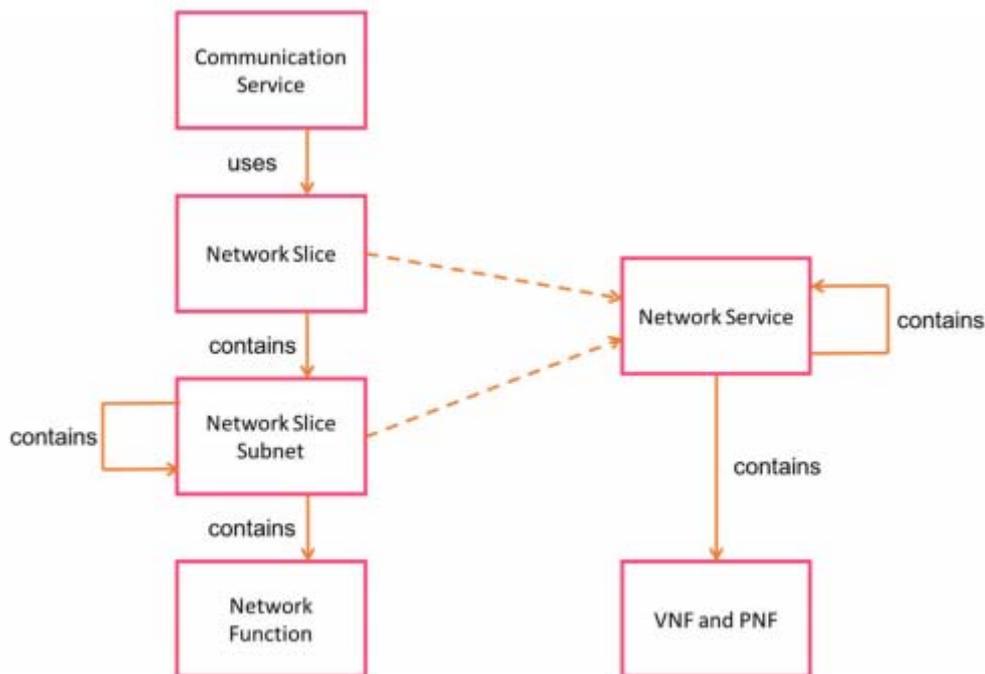
NOTE: Source ETSI GR NFV-EVE 012 [i.3].

Figure A.1.6-1: Relating the information mode

A.1.7   IETF

The Internet Engineering Task Force (IETF) has started working on network slicing, developing specifications to fulfil the requirements of transport part of the end-to-end network slice, i.e. IETF network slice. These specifications are updated and maintained by the Network Slice Design Team (NSDT), a task force formed in the Traffic Engineering and Architecture Signaling (TEAS) Working Group. The mission of the NSDT is to develop a framework for providing transport network slicing using IETF traffic engineered technologies (e.g. IP, (G)MPLS, Segment Routing and other enhanced VPN solutions [i.14]), IETF Traffic Engineering architecture (e.g. ACTN [i.9]) and IETF service delivery models (e.g. L3SM [i.19], L2SM [i.16]). The expectation is for these IETF assets to be used to create individual IETF network slices, each representing a specific, isolated and managed logical network instance executed atop a common transport network infrastructure.

According to the NSDT scope, an IETF network slice is a logical network topology connecting a number of endpoints with a set of shared or dedicated network resources, that are used to satisfy specific Service Level Objective (SLOs) [i.15]. These SLOs do not describe how the IETF network slices will be implemented or realized in the underlying network layers; instead, they are defined in terms of dimensions of operations, availability and other attributes. Examples of SLOs are guaranteed minimum bandwidth, guaranteed maximum latency, maximum permissible delay variation, maximum permissible packet loss rate and availability. This rationale allows establishing *a clear demarcation point between traditional L2/L3VPNs*, focused on segmentation (i.e. creation and management of private networks) and bound to a specific technology and traffic type, *and IETF network slices*, concerned with the assurance of SLOs and unaware of underlying infrastructure connectivity. This technology-agnostic feature provides means for the network operator to flexibly decide on the realization of individual IETF network slices, depending on the technology and traffic engineering mechanisms available for use on the operator's managed transport network infrastructure.

```
            |--------------------------------|
   NSE1 |                                    | NSE2
      O.....|                                |.....O
        .   |                                |   .
        .   |                                |   .
        .   |                                |   .
            |                                |
   NSEm |                                    | NSEn
      O.....|                                |.....O
            |                                |
            |--------------------------------|

        <------------ IETF Network Slice -------------->
                between endpoints NSE1 to NSEn

   Legend:
        NSE: IETF Network Slice Endpoint
          O: Represents IETF Network Slice Endpoints
```
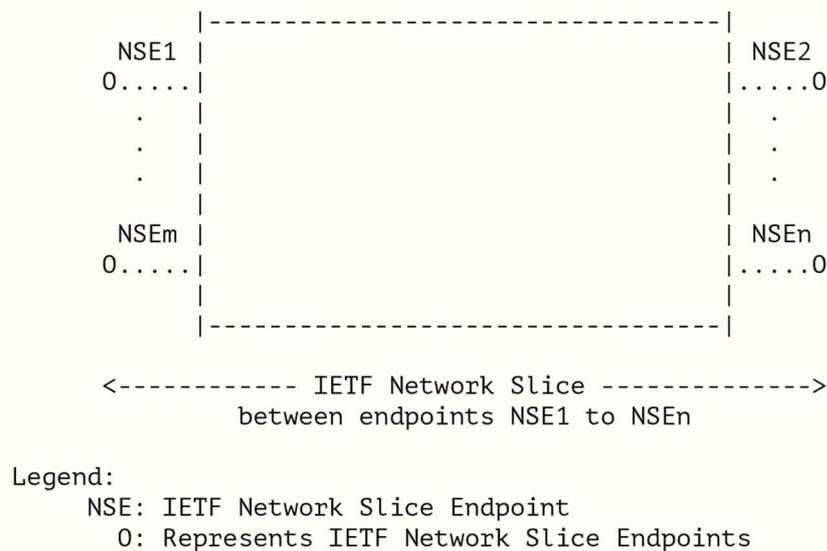
Figure A.1.7-1: An IETF Network Slice Endpoint (NSE) [i.16]

Figure A.1.7-1 captures an example of an IETF network slice endpoint - conceptual points of connection of a network function/device/application between the IETF network slice endpoints. For the provisioning of individual IETF network slices, a new management entity is defined: the IETF Network Slice Controller (NSC). Conceptually equivalent to 3GPP/BBF referred Transport Network Slice Subnet Management Function (T-NSSMF), the IETF NSC is the entity responsible for IETF network slice lifecycle management activities. For the interaction with upper/lower management systems, the IETF NSC defines two interfaces:

- NSC Northbound Interface (NBI): it is the interface that allows exposing NSC capabilities to higher level operation systems - e.g. the E2E service management domain. It is a technology-agnostic interface. Over this NBI, slice characteristics and other requirements can be communicated to the NSC and the operational state of an IETF network slice may be requested.

- NSC Southbound Interface (SBI): it is the interface that allows the NSC to interact with underlying, domain-specific network controller(s) - e.g. IP/MPLS controller, optical controller, microwave controllers. These interfaces are technology-specific and leverage many of the existing network models.

Figure A.1.7-2 illustrates the NSC interfaces and their interaction with other management systems. The resulting architectural framework can be easily mapped with the ACTN framework, as captured in [i.15].

```
+-------------------------------------------+
| Consumer higher level operation system    |
|    (e.g E2E network slice orchestrator)   |
+-------------------------------------------+
                     A
                     | NSC NBI
                     V
+-------------------------------------------+
|      IETF Network Slice Controller (NSC)  |
+-------------------------------------------+
                     A
                     | NSC SBI
                     V
+-------------------------------------------+
|             Network Controllers           |
+-------------------------------------------+
```
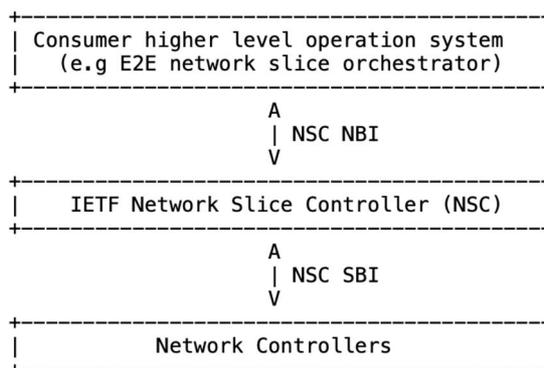
Figure A.1.7-2: IETF NSC interfaces [i.15]

Building upon the agreed IETF network slice and NSC concepts, the NSDT contributors are exploring solutions for transport network slicing in multiple workstreams, including:

i)   IETF network slice definition and terminology;

ii)   architectural framework for IETF network slices;

iii)   on modelling the NSC NBI.

From ZSM architecture perspective, the NSC NBI allows making TN domain management services available for external consumption, so that management functions from E2E service management domain and/or other management domains (e.g. CN, AN, virtualization management domains) can consume them. ZSM will keep track of the stage 2 and 3 solutions to be developed for the NSC NBI, considering them as part of ZSM technical specifications and reports, if/when required.

Annex B (informative):
Deployment scenario

B.1   Deployment scenario to support network slicing using NFV

The management services (MnSs) for E2E network slicing may be provided by a set of MDs. This clause shows an example of such operator deployment scenario where each MD including that for network slicing defined by 3GPP SA5 and that for NFV defined by ETSI NFV, provides various MnSs.
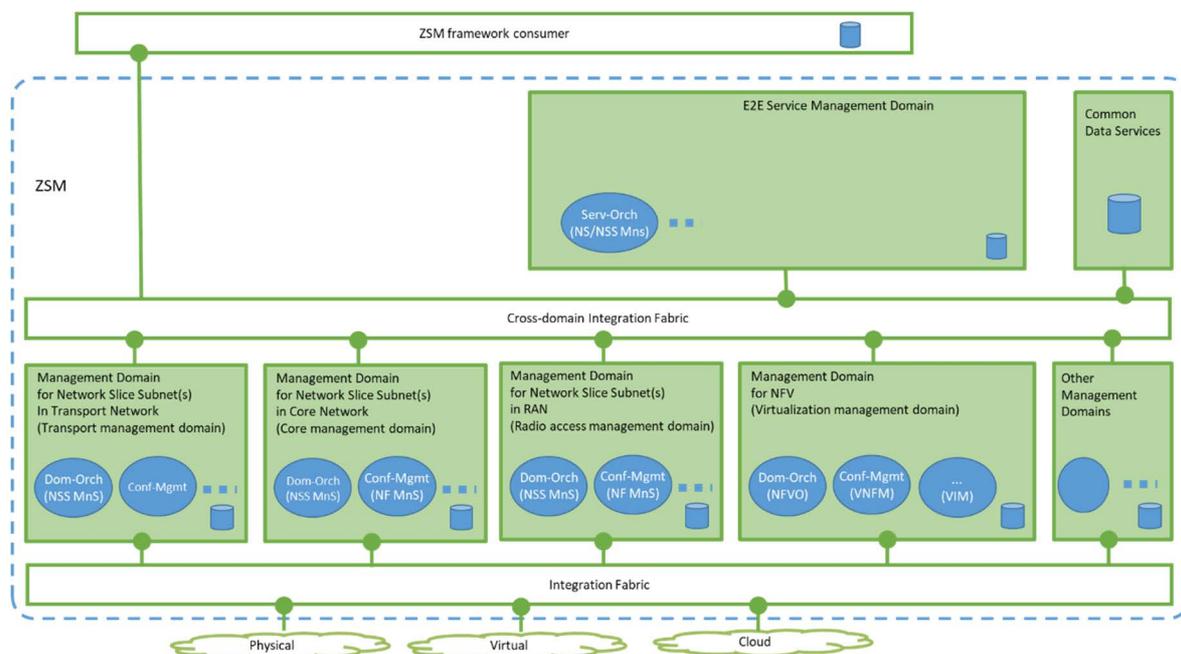
Figure B.1-1: Example of MDs to support network slicing using NFV

In this operator deployment example:

- E2E Service MD provides MnSs for E2E network slices/network slice subnets, e.g. Service Orchestration service (Serv-Orch), which orchestrates the individual Network Slice Subnets (NSSs) provided by Radio Access Network (RAN), Transport Network (TN) and Core Network (CN), and stitches them into an E2E network slice subnet being exposed as a network slice. The MnSs in this MD may also manage NSSs of Data Network (aka. SGi Network) using MD for NFV. It is expected that parts of specifications developed by 3GPP SA5 are re-used for the MnSs in this MD. This MD exposes e.g. management capabilities of E2E network slices (provisioning, performance assurance, fault supervision, etc.).

- MD for network slice subnet in TN provides MnSs for NSSs of TN, e.g. Dom-Orch service. This MD may consume TN resources outside of ZSM supported by e.g. Configuration Management service(s) (Conf-Mgmt). It is expected that parts of specifications developed by e.g. BBF, MEF, IETF and/or ETSI NFV are re-used for the MnSs in this MD. This MD exposes e.g. management capabilities of network slice subnet of TN (provisioning, performance assurance, fault supervision, etc.).

- MD for network slice subnet in RAN provides MnSs for NSSs of RAN, e.g. Dom-Orch service. This MD may consume application level RAN resources (i.e. application part of RAN Network Functions) outside of ZSM supported by e.g. Conf-Mgmt, and it may also consume MnSs for Network Services which include virtualized resources from MD for NFV. It is expected that parts of specifications developed by 3GPP SA5 are re-used for the MnSs in this MD. This MD exposes e.g. management capabilities of network slice subnet of RAN (provisioning, performance assurance, fault supervision, etc.).

- MD for network slice subnet in CN provides MnSs for NSSs of CN, e.g. Dom-Orch service. This MD may consume application level CN resources outside of ZSM (i.e. application part of CN Network Functions) supported by e.g. Conf-Mgmt, and it may also consume MnSs for Network Services which include virtualized resources from MD for NFV. It is expected that parts of specifications developed by 3GPP SA5 are re-used for the MnSs in this MD. This MD exposes e.g. management capabilities of network slice subnet of CN (provisioning, performance assurance, fault supervision, etc.).

- MD for NFV provides MnSs for NFV Network Service(s) (at resource level), e.g. Dom-Orch service (NFV Orchestrator). This MD may also have Conf-Mgmt (VNF Manager) and MnSs for managing compute/network/storage resources (Virtualized Infrastructure Manager). It is expected that parts of specifications developed by ETSI NFV are re-used for the MnSs in this MD. This MD exposes e.g. management capabilities related to NFV Network Services (Create/Read/Update/Delete of the Network Services, on-boarding of catalogues for those, etc.).

B.2   Providing media streaming service by deployment of an E2E network slicing

Using the operator deployment scenario in Figure B.2-1, a media streaming service over an E2E network slice instance comprising of DSL streaming access + Mobile users + virtualized application (streaming server) can be deployed. Figure B.2-1 describes the particular instance of service consumption across the domains.
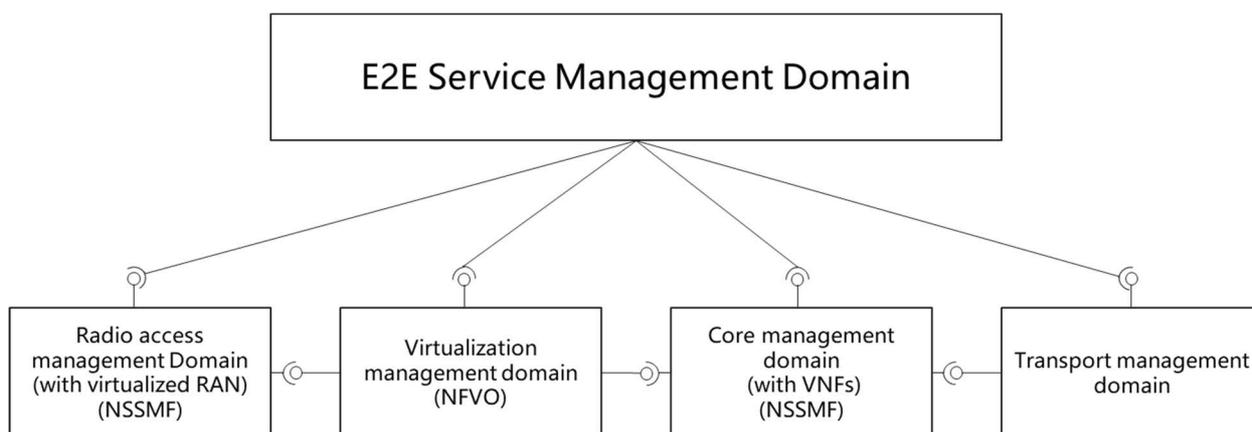
Figure B.2-1: Example management services' consumption to show E2E slice deployment

NOTE: All management service exposure and consumption is via the integration fabric.

The steps of deployment are:

- The E2E service breaks up the E2E network slicing deployment requests into Transport Part of the E2E network slice (for fixed users) + 3GPP Core Part of the E2E network slice (for Mobile users) + 3GPP RAN part of the E2E network slice + Streaming application service (Virtualized).

- The transport part of the E2E network slice is handed over to the TN management domain using the appropriate management services exposed by the transport management domain.

- The 3GPP core part (e.g. AMF, SMF, UPF, N1 or N6) goes to the core management system.

- The core management domain requests the connectivity (N1 and N6) to the transport management domain.

- The Core management domain hands over the VNFs (e.g. AMF, SMF or UPF) to the virtualization management domain.

- The access part goes to radio access service management domain.

- The radio access management domain uses the management services of the virtualization management domain to deploy the virtualized RAN part.

- The virtualized streaming AS is handed over to be deployed by the virtualization management system.

Annex C (informative):
Sequences of Network Slice Management by ZSM

C.0   Introduction

This informative annex describes examples of sequences of network slice management to help the reader of the present document to understand how ZSM works to support network slice management. The diagrams in this annex is high level illustration. Detailed operations which are not essential for understanding of ZSM and network slice instance management are not appeared. Also, Network Slice as a Service (NSaaS) is considered as a use case in this annex.

C.1   Sequence of network slice instance Creation

C.1.1   Basic Sequence of network slice instance Creation
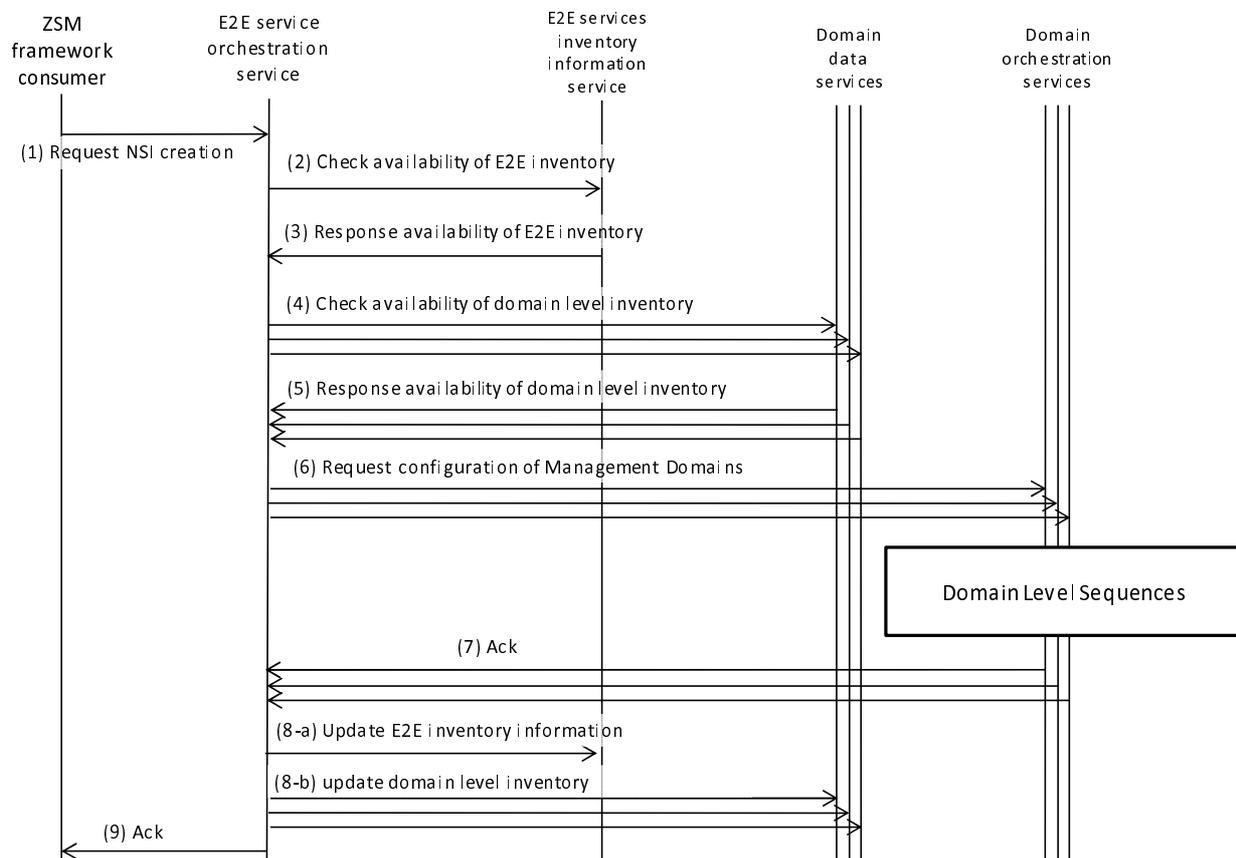
Figure C.1.1-1: Example of basic sequence diagram of network slice instance Creation

1)   The ZSM Framework Consumer requests the creation of network slice instance (by invoking the *AllocateNsi* operation defined in clause 6.5.1 of ETSI TS 128 531 [5]) to the E2E service orchestration service in the E2E Service Management Domain with requirements on the network slice instance.

2)   The E2E service orchestration checks with the E2E services inventory information service if there are sufficient inventories of E2E network slice instance.

3)   TheE2E services inventory service responses with availability of E2E network slice instance to the E2E service orchestration service. If there is an available E2E network slice instance, the E2E service orchestration service activates this (go to step 6)).

4)   If there is no available E2E network slice instance that is ready to use, the E2E service orchestration service requests the domain orchestration service to configure the Management Domains (by invoking the *AllocateNssi* operation defined in clause 6.5.2 of ETSI TS 128 531 [5]). This step initiates domain-level sequences of the relevant Management Domains (see clauses C.1.2 and C.1.3). A typical network slice instance consists of multiple Management Domains. Therefore, the multiple requests to configure managed entities are sent to each Management Domains.

5)   After completion of configuration of the Management Domains, the configuration management service sends the acknowledgement (see the *AllocateNssi* operation defined in clause 6.5.2 of ETSI TS 128 531 [5]) for step 4).

6)   The E2E service orchestration service sends the update of the inventory of the E2E network slice instances to the E2E service inventory information service. The E2E services inventory information service updates the inventory information based on this information.

7)   The E2E service orchestration service sends the acknowledgement (see the *AllocateNsi* operation defined in clause 6.5.1 of ETSI TS 128 531 [5]) for step 1).

C.1.2   Domain Level Sequence of network slice instance Creation

When the domain orchestration service receives the request (see the *AllocateNssi* operation defined in clause 6.5.2 of ETSI TS 128 531 [5]) to configure the Management Domain, the domain-level sequence is initiated. There are two possible cases of initiation of this sequence. One is the request from the E2E service orchestration service. The other one is the request from the domain orchestration service in the other Management Domain which has dependency with this Management Domain (see clause C.1.4 for details).
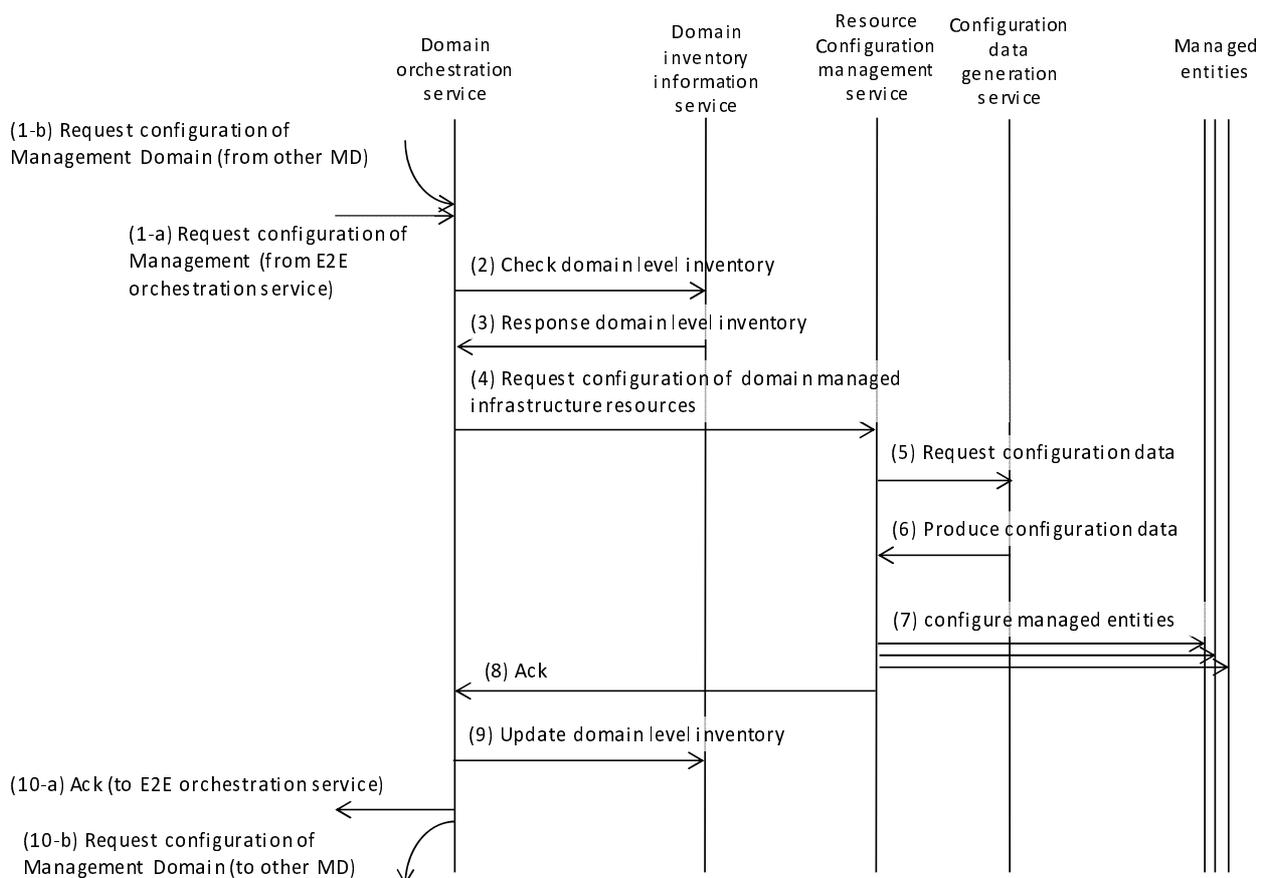
Figure C.1.2-1: Example of a domain-level sequence

1-a)   The domain orchestration service receives the request to configure the Management Domains from the E2E orchestration service.

1-b) The request to configure the Management Domain may be initiated by the domain orchestration service in other Management Domain.

2)   The domain orchestration service checks the domain inventory information service if there is domain-level inventory. The domain-level inventory can be a network slice subnetwork instance or a set of managed entities.

3)   The domain inventory information service responses the availability of domain-level inventory. If there is a network slice subnetwork instance, the domain orchestration service activates this (go to step 9)).

4)   If there is no available network slice subnetwork instance but enough capacity of managed entities, the domain orchestration service requests configuration of the managed entities to the resource configuration management service.

5)   If the configuration data is not available in the configuration management service, the configuration management service may request the configuration data to the configuration data generation service.

6)   The configuration data generation service produces the configuration data and sends them to the configuration management service.

7)   The configuration management service configures the managed entities.

8)   After completion of configuration of managed entities, the configuration management service sends the acknowledgement for step 4).

9)   The domain orchestration service updates the domain-level inventory in the domain inventory information service.

10-a) The domain orchestration service sends the acknowledgement for step 1-a).

10-b) If other Management Domain is waiting the completion of configuration of this Management Domain due to dependency, the domain orchestration service in this Management Domain may request configuration of the managed entities under other Management Domain on behalf of the E2E orchestration service.

C.1.3   Domain Level Sequence of network slice instance Creation with resource adjustment

The creation of a network slice instance gives impacts on the utilization of managed entities. This may demand the rebalancing of resource allocation among network slice instances. This sequence shows the domain-level sequence with additional feature of resource adjustment by a management service in the Domain Intelligence. Also, this sequence is initiated when domain orchestration service receives the request (see the *AllocateNssi* operation defined in clause 6.5.2 of ETSI TS 128 531 [5]) to configure the Management Domain.
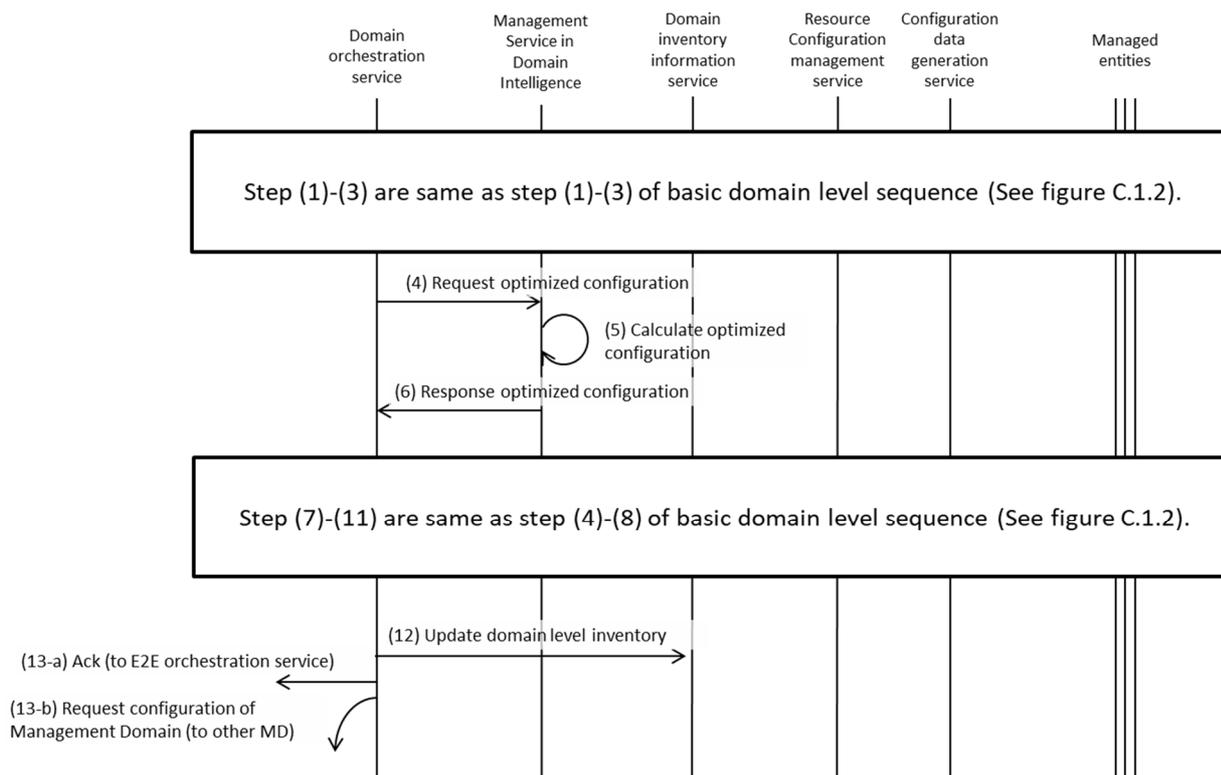
**Figure C.1.3-1: Example of a domain-level sequence diagram of
network slice instance Creation with resource adjustment**

1-a)   See step 1-a) in clause C.1.2.

1-b)   See step 1-b) in clause C.1.2.

2)   See step 2) in clause C.1.2.

3)   Same as step 3) in clause C.1.2. If there is a network slice subnetwork instance, go to step 12).

4)   If there is no available network slice subnetwork instance but enough capacity of managed entities, the domain
       orchestration service requests the management service in the Domain Intelligence for optimized configuration
       of the managed entities.

5)   The management service in the Domain Intelligence calculates the optimized configuration.

6)   The management service in the Domain Intelligence responses with the optimized configuration.

7)   See step 4) in clause C.1.2.

8)   See step 5) in clause C.1.2.

9)   See step 6) in clause C.1.2.

10)   See step 7) in clause C.1.2.

11)   See step 8) in clause C.1.2.

12)   The domain orchestration service updates the domain-level inventory in the domain inventory information
       service. This update of domain-level inventory considers the consequences of resource adjustment.

13-a) The domain orchestration service sends the acknowledgement for 1-a).

13-b) If other Management Domain is waiting for the completion of configuration of this Management Domain (e.g.
       due to dependency), the domain orchestration service in this Management Domain may request configuration
       of the managed entities under other Management Domain on behalf of the E2E orchestration service.

C.1.4 Patterns of interaction between E2E Service Management Domain and Management Domains

Typical E2E network consists of multiple different Management Domains. These Management Domains may or may not work independently. If more than two Management Domains have dependency, the operation of Management Domains should be sequential or interactive rather than parallel. Therefore, several different patterns of interaction between E2E Service Management Domain and Management Domains are described.
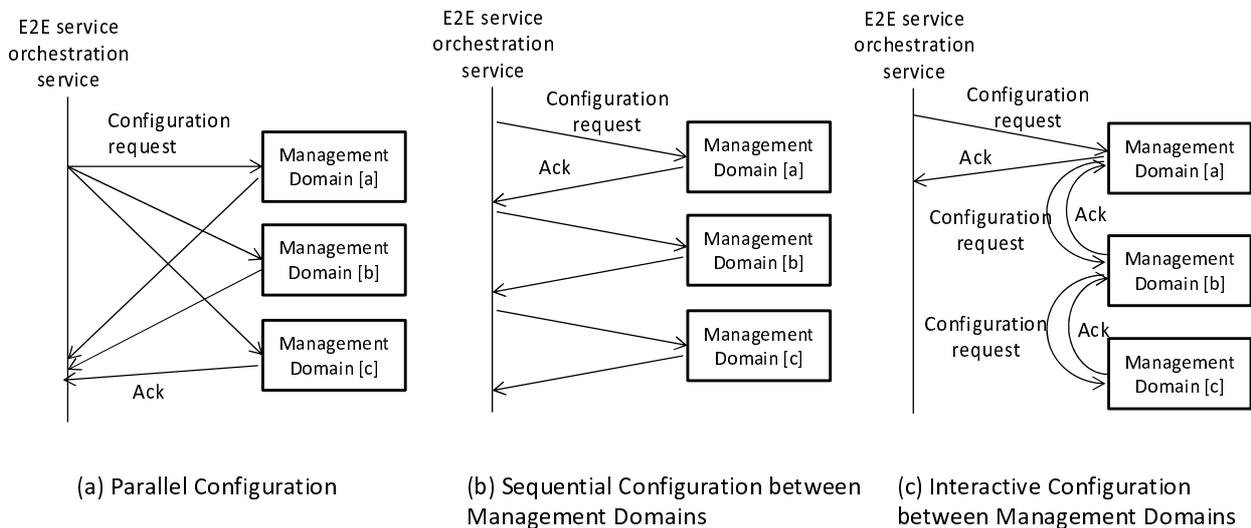
Figure C.1.4-1: Patterns of interaction between E2E Service Management Domain and Management Domains

C.2 Sequence of network slice instance Auto Healing

In an operational phase of network slice, it is possible that trouble happens on a managed entity constituting a network slice instance. In this case, the ZSM framework can detect the trouble and takes necessary actions (e.g. replacing troubled managed entity with alternative managed entity).
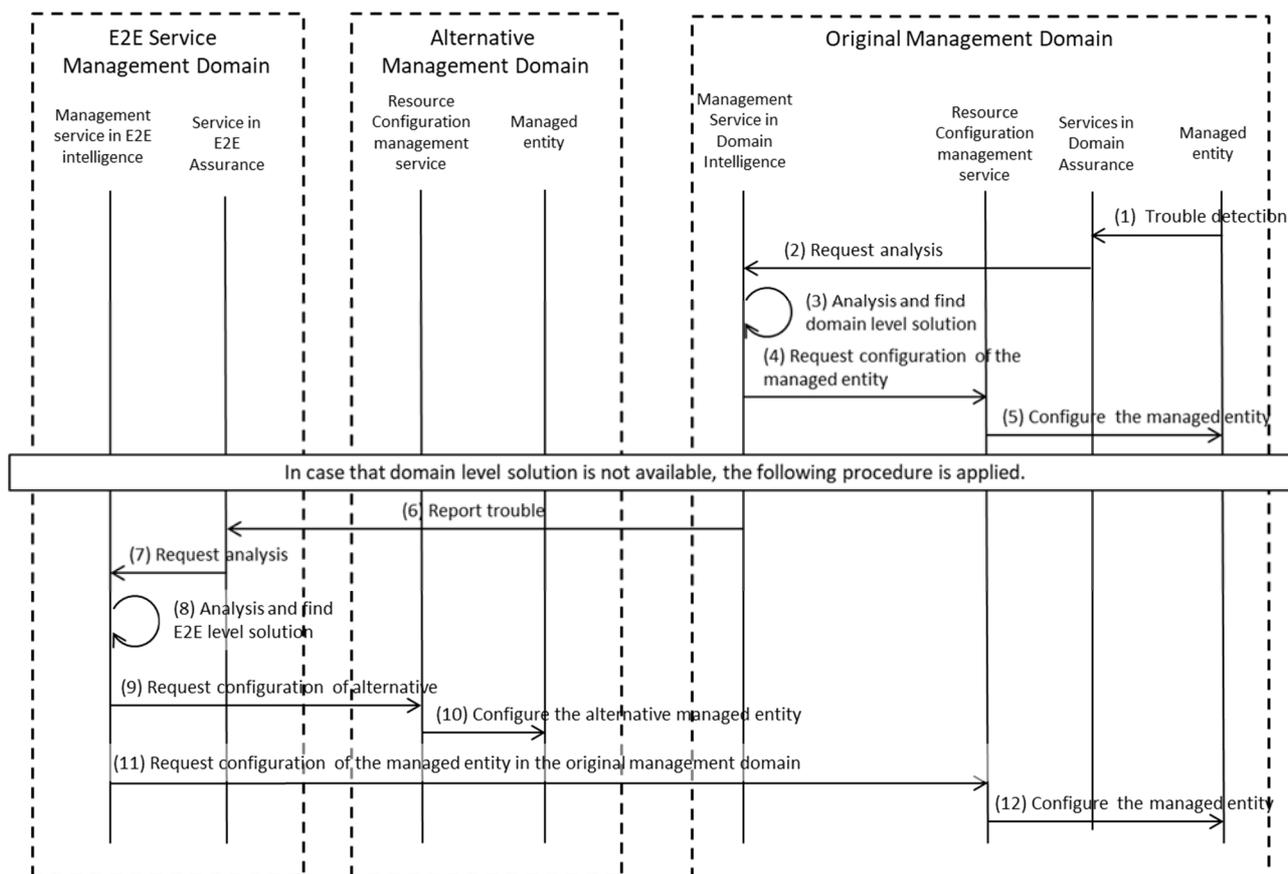
Figure C.2-1: Example of basic sequence diagram of network slice instance Auto Healing

1) The management service (note 1) in the Domain Assurance detects a trouble of a managed entity such as fault event, performance event or performance degradation.

2) The management service (note 1) in the Domain Assurance requests analysis for finding available domain-level solution to a management service (note 2) in the Domain Intelligence.

3) The management service (note 2) in the Domain Intelligence analyzes the trouble and produces a domain-level solution (e.g. replacing the troubled managed entity with an alternative managed entity).

4) The management service (note 2) in the Domain Intelligence requests the resource configuration management service to configure the troubled managed entity for implementing the domain-level solution. If no domain-level solution is available, go to step 6).

5) If the domain-level solution is available, the resource configuration management service configures the alternative managed entity.

6) If domain-level solution cannot fix the trouble, the management service (note 2) in the Domain Intelligence may request the management service (note 1) in the E2E Assurance

7) The management service in the E2E Assurance requests the management service in the E2E Intelligence for further analysis to find an E2E level solution.

8) The management service (note 2) in the E2E Intelligence analyzes the trouble and produces an E2E level solution (e.g. replacing the troubled managed entity with managed entity in the alternative management domain).

9) The management service (note 2) in the E2E Intelligence requests the resource configuration management service in the alternative management domain to configure the managed entity for implementing the solution.

10) The resource configuration management service in the alternative management domain configures the managed entity.

11) The management service (note 2) in the E2E Intelligence requests the configuration management service in the original management domain to configure the troubled managed entity (e.g. release the troubled managed entity).

12) The resource configuration management service in the original management domain configures the trouble management entity.

NOTE 1: There are some management services in the Domain/E2E Assurance which are relevant for this use case.

NOTE 2: The management service in the Domain/E2E Intelligence is FFS.

C.3 Sequence of network slice instance Termination

C.3.1 Basic Sequence of network slice instance Termination
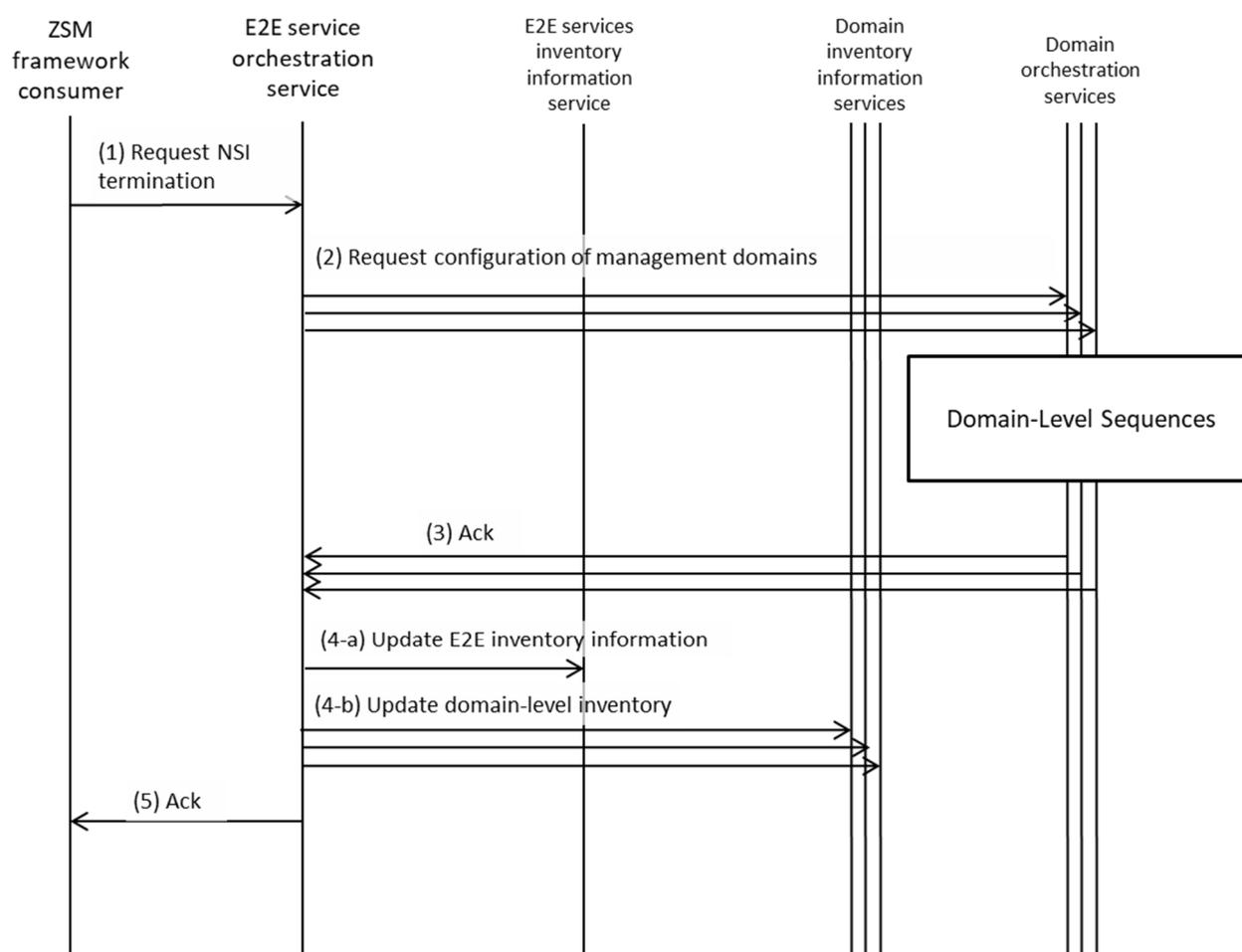
Figure C.3.1-1: Example of basic sequence diagram of network slice instance Termination

1) The ZSM Framework Consumer requests the termination of network slice instance (by invoking the *DeallocateNsi* operation defined in clause 6.5.3 of ETSI TS 128 531 [5]) to the E2E service orchestration service in the E2E Service Management Domain.

2) If the managed entities or the network slice instance can be released, the E2E service orchestration requests the domain orchestration service to configure managed entities (by invoking the *DeallocateNssi* operation defined in clause 6.5.4 of ETSI TS 128 531 [5]). This step initiates domain-level sequences of the relevant Management Domains. A typical network slice instance consists of multiple Management Domains. Therefore, the multiple requests to configure managed entities may be sent to each Management Domains.

3)   After completion of configuration of managed entities, the domain orchestration service sends the acknowledgement (see the *DeallocateNssi* operation defined in clause 6.5.4 of ETSI TS 128 531 [5]) for step 2).

4)   The E2E orchestration service sends updated the inventory of the E2E network slice instance to the E2E services inventory information service. The E2E services inventory information service updates the inventory information. Also, the updates of domain-level inventory are sent to the domain inventory information services.

5)   The E2E service orchestration service sends the acknowledgement (see the *DeallocateNsi* operation defined in clause 6.5.3 of ETSI TS 128 531 [5]) for step 1).

C.3.2   Domain-Level Sequence of network slice instance Termination

When the domain orchestration service receives the request (see the *DeallocateNssi* operation defined in clause 6.5.4 of ETSI TS 128 531 [5]) to configure the Management Domain, the domain-level sequence is initiated. There are two possible cases of initiation of this sequence. One is the request from the E2E service orchestration service. The other one is the request from the domain orchestration service in the other Management Domain which has dependency with this Management Domain (see clause C.1.4 for details).
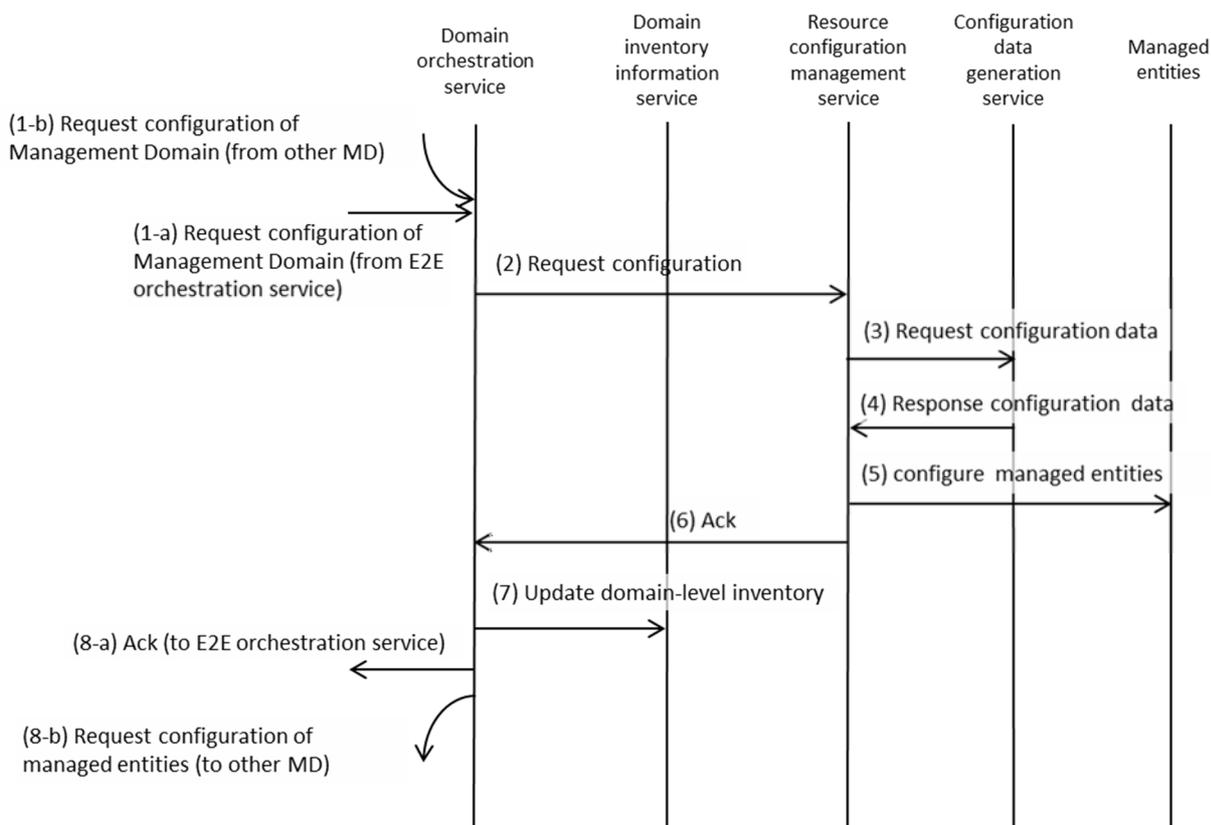
Figure C.3.2-1: Example of a domain-level sequence of network slice instance Termination

1-a)   The domain orchestration service receives the request to configure the managed entities from the E2E orchestration service.

1-b)   The request to configure the managed entities may be initiated by the domain orchestration service in other Management Domain.

2)   If the managed entities allocated to the network slice instance can be released, the domain orchestration service requests the resource configuration management service to configure the managed entities.

3)   If the configuration data is not available in the resource configuration management service, the resource configuration management service may request the configuration data to the configuration data generation service.

4)   The configuration data generation service produces the configuration data and sends them to the configuration management service.

5)   The configuration management service configures the relevant managed entities.

6)   After completion of configuration of managed entities, the configuration management service sends the acknowledgement for step 2).

7)   The domain orchestration service updates the domain-level inventory.

8-a) The domain orchestration service sends the acknowledgement for step 1-a).

8-b) If other Management Domain is waiting for the completion of configuration of this Management Domain (e.g. due to dependency), the domain orchestration service in this Management Domain may request configuration of the managed entities under other Management Domain on behalf of the E2E orchestration service.

C.3.3   Domain-Level Sequence of network slice instance Termination with resource adjustment

The termination of a network slice instance gives impacts on the utilization of managed entities. This may demand the rebalancing of resource allocation among network slice instances. This sequence shows the domain-level sequence with additional feature of resource adjustment by a management service in the Domain Intelligence. Also, this sequence is initiated when domain orchestration service receives the request (see the *DeallocateNssi* operation defined in clause 6.5.4 of ETSI TS 128 531 [5]) to configure the Management Domain.
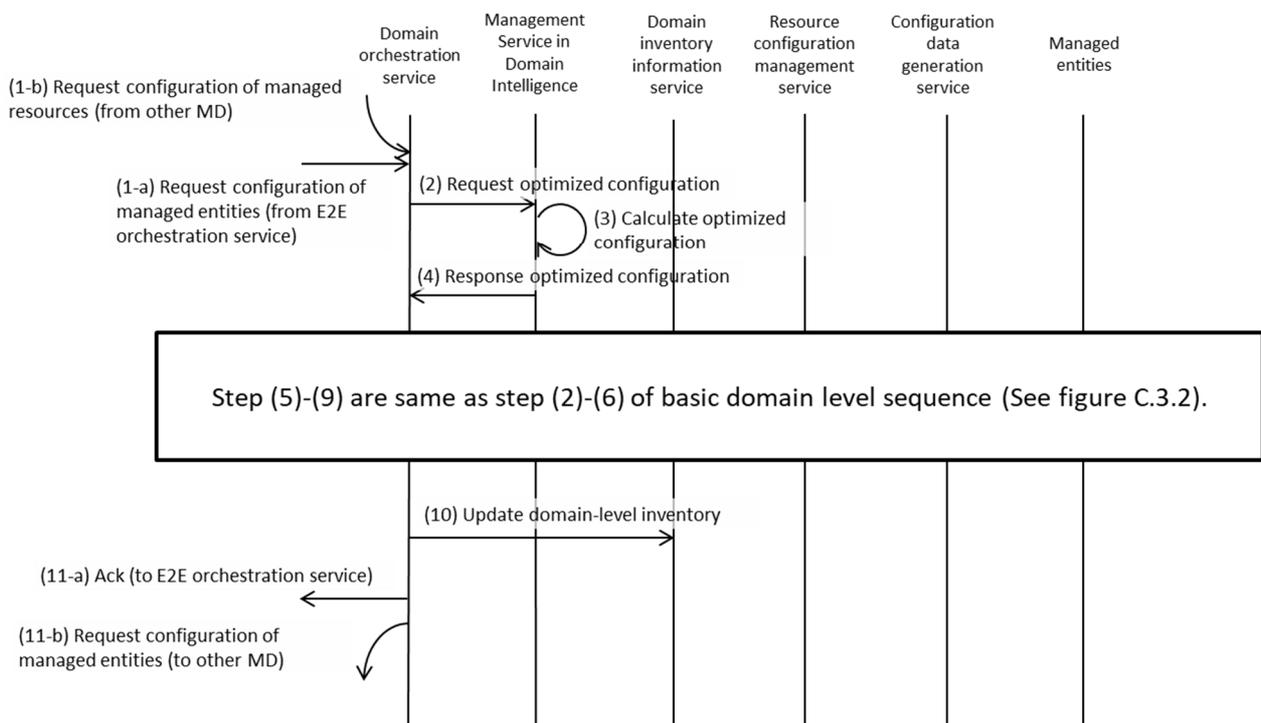
**Figure C.3.3-1: Example of a domain-level sequence of
network slice instance Termination with resource adjustment**

1-a) The domain orchestration service receives the request to configure the managed entities from the E2E orchestration service.

1-b) The request to configure the managed entities may be initiated by the domain orchestration service in other Management Domain.

2)   If the managed entities allocated to the network slice instance can be released, the domain orchestration service requests the management service in the Domain Intelligence for optimized configuration of the managed entities.

3)   The management service in the Domain Intelligence calculates the optimized configuration. This calculation may be based on the given policy or based on analysis using AI.

4)   The management service in the Domain Intelligence responses with the optimized configuration.

5)   See step 2) in clause C.3.2.

6)   See step 3) in clause C.3.2.

7)   See step 4) in clause C.3.2.

8)   See step 6) in clause C.3.2.

9)   See step 7) in clause C.3.2.

10) The domain orchestration service updates the domain-level inventory. This update of domain-level inventory considers the consequences of resource adjustment.

11-a) The domain orchestration service sends the acknowledgement for step 1-a).

11-b) If other Management Domain is waiting for the completion of configuration of this Management Domain (e.g. due to dependency), the domain orchestration service in this Management Domain may request configuration of the managed entities under other Management Domain on behalf of the E2E orchestration service.

C.4   Sequence of Switching Network Slice

There is a possibility that a network slice in use is changed to an alternative network slice when fault events occur in multiple management domains. By means of example, the anomaly events are detected in both core network management domain and transport network management domain. In such a case, network slice is switched over to another slice to solve the failure. This case provides an example of a sequence that a network slice instance is switched over to another one, triggered by the detection of anomaly by a ZSM service.
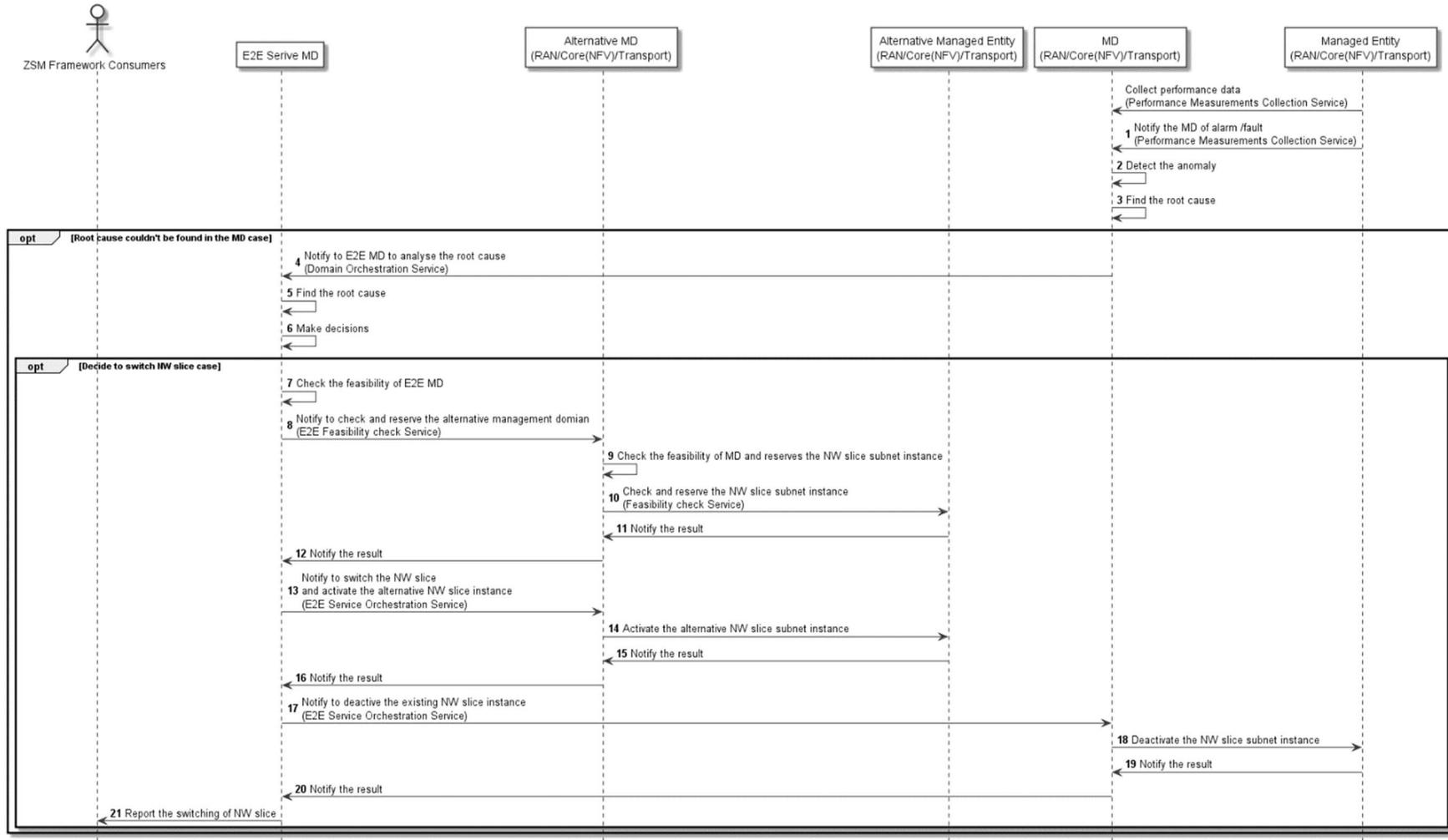
Figure C.4-1: Example of basic sequence diagram of Switching Network Slice

1)   The performance measurement collection service in the Domain Data Collection collects data (e.g. performance data or fault data) from managed entity (network slice subnet instance) and notifies the MD of alarms/fault.

NOTE: Other management services such as performance measurements streaming service and performance events service can be used to collect data.

2)   Based on collected data, the anomaly detection service in the Domain Analytics detects the trouble of a network slice subnet instance such as fault event, performance event or performance degradation.

3)   The analytics service in the Doman Analytics tries to find root cause.

4)   If the root cause could not be found in the MD, the domain orchestration service notifies the E2E service MD to analyse the root cause.

5)   The analytics service in the E2E Service Analytics analyses the anomaly event and finds root cause.

6)   The analytics service provides insights derived from the analysis with the service (which is responsible to make decisions).

7)   If the E2E service MD make a decision to switch the network slice instance, the E2E service orchestration service checks the feasibility of E2E service MD.

8)   The feasibility check service in E2E service MD notifies the alternative MD to check the feasibility of the MD.

9)   The feasibility check service in the alternative MD checks and reserves the network slice subnet instance.

10)   The feasibility check service in the alternative MD notifies the managed entity (network slice subnet instance) to check the feasibility.

11)   The managed entity (network slice subnet instance) notifies the result to alternative MD.

12)   The alternative MD notifies the result to E2E service MD.

13)   The E2E Service Orchestration service in the E2E service MD notifies to switch the network slice and activate the alternative network slice instance.

14)   The domain orchestration service in the alternative MD notifies to activate the alternative network slice subnet instance.

15)   The alternative managed entity (network slice subnet instance) notifies the result to alternative MD.

16)   The alternative MD notifies the result to E2E service MD.

17)   The E2E service orchestration service in the E2E service MD notifies to deactivate the existing network slice instance.

18)   The domain orchestration service in the MD notifies to deactivate the old network slice subnet instance.

19)   The managed entity (network slice subnet instance) notifies the result to MD.

20)   The MD notifies the result to E2E service MD.

21)   The E2E service orchestration service reports the switching of network slice to the ZSM Framework Consumer.

Annex D (informative):
Recommendation on the cooperation with the standard groups and open source groups

## D.1   Coordination between ZSM and other groups

Different groups have done specifications for network slicing management within their own domains. E2E network slicing needs to make use of the output from different groups and build federated solution with the coordination between different groups.

To provide E2E management solutions for management of E2E network slice instance, the ZSM provides the following functions:

1)   Stitch the work from different groups and provide federated solution. The E2E management domain of the ZSM framework coordinates with the underlying management domains from each of those technical fields. Stitching requires the following minimum set of capabilities to be exposed from the domains to create E2E network slice instances.

   a)   The capability to allocate and deallocate a domain slice subnet of the E2E network slice instance.

   b)   The capability to modify a domain slice subnet of a E2E network slice instance.

   c)   The capability to receive performance measures from the deployed domain slice subnet of the E2E network slice instance both file based and streaming.

   d)   The capability of configuring performance thresholds relating to a domain slice subnet belonging to the E2E network slice instance and receiving threshold violations.

   e)   The capability to receive fault events relating to a domain slice subnet belonging to the given E2E network slice instance from the management domain.

   f)   The capability to check feasibility for allocation and modification of a domain slice subnet belonging to the given E2E network slice instance prior to allocation/modification. It is important to guarantee that the result of the feasibility check is valid within a particular period.

   g)   The capability to request the customized exposure of management services from the respective management domains used to manage a domain slice subnet belonging to the given E2E network slice instance.

2)   Support vertical customers' requests for E2E network slice instance. This involves that the E2E MD can support:

   a)   Multiple vertical customers that may request different network slice instances at different times.

   b)   Support the understanding of a specified SLA related to an E2E network slice instance for the vertical consumer.

   c)   Support appropriate management service exposure and its configuration to the vertical consumer.

Figure D.1-1 shows the relation between ZSM and the other groups.

   NOTE: The following groups may not be the complete list.
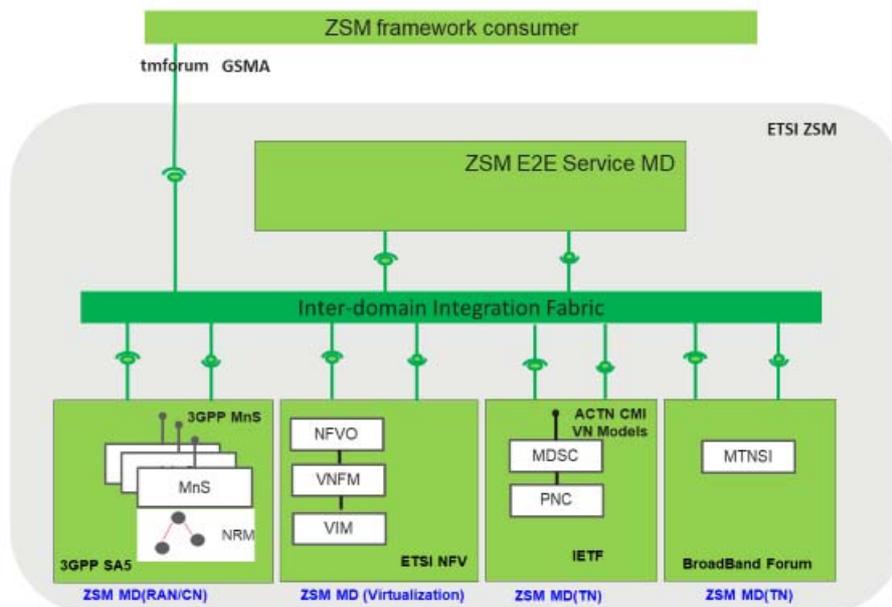
Figure D.1-1: Illustration of the relation between the scopes of ZSM and other groups

- Support to verticals:

  - Coordination with GSMA: GSMA is working on the GST and NEST to differentiate the service requirements from different vertical customers. ZSM federated solution can utilize outputs of vertical service requirements from GSMA as one of inputs.

  - Coordination with TM Forum: TM Forum has provided a series network slicing related northbound OPEN APIs defined in TMF641 [i.4], TMF638 [i.5], TMF633 [i.6], TMF628 [i.7], TMF642 [i.8]. ZSM federated solution could use these OPEN APIs to for the interaction between ZSM framework consumers and the ZSM E2E service MD.

- Support of E2E network slicing management:

  - Coordination with 3GPP SA5 on 3GPP RAN and core network: 3GPP SA5 has provided network slicing solutions within 3GPP Management System defined in ETSI TS 128 531 [5], ETSI TS 128 532 [13], ETSI TS 128 550 [6]. ZSM federated solution should utilize the management services defined in 3GPP for the interaction between ZSM E2E service MD and RAN management domain and CN management domain. ZSM federated solution could use APIs defined by SA5 to support the interaction between ZSM Framework Consumer and the ZSM E2E service MD.

  - Coordination with ETSI NFV on virtualization: ETSI NFV has provided virtualization resource management solutions. ZSM federated solution should utilize the virtualization solutions defined in ETSI GS NFV-IFA 013 [10] for the coordination between E2E service MD and virtualization management domain.

- Coordination on transport:

  - Coordination with ETSI NFV on transport: ETSI NFV has provided transport management solutions when NFVO MANO behaves as a TN manager. ZSM federated solution should utilize the solutions defined in ETSI GS NFV-IFA 013 [10] for the coordination between E2E service MD and TN domain.

  - Coordination with IETF on transport networks: interaction between ZSM E2E service MD and TN management domain could use network slicing specifications developed or being developed in the TEAS WG to fulfil the requirements of transport part of the E2E network slice instance. See the table below.

ZSM capabilities for E2E slicing		IETF RFCs/drafts to support ZSM functions for the TN MD	Remark
a.	The capability to allocate and deallocate a domain slice subnet of the E2E network slice instance as defined in the domain orchestration service (see clause 6.5.5.2.1 of ETSI GS ZSM 002 [12]).	draft-ietf-teas-actn-vn-yang [i.12]	Work in progress.
b.	The capability to modify a domain slice subnet of a E2E network slice instance as defined in the domain orchestration service (see clause 6.5.5.2.1of ETSI GS ZSM 002 [12]).	draft-ietf-teas-actn-vn-yang [i.12].	Work in progress.
c.	The capability to receive performance measures from the deployed domain slice subnet of the E2E network slice instance both file based and streaming in the performance measurements streaming service (see clause 6.5.2.2.2 of ETSI GS ZSM 002 [12]) and in the performance measurements collection service (see clause 6.5.2.2.3 of ETSI GS ZSM 002 [12]).	draft-ietf-teas-actn-pm-telemetry-autonomics [i.12].	Work in progress.
d.	The capability of configuring performance thresholds relating to a domain slice subnet belonging to the E2E network slice instance and receiving threshold violations as defined in the performance events service (see clause 6.2.3 of the present document).	draft-ietf-teas-actn-vn-yang [i.12].	Work in progress.
e.	The capability to receive fault events relating to a domain slice subnet belonging to the given E2E network slice instance from the management domain as defined in the fault events service (see clause 6.2.4).	IETF RFC 8632 [i.10].	IETF RFC 8632 [i.10] provides a general YANG model for alarm management. Further augmentation to support VN alarm management is needed.
f.	The capability to check feasibility for allocation and modification of a domain slice subnet belonging to the given E2E network slice instance prior to allocation/modification. It is important to guarantee that the result of the feasibility check is valid within a particular period as defined in the feasibility check service (see clause 6.3.2.2).	draft-ietf-teas-actn-vn-yang [i.12].	Work in progress.
g.	The capability to request the customized exposure of management services from the respective management domains used to manage a domain slice subnet belonging to the given E2E network slice instance as defined in in management capability exposure configuration service (see clauses 6.3.2.5 and 6.3.4 of ETSI GS ZSM 002 [12]).	draft-ietf-teas-actn-vn-yang [i.12] IETF RFC 8795 [i.13].	IETF RFC 8795 [i.13] defines a YANG data model for representing, retrieving and manipulating Traffic Engineering Topologies.

- Coordination with BBF on transport: ZSM federated solution should coordinated with BBF on the Mobile-Transport Network Slice Interface (MT network slice instance) which deals with the transport network capabilities exposure architecture towards the 3GPP network slice management function. The details is FFS.

Annex E (informative):
Network slice subnet and Management Domain

An E2E network slice instance is produced as a collection of network slice subnet instances which are associated with specific portions of network. The scope of network slice subnets may or may not be consistent with that of the Management Domains depending on the business environments and requirements of each operator. The ZSM framework needs to be flexible to support various patterns of relationship between Networks Slice Subnet and Management Domains. The annex shows some possible patterns and how these patterns are supported by ZSM framework.
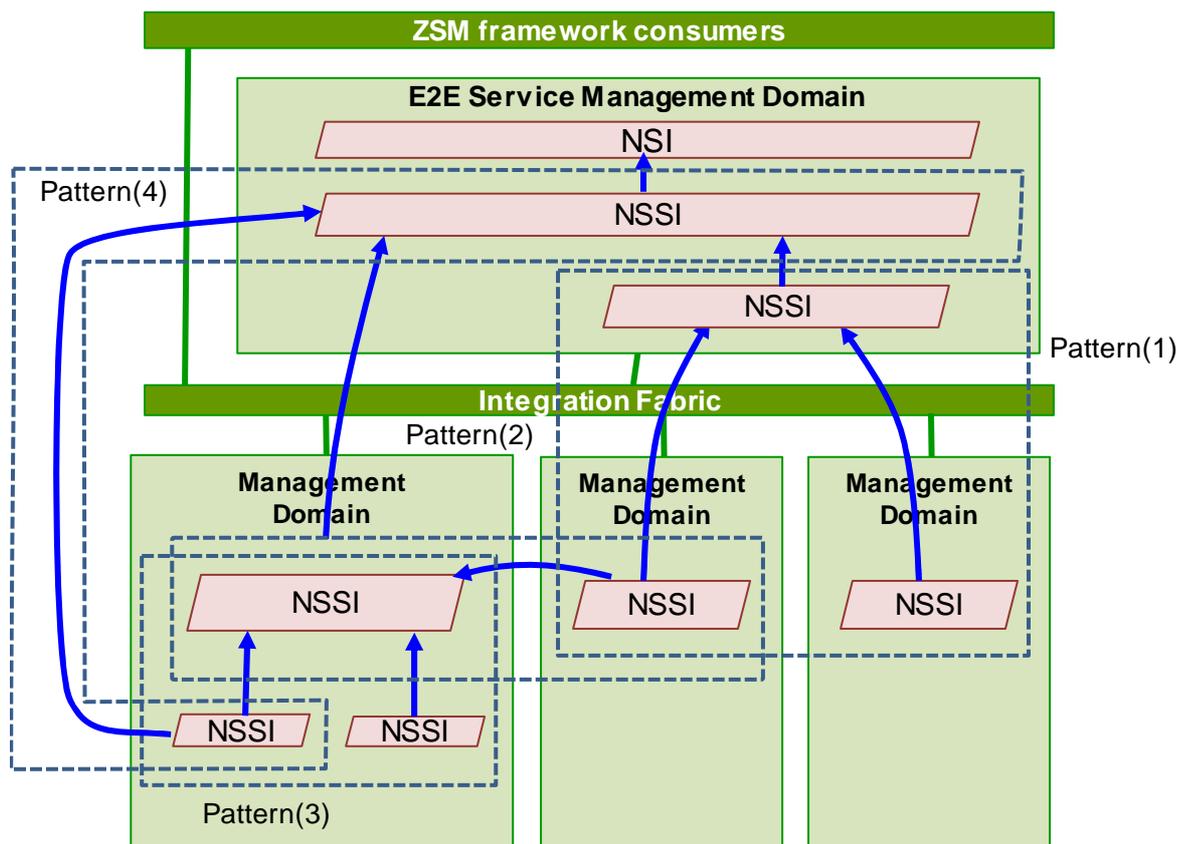
Figure E-1: Possible patterns of network slice subnet and Management Domain

The E2E Network Slice is under responsibility of E2E Service Management Domain. Network slice subnets are under responsibility of the E2E Service Management Domain and the Management Domains depending on the characteristics of the network slice subnet. The following patterns of network slice subnet are possible in the ZSM framework.

[Pattern-1]   Network slice subnet covering multiple Management Domains
                  An operator may want to make a network slice subnet covering multiple Management Domains.
                  This network slice subnet can be produced by collecting network slice subnets in the different
                  Management Domains. The network slice subnet made of the subordinate network slice subnets is
                  managed by the E2E Service Management Domain.

[Pattern-2]   Network slice subnet incorporating network slice subnet under other Management Domain
                  A basic assumption of ZSM is that a network slice subnet is produced by collecting resources only
                  under its own Management Domain. But there may be cases where the capability of the network
                  slice subnet needs to be enhanced incorporating the capabilities provided by the other Management
                  Domain. In such cases, network slice subnet incorporates network slice subnet in other
                  Management Domain.

[Pattern-3]   Hierarchical network slice subnets within the same Management Domains
                  Network slice subnets can be defined within the same Management Domain in hierarchical
                  manner. This allows to provide different levels of granularity of network slice subnets by the same
                  management domain. The network slice subnet can be the whole Management Domain or only a
                  specific part of the Management Domain depending on the business requirements. Also, this
                  allows multiple network slice subnets which have mutually exclusive sets of capabilities.

[Pattern-4]   Incorporating lower level network slice subnet to the network slice subnet in the E2E Service
                  Management Domain
                  The Management Domain can have a hierarchical structure of network slice subnet. In this case,
                  the lower level network slice subnets may be allowed to be directly provided to the E2E Service
                  Management Domain without producing higher level network slice subnet. This characteristic is
                  useful if, for example, the operator wants to define different levels of network slice subnets to
                  provide the different network slice customers based on the relationship with them.

Annex F (informative):
MnS mapping relations

F.1   MnS mapping table between ETSI GS ZSM 002 and 3GPP SA5

A series of management services are both defined in ETSI GS ZSM 002 [12] and 3GPP SA5. Furthermore, 3GPP SA5 has already defined the detailed operations and notifications of each management services. This clause maps the management services in ETSI GS ZSM 002 [12] with the related ones in 3GPP SA5 to facilitate the ZSM management services to interact with the 3GPP system as one of the management domains.

Table F.1-1 shows the mapping relations of MnS in 3GPP SA5 to ETSI GS ZSM 002 [12].

Table F.1-1: Mapping relations of MnS in ETSI GS ZSM 002 [12] to 3GPP SA5

Service Name in ETSI GS ZSM 002	Related 3GPP SA5 services
Fault events service	Fault supervision data report management service (ETSI TS 128 532 [13])
Security events service	
Performance measurements streaming service	Performance data streaming service (ETSI TS 128 550 [6])
Performance measurements collection service	Performance data file reporting service (ETSI TS 128 532 [13])
Network inventory service	
Domain condition detection service	Fault supervision data control management service (ETSI TS 128 532 [13])
Domain orchestration service	Provisioning Management Service (ETSI TS 128 532 [13])
Managed services catalogue management service	
Configuration management service	Provisioning Management Service (ETSI TS 128 532 [13])
Feasibility check service	
Analytics services	
Policy management service	

Annex G (informative):
Change History

Date	Version	Information about changes
06-2018	0.1.0	First draft Update with the agreed contribution in ZSM-2f: 1. ZSM(18)000161r3_Proposal on Current Network Slicing Progress in Existing groups Update with the agreed contributions in ZSM#3: 1. ZSM(18)000160r3_ZSM003_GS_Skeleton_proposal 2. ZSM(18)000199r1_Coordination_with_transport_on_netwrok_slicing
07-2018	0.2.0	Update with agreed documents from ZSM interim#1: 1. ZSM(18)000278-"ZSM003 Add reference to terminology specification" 2.ZSM(18)000279r13ZSM(18)000279-"ZSM003 Architecture component description for network slicing scenario"
09-2018	0.3.0	Update with agreed documents from ZSM interim#2: 1. ZSM(18)000371r1-"ZSM003 Add introduction of GSMA" 2. ZSM(18)000372r3"ZSM003 Provision of E2E network slicing instance" Rapporteur Editorial changes on the section renumbering
10-2018	0.4.0	Update with agreed documents from ZSM #4: 1. ZSM(18)000393r1-"ZSM003 Network Slicing - Reference to ETSI NFV EVE012" 2. ZSM(18)000447r2-"ZSM003 Procedure of end-to-end network slice provisioning" 3. ZSM(18)000448r1-"ZSM003 Procedure of end-to-end network slice performance assurance" 4. ZSM(18)000449r2-"ZSM003 Providing communication services in the scenario of network slice as NOP internals" 5. ZSM(18)000507r1-"ZSM003 add deployment scenario and operational flow to support network slicing using NFV"
11-2018	0.4.1	Update with agreed documents from # ZSM-4b Tech call: 1.ZSM(18)000528 Editorial modification of DRAFT GS ZSM 003 2.Update the contributor information
12-2018	0.5.0	Update with agreed documents from ZSM#5: 1. ZSM(18)000549r2-"ZSM003 Network Slice Instance Creation" 2. ZSM(18)000550r1-"ZSM003 Network Slice Instance Auto Healing" 3. ZSM(18)000551r2-"ZSM003 Network Slice Instance Termination" 4. ZSM(18)000568-"ZSM003 Update on solution of end-to-end network slicing provisioning" 5. ZSM(18)000569-"ZSM003 update on solution of end-to-end network slicing performance report" 6. ZSM(18)000570-"ZSM003 add mapping table of network slicing related MnS in ZSM 002 and 3GPP SA5 " 7. ZSM(18)000571-"ZSM003 Add business models for network slicing" 8. ZSM(18)000572-"ZSM003 Update on obsolete SA5 specs references"
02-2019	0.6.0	Update with agreed documents from ZSM interim#3: 1. ZSM(19)000018r1 ZSM003 Proposal for the sequence of switching network slices 2. ZSM(19)000023r3 Add end-to-end network slice instance modification solution
02-2019	0.7.0	Update with agreed document interim#3: 2. ZSM(19)000026r2-Add solutions of network slicing provisioning in NsaaS scenarios
04-2019	0.8.0	Update with agreed document interim#4: 1. ZSM(19)000110r6-"ZSM003 Add description of coordination relation between ZSM and other groups" 2. ZSM(19)000192-"ZSM003 Update mapping ZSM002 to SA5"
05-2019	0.8.1	Update with agreed document ZSM #6e: 1. ZSM(19)000245-" refresh network slicing deployment architecture based on the stable ZSM reference architecture" 2. ZSM(19)000250-"editor's notes clean-up of ZSM003 draft"
05-2019	0.9.0	Update with agreed document ZSM#6f: 1. ZSM(19) 000246r2-"ZSM003 procedures for e2e network slicing allocation" 2. ZSM(19) 000247r1-"ZSM003 procedures for e2e network slicing modification" 3. ZSM(19) 000248r1-"ZSM003 procedures for e2e network slicing deallocation" Update with agreed document ZSM#6h 4. ZSM(19) 000256r1-"ZSM003 Add introductory section on Roles" 5. ZSM(19) 000259r2-"ZSM003 Solution option for NsaaS"

Date	Version	Information about changes
06-2019	0.10.0	Update with agreed document ZSM#6g: 1. ZSM(19)000249r2_ZSM003_procedures_for_e2e_network_slicing_performance_reporting 2. ZSM(19)000263r1_Solution_option_for_NsaaS_modification 3. ZSM(19)000264r1_ZSM003_procedures_for_e2e_network_slicing_deallocation_in_NsaaS Update with agreed document ZSM#7 1. ZSM(19)000358r1_ZSM003_detailed_sequence_of_E2E_network_slice_activation 2. ZSM(19)000360r1_ZSM003_detailed_sequence_of_E2E_network_slice_termination 3. ZSM(19)000369_Capabilities_to_support_E2E_slicing 4. ZSM(19)000370r1_ZSM003_interfaces_to_verticals 5. ZSM(19)000371r1_ZSM003_procedures_for_e2e_network_slicing_performance_report
09-2019	0.11.0	Update with agreed document in ZSM#8: 1. ZSM(19)000480 ZSM003 Editorial corrections of ZSM003 draft 2. ZSM(19)000359r2 ZSM003_Proposal_for_NW_slice_activation_sequence 3. ZSM(19)000361r2 ZSM003_Proposal_for_NW_slice_deactivation_sequence 4. ZSM(19)000479r1 ZSM003 Management Domain and Network Slice Subnet 5. ZSM(19)000481r1 ZSM003 Update the ZSM architecture diagram for network slicing 6. ZSM(19)000482r2 ZSM003 Clarifications on the business model description 7. ZSM(19)000483r1 ZSM003 Add the descriptions of requirements for transport network 8. ZSM(19)000485r1 ZSM003 Update the descriptions and procedures of end-to-end network slicing performance management in network as NOP internal scenarios 9. ZSM(19)000487r1 ZSM003 Add definitions of utilization of network slice 10. ZSM(19)000488r6 ZSM003 Use of GSMA Generic Slice Template in NsaaS scenarios 11. ZSM(19)000489r2 ZSM003 - Add solution of end-to-end network slice instance feasibility check 12. ZSM(19)000506 ZSM003_Removal of editor's note 5.2.2.2.2 13. ZSM(19)000507 ZSM003_Add further capabilities required for coordination
10-2019	0.11.1	Update with agreed document in ZSM-8a tech call： 1. ZSM(19)000494r2_ZSM003_Sequence_of_getting_network_slicing_alarm_list 2. ZSM(19)000495r2_ZSM003_Sequence_of_network_slicing_fault_notification 3. ZSM(19)000502r3_ZSM003_Add_feasibility_check_and_reservation
11-2019	0.12.2	Update with agreed document in ZSM-6g tech call： 1. ZSM(19)000257_ZSM003_remove annex with contributors from ZSM 003 Update with agreed documents in ZSM in ZSM-Interim#05： 1. ZSM(19)000593_ZSM003_Add the descriptions of expectation of future work 2. ZSM(19)000589_ZSM003 clause 4 editorial clean up 3. ZSM(19)000588_ZSM003_Correction of scope 4. ZSM(19)000578_ZSM003_Update the clause 7.1 according to current progress 5. ZSM(19)000573_ZSM003_Simplify the sequence of switching network slice
01-2020	0.13.0	Update with agreed documents in ZSM#9: 1. ZSM(19)000641r1_ZSM003_Updates_of_Annex_C 2. ZSM(19)000577r1_ZSM003_SLA_translation_to_support_vertical_consumers 3. ZSM(19)000646_ZSM003_add_the_description_of_performance_assurance_procedure 4. ZSM(19)000649_ZSM003_Clarify_Coordination_with_Verticals 5. ZSM(19)000661_ZSM003_editorial_review_of_partial_section_5_1 6. ZSM(19)000667r2_ZSM003_Modification_in_Coordination_between_ZDM_and_other_groups
02-2020	0.14.0	Update with agreed documents in ZSM#10: 1. ZSM(20)000032 "Re-organize structure for GS-ZSM003v0d0-Slicing" 2. ZSM(20)000036r2 "ZSM003 Coordination with IETF on TN Network slicing subnet in the TN MD"
03-2020	0.15.0	Update with agreed documents in ZSM-10d-Tech call: 1. ZSM(20)000090r2_ZSM003_Withdraw_C_5_Sequence_of_E2E_Network_Slice_Activation 2. ZSM(20)000091r2_ZSM003_Withdraw_C_6_Sequence_of_E2E_Network_Slice_Terminatio
06-2020	0.16.0	Update with agreed documents in ZSM-11e Online: 1. ZSM(20)0000184r1_ZSM003_Moving_Clause_8_to_Annex 2. Editorial changes are implemented

Date	Version	Information about changes
06-2020	0.16.1	Editorial changes in Change History are implemented.
06-2020	0.17.0	Update with agreed documents in ZSM-11c Tech call: 1. ZSM(20)000142r2_ZSM003_UML_of_C.5_Activation 2. ZSM(20)000143r2_ZSM003_UML_of_C.6_Termination 3. ZSM(20)000226_ZSM003_NSI_LifeCycle_Overview
07-2020	0.18.0	1. ZSM(20)000256r1_ZSM003_update E2E network slicing fault management 2. ZSM(20)000259r2_ ZSM003_add_definition_of_network_slicing_topology_services 3. ZSM(20)000255r4_ZSM003_update E2E Network slicing performance management 4. ZSM(20)000229r4_ZSM003_translation_of_SLA_requirements
07-2020	0.18.1	The font format of the sub-titles and the cover page are corrected.
09-2020	0.19.0	Update with agreed documents in ZSM-12e Online: 1. ZSM(20)000322r1 ZSM003 Management exposure to vertical customers 2. ZSM(20)000327r1 Network slice management and SLAs 3. ZSM(20)000347r1 Clean-up of End to End network slicing management specification
09-2020	0.19.1	Update with agreed documents in ZSM-12a Tech call: 1. ZSM(20)000365r1 ZSM003_Update Network slice SLA
09-2020	0.19.2	Update with agreed documents in ZSM-12c Tech call: 1. ZSM(20)000352r2 ZSM003 Add the definition of e2e network slicing 2. ZSM(20)000353r2 ZSM003_Update coordination with transport network 3. ZSM(20)000362r1 ZSM003_update the procedures of end to end network slicing provisioning in network slicing as NOP internals scenario 4. ZSM(20)000364r1 ZSM003_Update terminology in Network slicing management architecture
10-2020	0.20.0	Update with agreed documents in ZSM-12c Tech call: 1．ZSM(20)000397r1_ZSM003_Merging_6_2_2_2_1_and_C_5
11-2020	0.21.0	Update with agreed documents in ZSM #13e online: 1. ZSM(20)000469_ZSM003_-_Removing_EN_in_Annex_D 2. ZSM(20)000464r2_ZSM003_Update_Annex_A_available_output_of_other_work_groups 3. ZSM(20)000439r2_ZSM003_Merging_6_2_2_2_5_and_C_6 4. ZSM(20)000438r2_ZSM003_Merging_6_2_2_2_4_and_C_5 5. ZSM(20)000437r2_ZSM003_Merging_6_2_2_2_3_and_C_6 Update with agreed documents in ZSM-13a Tech call: 6. ZSM(20)000466r2_ZSM003 Update the procedures of FM in network slice as NOP internals scenarios 7. ZSM(20)000465r2_ZSM003 Update the procedures of PM in network slice as NOP internals scenarios 8. ZSM(20)000465r2_ZSM003 Update the procedures of PM in network slice as NOP internals scenarios 9. ZSM(20)000463r2_ZSM003_Add example of using E2E network slicing for PNI-NPN
12-2020	0.21.1	Update with agreed documents in ZSM -13c Tech call: 1. ZSM(20)000490r2_ZSM003_Update_process of network slice allocation in NsaaS scenario 2. ZSM(20)000491r1_ZSM003_Update_process of network slice modification in NsaaS scenario 3. ZSM(20)000492r1_ZSM003_Update_process of network slice deallocation in NsaaS scenario
12-2020	0.22.0	Update with agreed documents in ZSM -13e Tech call: 1. ZSM(20)000514_ZSM003_Update the process of E2E communication service provisioning in Network Slice as NOP scenarios 2. ZSM(20)000509_ZSM003___Updates_of_Annex_D 3. ZSM(20)000494r2_ZSM003_Update_Annex_A_with_IETF
03-2021	0.23.0	Update with agreed documents in ZSM -13d Tech call: 1. ZSM(20)000508r3 ZSM003 - Abbreviations Update with agreed documents in ZSM -14e Tech call: 2. ZSM(21)000023r2 clarify network slice as a service
03-2021	0.24.0	Update with review comments received.
04-2021	0.24.1	Update with review comments received. • clause 6.2.3.2 • clause 6.2.4.2
04-2021	0.25.1	Update with review comments received. Add clause 6.2.2.3.

History

Document history		
V1.1.1	June 2021	Publication