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

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Reference
DGS/ZSM-003ed111_Slicing

Keywords
network management, orchestration, service, slicing

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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.

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[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)".
[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)".
[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)".
2.2 Informative references

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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.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".

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:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>Authentication-Authorisation-Accounting</td>
</tr>
<tr>
<td>ACTN</td>
<td>Abstraction and Control of TE Networks</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AMF</td>
<td>Access and Mobility Management Function</td>
</tr>
<tr>
<td>AN</td>
<td>Access Network</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>AS</td>
<td>Access Stratum</td>
</tr>
<tr>
<td>BBF</td>
<td>Broadband Forum</td>
</tr>
<tr>
<td>CMI</td>
<td>Customer Network Controller - Multi-Domain Service Coordinator Interface</td>
</tr>
<tr>
<td>CN</td>
<td>Core Network</td>
</tr>
<tr>
<td>CSC</td>
<td>Communication Service Customer</td>
</tr>
<tr>
<td>CSM</td>
<td>Communication Service Management</td>
</tr>
<tr>
<td>CSP</td>
<td>Communication Service Provider</td>
</tr>
<tr>
<td>DCN</td>
<td>Data Center Network</td>
</tr>
<tr>
<td>DL</td>
<td>DownLink</td>
</tr>
<tr>
<td>DN</td>
<td>Distinguished Name</td>
</tr>
<tr>
<td>DRB</td>
<td>Data Radio Bearer</td>
</tr>
<tr>
<td>DSL</td>
<td>Domain Specific Language</td>
</tr>
<tr>
<td>EVR</td>
<td>Evaluation Result</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile communications</td>
</tr>
<tr>
<td>GSMA</td>
<td>GSM Association</td>
</tr>
<tr>
<td>GST</td>
<td>Generic network Slice Template</td>
</tr>
<tr>
<td>IOC</td>
<td>Information Object Class</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>LCM</td>
<td>Life Cycle Management</td>
</tr>
<tr>
<td>MD</td>
<td>Management Domain</td>
</tr>
<tr>
<td>MDSC</td>
<td>Multi-Domain Service Coordinator</td>
</tr>
<tr>
<td>MEF</td>
<td>Metro Ethernet Forum</td>
</tr>
<tr>
<td>MNO</td>
<td>Mobile Network Operator</td>
</tr>
<tr>
<td>MnS</td>
<td>Management Service</td>
</tr>
<tr>
<td>MOI</td>
<td>Managed Object Instance</td>
</tr>
<tr>
<td>MPI</td>
<td>Main Path Interface</td>
</tr>
<tr>
<td>MPLS</td>
<td>Multiprotocol Label Switching</td>
</tr>
<tr>
<td>NBI</td>
<td>Northbound Interface</td>
</tr>
<tr>
<td>NEST</td>
<td>Net network Slice Type</td>
</tr>
<tr>
<td>NF</td>
<td>Network Function</td>
</tr>
<tr>
<td>NFVI</td>
<td>NFV Infrastructure</td>
</tr>
<tr>
<td>NFVO</td>
<td>NFV Orchestrator</td>
</tr>
<tr>
<td>NG</td>
<td>Next Generation</td>
</tr>
<tr>
<td>NGMN</td>
<td>Next Generation Mobile Networks</td>
</tr>
<tr>
<td>NG-RAN</td>
<td>NG Radio Access Network</td>
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<tr>
<td>NOP</td>
<td>Network Operator</td>
</tr>
<tr>
<td>NRM</td>
<td>Network Resource Model</td>
</tr>
<tr>
<td>NSC</td>
<td>Network Slice Controller</td>
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<tr>
<td>NSDT</td>
<td>Network Slice Design Team</td>
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<tr>
<td>NSE</td>
<td>Network Slice Endpoints</td>
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<tr>
<td>NSI</td>
<td>Network Slice Instance</td>
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<tr>
<td>NSM</td>
<td>Network Service Management</td>
</tr>
<tr>
<td>NSRE</td>
<td>Network Slice Realization Endpoints</td>
</tr>
<tr>
<td>NSS</td>
<td>Network Slice Subnet</td>
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<tr>
<td>NSSAI</td>
<td>Network Slice Selection Assistance Information</td>
</tr>
<tr>
<td>NSSI</td>
<td>Network Slice Subnet Instance</td>
</tr>
<tr>
<td>OAM</td>
<td>Operation, Administration and Maintenance</td>
</tr>
<tr>
<td>PDU</td>
<td>Protocol Data Unit</td>
</tr>
<tr>
<td>PLMN</td>
<td>Public Land Mobile Network</td>
</tr>
<tr>
<td>PM</td>
<td>Performance Management</td>
</tr>
<tr>
<td>PNC</td>
<td>Provisioning Network Controller</td>
</tr>
<tr>
<td>PNF</td>
<td>Physical Network Function</td>
</tr>
<tr>
<td>PRB</td>
<td>Physical Resource Block</td>
</tr>
<tr>
<td>PRD</td>
<td>Permanent Reference Document</td>
</tr>
<tr>
<td>PSA</td>
<td>PDU session anchor</td>
</tr>
<tr>
<td>RAN</td>
<td>Radio Access Network</td>
</tr>
<tr>
<td>RRM</td>
<td>Radio Resource Management</td>
</tr>
<tr>
<td>SBI</td>
<td>SouthBound Interface</td>
</tr>
<tr>
<td>Serv-Orch</td>
<td>Service Orchestration service</td>
</tr>
<tr>
<td>SLA</td>
<td>Service Level Agreement</td>
</tr>
<tr>
<td>SLS</td>
<td>Service-Level Specification</td>
</tr>
<tr>
<td>SMF</td>
<td>Session Management Function</td>
</tr>
<tr>
<td>S-NSSAI</td>
<td>Single Network Slice Selection Assistance Information</td>
</tr>
<tr>
<td>TEAS</td>
<td>Traffic Engineering and Architecture Signaling</td>
</tr>
<tr>
<td>TM</td>
<td>Telecom Management</td>
</tr>
<tr>
<td>TN</td>
<td>Transport Network</td>
</tr>
<tr>
<td>T-NSSMF</td>
<td>Transport Network Slice Subnet Management Function</td>
</tr>
<tr>
<td>TSG</td>
<td>Technical Specification Group</td>
</tr>
<tr>
<td>UE</td>
<td>User Equipment</td>
</tr>
<tr>
<td>UL</td>
<td>UpLink</td>
</tr>
<tr>
<td>UPF</td>
<td>User Plane Function</td>
</tr>
<tr>
<td>VLAN</td>
<td>Virtual Local Area Network</td>
</tr>
<tr>
<td>VN</td>
<td>Virtualised Network</td>
</tr>
<tr>
<td>VNF</td>
<td>Virtualised Network Function</td>
</tr>
<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
</tr>
<tr>
<td>YANG</td>
<td>Yet Another Next Generation</td>
</tr>
</tbody>
</table>
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.

![Diagram](standards.iteh.ai)

**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 4.3.2-2 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.
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 4.3.2-2: ZSM example of Network Slice as NOP internals

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 correspond 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.