

Special Articles on Release 15 Standardization  
—Advancements in the Completed Initial 5G and LTE/LTE-Advanced Specifications—

# Network Management Specifications for 5G Era

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With the introduction of 5G systems that provide for network slicing as a mandatory feature, the existing network management architecture has been revised accordingly. Consequently, 3GPP SA5 WG has produced network-slicing related specifications for management architecture, management model, provisioning, performance management, fault management, etc. in Release 15.

## 1. Introduction

The 3rd Generation Partnership Project (3GPP) has documented the specifications for network slicing<sup>\*1</sup> functionality and its management services in Release 15.

Network slicing makes it possible to accommodate communication services having different requirements (Internet of Things (IoT), mobile broadband, etc.) into logically separated networks (i.e., network slices) on a single physical network. This, in turn, enables network operators to offer a variety

of such services without mutual interference.

In this article, we describe network management specifications for managing network slices each consisting of Radio Access Network (RAN)<sup>\*2</sup> functions providing New Radio (NR) and Core Network (CN)<sup>\*3</sup> functions as overviewed in the leading article on Release 15 standardization in this issue [1].

## 2. Formulation of Network Management Specifications in 3GPP SA5 WG

The 3GPP Service and System Aspects (SA) 5<sup>\*4</sup>

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<sup>\*1</sup> Network slicing: One form for achieving next-generation networks in the 5G era by logically dividing the network into units of services corresponding to use cases, business models, etc.

<sup>\*2</sup> RAN: The network consisting of radio base stations and radio-circuit control equipment situated between the core network and mobile terminals.

Working Group (WG) has been specifying requirements, architecture, and solutions for managing the 3GPP network (including RAN, CN, IP Multimedia Subsystem (IMS)<sup>\*5</sup>) and services provided by that network.

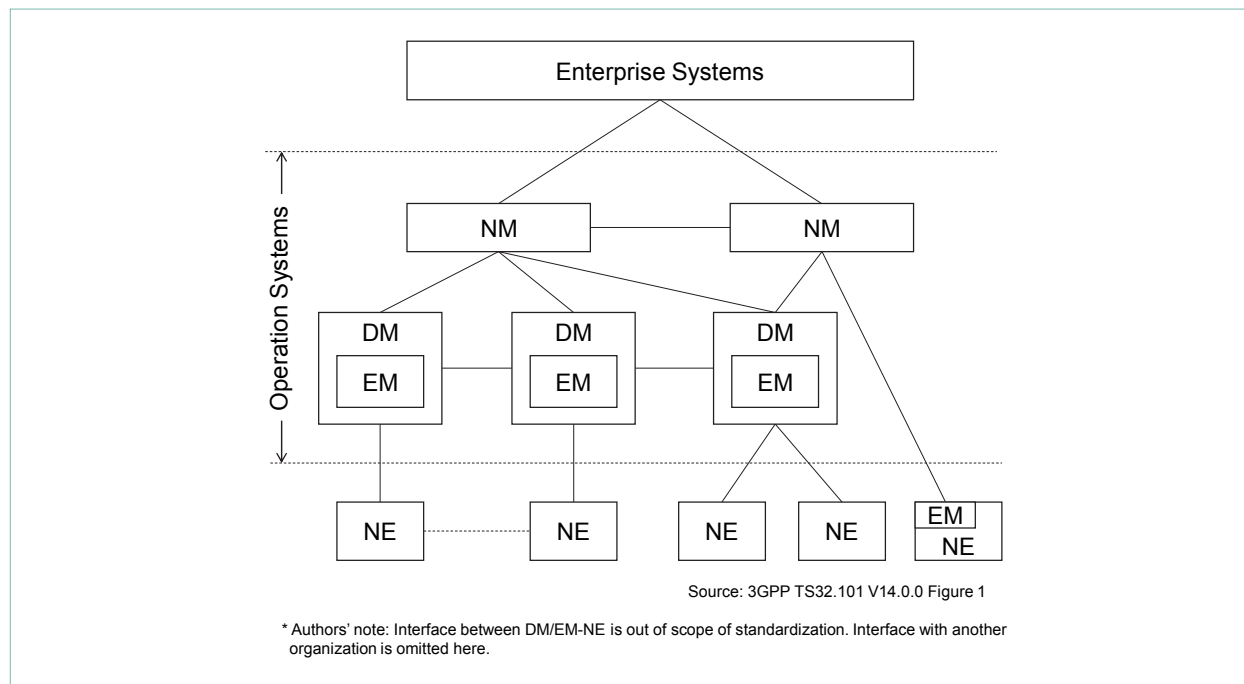
Prior to Release 15, the management architecture consisted of a hierarchical arrangement of functional blocks as shown in **Figure 1** (extracted from [2] Figure 1) and summarized below.

- Network Management (NM)<sup>\*6</sup> manages instances of Domain Management (DM)<sup>\*7</sup> that manages a 3GPP domain (RAN, CN)
- Each DM manages instances of Network Element (NE)<sup>\*8</sup> in the domain targeted for management via Element Management (EM)<sup>\*9</sup>
- EM manages corresponding NE

With the introduction of 5G systems that provide for network slicing as a mandatory feature, 3GPP SA5 WG specified the revised management architecture and produced network-slicing related specifications for management architecture, management model, provisioning<sup>\*10</sup>, performance management, fault management, etc. as network management specifications in Release 15 for the 5G era [3] [4].

### 3. Network-slice Configuration Specified by Release 15

In the new specifications in Release 15, a Network Slice Instance (NSI)<sup>\*11</sup> is defined to include all Network Functions (NFs)<sup>\*12</sup> necessary to provide a certain set of communication services.



**Figure 1 Management architecture prior to Release 15**

<sup>\*3</sup> CN: A network consisting of switches and subscriber information management equipment. Mobile terminals communicate with the core network via the radio access network.

<sup>\*4</sup> 3GPP SA5: 3GPP is a standardization organization concerned with mobile communications systems. SA5 is a working group discussing OSS/BSS relevant topics in 3GPP.

<sup>\*5</sup> IMS: A subsystem that provides IP multimedia services (e.g., VoIP, messaging, presence) on a 3GPP mobile communications

network. Session Initiation Protocol (SIP) is used for the call control protocol.

<sup>\*6</sup> NM: Provides functions for managing a network consisting of NEs.

<sup>\*7</sup> DM: Provides functions for managing a portion of the network consisting of NEs.

<sup>\*8</sup> NE: Generic term for a base station, switching station, or relay device that make up the system.

Also defined is a particular portion of a slice (such as RAN, CN, etc.) called a Network Slice Subnet Instance (NSSI), which is a concept unique to 3GPP SA5 WG not defined in any other WG.

As shown in **Figure 2**, NFs can be allocated exclusively by a single NSI/NSSI or shared by multiple NSIs/NSSIs. Furthermore, while an NSI/NSSI includes a Transport Network (TN)<sup>\*13</sup>, 3GPP SA5 WG specifies management only for the 3GPP-defined NFs in RAN and CN in Release 15 as has been the case so far. It only specifies input/instructions (configuration information, etc.) as required for the TN and relies on applicable Standards Developing Organizations (SDOs) to stipulate actual management.

## 4. Provision Formats for Network Slices

3GPP SA5 WG specifies Network Slice as a Service (NSaaS)<sup>\*14</sup> and Network Slices as Network Operator (NOP) internals<sup>\*15</sup> as the possible models for

providing network slices as shown in **Figure 3** (a) and (b), respectively [3]. The model in (a) provides a network slice as a network service to a third party (another operator) together with Application Program Interfaces (APIs)<sup>\*16</sup> for that operator. The model in (b), meanwhile, provides a network slice only as a communication service in a condition that cannot be managed by a third party (another operator), which means that that party is actually unaware of the slice's existence.

## 5. Management Architecture

### 5.1 Service Based Architecture

From Release 15 on, the 5G management system will adopt a service-oriented approach instead of conventional point-to-point connections between management functions.

This approach is achieved by Service Based Architecture (SBA)<sup>\*17</sup> in which management service producers provide a variety of management

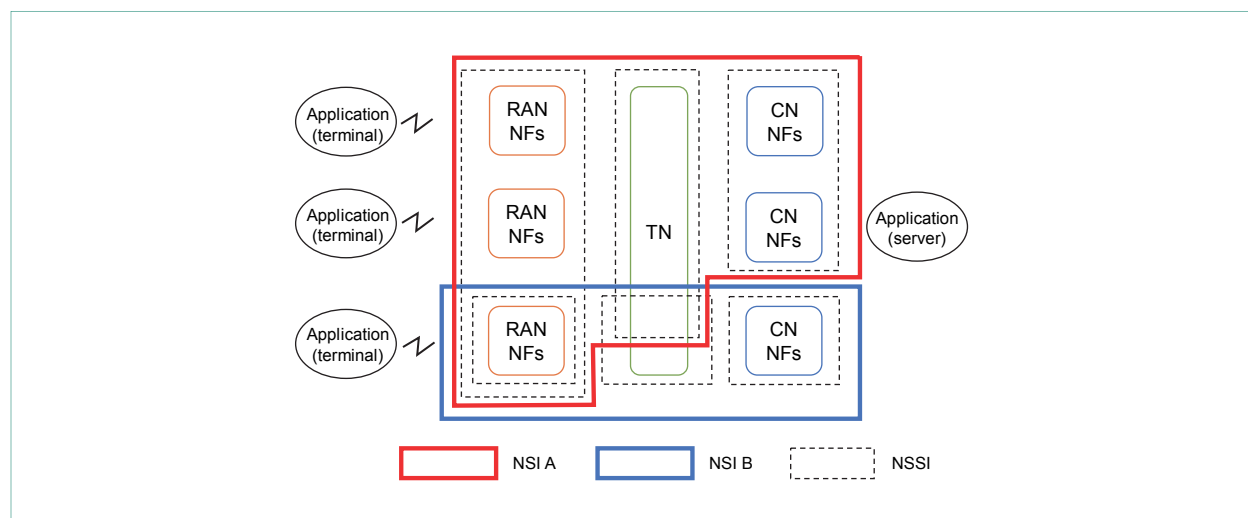


Figure 2 NSI/NSSI examples

<sup>\*9</sup> EM: Provides functions for managing NEs.

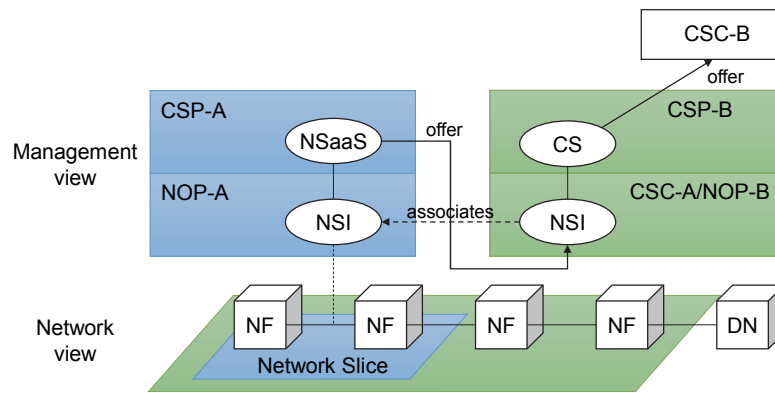
<sup>\*10</sup> Provisioning: Creation, modification, and deletion of equipment targeted for management such as NFs.

<sup>\*11</sup> NSI: NFs composing a network slice, and associated resources (e.g., computing resources, storage resources, networking resources).

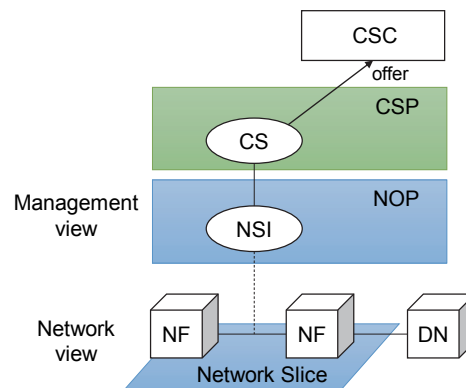
<sup>\*12</sup> NFs: Generic name for base stations, switches, and repeaters making up a system. NF is synonymous with NE.

<sup>\*13</sup> TN: The network connecting the access network with the core network or the network interconnecting equipment within each of those networks.

<sup>\*14</sup> NSaaS: One business model for providing a network slice. This model provides a network slice as a service to a third party (another operator).



(a) NSaaS



(b) Network Slice as NOP internals

Source: 3GPP TS28.530 V15.0.0

CS: Communication Service  
 CSC: Communication Service Customer  
 CSP: Communication Service Provider  
 DN: Data Network

Figure 3 Provision formats for network slices

services to authorized consumers. Here, an implementation of multiple management services for a particular product is defined as a Management Function (MF) as shown in **Figure 4** (extracted from [4] Figure 4.6.1).

In addition, APIs provided by a management service are documented as normative<sup>\*18</sup> while the

MFs themselves, which are implementation-dependent, are documented as informative<sup>\*19</sup>. One advantage of adopting SBA is that each operator can freely select and deploy a combination of products that implement groups of management services that are deemed necessary when making decisions at the time of management-system integration<sup>\*20</sup>.

<sup>\*15</sup> NOP internals: One business model for providing a network slice. In this model, a network operator provides a network slice as a communication service to an end user in a condition that cannot be managed by a third party (another operator).

<sup>\*16</sup> API: General-purpose interfaces for using functions and data.

<sup>\*17</sup> SBA: Architecture or framework that prescribes interfaces for using services and provides those interfaces to users.

<sup>\*18</sup> Normative: Information describing mandatory elements.

<sup>\*19</sup> Informative: Information describing non-mandatory elements provided mainly to help in understanding normative descriptions.

<sup>\*20</sup> Integration: The incorporation of equipment or systems in a network operated by an operator.

## 5.2 Management Services and MF

Management services are broadly specified as follows.

- Provisioning Management Service: Create, modify, get, and delete NSI/NSSI/NF management objects (life cycle management).
- Fault Management Service: Subscribe, notify

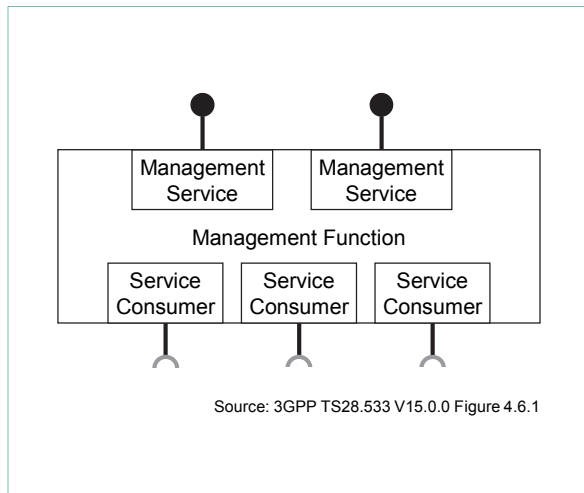


Figure 4 Example of management function and management services

NSI/NSSI/NF alarm, etc.

- Performance Management Service: Register, list, notify performance measurements, etc.

Figure 5 showing an example of implementing MF architecture is documented in an Informative Annex<sup>\*21</sup> [4]. The MFs included in this figure are explained below.

- NFMF (Network Function MF) provides the management services for one or more NFs and may consume other management services.
- NSSMF (Network Slice Subnet MF) provides the management services for NSSI and may consume other management services.
- NSMF (Network Slice MF) provides the management services for NSI and may consume other management services.
- CSMF (Communication Service MF) consumes the management services provided by other MFs to manage communication services.

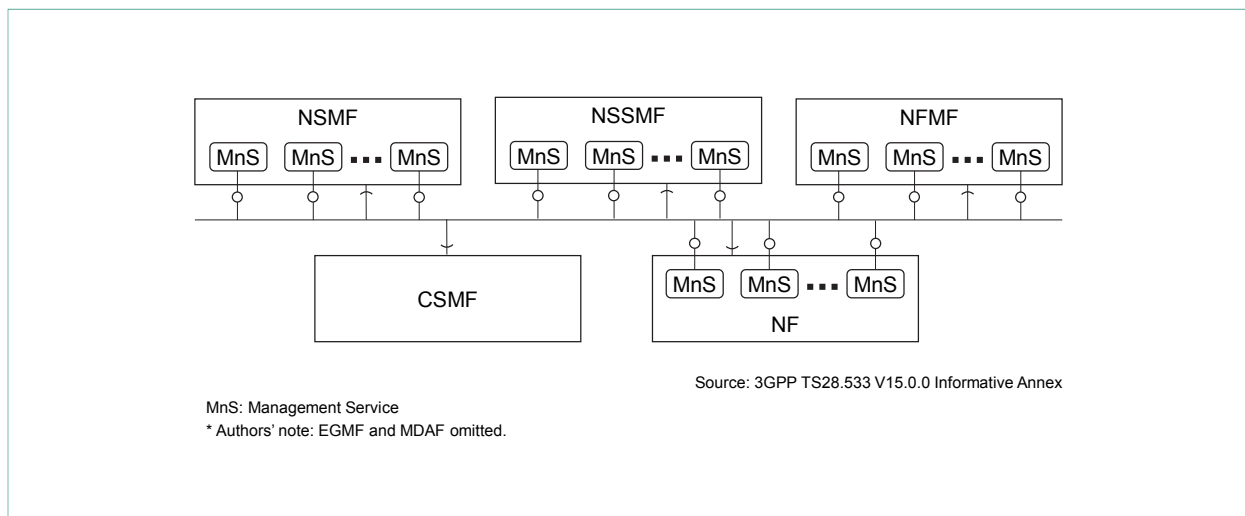


Figure 5 Example of implementing management function architecture

<sup>\*21</sup> Informative Annex: A supplementary chapter having no mandatory elements that is described mainly to provide information that can aid in understanding normative descriptions.

- NF provides management services such as NF performance management, NF fault supervision, and NF configuration management (does not consume other management services).

An important point reflected by this figure is that, while the interface between EM and NE/NF had not previously been standardized (Fig. 1), the NF interface is disclosed in Release 15 as part of an Informative Annex with expectations of being standardized in the future.

## 6. Conclusion

We described network management specifications prescribed by 3GPP. Going forward, SA5 WG is expected to specify general-purpose management

services specific to no particular NFs in Release 16. Additionally, considering that network slicing is closely related to Network Functions Virtualization (NFV)<sup>\*22</sup>, standardization in this area is likely to proceed in collaboration with European Telecommunications Standards Institute (ETSI)<sup>\*23</sup> ISG NFV.

## REFERENCES

- [1] S. Nagata et al.: "Technical Overview of the 3GPP Release 15 Standard," NTT DOCOMO Technical Journal, Vol.20, No.3, pp.37–48, Jan. 2019.
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- [3] 3GPP TS28.530 V15.0.0: "Management and orchestration; Concepts, use cases and requirements," Sep. 2018.
- [4] 3GPP TS28.533 V15.0.0: "Management and orchestration; Management and orchestration architecture," Sep. 2018.

<sup>\*22</sup> NFV: A technology that uses virtualization technologies to implement processing for communications functionality in software running on general-purpose hardware.

<sup>\*23</sup> ETSI: A standardization organization concerned with telecommunications technology in Europe.