International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Q.5020

(04/2019)

SERIES Q: SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

Signalling requirements and protocols for IMT-2020 – Protocols for IMT-2020

Protocol requirements and procedures for network slice life cycle management

Recommendation ITU-T Q.5020

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE	Q.1–Q.3
INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING	Q.4–Q.59
FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN	Q.60–Q.99
CLAUSES APPLICABLE TO ITU-T STANDARD SYSTEMS	Q.100–Q.119
SPECIFICATIONS OF SIGNALLING SYSTEMS No. 4, 5, 6, R1 AND R2	Q.120–Q.499
DIGITAL EXCHANGES	Q.500–Q.599
INTERWORKING OF SIGNALLING SYSTEMS	Q.600–Q.699
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7	Q.700–Q.799
Q3 INTERFACE	Q.800–Q.849
DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1	Q.850–Q.999
PUBLIC LAND MOBILE NETWORK	Q.1000–Q.1099
INTERWORKING WITH SATELLITE MOBILE SYSTEMS	Q.1100–Q.1199
INTELLIGENT NETWORK	Q.1200–Q.1699
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2000	Q.1700–Q.1799
SPECIFICATIONS OF SIGNALLING RELATED TO BEARER INDEPENDENT CALL CONTROL (BICC)	Q.1900–Q.1999
BROADBAND ISDN	Q.2000–Q.2999
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR THE NGN	Q.3000–Q.3709
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR SDN	Q.3710–Q.3899
TESTING SPECIFICATIONS	Q.3900–Q.4099
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2020	Q.5000–Q.5049
Signalling requirements and architecture of IMT-2020	Q.5000–Q.5019
Protocols for IMT-2020	**Q.5020–Q.5049**
COMBATING COUNTERFEITING AND STOLEN ICT DEVICES	Q.5050–Q.5069

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Q.5020

Protocol requirements and procedures for network slice life cycle management

Summary

Recommendation ITU-T Q.5020 describes the protocol requirements and procedures for network slice life cycle management, including the reference signalling architecture, requirements and protocol procedures.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.5020	2019-04-29	11	11.1002/1000/13888

Keywords

Life cycle management, network slice.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Q.5020

Protocol requirements and procedures for network slice life cycle management

1 Scope

This Recommendation specifies the protocol requirements and procedures for life cycle management of network slices, including the reference signalling architecture, requirements and protocol procedures for creating a new network slice instance, modifying an existing network slice instance, activating an existing network slice instance, deactivating an existing network slice instance and terminating an existing network slice instance.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3100] Recommendation ITU-T Y.3100 (2017), *Terms and definitions for IMT-2020 network.*

[ETSI GS NFV 003] ETSI GS NFV 003 v1.4.1 (2018), *Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV*.

[ETSI GS NFV-MAN 001] ETSI GS NFV-MAN 001 v1.1.1 (2014), *Network Functions Virtualisation; Management and Orchestration*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 network functions virtualization infrastructure (NFVI) [ETSI GS NFV 003]: Totality of all hardware and software components that build up the environment in which VNFs are deployed.

NOTE – The NFV-Infrastructure can span across several locations, e.g. places where data centres are operated. The network providing connectivity between these locations is regarded to be part of the NFV-Infrastructure. NFV-Infrastructure and VNF are the top-level conceptual entities in the scope of Network Function Virtualization. All other components are sub-entities of these two main entities.

3.1.2 network functions virtualization management and orchestration (NFV-MANO) [ETSI GS NFV 003]: Functions collectively provided by NFVO, VNFM, and VIM.

3.1.3 network functions virtualization orchestrator (NFVO) [ETSI GS NFV 003]: Functional block that manages the Network Service (NS) lifecycle and coordinates the management of NS lifecycle, VNF lifecycle (supported by the VNFM) and NFVI resources (supported by the VIM) to ensure an optimized allocation of the necessary resources and connectivity.

3.1.4 network service [ETSI GS NFV 003]: Composition of Network Functions and defined by its functional and behavioural specification.

NOTE – The Network Service contributes to the behaviour of the higher layer service, which is characterized by at least performance, dependability, and security specifications. The end-to-end network service behaviour

is the result of the combination of the individual network function behaviours as well as the behaviours of the network infrastructure composition mechanism.

3.1.5 network service descriptor [ETSI GS NFV 003]: Template that describes the deployment of a Network Service including service topology (constituent VNFs and the relationships between them, Virtual Links, VNF Forwarding Graphs) as well as Network Service characteristics such as SLAs and any other artefacts necessary for the Network Service on-boarding and lifecycle management of its instances.

3.1.6 network slice [ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

NOTE 1 – Network slices enable the creation of customized networks to provide flexible solutions for different market scenarios which have diverse requirements, with respect to functionalities, performance and resource allocation.

NOTE 2 – A network slice may have the ability to expose its capabilities.

NOTE 3 – The behaviour of a network slice is realized via network slice instance(s).

3.1.7 network slice blueprint [ITU-T Y.3100]: A complete description of the structure, configuration and work flows on how to create and control a network slice instance during its life cycle.

NOTE – A network slice template can be used synonymously with a network slice blueprint.

3.1.8 network slice instance [ITU-T Y.3100]: An instance of network slice, which is created based on a network slice blueprint.

3.1.9 virtualized infrastructure manager (VIM) [ETSI GS NFV 003]: Functional block that is responsible for controlling and managing the NFVI compute, storage and network resources, usually within one operator's Infrastructure Domain (e.g., NFVI-PoP).

3.1.10 virtualized network function manager (VNFM) [ETSI GS NFV 003]: Functional block that is responsible for the lifecycle management of VNF.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 network slice manager (NSM): This is a functional block that manages the network slice life cycle and coordinates with the operational support system (OSS) and network functions virtualization Orchestrator (NFVO) to accomplish network slice life cycle management operations, and it maintains one-to-one mapping between a network slice instance and a network service instance.

NOTE – NSM maintains multiple one-to-one mappings when multiple network slices exist.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

LCMP	Life Cycle Management Protocol
NFV-MANO	Network Functions Virtualization Management and Orchestration
NFVI	Network Functions Virtualization Infrastructure
NFVO	Network Functions Virtualization Orchestrator
NSD	Network Service Descriptor
NSM	Network Slice Manager
OSS	Operational Support System
vBNG	virtual Broadband Network Gateway

vEPC virtual Evolved Packet Core

VIM Virtualized Infrastructure Manager

vIMS virtual IP Multimedia Subsystem

VNFM Virtualized Network Function Manager

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

6 Reference signalling architecture for network slice life cycle management

A network service is a concept defined in [ETSI GS NFV 003], as a composition of network functions and defined by its functional and behavioural specification. While the network slice is defined in [ITU-T Y.3100] as a managed group of infrastructure resources, network functions and services. The NFV framework and NFV-MANO system are defined to support all types of virtualized networks, including the IMT-2020 network, virtual evolved packet core (vEPC), virtual IP multimedia subsystem (vIMS) and virtual broadband network gateway (vBNG), etc. From an NFV point of view, a network slice instance is an instance of network service. In addition, characteristics, e.g. network slice blueprint and network slice instance identifier, that are specific to a network slice instance shall be maintained by the network slice manager (NSM) and shall be transparent for the NFV-MANO system.

The NSM is responsible for managing the network slice life cycle. The NSM also maintains the mapping between the network slice instance and network service instance.

Figure 6-1 shows the reference signalling architecture for network slice life cycle management.

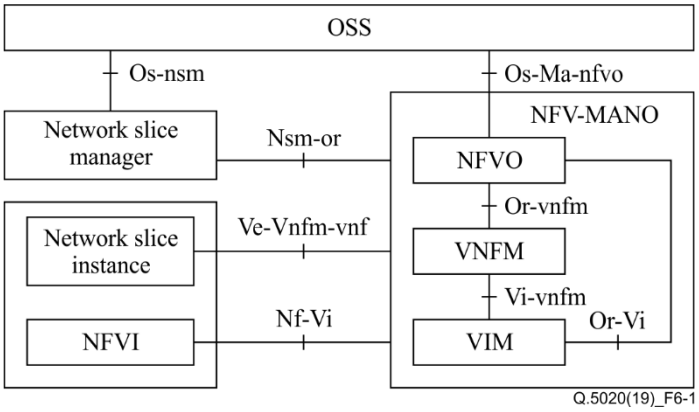

Figure 6-1 – The reference signalling architecture for network slice life cycle management

The NSM gets the network slice blueprint and triggers operations for network slice life cycle management from the OSS via the Os-nsm reference point.

NFVO, VNFM, VIM, NFVI support the functions and relevant reference points (Os-Ma-nfvo, Or-Vi, Or-vnfm, Vi-vnfm, Ve-Vnfm-vnf, Nf-Vi) defined by the ETSI NFV MANO framework [ETSI GS NFV-MAN 001]. Besides those functions and reference points defined by ETSI, the NFVO

coordinates with the NSM via the Nsm-or reference point to exchange necessary information and accomplish the life cycle operation of a network slice.

7 Requirements for network slice life cycle management

7.1 Requirements for life cycle management protocol

– The life cycle management protocol (LCMP) is required to support the creation of a new network slice instance through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is required to support the activation of an existing network slice instance through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is required to support the modification of an existing network slice instance through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is required to support the deactivation of an existing network slice instance through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is required to support the termination of an existing network slice instance through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is required to support the query of the life cycle status of a network slice instance through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is required to support the query of the information of a network slice instance through the interaction between the OSS and the NSM via the Os-nsm reference point.

NOTE – The information of a network slice instance includes, e.g., the status, the corresponding network slice blueprint, the allocated resources to this network slice instance, etc.

– The LCMP is required to support the query of the mapping relationship between the network slice instance and the virtual resources through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

– The LCMP is recommended to query the available resources through the interaction between the NSM and the NFV-MANO via the Nsm-or reference point.

7.2 Requirements for network slice manager

– The NSM is required to receive the life cycle change notification of a network slice instance via the Nsm-or reference point.

– The NSM is required to notify the OSS about any changes of the capability to support a network slice.

– The NSM is required to properly process the life cycle change notification of a network slice instance received via the Nsm-or reference point.

– The NSM is recommended to verify the request of life cycle operation from Os-nsm.

– The NSM is required to maintain the mapping of the network slice instance and network service instance.

– The NSM is required to identify and parse the network slice blueprint.

– The NSM is required to on-board, update, enable, disable and delete a network slice blueprint through the interaction between the OSS and the NSM via the Os-nsm reference point.

8 Protocol procedures for network slice life cycle management

8.1 Creating a new network slice instance

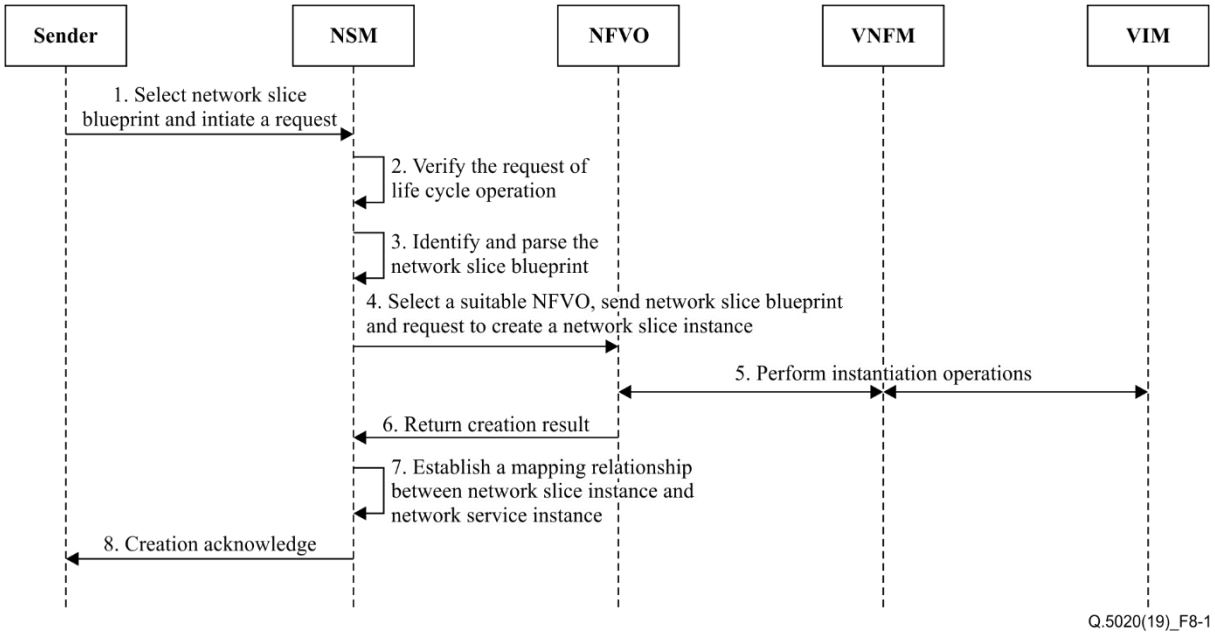

Figure 8-1 – Procedure for creating a new network slice instance

The main steps for creating a new network slice instance include:

1) The sender selects a network slice blueprint and sends a request to the NSM for creating a new network slice instance.
2) The NSM verifies the validity of the request.
3) If the request is valid, the NSM identifies and parses the network slice blueprint.
4) The NSM chooses a suitable NFVO, sends the parsed network slice blueprint and requests to create a network slice instance.
5) The NFVO, VNFM and VIM perform the network service instantiation operations using the interaction procedure defined by ETSI NFV [ETSI GS NFV-MAN 001].
6) The NFVO returns the operation result, including any necessary information (e.g., timestamps, network service instance id, etc.)
7) The NSM allocates a network slice instance id, and establishes a mapping between network slice instance id and network service instance id.
8) The NSM returns the Creation acknowledge to the sender, including the network slice instance id.

8.2 Activating an existing network slice instance

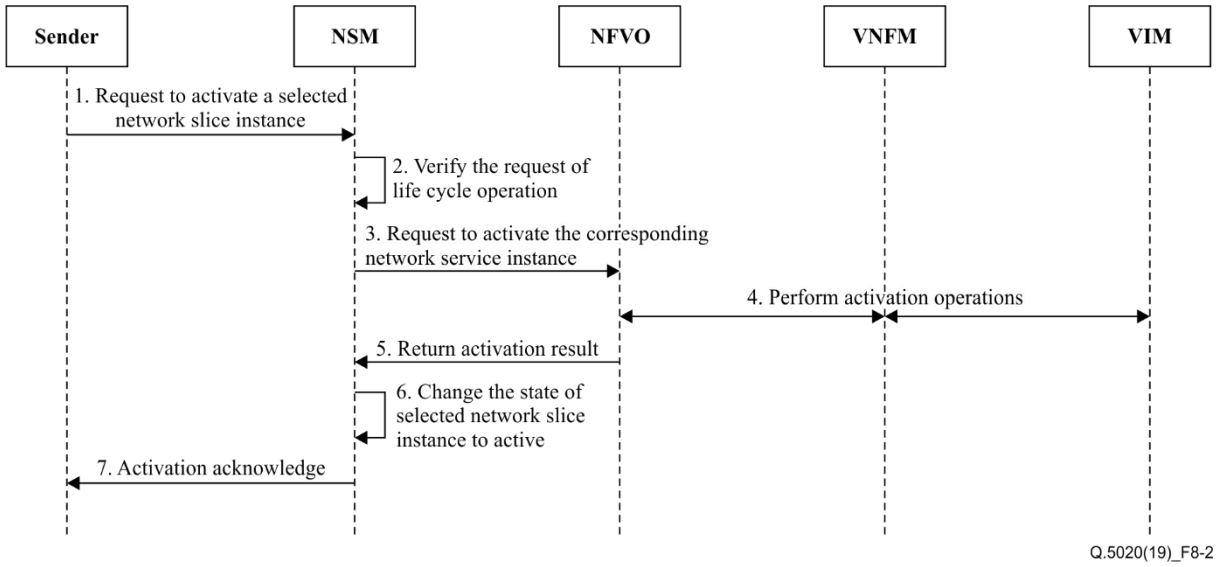

Figure 8-2 – Procedure for activating an existing network slice instance

The main steps for activating an existing network slice instance include:

1) The sender sends an activation request including the network slice instance id for a selected network slice instance to the NSM.
2) The NSM verifies the validity of the request.
3) If the request is valid, the NSM checks the mapping between the network slice instance id and network service instance id, then it sends the corresponding network service instance id to the corresponding NFVO and requests to activate the selected network service instance.
4) The NFVO, VNFM and VIM perform the network service instance activation operations, using the interaction procedure defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the activation operation, including any necessary information (e.g., timestamps, network service instance id, etc.)
6) The NSM changes the state of the selected network slice instance to active.
7) The NSM returns Activation acknowledge to the sender.

8.3 Modifying an existing network slice instance

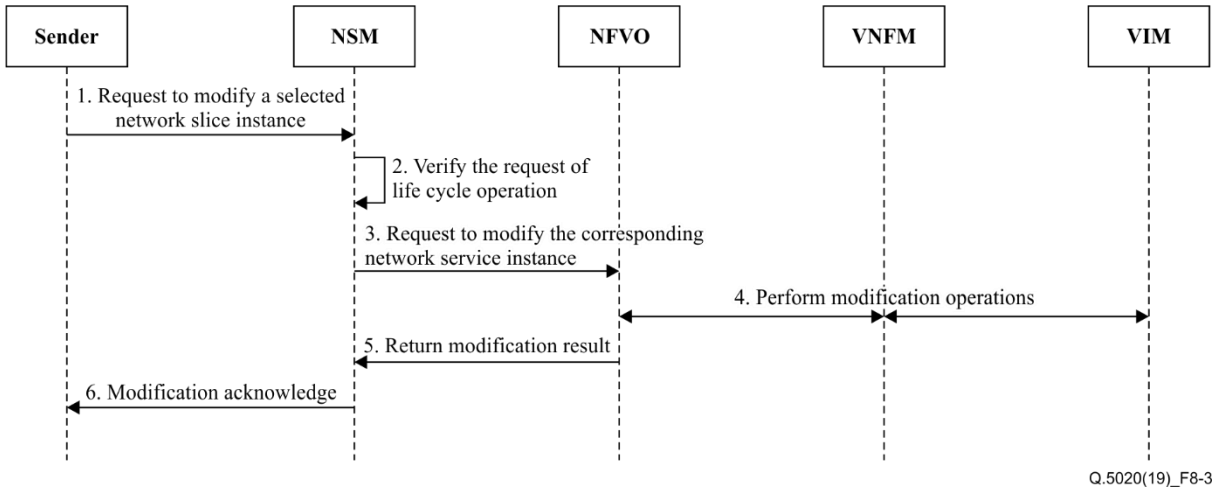

Figure 8-3 – Procedure for modifying an existing network slice instance

The main steps for modifying an existing network slice instance include:

1) The sender sends a modification request including the selected network slice instance id and modification policy for a selected network slice instance to the NSM.

2) The NSM verifies the validity of the request.

3) If the request is valid, the NSM checks the mapping between the network slice instance id and network service instance id, then sends the corresponding network service instance id and modification policy to the corresponding NFVO and requests to modify the selected network service instance.

4) The NFVO, VNFM and VIM perform the network service instance modification operations, e.g. network service instance scaling or network service instance updating due to VNF instance modification, using the interaction procedure defined by ETSI NFV [ETSI GS NFV-MAN 001].

5) The NFVO returns the result of the modification operation, including any necessary information (e.g., timestamps, network service instance id, modification result, etc.)

6) The NSM returns Modification acknowledge to the sender.

8.4 Deactivating an existing network slice instance

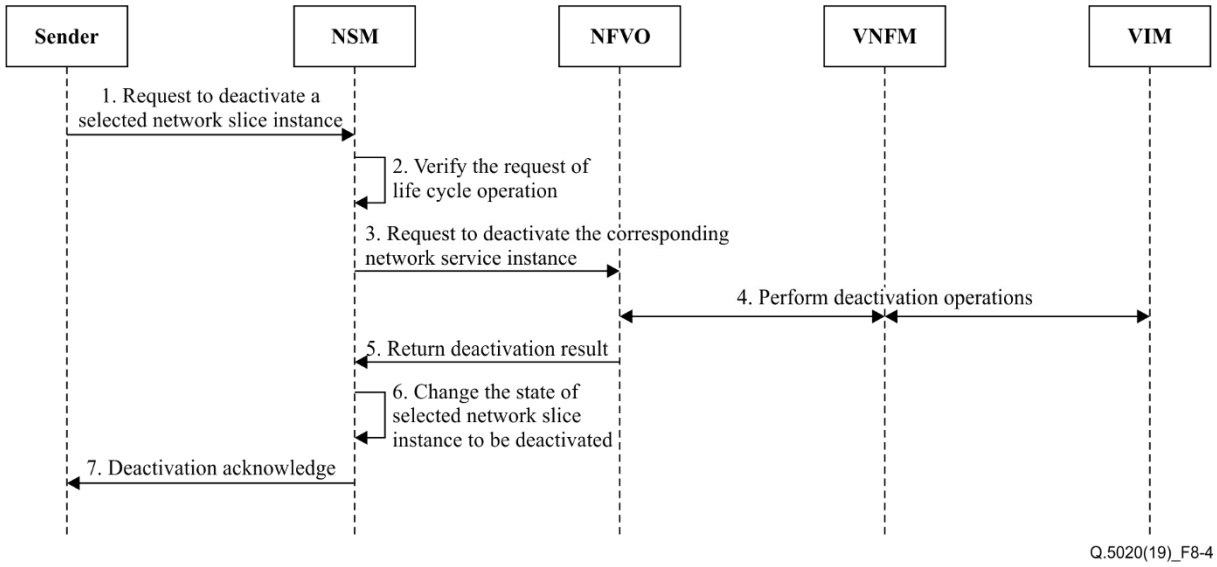

Figure 8-4 – Procedure for deactivating an existing network slice instance

The main steps for deactivating an existing network slice instance include:

1) The sender sends a deactivation request including the network slice instance id for a selected network slice instance to the NSM.
2) The NSM verifies the validity of the request.
3) If the request is valid, the NSM checks the mapping between the network slice instance id and network service instance id, then sends the corresponding network service instance id to the corresponding NFVO and requests to deactivate the selected network service instance.
4) The NFVO, VNFM and VIM perform the network service instance deactivation operations, using the interaction procedure defined by ETSI NFV [ETSI GS NFV-MAN 001]. The network functions shared with other network service instances are not deactivated.
5) The NFVO returns the result of the deactivation operation, including any necessary information (e.g., timestamps, network service instance id, etc.)
6) The NSM changes the state of the selected network slice instance to be deactivated.
7) The NSM returns Deactivation acknowledge to the sender.

8.5 Terminating an existing network slice instance

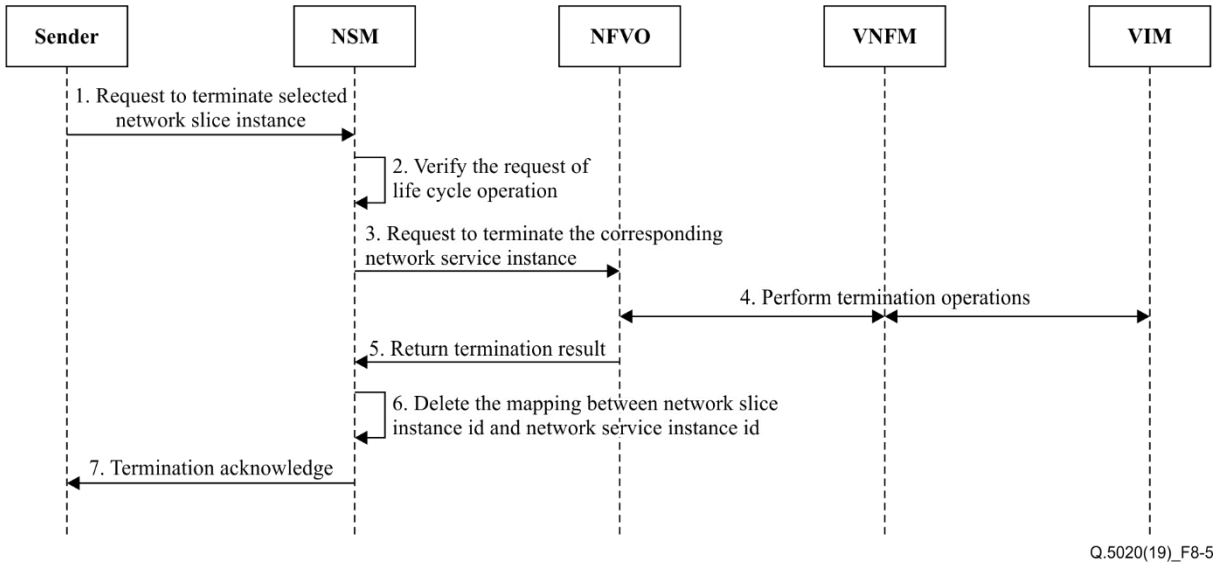

Figure 8-5 – Procedure for terminating an existing network slice instance

The main steps for terminating an existing network slice instance include:

1) The sender sends a termination request including the selected network slice instance id for a selected network slice instance to the NSM.
2) The NSM verifies the validity of the request.
3) If the request is valid, the NSM checks the mapping between the network slice instance id and network service instance id, then sends the network service instance id to the corresponding NFVO and requests to terminate the selected network service instance.
4) The NFVO, VNFM and VIM perform the network service instance termination operations, using the interaction procedure defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the termination operation, including any necessary information (e.g., timestamps, network service instance id, termination result, etc.)
6) The NSM deletes the mapping between the network slice instance id and the network service instance id.
7) The NSM returns the Termination acknowledge to the sender.

8.6 On-boarding a network slice blueprint

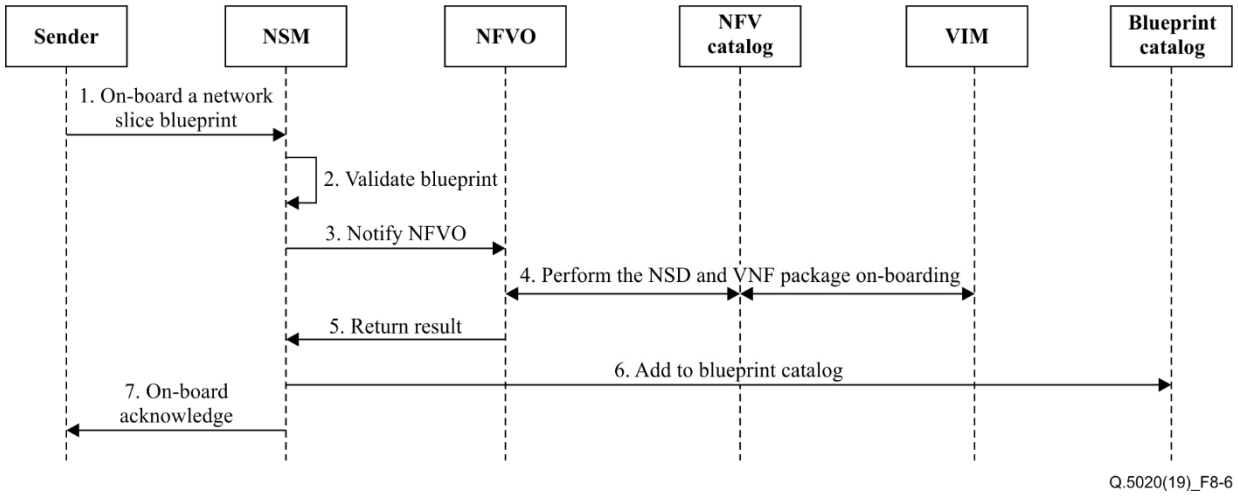

Figure 8-6 – Procedure for on-boarding a network slice blueprint

The main steps for on-boarding a network slice blueprint include:

1) The sender submits a network slice blueprint to the NSM for on-boarding.
2) The NSM checks if the blueprint is valid.
3) If it is valid, the NSM parses the network slice blueprint and sends its network service descriptor (NSD) and VNF packages to the NFVO for on-boarding.
4) The NFVO, NFV catalogue and VIM perform the NSD and VNF package on-boarding operations, using the interaction procedures defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the on-boarding operation to the NSM.
6) The NSM notifies the blueprint catalogue and adds the blueprint to it.
7) The NSM returns the on-boarding acknowledge to the sender.

8.7 Enabling a network slice blueprint

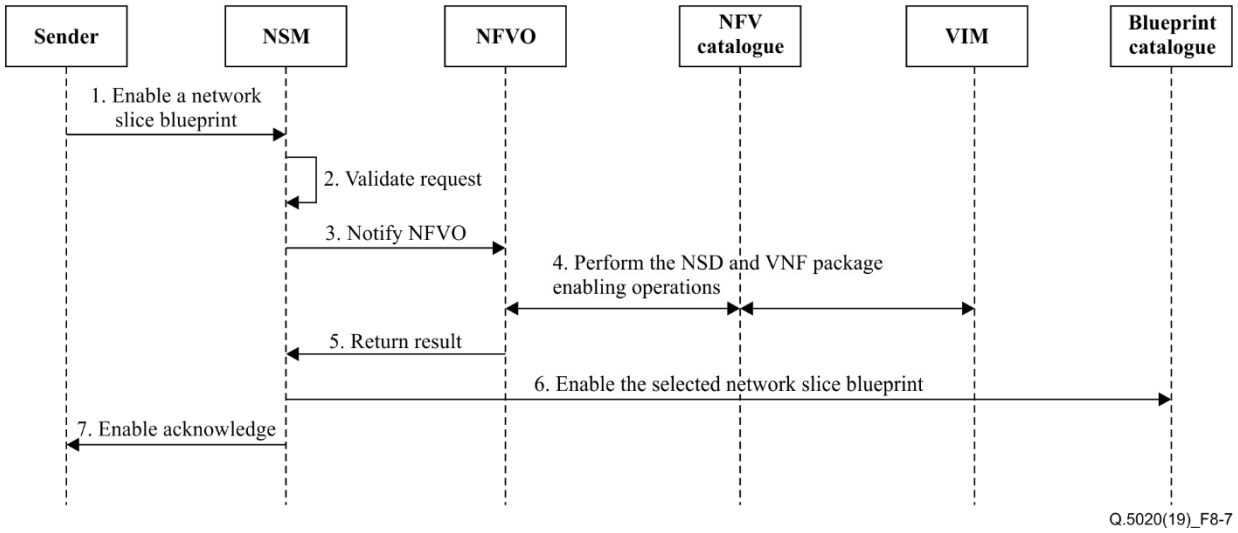

Figure 8-7 – Procedure for enabling a network slice blueprint

The main steps for enabling a network slice blueprint include:

1) The sender requests to enable a selected network slice blueprint.
2) The NSM checks if the blueprint is valid and disabled.
3) If it is disabled, the NSM parses the network slice blueprint and notifies the NFVO to enable the corresponding NSD and VNF packages.
4) The NFVO, NFV catalogue and VIM perform the NSD and VNF package enabling operations, using the interaction procedures defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the enabling operation to the NSM.
6) The NSM notifies the blueprint catalogue for the enabling of the selected network slice blueprint in the blueprint catalogue.
7) The NSM returns the Enable acknowledge to the sender.

8.8 Disabling a network slice blueprint

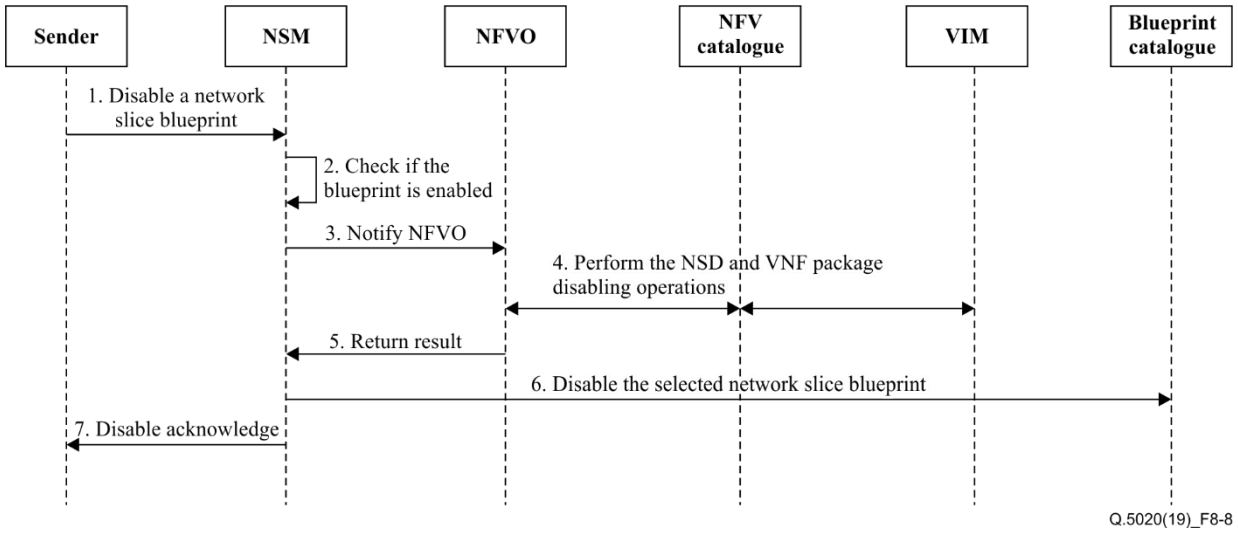

Figure 8-8 – Procedure for disabling a network slice blueprint

The main steps for disabling a network slice blueprint include:

1) The sender requests to disable a selected network slice blueprint.
2) The NSM checks if the blueprint is valid and enabled.
3) If it is enabled, the NSM parses the network slice blueprint and notifies the NFVO to disable the corresponding NSD and VNF packages.
4) The NFVO, NFV catalogue and VIM perform the NSD and VNF package disabling operations, using the interaction procedures defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the disabling operation to the NSM.
6) The NSM notifies the blueprint catalogue for the disabling of the selected network slice blueprint in the blueprint catalogue.
7) The NSM returns the Disable acknowledge to the sender.

8.9 Updating a network slice blueprint

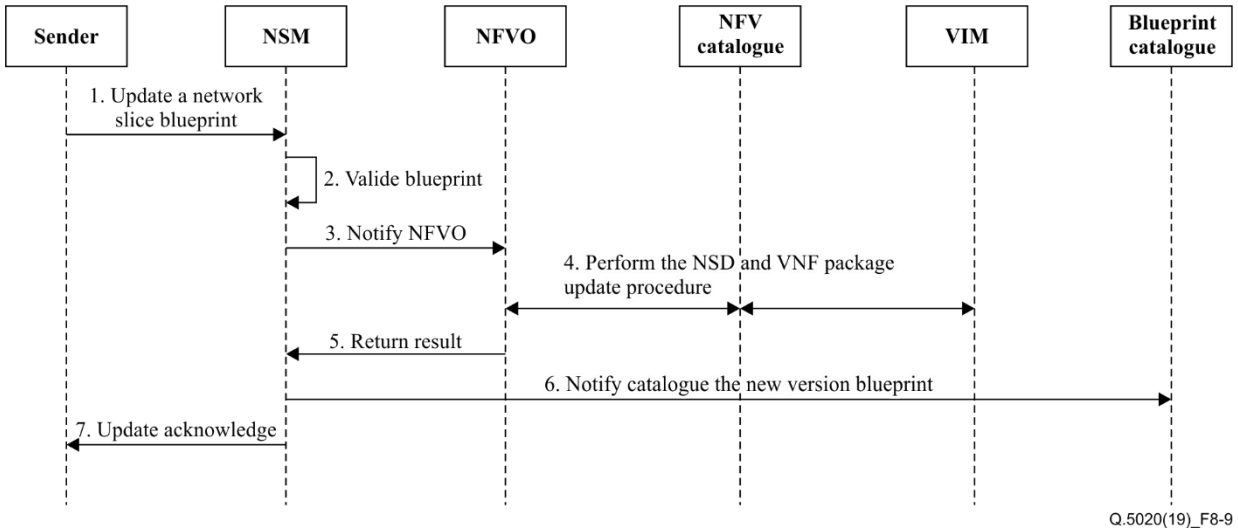

Figure 8-9 – Procedure for updating a network slice blueprint

The main steps for updating a network slice blueprint include:

1) The sender submits a new version of the network slice blueprint to the NSM for updating.
2) The NSM checks if the blueprint is valid.
3) If it is valid, the NSM parses the new version network slice blueprint and sends its NSD and VNF packages to the NFVO for updating.
4) The NFVO, NFV catalogue and VIM perform the NSD and VNF package updating operations, using the interaction procedures defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the updating operation to the NSM.
6) The NSM notifies the blueprint catalogue to update the blueprint version.
7) The NSM returns the Update acknowledge to the sender.

8.10 Deleting a network slice blueprint

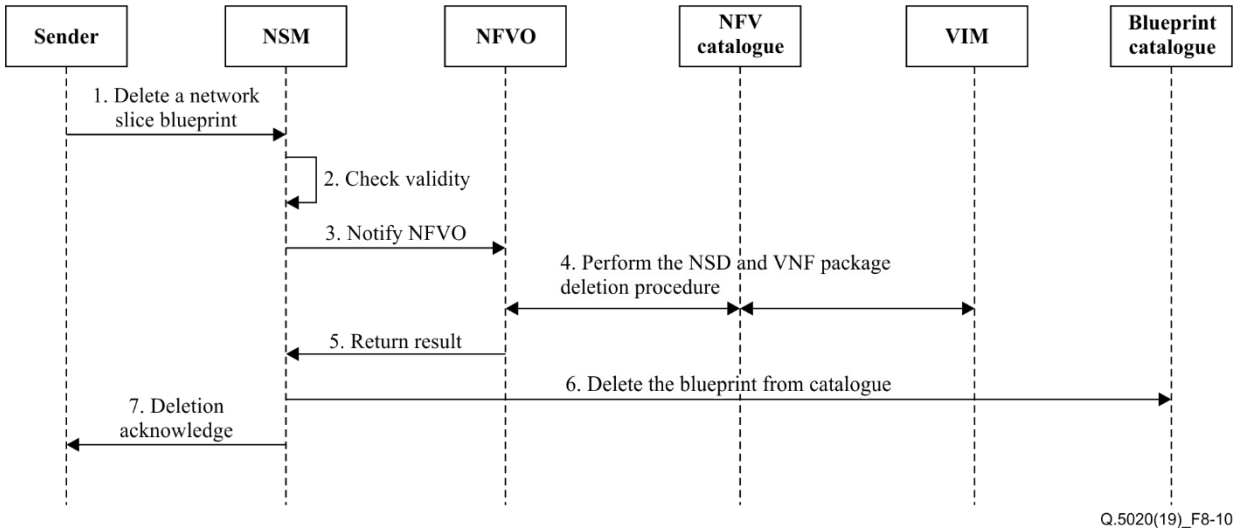

Figure 8-10 – Procedure for deleting a network slice blueprint

The main steps for deleting a network slice blueprint include:

1) The sender requests to delete a selected network slice blueprint.
2) The NSM checks the validity of the request.
3) The NSM notifies the NFVO to delete the corresponding NSD and VNF packages.
4) The NFVO, NFV catalogue and VIM perform the NSD and VNF package deleting operations, using the interaction procedures defined by ETSI NFV [ETSI GS NFV-MAN 001].
5) The NFVO returns the result of the deleting operation to the NSM.
6) The NSM notifies the blueprint catalogue to delete the selected network slice blueprint.
7) The NSM returns the Deletion acknowledge to the sender.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	**Switching and signalling, and associated measurements and tests**
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2019