# ETSI GS NFV-SOL 016 V4.5.1 (2024-01)


# Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV-MANO procedures specification

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# Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Network Functions Virtualisation (NFV).

# 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 NFV-MANO procedures involving multiple interfaces that reference the operations specified in ETSI GS NFV-SOL 003 [3], ETSI GS NFV-SOL 002 [2] and ETSI GS NFV-SOL 005 [4], and the information from NFV descriptors as specified in ETSI GS NFV-SOL 001 [1] and ETSI GS NFV-SOL 006 [5]. In addition, the procedures consider the functional requirements specified in ETSI GS NFV-IFA 010 [i.3] and related interface specifications.

# 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 GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on TOSCA specification".

[2] ETSI GS NFV-SOL 002: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point".

[3] ETSI GS NFV-SOL 003: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point".

[4] ETSI GS NFV-SOL 005: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Os-Ma-nfvo Reference Point".

[5] ETSI GS NFV-SOL 006: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on YANG Specification".

[6] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Network Service Templates Specification".

[7] ETSI GS NFV-SOL 013: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Specification of common aspects for RESTful NFV MANO APIs".

[8] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification".

[9] ETSI GS NFV-SOL 014: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; YAML data model specification for descriptor-based virtualised resource management.

[10] ETSI GS NFV-SOL 009: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the management of NFV-MANO".

[11] ETSI GS NFV-SOL 018: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Profiling specification of protocol and data model solutions for OS Container management and orchestration".

[12] ETSI GS NFV-IFA 040: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification".

## 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] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.2] Void.

[i.3] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Functional requirements specification".

[i.4] ETSI GR NFV-IFA 038: "Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on network connectivity for container-based VNF".

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in ETSI GR NFV 003 [i.1] apply.

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.1] apply.

# 4 Overview of NFV-MANO procedures

## 4.1 Introduction

The present document specifies NFV-MANO procedures that consist of information flows and the key information to be sent across the NFV-MANO interfaces to realize the interaction with and within the NFV-MANO framework. For each one of the procedures, it specifies:

- the order in which the information is exchanged;
- the input data to operations based on the information state held by the interface consumers (e.g. from NFV descriptors); and
- key information to be exchanged between the different NFV-MANO entities in various scenarios.

Each NFV-MANO procedure specifies the baseline interaction steps corresponding to the functionality and capabilities specified in NFV-MANO API specifications in the ETSI GS NFV-SOL series ( [2], [3] and [4]), clarifying the key information exchanged among the different NFV-MANO functional entities and with other external entities such as OSS/BSS, EM and VNF. The specified NFV-MANO procedures focus on the interactions and management capabilities offered by the NFV-MANO framework. In this respect, additional interactions performed by other management systems such as the OSS/BSS and EM with the VNF might be necessary to ensure that the NS and VNF instances are fully configured and operational, or to decommission services that the NS and VNF instances perform.

## 4.2 List of NFV-MANO procedures

The present document specifies NFV-MANO procedures involving the baseline interactions with and within the NFV-MANO framework based on ETSI NFV Release-2 specifications. The present document details the procedures below:

1) On-boarding of a VNF Package: The procedure for the on-boarding of a VNF package.

2) Instantiation of a NS instance: The procedure for the creation and instantiation of a NS instance needed for a network service.

3) Termination of a NS instance: The procedure for the termination of a NS instance triggered through Update NS or Terminate NS.

4) Scaling of VNF instance(s) in a NS instance: The procedure for the scaling of VNF instance(s) associated with a NS instance triggered through Scale NS with option of scaling VNF instance(s).

5) Change VNF external connectivity of VNF instance(s) in a NS instance: The procedure for the change of external connectivity of VNF instance(s) associated with a NS instance triggered through NS update.

6) Creation of a VNF snapshot: The procedure for the creation of a VNF snapshot triggered through NS update.

7) Creation of a VNF snapshot package: The procedure for the creation of a VNF snapshot package based on a snapshotted VNF instance.

In the subsequent clauses, the applicable flows, procedural steps and mapping of key attributes across different interfaces corresponding to the individual MANO procedures are specified in detail.

NOTE: The present document version does not specify detailed error handling applicable to NFV-MANO procedures.

## 4.3 Security considerations

### 4.3.1 Overview

The NFV-MANO procedures documented in the present document do not specify the steps to handle the authorization to consume the NFV-MANO APIs referred in the procedures.

Before the start of the NFV-MANO procedure (as a general security framework setup policy), or as part of the steps in which the NFV-MANO API interactions take place, the producer and consumer functional blocks of an API shall have established the proper authorization setup as specified in clause 8 of ETSI GS NFV-SOL 013 [7].

### 4.3.2 Security information on NFV-MANO functional entity

#### 4.3.2.1 Overview

As a pre-condition for all the NFV-MANO procedure flows specified in the present document:

- The NFV-MANO functional entity acting as a producer functional block of an API shall have been configured with the server interface security information for each of its produced interfaces.

- The NFV-MANO functional entity acting as a consumer functional block of an API shall have been configured with the client interface security information for each of the consumed interfaces.

The approach to configure the interface security information via NFV-MANO management procedures specified in ETSI GS NFV-SOL 009 [10] is specified in clause 4.3.2.2.

#### 4.3.2.2 NFV-MANO configuration settings approach

This clause applies if the security information as a pre-condition for all the NFV-MANO procedure flows specified in the present document are set using configuration approach following the procedure defined in ETSI GS NFV-SOL 009 [10].

- The NFV-MANO functional entity acting as a producer functional block of an API shall have been configured with the server interface security information defined in Table 5.6.3.11-1 of ETSI GS NFV-SOL 009 [10] for each of its produced interfaces.
- The NFV-MANO functional entity acting as a consumer functional block of an API shall have been configured with the client interface security information defined in Table 5.6.3.12-1 of ETSI GS NFV-SOL 009 [10] for each of the consumed interfaces.

# 5 NFV-MANO procedures

## 5.1 VNF Package on-boarding procedure

### 5.1.1 Introduction

Clause 5.1 specifies the NFV-MANO procedure for VNF package on-boarding.

NOTE: Additional interactions previous to the VNF Package on-boarding might be possible as required for operations that are handled outside MANO such as collecting VNFD creation requirement, developing VNFD, build VNF package, checking the VNF package consistency and its contents, and verifying the instantiation in test environment.

### 5.1.2 Pre-conditions

Table 5.1.2-1 specifies the pre-conditions applicable to the VNF package on-boarding procedure.

**Table 5.1.2-1: VNF package on-boarding procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | VNF Provider delivers the VNF descriptor, artefacts and other CSAR content in a VNF package. | VNF Provider delivers a new VNF package to the Service Provider. |
| 2 | If the NSD contains one or multiple "container-based VNFs", the VNF Packages include the MCIOP(s). | N/A |
| 3 | The local MCIOP repository is connected with the CISM in the same NFVI-PoP and the CISM is configured and has access rights to the local MCIOP repository. | The CISM needs to be connected to the local MCIOP repository to obtain the MCIOPs that will be interpreted by CISM to create the MCIOs by allocating their requested infrastructure resources on Container Infrastructure Service (CIS) instances. |
| 4 | The local CIRs repository is connected with the CISM in the same NFVI-PoP and the CISM is configured and has access rights to the local CIR repository. | CISM needs to be connected to the local CIRs to obtain the OS container images, as an MCIO may be deployed as an OS container from its corresponding OS container image. |

### 5.1.3 Procedure flow

Depending on the service provider's requirement and the size of artifacts (such as software images), the VNF package may include or exclude certain artifacts in a flexible manner. For example, the VNF package may exclude software images or other artifacts and provide artefact path or link to the external artifacts as specified in clause 9.2 of ETSI GS NFV-SOL 005 [4]. The means to provide these artifacts is not specified in the present document.

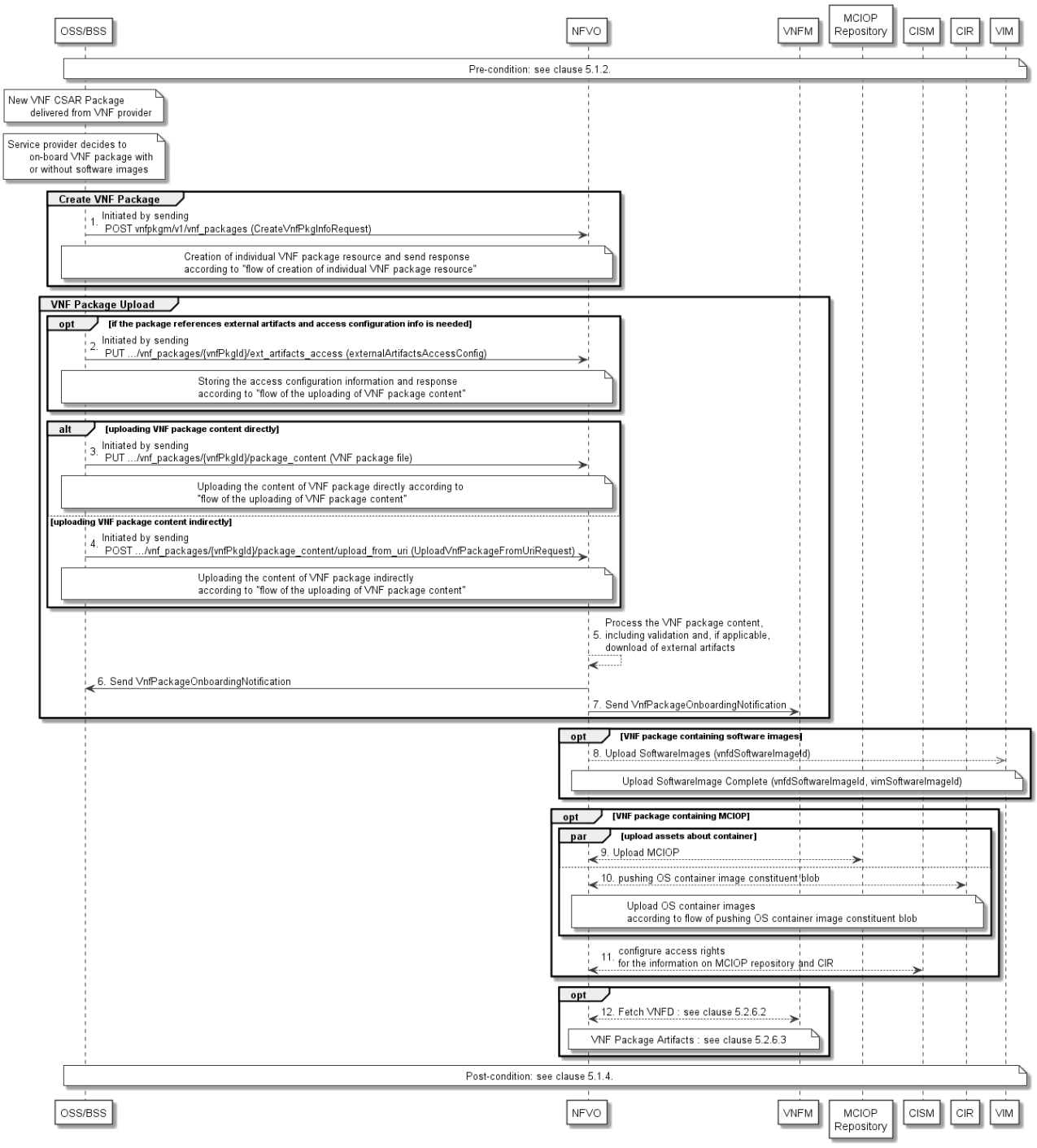


**Figure 5.1.3-1: Procedure flow of VNF package on-boarding**

The NFV-MANO procedure of VNF package on-boarding comprises the following steps:

1. To perform the VNF package on-boarding process, the OSS/BSS shall first send to the NFVO a "CreateVnfPkgInfoRequest" in the payload of the POST request to the "VNF packages" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 005 [4].

   As described in "Flow of the creation of an individual VNF package resource" (see clause 9.3.1 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the "Individual VNF package" resource.

   The NFVO generates a unique VnfPkgId for the VNF package.

   Table 5.1.5.1-1 lists the key information exchanged between OSS/BSS and NFVO for the create VNF package operation.

2. In case the VNF package references external artifacts and access configuration information is needed, the OSS/BSS shall provide access configuration information for the subsequent download of the external VNF package artifacts to the NFVO by sending a PUT request to the "Access configuration for external artifacts" resource as specified in clause 9.4.4a.3.3 of ETSI GS NFV-SOL 005 [4], according to the "Flow of the uploading of VNF package content" (see clause 9.3.2 of ETSI GS NFV-SOL 005 [4]). The NFVO stores the access configuration information for later use.

3. In case the OSS/BSS uploads the VNF package content to the NFVO directly, the OSS/BSS shall send to the NFVO a "ZIP file that represents the VNF package" in the payload of the PUT request to the "VNF package content" resource as specified in clause 9.4.5.3.3 of ETSI GS NFV-SOL 005 [4], and as described in the "Flow of the uploading of VNF package content" (see clause 9.3.2 of ETSI GS NFV-SOL 005 [4]).

   Table 5.1.5.2-1 lists the key information exchanged between NFVO and VNFM during VNF package upload operation.

   The OSS/BSS can poll the "Individual VNF package" resource to track the completion of uploading operation by sending a GET request to the "Individual VNF package" resource as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 005 [4].

4. In case the OSS/BSS uploads the VNF package content to the NFVO indirectly from URI, the OSS/BSS shall send to the NFVO a data structure of type "UploadVnfPackageFromUriRequest" in the payload of the POST request to the "Upload VNF package from URI task" resource as specified in clause 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4], and as described in the "Flow of the uploading of VNF package content" (see clause 9.3.2 of ETSI GS NFV-SOL 005 [4]). The NFVO utilizes the address information to retrieve the VNF package content.

   Table 5.1.5.2-2 lists the key information exchanged between NFVO and VNFM during VNF package upload operation.

   The OSS/BSS can poll the "Individual VNF package" resource to track the completion of uploading operation by sending a GET request to the "Individual VNF package" resource as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 005 [4].

   In case the VNF package references external artifacts, the NFVO downloads the external artifacts (see clause 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4], as applicable) by utilizing the access configuration information and the information in the VNF package.

NOTE 1: Some parts of the validation of the package on NFVO side can happen before downloading external artifacts (for instance, in case of a double zipped, externally signed package, the validation of the signature would typically be performed after uploading the package.

5. Further, the NFVO processes the VNF package validating the contents of the package such as checksum, certificates, etc. Upon completion of validating the VNF package (including external artifacts, if applicable), the NFVO stores the VNF package contents in its repository and updates the VNF package information. Table 5.1.5.3-1 lists the key information updated in the VNF package information.

Sending the VnfPackageOnBoardingNotification (step 6 and step 7) may be executed in any order, and in parallel to the step 8.

6. On completion of successful on-boarding of the VNF content, if there are any applicable subscriptions for VNF Package Management notifications, NFVO sends a POST request, each containing a "VnfPackageOnboardingNotification" in the payload body, to the OSS/BSS as "notification endpoint" resources defined in the matching subscriptions, as per clauses 9.5.2.8 and 9.4.10.3.1 of ETSI GS NFV-SOL 005 [4].

7. On completion of successful on-boarding of the VNF content, if there are any applicable subscriptions for VNF Package Management notifications, NFVO sends a POST request, each containing a "VnfPackageOnboardingNotification" in the payload body, to the VNFM as "notification endpoint" resources defined in the matching subscriptions, as per clauses 9.5.2.5 and 10.4.9.3.1 of ETSI GS NFV-SOL 003 [3].

Uploading software images (step 8) can be executed after successful completion of step 4. Uploading software images (step 8) and fetching of VNFD (step 9) may be executed in any order.

8. Based on operational policies, if the on-boarded VNF package software images are available to the NFVO, the NFVO may start distributing the software images and associated signatures and certificates to related VIM(s) and create the associated software image VIM assets. In this case, the NFVO shall request the VIM(s) to add the corresponding software images to the image repository managed by the VIM, and then map the respective VNFD software image identifiers with the identifiers of the software images in the VIM(s). Likewise, the NFVO may start creating the compute flavours corresponding to the VNFD compute resource definitions. In this case, the NFVO shall request the VIM(s) to create these compute flavours managed and then map the respective VNFD compute resources definitions with the identifiers of the compute flavours in the VIM(s). Software images and compute flavours shall be available in the appropriate VIM(s) at latest when the NFVO sends the Grant response including references to the identifiers in the VIM of the respective software images and compute flavours.

   Table 5.1.5.4-1 lists key information sent toward the VIM(s) for the creation of the compute flavours. The listed key information applies only in case the VIM's consumer communicates with the VIM(s) using the descriptor-based approach defined in ETSI GS NFV-SOL 014 [9], and if the NFVO requests the VIM(s) to create compute flavours during step 8.

NOTE 2: It is determined based on operational policies, whether the NFVO distributes software images to all or specific VIM(s) and whether this is done as part of the VNF package onboarding procedure, immediately afterwards or at a later appropriate point in time. Likewise, whether and when the NFVO creates compute flavours in all or specific VIM(s) is determined based on operational policies. Delaying the distribution of software images and/or creation of compute flavours to happen during VNF LCM interactions might result in only being able to handle VNF LCM operation granting in asynchronous mode.

In case the VIM only supports raw signatures, the NFVO shall extract the raw signature value from the signature file provided in the VNF Package and upload this to the VIM.

Fetching VNFD (step 12) can be executed after successful completion of step 5.

9. Based on operational policies, if the on-boarded VNF package MCIOP are available to the NFVO, the NFVO may start distributing the MCIOP and associated signatures and certificates to related MCIOP repositories.

NOTE 3: It is determined based on operational policies, whether the NFVO distributes MCIOP to all or specific MCIOP repositories and whether this is done as part of the VNF package onboarding procedure, immediately afterwards or at a later appropriate point in time. Delaying the distribution of MCIOP to happen during VNF LCM interactions might result in only being able to handle VNF LCM operation granting in asynchronous mode.

10. Based on operational policies, if the on-boarded VNF package OS container images are available to the NFVO, the NFVO may start distributing the OS container images and associated signatures and certificates to related CIR(s) as specified in clause 12.4.1 of ETSI GS NFV-SOL 018 [11].

NOTE 4: It is determined based on operational policies, whether the NFVO distributes OS container images to all or specific CIR(s) and whether this is done as part of the VNF package onboarding procedure, immediately afterwards or at a later appropriate point in time. Delaying the distribution of OS container images to happen during VNF LCM interactions might result in only being able to handle VNF LCM operation granting in asynchronous mode.

11. On completion of successful on-boarding of the MCIOP and OS container images, the NFVO configure access right for the information on MCIOP repositories and CIR(s) to CISM.

12. If the VNFM is subscribed to VnfPackageOnboardingNotifications and has received a VnfPackageOnboardingNotification from NFVO for an on-boarded VNF package, VNFM can query and retrieve the VNF Package information and its content. The VNFM fetches the VNFD according to "Fetch VNFD" as specified in clause 5.2.7.2 and any needed artifacts according to "Fetch VNF Package Artifacts" as specified in clause 5.2.7.3.

NOTE 5: Alternatively, VNFM may fetch the VNFD and other artifacts in the VNF package during VNF instance resource creation, VNF instantiation or other LCM operations based on need.

### 5.1.4 Post-conditions

Table 5.1.4-1 specifies the post-conditions applicable to the VNF package on-boarding procedure.

**Table 5.1.4-1: VNF package on-boarding procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The VNF package is on-boarded to NFVO and is available for further operation and management. | |
| 2 | The NFVO shall maintain the mapping of VNFD and VIM software image identifiers upon successful completion of the distribution and transfer of software images to the VIM. | The mapping between software image definitions in the VNFD and the corresponding software images managed by the NFVO in the VIM is provided to the VNFM as part of the Grant, as specified in clause 9.5.3.10 of ETSI GS NFV-SOL 003 [3]. |
| 3 | The NFVO shall maintain the mapping of VNFD compute resources definitions and VIM-managed compute flavours upon successful completion of the creation of the compute flavours to the VIM. | The mapping between compute resources definitions in the VNFD and the corresponding compute flavours by the NFVO in the VIM is provided to the VNFM as part of the Grant, as specified in clause 9.5.3.10 of ETSI GS NFV-SOL 003 [3]. |
| 4 | If the NSD contains one or multiple "container-based VNFs", the local MCIOP repository is connected with the CISM, in the same NFVI-PoP and the CISM is configured and has access rights to the local MCIOP repository. | N/A |
| 5 | If the NSD contains one or multiple "container-based VNFs", the MCIOP(s) within the VNF Packages of the constituent VNFs in the NSD are available. | The mapping between MCIOP definitions in the VNFD and the corresponding MCIOP managed by the NFVO in the MCIOP repositories is provided to the VNFM as part of the Grant, as specified in clause 9.5.3.10 of ETSI GS NFV-SOL 003 [3]. |
| 6 | If the NSD contains one or multiple "container-based VNFs", the local CIRs repository is connected with the CISM, in the same NFVI-PoP and the CISM is configured and has access rights to the local CIR repository. | N/A |
| 7 | If the NSD contains one or multiple "container-based VNFs", the VNF Packages contains the reference to the OS container images used by the "container-based VNFs" and the images are available. | The mapping between OS container image definitions in the VNFD and the corresponding OS container images managed by the NFVO in the CIR is provided to the VNFM as part of the Grant, as specified in clause 9.5.3.10 of ETSI GS NFV-SOL 003 [3]. |

## 5.1.5 Key information exchanged in the procedure

### 5.1.5.1 VNF package id creation

Table 5.1.5.1-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during creation of VnfPkgInfoId in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.1.5.1-1: Key information exchanged during Create VNF package**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| CreateVnfPkgInfoRequest in the request | N/A | |
| VnfPkgInfo in the response | id | Unique package identifier assigned by the NFVO for this VNF package. |
| | onboardingState | Set by the NFVO to "CREATED", as defined in clause 9.4.2.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | operationalState | Set by the NFVO to "DISABLED", as defined in clause 9.4.2.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | usageState | Set by the NFVO to "NOT_IN_USE", as defined in clause 9.4.2.3.1 of ETSI GS NFV-SOL 005 [4]. |

### 5.1.5.2 VNF package upload

Table 5.1.5.2-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the VNF package upload process in the context of the NFV-MANO procedure if the package file is provided. Table 5.1.5.2-2 lists the source and mapping of key information exchanged between OSS/BSS and NFVO during the VNF package upload process in case of triggering the upload of the VNF Package from a URI.

The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.1.5.2-1: Key information exchanged during VNF package upload with package file**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfPkgId | Shall be set by the OSS/BSS to the "id" attribute of "VnfPkgInfo" representing the "Individual VNF package" resource created by NFVO. |
| VnfPackageFile in the request | N/A | VNF package file in ZIP format. |

**Table 5.1.5.2-2: Key information exchanged during VNF package upload from a URI**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfPkgId | Shall be set by the OSS/BSS to the "id" attribute of "VnfPkgInfo" representing the "Individual VNF package" resource created by NFVO. |
| UploadVnfPackageFromUri Request in the request | addressInformation | Shall be set by the OSS/BSS to the location information where the VNF package is available to be downloaded by the NFVO. |

### 5.1.5.3 VNF package on-boarding complete

Table 5.1.5.3-1 lists the selected key information updated in the VNF package information after processing and successful validation of the on-boarded VNF package.

**Table 5.1.5.3-1: Key information updated in VNF package information after successful on-boarding**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfPkgInfo in the response | onboardingState | Set by the NFVO to "ONBOARDED", as defined in clauses 9.4.5.3.3 and 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | operationalState | Set by the NFVO to "ENABLED", as defined in clauses 9.4.5.3.3 and 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | usageState | Set by the NFVO to "NOT_IN_USE", as defined in clauses 9.4.5.3.3 and 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | vnfProvider | Set by the NFVO to the provider of the VNF package and VNFD, as defined in clauses 9.4.5.3.3 and 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | vnfProductName | Set by the NFVO to the VNF product name, as defined in clauses 9.4.5.3.3 and 9.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. |

### 5.1.5.4 Creating compute flavours

This clause applies if the VIM's consumer communicates with the VIM(s) using the descriptor-based approach defined in ETSI GS NFV-SOL 014 [9]. ETSI GS NFV-SOL 014 [9] specifies a set of request/response/notification data types and attributes for a descriptor-based approach and this clause describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 014 [9].

Table 5.1.5.4-1 lists the selected key information sent toward the VIM(s) for the creation of the compute flavours.

**Table 5.1.5.4-1: Key information sent for compute flavours creation**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| virtualMemory for the compute flavour in the request | virtualMemSize | Shall be set by the NFVO to the value declared in the VNFD>topology_template>node_templates>tosca.nodes.nfv.Vdu.Compute>capabilities>virtual_compute>properties>virtual_memory>virtual_mem_size, as defined in clause 6.4.3.2 of ETSI GS NFV-SOL 001 [1], and according to the clause 6.2.10 of ETSI GS NFV-SOL 014 [9]. |
| virtualCpu for the compute flavour in the request | numVirtualCpu | Shall be set by the NFVO to the value declared in the VNFD>topology_template>node_templates>tosca.nodes.nfv.Vdu.Compute>capabilities>virtual_compute>properties>virtual_cpu>num_virtual_cpu, as defined in clause 6.4.3.2 of ETSI GS NFV-SOL 001 [1], and according to the clause 6.2.10 of ETSI GS NFV-SOL 014 [9]. |
| storageAttributes for the compute flavour in the request | typeOfStorage | Set by the NFVO to the value that is valid for the compute resource, according to the clause 6.2.10 of ETSI GS NFV-SOL 014 [9]. |
| | sizeOfStorage | Set by the NFVO to the value declared in the VNFD>topology_template>node_templates>tosca.nodes.nfv.Vdu.Compute>capabilities>virtual_compute>properties>virtual_local_storage>size_of_storage, as defined in clause 6.4.3.2 of ETSI GS NFV-SOL 001 [1], and according to the clause 6.2.10 of ETSI GS NFV-SOL 014 [9]. |

## 5.1.6 Execution of dependent and non-dependent side procedures

### 5.1.6.1 Introduction

Side procedures (i.e. other management functionality, supported via the NFV-MANO interfaces, which does not form the core of functionality specified in the main procedure flow) can have a dependency (i.e. be impacted) or be independent from the VNF package on-boarding procedure.

The following clauses specify the considerations of these other side procedures with respect to the VNF package on-boarding procedure.

### 5.1.6.2 Non-dependent side procedures

#### 5.1.6.2.1 VNF Package management

Operations about management of subscriptions to notifications related to VNF Package management (request to create a new subscription, delete an existing subscription, query and read existing subscriptions) corresponding to VNF packages may be executed by the OSS/BSS (as specified in clause 9.4.8 of ETSI GS NFV-SOL 005 [4]) and/or VNFM (as specified in clause 10.4.7 of ETSI GS NFV-SOL 003 [3]), in parallel to any of the steps in the VNF package on-boarding procedure. If a specific VNF package identifier is to be referred in a subscription request, such a request can only be sent by the OSS/BSS and/or by the VNFM once the specific VNF package identifier is known to the OSS/BSS and/or to the VNFM from the NFVO as a result of or after the "VNF package resource" creation.

Operations about querying and reading information related to on-boarded VNF packages, corresponding to the VNF package that is being on-boarded, may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF package on-boarding procedure. If a specific VNF package identifier is to be referred in a reading information request, such a request can only be sent by the OSS/BSS and/or by the VNFM once the specific VNF package identifier is known to the OSS/BSS and/or to the VNFM from the NFVO as a result of or after the "VNF package resource" creation.

#### 5.1.6.2.2 NSD management

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, query and read of existing subscriptions) of NSD(s) may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF package on-boarding procedure. If a specific VNF package identifier is to be referred in a subscription request, such a request can only be sent by the OSS/BSS once the specific VNF package identifier is known to the OSS/BSS from the NFVO as a result of or after the "VNF package resource" creation.

Operations about querying and reading information related to on-boarded NSD and request to delete an onboarded NSD may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF package on-boarding procedure.

If the NSD has constituent PNFD(s), operations about management of the PNFD, query and read information about PNFD, retrieval of the PNFD content may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF package on-boarding procedure.

#### 5.1.6.2.3 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, query and read existing subscriptions) corresponding to VNF(s) may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18, 5.4.19, 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF package on-boarding procedure.

Operations about querying, reading information and executing VNF lifecycle management related to VNF instances corresponding to VNF(s) other than the VNF package that is being on-boarded may be executed by the NFVO (as specified in clause 5.4 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clause 5.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF package on-boarding procedure.

### 5.1.6.3 Dependent side procedures

#### 5.1.6.3.1 VNF Package management

Operations about management of the VNF package and the content (retrieval of the VNF package content, VNF package artifacts, VNFD and Manifest file, update of information of a VNF package, and delete of the VNF package), corresponding to the VNF package that is being on-boarded may be executed by the OSSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) only after the VNF package has been successfully on-boarded to the NFVO.

Operations about management of the VNF package and the content (retrieval of the VNF package content, VNF package artifacts, VNFD and Manifest file), corresponding to the VNF package that is being on-boarded may be executed by the VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) only after the VNF package has been successfully on-boarded to the NFVO.

#### 5.1.6.3.2 NSD management

Operations about management of the NSD and its content (retrieval of the NSD content, query and read information about NSD, and request to delete an onboarded NSD) that references the VNF package being on-boarded can only be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) after VNF package is onboarded to NFVO.

#### 5.1.6.3.3 NS lifecycle management

Operations to instantiate any new NS instance that include instantiation of new VNF instance(s) to be created from the VNF package that is being on-boarded can only be executed by the NFVO (as specified in clause 5.2.2) after the VNF package is onboarded to NFVO.

#### 5.1.6.3.4 VNF lifecycle management

The VNF instance creation and operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to a specific VNF instance from the VNF package that is being on-boarded, may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) only after the VNF package used for the creation of the instance has been on-boarded to the NFVO.

NOTE: Subscriptions that do not apply to a single specific VNF instance can be created anytime.

#### 5.1.6.3.5 VNF lifecycle granting

During the VNF lifecycle granting in the VNF LCM procedures, the NFVO provides in the Grant response the set of VIM assets related to the VNF package that is identified by the vnfdId attribute in the corresponding Grant request (refer to clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]).

As specified in the main procedure flow in clause 5.1.3, if the on-boarded VNF package software images are available to the NFVO, the NFVO may start distributing the software images and associated signatures and certificates to the related VIM and create the associated VIM assets.

### 5.1.6.4 Error cases and other considerations

#### 5.1.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "VNF package on-boarding procedure" is defined in clause 9.4.3.3.5 of ETSI GS NFV-SOL 005 [4], which specifies the handling of error cases such as the on-boarding state is "UPLOADING" or "PROCESSING", or the operational state of the "Individual VNF package" resource is "ENABLED" or the usage state is "IN_USE" (i.e. "Individual VNF instance" resource(s) based on the concerned VNF package exist).

NOTE: Example of use cases to be considered by the consumer, prior to requesting the deletion of an onboarded VNF Package are, e.g. the VNF Package could be referred by some other NSD to be on-boarded at a later stage, or the VNF Package is being referred by some other on-boarded NSD.

## 5.2 NS instantiation procedure

### 5.2.1 Introduction

Clause 5.2 specifies the NFV-MANO procedure for instantiating a Network Service.

The NS to be instantiated has the following characteristics:

- The NS does not include nested NSs.
- The NSD refers to VNF Packages and it includes information for none, one or multiple VNFs, and its constituent VNFs can be VM-based, container-based or hybrid.

NOTE: In the present procedure, the use of virtualised resource management in indirect mode is not defined because the referenced version of ETSI GS NFV-SOL 003 [3] lacks such a specification, as opposed to the remaining NFV-MANO APIs which are fully specified and specific references in the procedure flow and key information exchanges can be provided. In addition, the procedure flows, while specifying the steps and stages at which virtualised resource management interactions take place, do not provide any reference to protocol and data model solutions of NFV-MANO APIs concerning to virtualised resource management, since these are not available at the time the present document is published.

### 5.2.2 Pre-conditions

Table 5.2.2-1 specifies the pre-conditions applicable to the NS instantiation procedure.

**Table 5.2.2-1: NS instantiation procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | The NSD used for NS instantiation is on-boarded in the NFVO. | If the NSD is not on-boarded, it needs to be on-boarded in the NFVO before proceeding with NS instantiation steps. |
| 2 | If NSD contains one or multiple "VM-based VNFs", the VNF Packages of the constituent VNFs in the NSD are on-boarded in the NFVO. | The VNF packages required for NS instantiation for the specific NS deployment flavour are needed to be on-boarded before proceeding with NS instantiation steps. Furthermore, if the operation indicates an overriding descriptor, the precondition of on-boarded applies to the overriding descriptor and the overridden descriptor does not need to be on-boarded as described in clause 6.4.4.3.1 of ETSI GS NFV-SOL 005 [4]. |
| 3 | If the NSD contains one or multiple "container-based VNFs", the MCIOP(s) within the VNF Packages of the constituent VNFs in the NSD are on-boarded according to "VNF Package on-boarding procedure" as specified in clause 5.1 and downloaded to the local MCIOP repository by the NFVO. See note 1. | MCIOPs (Helm™ Charts) required within VNF Packages for NS instantiation for the specific NS deployment flavour are needed to be on-boarded before proceeding with NS instantiation steps. |
| 4 | If the NSD contains one or multiple "container-based VNFs", the local MCIOP repository is connected with the CISM, in the same NFVI-PoP and the CISM is configured and has access rights to the local MCIOP repository. | The CISM needs to be connected to the local MCIOP repository to obtain the MCIOPs that will be interpreted by CISM to create the MCIOs by allocating their requested infrastructure resources on Container Infrastructure Service (CIS) instances. These resources of an MCIO are allocated in the scope of a namespace under the limits of its namespace quota.<br>The CISM needs to be configured to have the access rights for the information on the repository. |
| 5 | If the NSD contains one or multiple "container-based VNFs", the local CIRs repository is connected with the CISM, in the same NFVI-PoP and the CISM is configured and has access rights to the local CIR repository. See note 2. | CISM needs to be connected to the local CIRs to obtain the OS container images, as an MCIO may be deployed as an OS container from its corresponding OS container image.<br>The CISM needs to be configured to have the access rights for the registry to fetch container images from the registry. |
| 6 | If the NSD contains one or multiple "container-based VNFs", the VNF Packages contains the reference to the OS container images used by the "container-based VNFs" and the images are on-boarded according to "VNF Package on-boarding procedure" as specified in clause 5.1 and downloaded to the local CIR repository by the NFVO. | The OS container images used by the "container-based VNFs" are needed to be uploaded or on-boarded, and accessible via the local container image registry. |
| 7 | If NSD contains any PNFs, the PNF archives containing PNF descriptors of the constituent PNFs in the NSD are on-boarded in the NFVO. | If PNFs are required for the NS instantiation for the specific NS deployment flavour then on-boarding of the PNF archives need to be done prior to NS instantiation steps. |
| 8 | If the NSD contains one or multiple VNFs that use a PaaS service, the PaaS service is available and resource of the PaaS service is sufficient to be used by the VNFs. | PaaS service is deployed and configured to be used by VNFs, and NFVO obtain the access information and interface information of the PaaS service. |

NOTE 1: The NFVO fetches the MCIOPs from the VNF package or downloads them from an external repository, at VNF package onboarding, and stores them in the local MCIOP repository. The OS container images are referenced in the VNFD as software image artifacts, which may be included in the VNF Package, and the MCIOPs are referenced in the VNFD as file artifacts included in the VNF Package as specified in clauses 5.2.2.2 and 5.3 of ETSI GS NFV-IFA 040 [12].

NOTE 2: The CIR stores and maintains the OS container images and the NFVO fetches the images from the VNF package or downloads them from an external repository, at VNF package onboarding, and stores them in the local CIR repository.

## 5.2.3 Procedure flow

For instantiating a Network Service, the consumer performs the creation of "Individual NS instance" resource, and uses NS instantiate operation of the NS LCM interface on the "Individual NS instance" resource.

Figures 5.2.3-1 and 5.2.3-2 show the procedure when the consumer performs create and instantiate operations for instantiating a NS.

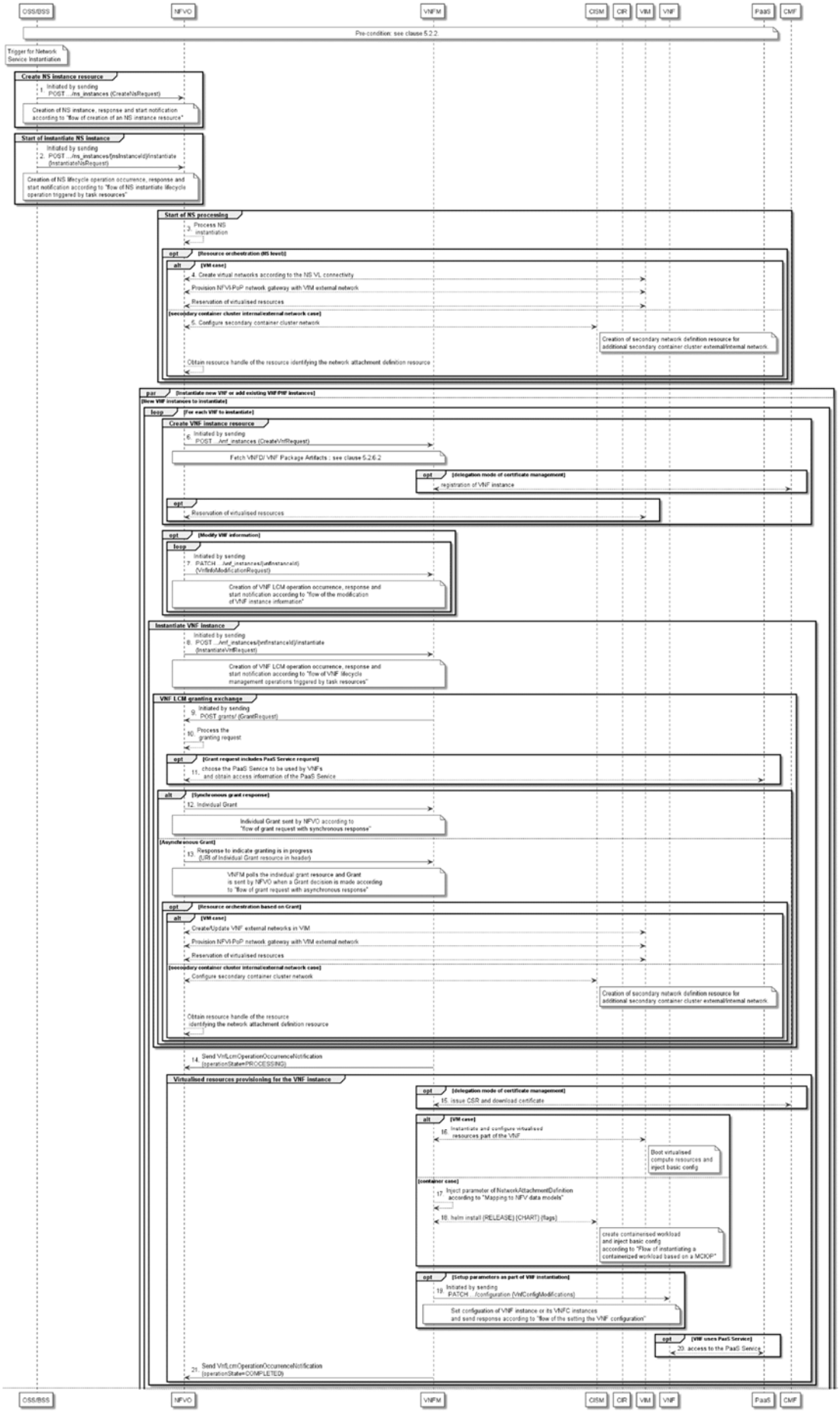


**Figure 5.2.3-1: Procedure flow of NS instantiation (first part)**

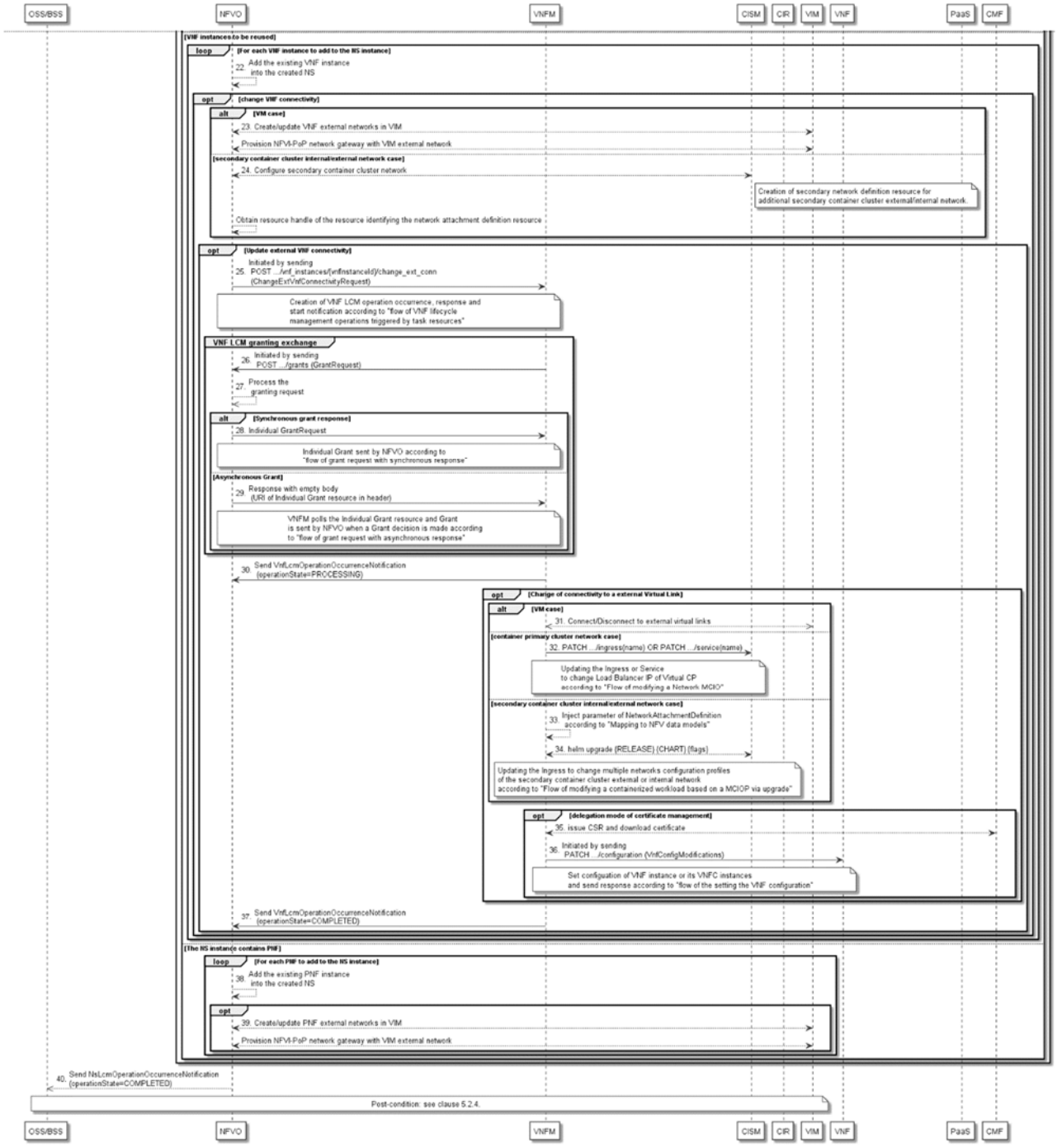


**Figure 5.2.3-2: Procedure flow of NS instantiation (second part)**

The NFV-MANO procedure of NS instantiation comprises the following steps:

1. To perform an NS instantiation, the OSS/BSS shall first send to the NFVO a "CreateNsRequest" in the payload of the POST request to the "NS Instances" resource as specified in clause 6.4.2.3.1 of ETSI GS NFV-SOL 005 [4].

   As described in "Flow of the creation of a NS instance resource" (see clause 6.3.1 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the "Individual NS instance" resource. If there is an applicable subscription for NS LCM notifications to the OSS/BSS, NFVO sends "NsIdentifierCreationNotification". The OSS/BSS may obtain information about the NS Instance by sending a GET request to the "Individual NS instance" resource as specified in clause 6.4.3.3.2 of ETSI GS NFV-SOL 005 [4].

   Table 5.2.5.1-1 lists the key information exchanged between OSS/BSS and NFVO during creation of NS instance process.

2. In order to proceed with the NS instantiation, the OSS/BSS shall send to the NFVO an "InstantiateNsRequest" in the payload of the POST request to the "Instantiate NS task" resource on the NS instance id created in the previous step as specified in clause 6.4.4.3.1 of ETSI GS NFV-SOL 005 [4].

   As described in the "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. NFVO sends NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The OSS/BSS can poll the "Individual NS LCM operation occurrence" resource to obtain information about the ongoing operation by sending a GET request to the "Individual NS LCM operation occurrence" resource as specified in clause 6.4.10.3.2 of ETSI GS NFV-SOL 005 [4]. NFVO will set the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the operations required for the NS instantiation as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

   Table 5.2.5.2-1 lists the key information exchanged between OSS/BSS and NFVO to instantiate the NS instance.

3. Based on the information contained in the NSD, in the instantiation request and additional policies, the NFVO determines the NFVI-PoPs involved, VNFs to be newly instantiated, existing VNF instances to be reused, and the PNFs to be used. The NFVO determines the VNFM for each VNF to be instantiated for the NS, based on information contained in the VNFD and additional policies.

4. If the NS to be instantiated contains NS VL and associated resources, as part of the NS instance instantiation, resource orchestration is performed by the NFVO for the fulfilment of network resources. Based on the NS VL connectivity requirements expressed in the NSD (e.g. specific connectivity across VNFs and PNFs), the NFVO determines the connection information of the constituent VNFs and PNFs. If the placement of the VNF can already be determined by the NFVO and new virtual network(s) in the assigned NFVI-PoP is (are) needed to enable the external connectivity of the VNF, the NFVO may request the VIM the creation of the new virtual network(s). Furthermore, if the NFVO is responsible for creating the link ports to enable external connectivity of the VNF, the NFVO may request the VIM to also allocate link ports on these networks to attach later the external connection points of the VNF. If the placement of the VNF can already be determined by the NFVO and existing virtual network(s) are to be reused, the NFVO may request the VIM to allocate link ports on these networks to attach later the external connection points of the VNF.

   Table 5.2.5.9-1 lists key information exchange between NFVO and VIM to allocate link port. The listed key information applies only in case the VIM's consumer communicates with the VIM using the descriptor based approach defined in ETSI GS NFV-SOL 014 [9], and if the NFVO requests the VIM to allocate link ports to attach the existing or to be created virtual network during the step 4.

NOTE 1: The means by which the NFVO determines whether to create new virtual networks or reuse existing virtual networks to enable the external connectivity of the VNF/PNF is not specified in the present document.

NOTE 2: The means by which the NFVO determines whether to create the link ports to enable the external connectivity of the VNF/PNF is not specified in the present document.

   Furthermore, if the placement of the VNF can already be determined by the NFVO and externally-managed internal VLs are to be used, the NFVO may request the VIM the creation of the new virtual network(s) for the externally-managed internal VL.

NOTE 3: The means by which the NFVO determines whether to create the "externally-managed internal VLs for the VNF" is not specified in the present document.

   In case reservation of virtualised resources is required for the VNF to be instantiated, the NFVO and VIM may perform the reservation of the virtualised resources that are known (at this stage) to be required for the respective VNFs to instantiate.

5. If the NS to be instantiated contains NS VL and associated resources, and the containerized VNF case, as part of the NS instance instantiation, NFVO may request the CISM to configure secondary container cluster network.

Instantiation of new VNF (steps 6 to 21, performed with the respective VNFM for each new VNF instance to be instantiated), adding existing VNF instances into the NS (steps 22 to 37) and adding PNFs (steps 38 to 39) can be executed in any order or in parallel unless there are dependencies defined in the NSD (dependencies apply to VNF and/or nested NS that are to be instantiated, as specified in clause 6.3.12 of ETSI GS NFV-IFA 014 [6]).

6. In case the NS to be instantiated includes new VNF(s) (as determined in step 3), the NFVO shall send to the VNFM a "CreateVnfRequest" in the payload of the POST request to the "VNF Instances" resource as specified in clause 5.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   For reference, figure 5.2.7.1-1 lists decision tree involved in the creation of VNF instance from VNFD.

   If the VNFM does not have the VNFD of the corresponding VNF instance resource to be created, the VNFM fetches the VNFD according to "Fetch VNFD" as specified in clause 5.2.7.2.

NOTE 4: If VNFM requires any artifacts or other additional content beyond the VNFD from the VNF package, the VNFM may fetch the artifacts from the VNF package during any VNF LCM operation according to "Fetch VNF Package Artifacts" as specified in clause 5.2.7.3.

   Table 5.2.5.3-1 lists the key information exchanged between NFVO and VNFM for the create VNF resource operation.

   As described in the "Flow of the creation of a VNF instance resource" (see clause 5.3.1 of ETSI GS NFV-SOL 003 [3]), the VNFM creates the "Individual VNF instance" resource. If there is an applicable subscription for VNF LCM notifications to the NFVO, VNFM sends to the NFVO a "VnfIdentifierCreationNotification". If there is an applicable subscription for VNF LCM notifications to the EM, VNFM sends to the EM same type of "VnfIdentifierCreationNotification". Optionally, if the certificate is required for the VNF to be instantiated and the certificate management is delegation-mode, the VNFM and CMF may perform the registration of the VNF instance. If reservation of virtualised resources is required for the VNF to be instantiated, the NFVO and VIM may perform the reservation of the virtualised resources that are known (at this stage) to be required for the respective VNFs to instantiate.

7. In the case that VNF information modifications about metadata, extensions or VNF configurable properties are required before triggering the instantiation of the VNF, the NFVO shall request the VNFM the modification of information of the VNF by sending a "VnfInfoModificationRequest" in the payload of the PATCH request to the "Individual VNF instance" resource created in step 6 as specified in clause 5.4.3.3.4 of ETSI GS NFV-SOL 003 [3]. For a description of the cases and conditions of when the VNF information can be provided, refer to clause 5.2.5.4.

   As described in the "Flow of the Modify VNF Information operation" (see clause 5.3.6 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource, and sends the response to NFVO. VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

   Table 5.2.5.4-1 lists the key information exchanged between NFVO and VNFM for the modification of VNF instance information.

NOTE 5: This allows the operator to set VNF configurable properties (e.g. deployment specific configuration), metadata and extensions to be used during the VNF instantiation.

8. In order to start with the VNF instantiation, the NFVO shall send to the VNFM an "InstantiateVnfRequest" in the payload of the POST request to the "Individual VNF instance" resource created in step 4 as specified in clause 5.4.4.3.1 of ETSI GS NFV-SOL 003 [3].

   As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource, and sends the response to NFVO. Clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3] specifies the requirements of the VNFM in handling the task resources that trigger VNF LCM operations.

   Table 5.2.5.5-1 lists the key information exchanged between NFVO and VNFM to instantiate the VNF instance.

   VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

The NFVO can poll the "Individual VNF LCM operation occurrence" resource to obtain information about the ongoing operation by sending a GET request to the "Individual VNF LCM operation occurrence" resource as specified in clause 5.4.3.3.2 of ETSI GS NFV-SOL 003 [3].

VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

9. As part of the VNF instantiation, the NFVO and VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle instantiate operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the payload of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.2.5.6-1 lists the key information exchanged between NFVO and VNFM during the VNF resource grant process.

10. The NFVO processes the granting request. Based on the NSD information and the input information from the granting request, the NFVO shall make a final selection of the NFVI-PoPs and CIS Cluster for the VNF that is to be instantiated.

NOTE 6: The reservation of virtualised resources may happen also or in addition before sending the VNF instantiation request.

11. In case that the Grant request includes PaaS Service request, the NFVO shall choose the PaaS Service to be used by the VNFs and obtain access information of the PaaS Service.

12. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]) the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code 201 (Created) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

13. For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code 202 (Accepted) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

    For the case of "asynchronous mode", as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code 202 (Accepted) which indicates that the grant processing is in progress. When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code 200 (OK) with the content of the Grant.

NOTE 7: The grant processing and message exchanges specified in the steps above only describe the success cases.

As part of granting, resource orchestration is performed by the NFVO as required for the resource fulfilment and additional policies. Based on the NSD information and the input information from the granting request, the NFVO and VIM/CISM prepare/update the external networks (from the VNF instance point of view) based on the newly instantiated VNF (this can involve creation of new networks or preparing link ports on existing ones). If new virtual network(s) in the assigned NFVI-PoP and CIS Cluster is (are) needed to enable the external connectivity of the VNF, and the network has not been allocated in steps 4 and 5, the NFVO shall request the VIM and CISM the creation of the new virtual network(s) and secondary container cluster network. Furthermore, if the NFVO is responsible for creating the link ports to enable external connectivity of the VNF, the NFVO shall request the VIM to also allocate link ports on the newly allocated virtual networks or on the virtual networks to be reused, to attach later the external connection points of the VNF. Refer also to note 1 and note 2 in step 4.

Table 5.2.5.9-1 lists key information exchange between NFVO and VIM to allocate link port. The listed key information applies only in case the VIM's consumer communicates with the VIM using the descriptor based approach defined in ETSI GS NFV-SOL 014 [9], and if the NFVO requests the VIM to allocate link ports to attach the existing or to be created virtual network during the step 13.

Furthermore, if externally-managed internal VLs are to be used and their setup has not been performed in step 4, the NFVO shall request the VIM the creation of the new virtual network(s) for the externally-managed internal VL. Upon successfully creating the externally-managed internal VL, the NFVO shall provide their information to the VNFM by filling in the designated parameters in the "Individual grant" resource. Refer also to note 3 in step 4.

In case that reservation of virtualised resources is required for the VNF to be instantiated, the NFVO and VIM shall perform the reservation of the virtualised resources that have not been reserved so far (if this is the case), before making the "Individual grant" resource available. In case that allocation of container workload in CIS cluster is required for the VNF to be instantiated, the NFVO shall request CISM to allocate a namespace of the container workload if not already created before.

14. Upon completion of the VNF LCM operation granting exchange (steps 8 to 13), if there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM sends to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

15. Optionally, if the certificate is required for the VNF to be instantiated and the certificate management is delegation-mode, the VNFM may request to issue the CSR to the CMF, and the VNFM may download the certificates and certificate chains from the CMF.

16. In the case of virtualised resources management in direct mode, the VNFM shall request to the VIM the provisioning of the virtualised resources for the VNF. If the VNFD contains boot data information, the VNFM shall provide during this step the initial configuration while requesting the instantiation of the compute resources according to the specified boot data information in the VNFD and other data held by the VNFM. Optionally, if the certificate is required for the VNF to be instantiated and the certificate management is delegation-mode, the initial configuration may contain certificates and certificate chains. Table 5.2.5.4-2 lists the key configuration information exchanged provided by the VNFM during the compute resources instantiation.

    Table 5.2.5.10-1 lists key information exchange between VNFM and VIM for compute resource provisioning and Table 5.2.5.10-2 lists key information exchange between VNFM and VIM for storage resource provisioning. The listed key information applies only in case the VIM's consumer communicates with the VIM using the descriptor-based approach as defined in ETSI GS NFV-SOL 014 [9], and if the VNFM requests the VIM to provision compute and storage resource(s) during the step 15.

Setting configuration for a VNF instance (step 18) and creating subscription to receive notifications related to VNF indicator value changes (see clause 5.2.6.2.9) can be executed in parallel.

17. In the case of containerized VNF, VNFM creates input parameter as specified in clause 6.2 of ETSI GS NFV-SOL 018 [11].

18. VNFM request to CISM to instantiate and configurate containerized workload part of VNF as described in clause 7.3.1 of ETSI GS NFV-SOL 018 [11]. Table 5.2.5.11-1 lists the key information exchanged between VNFM and CISM during the VNF instantiation process.

19. In the case that certain configuration needs to be setup into the VNF after the virtualised resources have been created, and before completing the VNF instantiation (e.g. as controlled by the workflows/scripts declared in the VNFD), and the VNF supports the VNF configuration interface as specified in clause 9 of ETSI GS NFV-SOL 002 [2], the VNFM shall send to the VNF a "VnfConfigModifications" in the payload of the PATCH request to the "configuration" resource as specified in clause 9.4.2.3.4 of ETSI GS NFV-SOL 002 [2]. As described in the "Flow of setting the VNF configuration" (see clause 9.3.1 of ETSI GS NFV-SOL 002 [2]), the VNF sets the configuration of the VNF instance and/or its VNFC instances. If VNF configuration is supported by means of LCM scripts, VNFM invokes these LCM scripts as part of VNF configuration.

20. In the case that VNF uses the PaaS Service, VNF may access to the PaaS Service by using the access information.

21. Upon completion of the VNF instantiation by the VNFM, the VNFM sends to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for VNF LCM operation occurrence notifications to the NFVO, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM. VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clauses 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3] and the "instantiationState" attribute of the "VnfInstance" to the value "INSTANTIATED", as per clause 5.4.4.3.1 of ETSI GS NFV-SOL 003 [3].

Following steps 22 to 36 are performed by the NFVO, and with the respective VNFM (if interactions with the VNFM are needed), for each existing VNF instance to be reused for the NS that is being instantiated. These steps can be performed in parallel for different VNF instances:

NOTE 8: In the present document version, the procedure steps for the potential case of scaling a VNF instance prior to adding the VNF instance to the NS are not specified.

22. In case the NS to be instantiated includes existing VNF instances to be reused (as determined in step 3), the NFVO adds the existing VNF instance into the newly created NS.

23. In case additional updates are needed to fulfil the external connectivity of the existing VM based VNF instances to reuse in the NS, and based on the NSD information, the NFVO and VIM prepare/update the external networks to the existing VNF instances (this can involve creation of new networks or preparing link ports on existing ones). If new virtual network(s) is (are) needed to enable the external connectivity of the VNF, and the network has not been allocated in step 4, the NFVO shall request the VIM the creation of the new virtual network(s). Furthermore, if the NFVO is responsible for creating the link ports to enable external connectivity of the VNF, the NFVO shall request the VIM to also allocate link ports on the newly allocated virtual networks or on the virtual networks to be reused, to attach later the external connection points of the VNF. Refer also to note 1 and note 2 in step 4.

    Table 5.2.5.9-1 lists key information exchange between NFVO and VIM to allocate link port. The listed key information applies only in case the VIM's consumer communicates with the VIM using the descriptor based approach defined in ETSI GS NFV-SOL 014 [9], and if the NFVO requests the VIM to allocate link ports to attach the existing or to be created virtual network during the step 23.

24. In case additional updates are needed to fulfil the external connectivity of the existing container based VNF instances to reuse in the NS, and based on the NSD information, the NFVO and CISM prepare/update the secondary container cluster network to the existing VNF instances.

25. In case the external connectivity for the existing VNF instance needs to be updated, the NFVO shall send to the VNFM a "ChangeExtVnfConnectivityRequest" in the payload of the POST request to the "Individual VNF instance" resource as specified in clause 5.4.11.3.1 of ETSI GS NFV-SOL 003 [3]. As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource and sends the response to NFVO. VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

    VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

    Table 5.5.5.2-1 lists the key information exchanged between NFVO and VNFM to change the external connectivity of the VNF instance.

26. As part of the VNF external connectivity change, the NFVO and VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle change external VNF connectivity operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the payload of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

    Table 5.5.5.3-1 lists the key information exchanged between NFVO and VNFM during the VNF LCM operation grant process.

27. The NFVO processes the granting request. Based on the NSD information, the current information and state of "Individual NS instance" resource, and the input information from the granting request, the NFVO makes a decision about the VNF LCM operation granting request related to the VNF termination.

28. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]), the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code 201 (Created) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

29. For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code 202 (Accepted) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

    For the case of "asynchronous mode", as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code 202 (Accepted) which indicates that the grant processing is in progress. When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code 200 (OK) with the content of the Grant.

NOTE 9: The grant processing and message exchanges specified in the steps above only describe the success cases.

30. Upon successful completion of the VNF LCM operation granting exchange (steps 26 to 29), if there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM will send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

31. For the VM case, the VNFM changes (connect/disconnect) the network connectivity with the external virtual links.

32. For the container of container primary cluster network case, the VNFM changes (connect/disconnect) the network connectivity to update Ingress or Service with the external virtual links.

33. For the container of container secondary cluster network case, the VNFM inject parameter to change (connect/disconnect) the network connectivity.

34. The VNFM changes (connect/disconnect) the network connectivity.

35. Optionally, if the certificate is required for the VNF instance and the certificate management is delegation-mode, the VNFM may request to issues the CSR to the CMF, and the VNFM may download the certificates and certificate chains from the CMF.

36. If the certificate is required for the VNF instance, the certificate management is delegation-mode, and the VNF supports the VNF configuration interface as specified in clause 9 of ETSI GS NFV-SOL 002 [2], the VNFM may send to the VNF a "VnfConfigModifications" in the payload of the PATCH request to the "configuration" resource as specified in clause 9.4.2.3.4 of ETSI GS NFV-SOL 002 [2]. As described in the "Flow of setting the VNF configuration" (see clause 9.3.1 of ETSI GS NFV-SOL 002 [2]), the VNF sets the configuration of the VNF instance and/or its VNFC instances. If VNF configuration is supported by means of LCM scripts, VNFM invokes these LCM scripts as part of VNF configuration.

37. Upon successful completion of the Change External VNF connectivity by the VNFM, the VNFM will send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for VNF LCM operation occurrence notifications to the NFVO, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM. VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clauses 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3].

Following steps 38 and 39, are performed by the NFVO for each existing PNF to be reused for the NS that is being instantiated. These steps can be performed in parallel for different PNFs:

38. In case the NS to be instantiated includes PNFs (as determined in step 3), the NFVO adds the PNF into the newly created NS instance.

39. Based on the NSD information, the current information and state of the "Individual NS instance" resource, and the outcomes from the PNF addition, the NFVO and VIM add or update external networks (from the PNF instance point of view) and/or link ports used to connect the PNF within the NS instance. If new virtual network(s) is (are) needed to enable the external connectivity of the PNF, and the network has not been allocated in step 4, the NFVO shall request the VIM the creation of the new virtual network(s). Furthermore, if the NFVO is responsible for creating the link ports to enable external connectivity of the PNF, the NFVO shall request the VIM to also allocate link ports on the newly allocated virtual networks or on the virtual networks to be reused, to attach the external connection points of the PNF. See also note 1 and note 2 in step 4.

    Table 5.2.5.9-1 lists key information exchange between NFVO and VIM to allocate link port. The listed key information applies only in case the VIM's consumer communicates with the VIM using the descriptor based approach defined in ETSI GS NFV-SOL 014 [9], and if the NFVO requests the VIM to allocate link ports to attach the existing or to be created virtual network during the step 39.

40. Upon completion of instantiation of all involved VNF instances, addition of existing VNF instances and PNF, and connectivity needed for the Network Service, the NFVO sends to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS, as defined in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4], and the "nsState" of "NsInstance" to "INSTANTIATED" as per clause 6.4.4.3.1 of ETSI GS NFV-SOL 005 [4]. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations.

## 5.2.4 Post-conditions

Table 5.2.4-1 specifies the post-conditions applicable to the NS instantiation procedure.

**Table 5.2.4-1: NS instantiation procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The NS has been instantiated and is available for further operation and management. | |

## 5.2.5 Key information exchanged in the procedure

### 5.2.5.1 Create NS instance resource

Table 5.2.5.1-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the creation of NS instance in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.2.5.1-1: Key information exchanged during create NS instance resource**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| CreateNsRequest in the request | nsdId | Shall be set to the identifier of the NSD in the NFVO to be used in creating the NS instance. The appropriate NSD to use is determined by the OSS/BSS based on the required network service. |
| | certificateConfigurationData | Shall be set to the Configuration for certificate management if the certificate is required for the VNF in the NS instance to be instantiated and the certificate management is delegation-mode. |

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| NsInstance in the response | id | Set by the NFVO to the identifier of NS instance created by the NFVO. |
| | nsdId | Set by the NFVO to the same "nsdId" provided in the "CreateNsRequest", based on which the "Individual NS instance" resource represented by "NsInstance" is created, as defined in clause 6.4.2.3.1 of ETSI GS NFV-SOL 005 [4]. |
| | nsState | Set by the NFVO to "NOT_INSTANTIATED", as defined in clause 6.4.2.3.1 of ETSI GS NFV-SOL 005 [4]. |
| NsIdentifierCreationNotification | nsInstanceId | Set by the NFVO to the "id" attribute of "NsInstance" representing the "Individual NS instance" resource created by the NFVO, defined in clause 6.5.2.6 of ETSI GS NFV-SOL 005 [4]. |

### 5.2.5.2 Instantiate NS instance

Table 5.2.5.2-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO to instantiate the NS instance in the context of the NFV-MANO procedure. The full set of request/response data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.2.5.2-1: Key information exchanged during Instantiate NS instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set by the OSS/BSS to the "id" attribute of "NsInstance" representing the "Individual NS instance" resource created by NFVO. |
| InstantiateNsRequest in the request | nsFlavourId | Shall be set by the OSS/BSS to the identifier of the NS deployment flavour to be instantiated. The OSS/BSS determines the appropriate NS deployment flavour based on the required network service. This identifier shall be among the values declared in the NSD. |
| | addpnfData | If PNFs are used in the NS, this shall be set by the OSS/BSS to the PNF data as specified in clause 6.5.3.14 of ETSI GS NFV-SOL 005 [4] for each PNF to be added to the NS instance. |
| | vnfInstanceData | If existing VNFs are to be used in the NS, this shall be set by the OSS/BSS to existing VNF instance data as specified in clause 6.5.3.19 of ETSI GS NFV-SOL 005 [4] for each existing VNF instance to be used in the NS instance. |

### 5.2.5.3 Create VNF instance resource

Table 5.2.5.3-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM during the creation of VNF instance in the context of the present NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.2.5.3-1: Key information exchanged during create VNF instance resource**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| CreateVnfRequest in the request | vnfdId | Shall be set by the NFVO to the VNFD identifier of the VNF instance to be created corresponding to the NsInstance requested to be instantiated. |
| | vnfInstanceName | The human-readable name of the VNF instance to be created shall be set by the NFVO according to the values indicated in the "ParamsForVnf" attribute in the "InstantiateNsRequest". |
| | vnfInstanceDescription | The human-readable description of the VNF instance to be created shall be set by the NFVO according to the values indicated in the "ParamsForVnf" attribute in the "InstantiateNsRequest". |
| | Metadata | Values for the "metadata" attribute in "VnfInstance". The keys in the key value pairs are declared in the VNFD, along with a possible default value. The NFVO shall set the values of all required key value pairs based on pre-configured information or present values available to the NFVO. |
| | certificateConfigurationData | Shall be set to the same value of certificateConfigurationData in CreateNsRequest, if the certificate is required for the VNF to be instantiated and the certificate management is delegation-mode. |
| VnfInstance in the response | id | Set by the VNFM to the identifier of VNF instance created by VNFM. |
| | vnfdId | Set by the VNFM to the same "vnfdId" provided in the "CreateVnfRequest", based on which the "Individual VNF instance" resource represented by "VnfInstance" is created, as defined in clause 5.4.2.3.1 of ETSI GS NFV-SOL 003 [3]. |

### 5.2.5.4 Modification of VNF information and virtualised resource configuration data

The NFVO can learn from the VNFD whether a VNF information attribute is to be set prior to/at instantiation time or anytime as specified in clauses 7.1.12 and 7.1.14 of ETSI GS NFV-IFA 011 [8]. In addition, as per note 4 in table 5.5.2.2-1 of ETSI GS NFV-SOL 003 [3], in the specification of the representation of the "Individual VNF instance" resource (the "VnfInstance" structure) specifies the initialization of the child attributes of "vnfConfigurableProperties", "metadata" and "extensions" upon creation of the "VnfInstance" structure.

Table 5.2.5.4-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM during the modification of VNF information in the context of the present NFV-MANO procedure. The full set of request/response data types and attributes are specified in clauses 5.5.2.12 and 5.5.2.12a of ETSI GS NFV-SOL 003 [3].

**Table 5.2.5.4-1: Key information exchanged during Modify VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO in the request to the same "id" attribute of VnfInstance created by VNFM. |
| VnfInfoModificationRequest in the request | vnfConfigurableProperties | Shall be set by the NFVO to the required key value pairs if the values for the "vnfConfigurableProperties" attribute in "VnfInstance" are different from the values declared in VNFD and such information is to be provided prior to instantiation time. |
| | Metadata | Shall be set by the NFVO to the required key value pairs if the values for the "metadata" attribute in "VnfInstance" are different from the values declared in VNFD and such information is to be provided prior to instantiation time. |
| | Extensions | Shall be set by the NFVO to the required key value pairs if the values for the "extensions" attribute in "VnfInstance" are different from the values declared in VNFD and such information is to be provided prior to instantiation time. |

Table 5.2.5.4-2 lists the source and mapping of selected key VNF information exchanged between the NFVO and VNFM during the VNF instantiation request in the context of the present NFV-MANO procedure. The full set of request/response data types and attributes are specified in clause 5.5.2.4 of ETSI GS NFV-SOL 003 [3].

**Table 5.2.5.4-2: Key VNF information modifications exchanged during Instantiate VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| InstantiateVnfRequest in the request | vnfConfigurableProperties | Shall be set by the NFVO to the required key value pairs if the values for the "vnfConfigurableProperties" attribute in "VnfInstance" are different from the values declared in VNFD or currently set in the "VnfInstance" and such information is to be provided prior to or at instantiation time. |
| | Extensions | Shall be set by the NFVO to the required key value pairs if the values for the "extensions" attribute in "VnfInstance" are different from the values declared in VNFD or currently set in the "VnfInstance" and such information is to be provided prior to or at instantiation time. |

Table 5.2.5.4-3 lists selected key configuration information exchanged on VNF LCM operations or set from values in the VNFD which can become the source of boot data during the compute resources instantiation.

**Table 5.2.5.4-3: Sources of boot data variables values**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| InstantiateVnfRequest in the request | additionalParams | Specific values to substitute predefined variables in the boot data template can be obtained via the additional parameters. Values obtained by the VNFM as additional params are "volatile", i.e. only applicable and available to the boot data template during the respective VNF lifecycle management operation execution.<br><br>Shall be set by the NFVO to the required key value pairs as defined in the VNFD. |
| "VnfInstance" structure | vnfConfigurableProperties | Specific values to substitute predefined variables in the boot data template can be obtained via the "vnfConfigurableProperties" attributes. Values obtained by the VNFM as VNF configurable properties are "persistent", i.e. such values are available to the boot data template during the lifetime of the VNF instance. Values may be modified during the lifetime of the VNF instance, as defined in the VNFD.<br><br>For the setting of these values by the NFVO see tables 5.2.5.4-1 and 5.2.5.4-2. |
| | Extensions | Specific values to substitute predefined variables in the boot data template can be obtained via the "extensions" attribute. Values obtained by the VNFM as extensions are "persistent", i.e. such values are available to the boot data template during the lifetime of the VNF instance. Values may be modified during the lifetime of the VNF instance, as defined in the VNFD.<br><br>For the setting of these values by the NFVO see tables 5.2.5.4-1 and 5.2.5.4-2. |

### 5.2.5.5 Instantiate VNF instance

Table 5.2.5.5-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM during the instantiation of the VNF in the context of the present NFV-MANO procedure. The full set of request/response data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.2.5.5-1: Key information exchanged during Instantiate VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO in the request to the same "id" attribute of "VnfInstance" created by VNFM. |
| InstantiateVnfRequest in the request | flavourId | Shall be set by the NFVO to the "flavourId" attribute value of the VnfProfile of NsDf in the NSD, upon validation of this value being present in the corresponding VNFD. |
| | instantiationLevelId | Shall be set by the NFVO to the "instantiationLevel" attribute value of the VnfProfile of NsDf in the NSD applicable to this VNF instance, upon validation of this value being present in the corresponding VNFD, if the desired instantiation level is different from the default instantiation level declared in the VNFD. If not provided, the "defaultInstantiationLevelId" attribute value declared in the VnfDf of VNFD shall be used. See note 2. |
| | targetScaleLevelInfo | Shall be set by the NFVO to the "targetScaleLevelInfo" attribute value of the VnfProfile of NsDf in the NSD, applicable to this VNF instance, upon validation of this value being present in the corresponding VNFD, if the desired instantiation level is different from the default target scale level declared in the VNFD. If not provided, the "defaultInstantiationLevelId" attribute value declared in the VnfDf of VNFD shall be used. See note 2. |
| | extVirtualLinks | If the external connection for the VNF is known to the NFVO prior to the instantiation of VNF, this attribute shall be set by the NFVO to provide to the VNFM information about external VLs to connect the VNF to (refer to step 4 in the procedure flow). See note 1. |
| | extManagedVirtualLinkData | If the information is known to the NFVO prior to instantiation, this attribute shall be set by the NFVO to provide to the VNFM information about internal VL that are managed by other entities than the VNFM (refer to step 4 in the procedure flow). See note 1. |
| NOTE 1: External connectivity for the VNF and externally-managed VL information can also be provided during the VNF LCM granting exchange, as also defined in clause 5.2.5.6. | | |
| NOTE 2: The target size for VNF instantiation may be specified in either instantiationLevelId or targetScaleLevelInfo, but not both. The "targetScaleLevelInfo" attribute is applicable if VNF supports target scale level instantiation for each scaling aspect of the current VNF deployment flavour. | | |

### 5.2.5.6 VNF LCM granting exchange

Table 5.2.5.6-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM during the VNF LCM operation granting corresponding to the VNF instantiation, in the context of the present NFV-MANO procedure. The full set of request/response data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.2.5.6-1: Key information exchanged during VNF LCM granting exchange**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| GrantRequest in the request | vnfInstanceId | Shall be set by the VNFM to the same "id" attribute of "VnfInstance" created by the VNFM that has been requested to be instantiated. |
| | vnfLcmOpOccId | Shall be set by the VNFM to the identifier of the VNF lifecycle management operation occurrence associated to the GrantRequest. |
| | vnfdId | Shall be set by the VNFM to the "vnfdid" attribute of "VnfInstance" created by the VNFM that has been requested to be instantiated. |
| | Operation | Shall be set by the VNFM to "INSTANTIATE". |
| | isAutomaticInvocation | Shall be set by the VNFM to false. |
| | addResources | Shall be set by the VNFM to the list of resource definitions in the VNFD for resources to be added by the LCM operation which is related to this grant request, with one entry per resource.<br><br>This attribute is not included if the "instantiationLevelId" or "targetScaleLevelInfo" attribute is present in the InstantiateVnfRequest. |
| | instantiationLevelId | Shall be set by the VNFM to the same attribute in InstantiateVnfRequest if present.<br><br>This attribute is not included if the "instantiationLevelId" attribute is not present in the InstantiateVnfRequest. |
| | targetScaleLevelInfo | Shall be set by the VNFM to the same attribute in InstantiateVnfRequest if present.<br><br>This attribute is not included if the "targetScaleLevelInfo" attribute is not present in the InstantiateVnfRequest. This attribute provides an alternative way to add the resources to VNFs. See note 2. |
| Grant in the response | vnfInstanceId | Set by the NFVO to the same value of the "id" attribute of "VnfInstance" to be instantiated by the VNFM as provided in the GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | vnfLcmOpOccId | Set by the NFVO to the same value of the "vnfLcmOpOccId" attribute of GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | addResources | Set by the NFVO to indicate the list of resources that are approved to be added, with one entry per resource, as defined in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3]. |
| | extVirtualLinks | If the extVirtualLinks data has not been provided in the VNF instantiation request, this attribute is set by the NFVO to provide to the VNFM information about external VLs to connect the VNF to (refer to step 11 in the procedure flow). The NFVO might choose to override in the grant response external VL instances information that has been passed previously in the VNF instantiation request, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. See note 1. |
| | extManagedVirtualLinkData | If the extManagedVirtualLinkData has not been provided in the VNF instantiation request, this attribute is set by the NFVO, if needed to provide to the VNFM information about internal VL that are managed by other entities than the VNFM (refer to step 11 in the procedure flow). The NFVO might choose to override in the grant response externally-managed VL instances information that has been passed previously in the VNF instantiation request, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. See note 1. |
| | containerNamespace | If addResources is containerized components managed by CISM, set by the NFVO to indicate namespace in CISM as defined in clause 9.5.3.3 of ETSI GS NFV-SOL 003 [3]. |
| | vimConnectionInfo | Set by the NFVO to indicate the list of information of VIM and CISM to be used by the VNFM to allocate resources as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| | cirConnectionInfo | If addResources is containerized components managed by CISM, set by the NFVO to indicate the list of information of CIR to be used by the VNFM as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | mciopRepositoryInfo | If addResources is containerized components managed by CISM, set by the NFVO to indicate the list of information of MCIOP repository to be used by the VNFM as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | paasAssets | If addResources is PaaS Service, set by the NFVO to indicate the PaaS Services assigned to the VNF as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| NOTE 1: External connectivity for the VNF and externally-managed VL information can also be provided as part of the VNF instantiation request, as also defined in clause 5.2.5.5.<br>NOTE 2: The target size for VNF instantiation may be specified in either instantiationLevelId or targetScaleLevelInfo, but not both. | | |

### 5.2.5.7 VNF lifecycle change notifications

Table 5.2.5.7-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of the VNF lifecycle change notifications corresponding to the VNF instantiation, in the context of the present NFV-MANO procedure.

The full set of notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO as recipient of the notifications and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.2.5.7-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.2.5.7-1: Key information exchanged during VNF lifecycle change notifications**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfLcmOperationOccurrenceNotification payload in the request | notificationType | Set by the VNFM to "VnfLcmOperationOccurrenceNotification", as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | subscriptionId | Set by the VNFM to the value of the "id" attribute of the associated "LccnSubscription" representing the "Individual subscription" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | notificationStatus | Set by the VNFM to either "START" or "RESULT", depending on whether the notification relates to start, final or intermediate result of the VNF LCM operation occurrence, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | operationState | Set by the VNFM to the value of the "operationState" attribute in the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence", as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | Operation | Set by the VNFM to "INSTANTIATE" for the present VNF instantiation procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |
| | vnfLcmOpOccId | Set by the VNFM to the value of the "id" attribute of associated "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |

### 5.2.5.8 VNF lifecycle management operation occurrences

Table 5.2.5.8-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of reading the VNF lifecycle management operation occurrence corresponding to the VNF instantiation, in the context of the present NFV-MANO procedure.

The full set of data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.2.5.8-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.2.5.8-1: Key information exchanged during reading VNF lifecycle management operation occurrences**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfLcmOpOccId | Shall be set by the NFVO to the "id" attribute of the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource to read. |
| VnfLcmOpOcc in the response | operationState | Set by the VNFM to the state value of the VNF LCM operation occurrence, as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | vnfInstanceId | Set by the VNFM to the value of the "id" attribute of the "VnfInstance" representing the associated "Individual VNF instance" resource, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | grantId | Set by the VNFM to the value of the "id" attribute in the "Grant" representing the associated "Individual grant" resource, if such a grant exists, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | Operation | Set by the VNFM to "INSTANTIATE" for the present VNF instantiation procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |

### 5.2.5.9 Link ports

This clause applies if the VIM's consumer communicates with the VIM using the descriptor-based approach defined in ETSI GS NFV-SOL 014 [9]. ETSI GS NFV-SOL 014 [9] specifies a set of request/response/notification data types and attributes for a descriptor-based approach and this clause describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 014 [9].

Table 5.2.5.9-1 lists the source and mapping of selected key information between NFVO and VIM to allocate link port as part of "Resource orchestration".

**Table 5.2.5.9-1: Key information for link port creation**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| Link port in the request | networkResourceType | Shall be set by the NFVO to "network-port", as defined in clause 7.2.2 of ETSI GS NFV-SOL 014 [9]. |
| typeNetworkPortData in the request | networkId | Shall be set by the NFVO to the value of the nfvNetworkInfo>networkResourceId for the network to which this port attach, as defined in clause 7.2.4 of ETSI GS NFV-SOL 014 [9], if the existing virtual network(s) are re-used for the port to be created or if the new virtual network(s) for the port are already created. |

### 5.2.5.10 Virtualised resources provisioning for the VNF Instance

This clause applies if the VIM's consumer communicates with the VIM using the descriptor-based approach defined in ETSI GS NFV-SOL 014 [9]. ETSI GS NFV-SOL 014 [9] specifies a set of request/response/notification data types and attributes for a descriptor-based approach and this clause describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 014 [9].

Table 5.2.5.10-1 lists the selected key information sent towards the VIM(s) for provisioning of the compute resource.

**Table 5.2.5.10-1: Key information for compute resource provisioning**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| Compute name in the request | computeName | Shall be set by the VNFM to node template name of type tosca.nodes.nfv.Vdu.Compute declared in the VNFD>topology_template>node_templates as specified in clause 6.8.3.7 of ETSI GS NFV-SOL 001 [1].<br>(e.g. "dbBackend" in the example described in clause 6.8.3.8 of ETSI GS NFV-SOL 001 [1]). |
| Compute flavour ID in the request | computeFlavourId | Shall be set by the VNFM to vimFlavourId of the grant response>vimAssets>computeResourceFlavours as specified in clause 9.5.3.9 of ETSI GS NFV-SOL 003 [3] during the VNF LCM granting exchange which (computeResourceFlavours) includes vnfdVirtualComputeDescId that equals to node template name of type tosca.nodes.nfv.Vdu.Compute declared in the VNFD>topology_template>node_templates as specified in clause 6.8.3.7 of ETSI GS NFV-SOL 001 [1]. |
| Virtual Compute image ID in the request | vcImageId | Shall be set by the VNFM to vimSoftwareImageId of the grant response>vimAssets>softwareImages as specified in clause 9.5.3.9 of ETSI GS NFV-SOL 003 [3] during the VNF LCM granting exchange which (softwareImages) includes vnfdSoftwareImageId that equals to node temple name of type tosca.nodes.nfv.Vdu.Compute declared in the VNFD>topology_template>node_templates as specified in clause 6.8.3.7 of ETSI GS NFV-SOL 001 [1]. |
| Location Constrains in the request | locationConstraints | Shall be set by the VNFM to zoneId of the grant response>addResources as specified in clause 9.5.3.9 of ETSI GS NFV-SOL 003 [3] during the VNF LCM granting exchange which (addResources) includes resourceDefinitionId that equals to the value of GrantRequest>addResources>id as specified in clause 9.5.3.9 of ETSI GS NFV-SOL 003 [3], also this addResources includes vduId that equals to node template name of type tosca.nodes.nfv.Vdu.Compute declared in the VNFD>topology_template>node_templates as specified in clause 6.8.3.7 of ETSI GS NFV-SOL 001 [1]. |
| User Data in the request | >content | Shall be set by the VNFM to the value of the property named content of type tosca.datatypes.nfv.ContentOrFileData declared in the VNFD>topology_template>node_templates as specified in clause 6.2.58 of ETSI GS NFV-SOL 001 [1]. |
| | >method | Shall be set by the VNFM according to the property named properties of type tosca.datatypes.nfv.BootDataVimSpecificProperties declared in the VNFD>topology_templates>node_templates as specified in clause 6.2.59 of ETSI GS NFV-SOL 001 [1], and according to the clause 6.2.11 of ETSI GS NFV-SOL 014 [9]. |
| | >certificateData | Shall be set to the certificate file or configuration related to certificate management, if the certificate is required for the VNF to be instantiated and the certificate management is delegation-mode. |

Table 5.2.5.10-2 lists the selected key information sent towards the VIM(s) for provisioning of the storage resource.

**Table 5.2.5.10-2: Key information for storage resource provisioning**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| Storage name in the request | storageName | For the VirtualBlockstorage used case, shall be set by the VNFM to node template name of type tosca.nodes.nfv.Vdu.VirtualBlockStorage declared in the VNFD>topology_template>node_templates as specified in clause 6.8.4 of ETSI GS NFV-SOL 001 [1]. (e.g. "VirtualStorage_A1" in the example described in clause 6.2.12.4 of ETSI GS NFV-SOL 001 [1])<br><br>For the VirtualObjectstorage used case, shall be set by the VNFM to node template name of type tosca.nodes.nfv. Vdu.VirtualObjectStorage declared in the VNFD>topology_template>node_templates as specified in clause 6.8.5 of ETSI GS NFV-SOL 001 [1].<br><br>For the VirtualFilestorage used case, shall be set by the VNFM to node template name of type tosca.nodes.nfv. Vdu.VirtualFileStorage declared in the VNFD>topology_template>node_templates as specified in clause 6.8.6 of ETSI GS NFV-SOL 001 [1]. |
| storageData>storageAttributes for the storage resource in the request | typeOfStorage | Set by the VNFM to the type of virtualised storage resource used. |
| | sizeOfStorage | For the VirtualBlockstorage used case, shall be set by the VNFM to the value declared in the VNFD>topology_template>node_templates>tosca.nodes.nfv.Vdu.VirtualBlockStorage>properties>virtual_block_storage_data>size_of_storage as specified in clause 6.8.4 of ETSI GS NFV-SOL 001 [1].<br><br>For the VirtualObjectstorage used case, shall be set by the VNFM to the value declared in the VNFD>topology_template>node_templates>tosca.nodes.nfv.Vdu.VirtualObjectStorage>properties>virtual_object_storage_data>max_size_of_storage as specified in clause 6.8.5 of ETSI GS NFV-SOL 001 [1].<br><br>For the VirtualFilestorage used case, shall be set by the VNFM to the value declared in the VNFD>topology_template>node_templates>tosca.nodes.nfv.Vdu.VirtualFileStorage>properties>virtual_file_storage_data>size_of_storage as specified in clause 6.8.6 of ETSI GS NFV-SOL 001 [1]. |

## 5.2.5.11 containerized resources provisioning for the VNF Instance

This clause applies if the CISM's consumer communicates with the CISM using Deployment object of Kubernetes® resource object kind defined in ETSI GS NFV-SOL 018 [11]. This clause describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 018 [11].

Table 5.2.5.11-1 lists the selected key information sent towards the CISM(s) for provisioning of the compute resource.

**Table 5.2.5.11-1: Key information for compute resource provisioning**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| instantiating a containerized workload based on a MCIOP | name | Shall be set by the VNFM from VNFD as specified in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11]. |
| | namespace | Shall be set by the VNFM from Grant response in clause 5.2.5.6 as specified in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11]. |
| | replicas | Shall be set by the VNFM from VNFD as specified in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11]. |

Table 5.2.5.11-2 lists the selected key information sent towards the CISM(s) for provisioning of the storage resource.

**Table 5.2.5.11-2: Key information for storage resource provisioning**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| PersistentVolumeClaim | name | Shall be set by the VNFM from VNFD as specified in clause 6.2.4.1 of ETSI GS NFV-SOL 018 [11]. |
| | namespace | Shall be set by the VNFM from Grant response in clause 5.2.5.6 as specified in clause 6.2.4.1 of ETSI GS NFV-SOL 018 [11]. |
| | storage | Shall be set by the VNFM from VNFD as specified in clause 6.2.4.1 of ETSI GS NFV-SOL 018 [11]. |
| | storageClassName | Shall be set by the VNFM from Grant response as specified in clause 6.2.4.1 of ETSI GS NFV-SOL 018 [11]. |
| | volumeMode | Shall be set by the VNFM from VNFD as specified in clause 6.2.4.1 of ETSI GS NFV-SOL 018 [11]. |

## 5.2.6 Execution of dependent and non-dependent side procedures

### 5.2.6.1 Introduction

The following clauses specify the considerations of side procedures supported via the NFV-MANO interfaces, which do not form the core of functionality specified in the main NS instantiation procedure flow but can have a dependency (i.e. be impacted) or be independent from the NS instantiation.

The following clauses specify the considerations of these other side procedures with respect to the NS instantiation procedure.

### 5.2.6.2 Non-dependent side procedures

#### 5.2.6.2.1 VNF Package management

Operations about management of subscriptions to notifications (request to create a new subscription, delete and existing subscription, query and read existing subscriptions) related to VNF Package management of VNF Packages associated to the VNFs which are part of the NS instance that is being instantiated may be executed by the OSS/BSS (as specified in clauses 9.4.8 and 9.4.9 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clauses 10.4.7 and 10.4.8 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS instantiation procedure.

Operations about management of the VNF packages, and their content (retrieval of the VNF package content, query and read VNF packages information and update of information of a VNF package), corresponding to VNFs which are part of the NS instance that is being instantiated may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS instantiation procedure.

#### 5.2.6.2.2 NSD management

Operations about management of the NSD, query and read information about NSD, and retrieval of the NSD may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure.

If the NSD has constituent PNFD(s), operations about management of the PNFD, query and read information about PNFD, retrieval of the PNFD content may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure.

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, and query and read of existing subscriptions) of the NSD and PNFD related to the NS instance that is being instantiated may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure.

#### 5.2.6.2.3 NS lifecycle management

Operations about management of subscriptions to notifications related to NS lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to the NS may be executed by the OSS/BSS (as specified in clauses 6.4.16 and 6.4.17 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure. Operations about querying and reading information about NS instances, including the NS being instantiated, may be executed by the OSS/BSS (as specified in clauses 6.4.2 and 6.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure. If a specific NS instance is to be referred in a request, such a request can be only sent by the OSS/BSS once the specific NS instance identifier is known to the OSS/BSS from the NFVO as a result of or after the "Individual NS instance resource" creation.

#### 5.2.6.2.4 NS fault management

Operations about management of subscriptions to notifications related to NS fault management (request to create new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to the NS may be executed by the OSS/BSS (as specified in clauses 8.4.4 and 8.4.5 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure. Operations about querying, reading and acknowledging alarms about NS instances, including the NS being instantiated, may be executed by the OSS/BSS (as specified in clauses 8.4.2 and 8.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS instantiation procedure. If a specific NS instance is to be referred in a request, such a request can be only sent by the OSS/BSS once the specific NS instance identifier is known to the OSS/BSS from the NFVO as a result of or after the "Individual NS instance resource" creation.

#### 5.2.6.2.5 NS performance management

The request by the OSS/BSS to create a PM job and threshold, as specified in clauses 7.4.2.3.1 and 7.4.5.3.1 of ETSI GS NFV-SOL 005 [4] respectively may be executed in parallel to any of the steps in the NS instantiation procedure if no specific sub-object instance associated to the NS instance is requested to be monitored (i.e. all sub-object instances of the measured object instance are monitored). Otherwise, such a request can be only sent by the OSS/BSS once the specific sub-object instance identifier(s) are known to the OSS/BSS from the NFVO.

The request by the OSS/BSS of other operations about management of "Individual PM job" (query PM jobs, reading single PM job, deleting a PM job, and updating associated PM job callback URI), reading an "Individual performance report" and other operations about management of "Individual thresholds" (query thresholds, reading a single threshold, deleting a threshold, and updating associated threshold callback URI) (as specified in clauses 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 005 [4]) related to the NS instance that is being instantiated may be executed by the OSS/BSS in parallel to any of the steps in the NS instantiation procedure.

#### 5.2.6.2.6 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to a VNF instance may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. Operations about querying and reading information about VNF instances, including VNFs being instantiated as part of the NS instantiation, may be executed by the NFVO (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 003 [3]) and by the EM (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. If a specific VNF instance is referred in a request, such a request can be only sent by the NFVO, EM or VNF once the specific VNF instance identifier is known to the NFVO, EM or VNF from the VNFM.

NOTE: Subscriptions that do not apply to a single specific VNF instance can be created anytime.

#### 5.2.6.2.7 VNF fault management

Operations about management of subscriptions to receive notifications from the VNFM related to VNF fault management of the VNFs may be executed by the NFVO (as specified in clauses 7.4.3 and 7.4.5 of ETSI GS NFV-SOL 003 [3]) or EM (as specified in clauses 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. Operations about querying, reading and acknowledging alarms about VNF instances, including VNFs being instantiated as part of the NS instantiation, may be executed by the NFVO (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. If a specific VNF instance is to be referred in a request, such a request can only be sent by the NFVO or EM once the specific VNF instance identifier is known to the NFVO or EM from the VNFM as a result of or after the "Individual VNF instance resource" creation.

In addition, operations to escalate the perceived severity of an alarm about a VNF instance, including VNFs being instantiated as part of the NS instantiation, may be executed by the EM (as specified in clause 7.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure.

#### 5.2.6.2.8 VNF performance management

Operations about management of "Individual PM job" (create a PM job, query PM jobs, reading single PM job, deleting a PM job, and updating associated PM job callback URI), reading an "Individual performance report" and management of "Individual threshold" (create a threshold, query thresholds, reading a single threshold, deleting a threshold, and updating associated threshold callback URI) related to the VNF may be executed by the NFVO (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 003 [3]) or by EM (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. If a specific VNF instance is to be referred in a subscription request, such a request can only be sent by the NFVO or EM once the specific VNF instance identifier is known to the NFVO or EM from the VNFM as a result of or after the "Individual VNF instance resource" creation.

#### 5.2.6.2.9 VNF indicators

Operations about the management of subscriptions to receive notifications from the VNFM related to VNF indicator value changes of the VNFs may be executed by the NFVO (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS instantiation procedure. Operations about querying and reading VNF indicators information, including of VNFs being instantiated as part of the NS instantiation, may be executed by the NFVO (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS instantiation procedure. If a specific VNF instance is to be referred in a subscription request, such a request can only be sent by the NFVO once the specific VNF instance identifier is known to the NFVO from the VNFM as a result of or after the "Individual VNF instance resource" creation.

If the VNFM has not subscribed to receive VNF indicator value change notifications from the EM/VNF, the VNFM shall send the EM/VNF a "VnfIndicatorSubscriptionRequest" in the payload of a POST request to the "Subscriptions" resource as specified in clause 8.4.5.3.1 of ETSI GS NFV-SOL 002 [2] to create a subscription on the EM/VNF to receive VNF indicator value change notifications.

Likewise, operations about management of subscriptions to receive notifications from the VNF/EM related to VNF indicator value changes of the VNFs may be executed by the VNFM (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. Operations about querying and reading VNF indicators information, including of VNFs being instantiated as part of the NS instantiation, may be executed by the VNFM (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS instantiation procedure. If a specific VNF instance is to be referred in a request, such a request can only be sent by the VNFM to the EM once the specific VNF instance identifier is known to the EM as a result of or after the "Individual VNF instance resource" creation.

### 5.2.6.3 Dependent side procedures

#### 5.2.6.3.1 NS lifecycle management

For proceeding with the execution of Scale NS (as specified in clause 6.4.5 of ETSI GS NFV-SOL 005 [4]), Update NS (as specified in clause 4.6.4 of ETSI GS NFV-SOL 005 [4]), Heal NS (as specified in clause 6.4.7 of ETSI GS NFV-SOL 005 [4]), or Terminate NS (as specified in clause 6.4.8 of ETSI GS NFV-SOL 005 [4]) of the NS that is being instantiated, the "nsState" in the representation of the "Individual NS instance" resource of such NS instance is "INSTANTIATED" (refer to clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]), as a result of a successful completion of the NS instantiation procedure specified in clause 5.2.

#### 5.2.6.3.2 VNF lifecycle management

For proceeding with the execution of Scale VNF (as specified in clause 5.4.5 of ETSI GS NFV-SOL 003 [3]), Scale VNF to level (as specified in clause 5.4.6 of ETSI GS NFV-SOL 003 [3]), Change VNF flavour (as specified in clause 5.4.7 of ETSI GS NFV-SOL 003 [3]), Heal VNF (as specified in clause 5.4.9 of ETSI GS NFV-SOL 003 [3]), Operate VNF (as specified in clause 5.4.10 of ETSI GS NFV-SOL 003 [3]), or Terminate VNF (as specified in clause 5.4.8 of ETSI GS NFV-SOL 003 [3]) of a specific VNF instance which is part of the NS that is being instantiated, the "instantiationState" in the representation of the "Individual VNF instance" resource of such a VNF instance is in "INSTANTIATED" state (refer to clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]), as a result of a successful completion of the VNF instantiation sub-procedure steps of the NS instantiation procedure specified in clause 5.2.

For proceeding with the execution of VNF configuration not performed during the VNF instantiation of a specific VNF instance which is part of the NS that is being instantiated (by using the Modify VNF information as specified in clause 5.4.3.3.4 of ETSI GS NFV-SOL 003 [3] for modifications requested by the NFVO, and clause 5.4.3.3.4 of ETSI GS NFV-SOL 002 [2] for modifications requested by the EM), the "instantiationState" in the representation of the "Individual VNF instance" resource of such a VNF instance is in "INSTANTIATED" state (refer to clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]), as a result of a successful completion of the VNF instantiation sub-procedure steps of the NS instantiation procedure specified in clause 5.2.

#### 5.2.6.3.3 NSD management

Once the "Individual NS instance" resource has been created by successful completion of the step 1 in the NS instantiation procedure specified in clause 5.2.3, the NFVO will set the "nsdUsageState" in the representation of the "Individual NS Descriptor" resource of a specific NSD from "NOT_IN_USE" to "IN_USE", if there is some representation of an "Individual NS instance" resource that refers to an NSD, and will maintain the "nsdUsageStage" set to "IN_USE" as long as such "Individual NS instance" exists, as defined in clause B.1.2 of ETSI GS NFV-SOL 005 [4].

### 5.2.6.4 Error cases and other considerations

#### 5.2.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "NS instantiation procedure" is the same as the one defined in clause 5.1.6.4.1. In particular, a VNF Package cannot be deleted while the usage state of the "Individual VNF package" resource is "IN_USE", which happens when at least an "Individual VNF instance" resource created from the VNF package exists (see also clause 9.5.4.5 of ETSI GS NFV-SOL 005 [4]).

#### 5.2.6.4.2 NSD management

The handling of the request by the OSS/BSS to delete an onboarded NSD during the "NS instantiation procedure" is defined in clause 5.4.3.3.5 of ETSI GS NFV-SOL 005 [4], which specifies the handling of error cases such as the "Individual NS descriptor" resource being ENABLED or having current NS instances based on the concerned NSD. Likewise, the request by the OSS/BSS to delete an onboarded PNFD defined in clause 5.4.6.3.5 of ETSI GS NFV-SOL 005 [4].

NOTE: Examples of use cases to be considered by the consumer, prior to requesting the deletion of an onboarded NSD or PNFD are the NSD could be referred by some other NSD to be on-boarded at a later stage, or the NSD could be still referred to instantiate a subsequent NS.

## 5.2.7 Other information

### 5.2.7.1 Creation of VNF instance from VNFD

Figure 5.2.7.1-1 lists decision tree involved in the creation on VNF instance from VNFD.

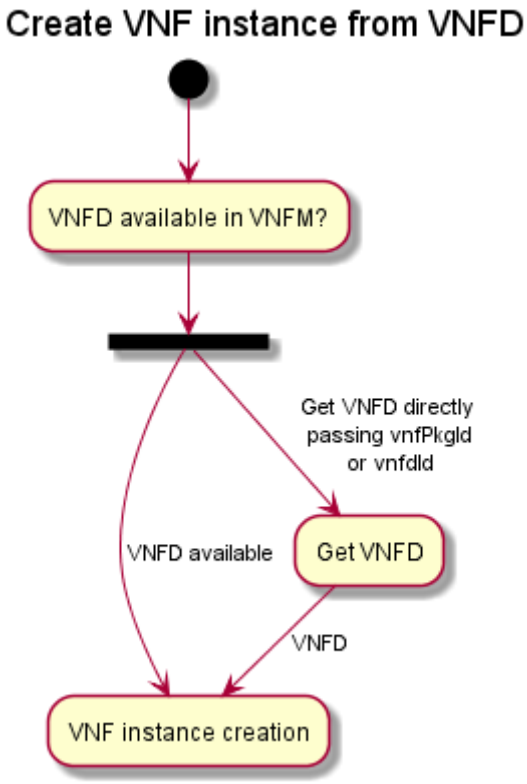


**Figure 5.2.7.1-1: Creation of VNF instance from VNFD**

### 5.2.7.2 Fetch VNFD

The VNFM shall send to the NFVO a GET request to the "VNFD in an individual VNF package" resource by passing the vnfPkgId or the vnfdId (according to the possible resource URIs) as specified in clause 10.4.4.3.2 of ETSI GS NFV-SOL 003 [3]. As described in the "Flow of reading the VNFD of an on-boarded VNF package" (see clause 10.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM receives the VNFD in the payload of the response.

### 5.2.7.3 Fetch VNF Package Artifacts

VNFM can fetch certain artifacts individually as needed or bulk fetch multiple artifacts or fetch the complete on-boarded package. If VNFM needs VNF package information, VNFM queries this information from the NFVO. To obtain VNF package information, the VNFM shall send a GET request to the "Individual VNF package" resource, by passing the vnfPkgId or the vnfdId (according to the possible resource URIs) as specified in clause 10.4.3.3.2 of ETSI GS NFV-SOL 003 [3]:

- For fetching the individual artifacts directly, the VNFM shall send a GET request to the needed "Individual VNF package artifact" resource by passing the vnfPkgId or vnfdId (according to the possible resource URIs) as specified in clause 10.4.6.3.2 of ETSI GS NFV-SOL 003 [3], as many times as needed depending on the artifacts to fetch.
- For fetching multiple artifacts in bulk, where said artifacts exclude software images, the VNFM shall send a GET request to the "VNF package artifacts" resource by passing the vnfPkgId or vnfdId (according to the possible resource URIs) as specified in clause 10.4.5a.3.2 of ETSI GS NFV-SOL 003 [3]. By using the appropriate URI query parameters, the VNFM can request to include the external artifacts to the VNF package in the archive returned with the bulk fetching.

- For fetching the complete on-boarded VNF package from the NFVO (see note), VNFM shall send a GET request to the "VNF package content" resource, by passing the vnfPkgId or the vnfdId (according to the possible resource URIs) as specified in clause 10.4.5.3.2 of ETSI GS NFV-SOL 003 [3].

NOTE: It is not recommended to fetch artifacts or the whole VNF Package when the VNFM is expected to provide a synchronous response, as fetching can potentially incur delays in processing the request and providing a response (e.g. affecting HTTP timers).

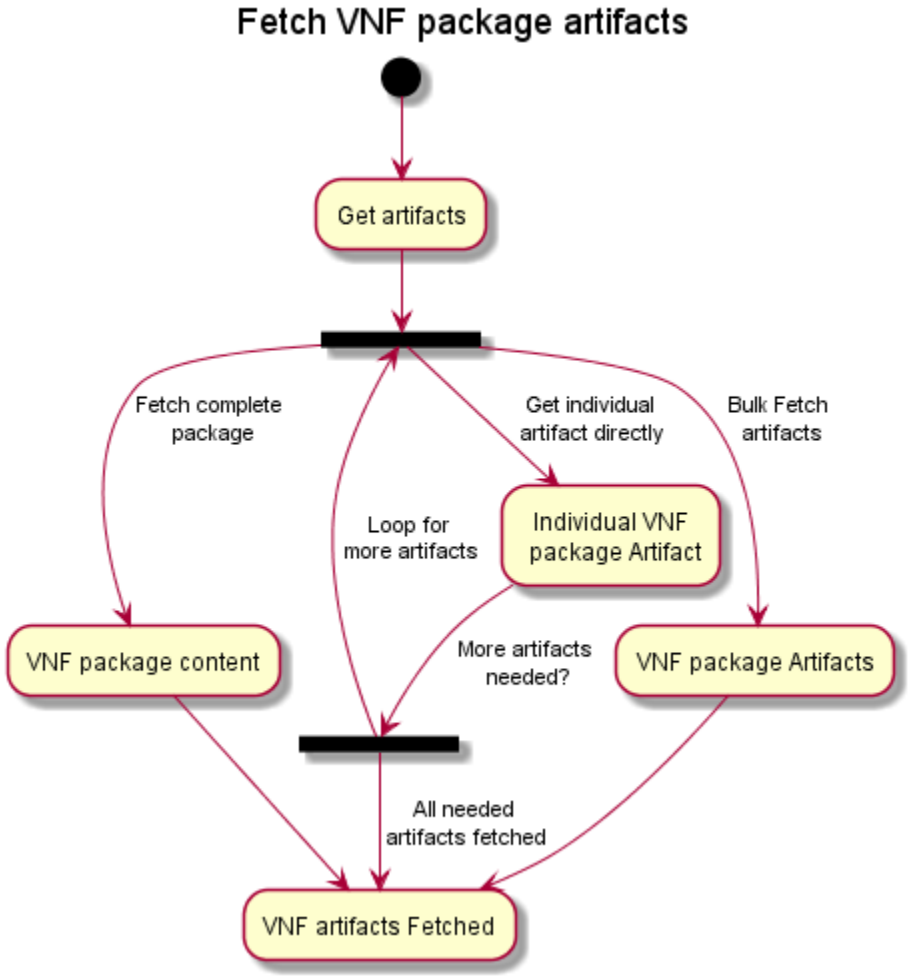


**Figure 5.2.7.3-1: Decision tree on Fetch artifacts**

# 5.3 NS termination procedure

## 5.3.1 Introduction

Clause 5.3 specifies the NFV-MANO procedure for terminating a Network Service.

The NS instance to terminate has the following characteristics:

- The NS instances does not include nested NS instances.
- The NSD refers to VNF Packages and it includes information for none, one or multiple VNFs, and its constituent VNFs can be VM-based, container-based or hybrid.

NOTE: In the present procedure, the use of virtualised resource management in indirect mode is not defined because the referenced version of ETSI GS NFV-SOL 003 [3] lacks such a specification, as opposed to the remaining NFV-MANO APIs which are fully specified and specific references in the procedure flow and key information exchanges can be provided. In addition, the procedure flows, while specifying the steps and stages at which virtualised resource management interactions take place, do not provide any reference to protocol and data model solutions of NFV-MANO APIs concerning to virtualised resource management, since these are not available at the time the present document is published.

## 5.3.2 Pre-conditions

Table 5.3.2-1 specifies the pre-conditions applicable to the NS termination procedure.

**Table 5.3.2-1: NS termination procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | The NS instance to terminate is in INSTANTIATED state. | N/A |

## 5.3.3 Procedure flow

### 5.3.3.1 Overview

For the termination of the NS instance, the consumer may choose to terminate the NS instance by:

a) terminating and disconnecting the NS constituents (e.g. the VNF instances) individually, as defined in clause 5.3.3.2;

b) using the NS termination operation of the NS LCM interface, as defined in clause 5.3.3.3; or

c) a combination of terminating and disconnecting NS constituents individually and using the NS termination operation, as defined in clause 5.3.3.4.

### 5.3.3.2 Procedure flow terminating and disconnecting the NS constituents

Figures 5.3.3.2-1 and 5.3.3.2-2 show the procedure when the consumer uses the termination of individual NS constituents.

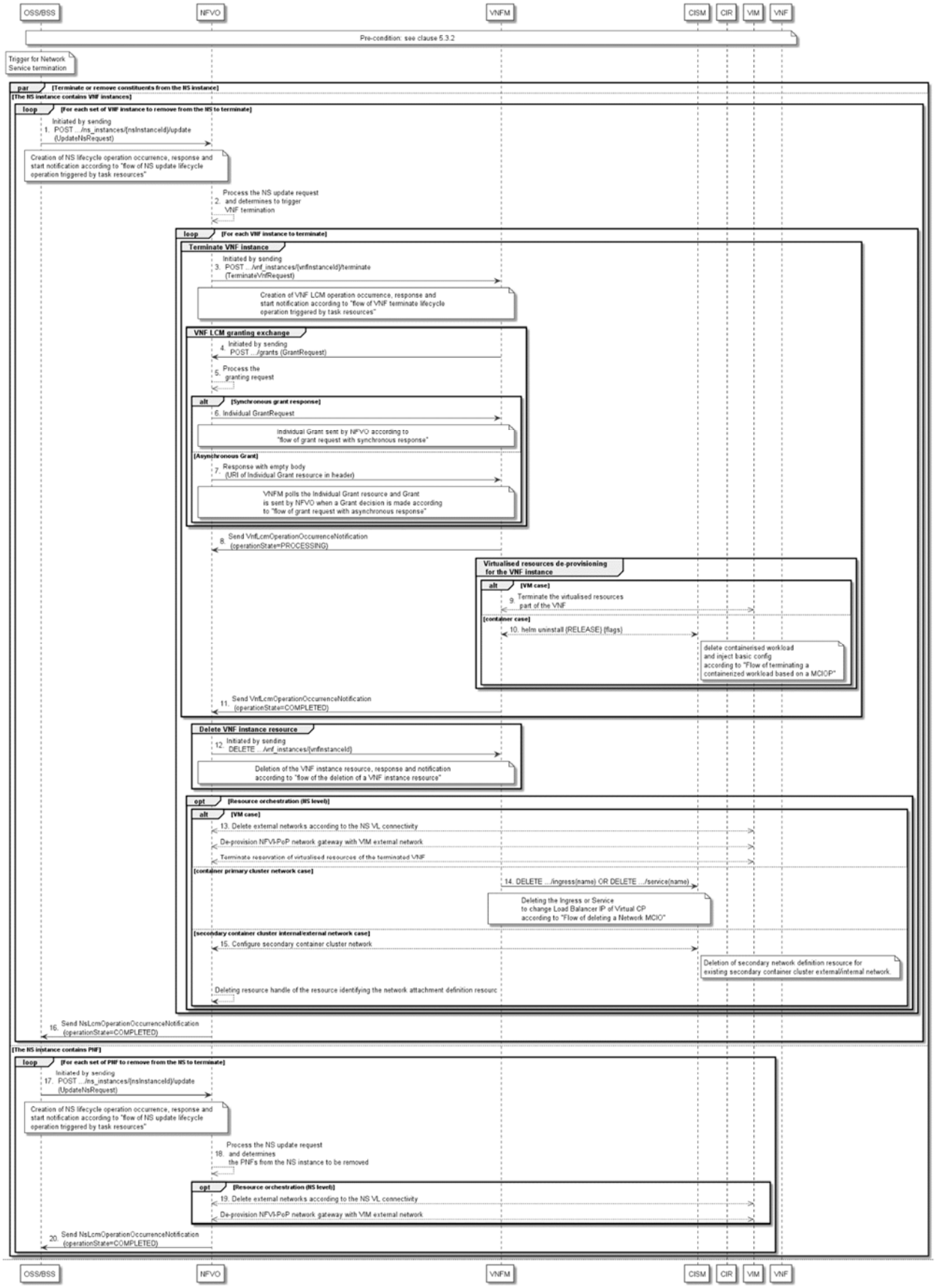


**Figure 5.3.3.2-1: Procedure of NS termination by terminating individual NS constituents (first part)**

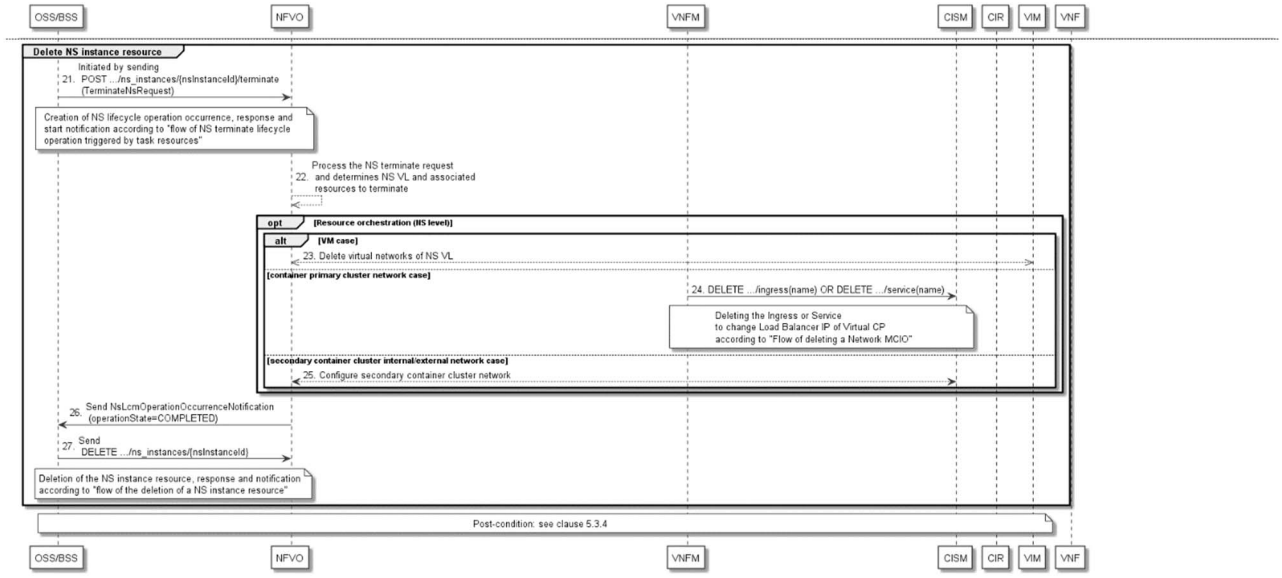


**Figure 5.3.3.2-2: Procedure of NS termination by terminating individual NS constituents (second part)**

The NFV-MANO procedure of NS termination by terminating individual NS constituents comprises the following steps. Terminating or removing VNF instances (steps 1 to 12), and removing PNFs (steps 13 to 15) may be executed in any order or in parallel:

1. To perform the termination of individual VNF instances part of the NS instance, the OSS/BSS shall send to the NFVO a "UpdateNsRequest" in the payload of the POST request to the "Update NS task" resource on the NS instance identifier of the NS to terminate as specified in clause 6.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. The UpdateNsRequest includes the list of VNF instances to be removed from the NS instance.

   As described in "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. The NFVO sends an NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The OSS/BSS can obtain information about the ongoing operation by sending a GET request to the "Individual NS LCM operation occurrence" resource as specified in clause 6.4.10.3.2 of ETSI GS NFV-SOL 005 [4]. The NFVO sets the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.6.2.1 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the operations required for the termination of the affected NS constituents as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

   Table 5.3.5.1-1 lists the key information exchanged between OSS/BSS and NFVO during the update of the NS instance to terminate one or more individual VNF instance.

2. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource and the NS update request, the NFVO determines the VNF instances to be terminated. VNF instances that are also part of some other NS instance cannot be requested to be terminated as specified in table 6.5.2.12-1 of ETSI GS NFV-SOL 005 [4].

Following steps 3 to 11 are performed with the respective VNFM for each VNF instance to be terminated. These terminations can be performed in any order or in parallel for different VNF instances:

3. To terminate a VNF instance, the NFVO shall send to the VNFM a "TerminateVnfRequest" in the payload of the POST request to the "Terminate VNF task" resource on the VNF instance identifier of the VNF to terminate as specified in clause 5.4.8.3.1 of ETSI GS NFV-SOL 003 [3].

   As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource, and sends the response to NFVO. Clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3] specifies the requirements of the VNFM in handling the task resources that trigger VNF LCM operations.

Table 5.3.5.2-1 lists the key information exchanged between NFVO and VNFM to terminate the VNF instance.

The VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

The NFVO can obtain information about the ongoing operation by sending a GET request to the "Individual VNF LCM operation occurrence" resource as specified in clause 5.4.13.3.2 of ETSI GS NFV-SOL 003 [3].

The VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

4. As part of the VNF termination, the NFVO and VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle terminate operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the payload of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.3.5.3-1 lists the key information exchanged between NFVO and VNFM during the VNF LCM operation grant process.

5. The NFVO processes the granting request. Based on the NSD information, the current information and state of "Individual NS instance" resource, and the input information from the granting request, the NFVO makes a decision about the VNF LCM operation granting request related to the VNF termination.

6. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]), the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code 201 (Created) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

7. For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code 202 (Accepted) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   For the case of "asynchronous mode", as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code 202 (Accepted) which indicates that the grant processing is in progress. When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code 200 (OK) with the content of the Grant.

NOTE 1: The grant processing and message exchanges specified in the steps above only describe the success cases.

8. Upon completion of the VNF LCM operation granting exchange (steps 4 to 7), if there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM shall send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

9. Based on the type of VNF termination request (forceful or graceful), the VNFM will determine when the virtualised resources associated to the VNF can be released, as specified in clause 5.5.2.8 of ETSI GS NFV-SOL 003 [3]. In the case of virtualised resources management in direct mode, the VNFM shall request the VIM the termination of the virtualised resources for the VNF instance that is being terminated.

10. In the case of containerized VNF, the VNFM shall request the CISM the termination of the container workload that is being terminated, as specified in clause 7.3.4 of ETSI GS NFV-SOL 018 [11]. Table 5.3.5.8-1 lists the key information exchanged between VNFM and CISM during the VNF termination process.

11. Upon completion of the VNF termination by the VNFM, the VNFM shall send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clauses 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. Once the VNFM has successfully completed the underlying VNF LCM operation occurrence, the VNFM will set the "instantiationState" attribute in the representation of the "Individual VNF instance" resource to the value "NOT_INSTANTIATED" as specified in clause 5.4.8.3.1 of ETSI GS NFV-SOL 003 [3].

12. To perform the deletion of the "Individual VNF instance" resource, the NFVO shall send to the VNFM a DELETE request to the "Individual VNF instance" resource as specified in clause 5.4.3.3.5 of ETSI GS NFV-SOL 003 [3].

    As described in the "Flow of the deletion of a VNF instance resource" (see clause 5.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM deletes the "Individual VNF instance" resource. If there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM sends a "VnfIdentifierDeletionNotification" to the NFVO. If there is an applicable subscription for VNF LCM notifications to the EM, the VNFM sends a "VnfIdentifierDeletionNotification" to the EM.

13. As part of the VNF termination, resource orchestration can be performed by the NFVO for the resource fulfilment.

    Based on the NSD information, the current information and state of the "Individual NS instance" resource, and the outcomes from the VNF termination, when the VNF is VM, the NFVO and VIM may terminate unused external networks (from the VNF instance point of view) and/or link ports associated to the VNF that has been terminated. This also includes the de-provision of the NFVI-PoP network gateway(s) based on the number of SAPs associated with the VNF that have been terminated.

    The NFVO and VIM shall perform the termination of the unused reservations of the virtualised resources, if it is determined that the reservations of virtualised resources associated to the VNF are required to be inactive.

14. In the case of containerized VNF and primary container cluster network, the VNFM shall request the CISM the termination of the ingress or service that is being terminated, as specified in clause 10.4 of ETSI GS NFV-SOL 018 [11].

15. In the case of containerized VNF and secondary container cluster network, the NFVO may request to the CISM to configure secondary container cluster network that is being terminated and delete resource handle of the resource.

16. Upon completion of the termination of all involved VNF instances in the Update NS request set and associated connectivity needed for the NS, the NFVO shall send to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

17. If the NS instance to be terminated includes PNFs, to perform the removal of the PNFs which are part of the NS instance, the OSS/BSS shall send to the NFVO a "UpdateNsRequest" in the payload of the POST request to the "Update NS task" resource on the NS instance identifier of the NS to terminate as specified in clause 6.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. The UpdateNsRequest includes the list of PNF to be removed from the NS instance.

    As described in "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. The NFVO sends an NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The OSS/BSS can obtain information about the ongoing operation by sending a GET request to the "Individual NS LCM operation occurrence" resource as specified in clause 6.4.10.3.2 of ETSI GS NFV-SOL 005 [4]. The NFVO will set the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the operations required for the termination of the affected NS constituents as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

    Table 5.3.5.4-1 lists the key information exchanged between OSS/BSS and NFVO during the update of the NS instance to remove one or more PNF from the NS instance.

18. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource, and the NS update request, the NFVO determines the PNFs that have to be removed from the NS instance.

19. As part of the PNF removal from the NS instance, resource orchestration can be performed by the NFVO for the resource fulfilment.

    Based on the NSD information, the current information and state of the "Individual NS instance" resource, and the outcomes from the PNF removal, the NFVO and VIM may terminate unused external networks (from the PNF instance point of view) and/or link ports used to connect the PNF within the NS instance. This also includes the de-provisioning of the NFVI-PoP network gateway(s) based on the number of SAPs associated with the PNF that is removed.

20. Upon completion of the removal of all the involved PNF in the Update NS request set and the connectivity needed for the Network Service, the NFVO shall send to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS. NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

21. To proceed with the termination of the NS instance, the OSS/BSS shall send to the NFVO a "TerminateNsRequest" in the payload of the POST request to the "Terminate NS task" resource on the NS instance identifier of the NS to terminate, as specified in clause 6.4.8.3.1 of ETSI GS NFV-SOL 005 [4].

    As described in "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. The NFVO sends an NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The OSS/BSS can obtain information about the ongoing operation by sending a GET request to the "Individual NS LCM operation occurrence" resource as specified in clause 6.4.10.3.2 of ETSI GS NFV-SOL 005 [4]. The NFVO will set the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the operations required for the termination of the NS instance as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

22. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource, and the NS termination request, the NFVO determines whether additional constituent components of the NS instance need to be removed or terminated.

23. If the NS instance contains NS VL and associated resources, as part of the NS instance termination, resource orchestration is performed by the NFVO for the resource fulfilment. The NFVO and VIM shall terminate external networks (from the VNF/PNF instance point of view) and/or link ports realizing the one or more unused NS VL instances that are still part of the NS instance.

NOTE 2: The referenced ETSI GS NFV-SOL 005 [4] does not provide the capability for the OSS/BSS to control when network resources used by an NS instance can be terminated or whether to remain instantiated, if such network resources are not shared among NS instances and have been completely dissociated from the NS instance that is being terminated. Because of this, and in order to avoid an unspecified behaviour with respect to such type of network resources, in the above step, the NFVO and VIM terminate the external network and/or links ports realizing the one or more unused NS VL instances.

24. In the case of containerized VNF and primary container cluster network, the VNFM shall request the CISM the termination of the ingress or service that is being terminated, as specified in clause 10.4 of ETSI GS NFV-SOL 018 [11].

25. In the case of containerized VNF and secondary container cluster network, the NFVO may request to the CISM to configure secondary container cluster network that is being terminated and delete resource handle of the resource.

26. Upon completion of the termination of the NS instance and its resources, the NFVO shall send to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

27. To complete the procedure, the OSS/BSS shall send to the NFVO a DELETE request to the "Individual NS instance" resource as specified in clause 6.4.3.3.5 of ETSI GS NFV-SOL 005 [4].

    As described in the "Flow of the deletion of a NS instance resource" (see clause 6.3.2 of ETSI GS NFV-SOL 005 [4]), the NFVO deletes the "Individual NS instance" resource. If there is an applicable subscription for NS LCM notifications to the OSS/BSS, the NFVO sends a "NsIdentifierDeletionNotification" to the OSS/BSS.

#### 5.3.3.3 Procedure flow using the NS termination operation

Figure 5.3.3.3-1 shows the procedure when the consumer uses the NS termination operation of the NS LCM interface.

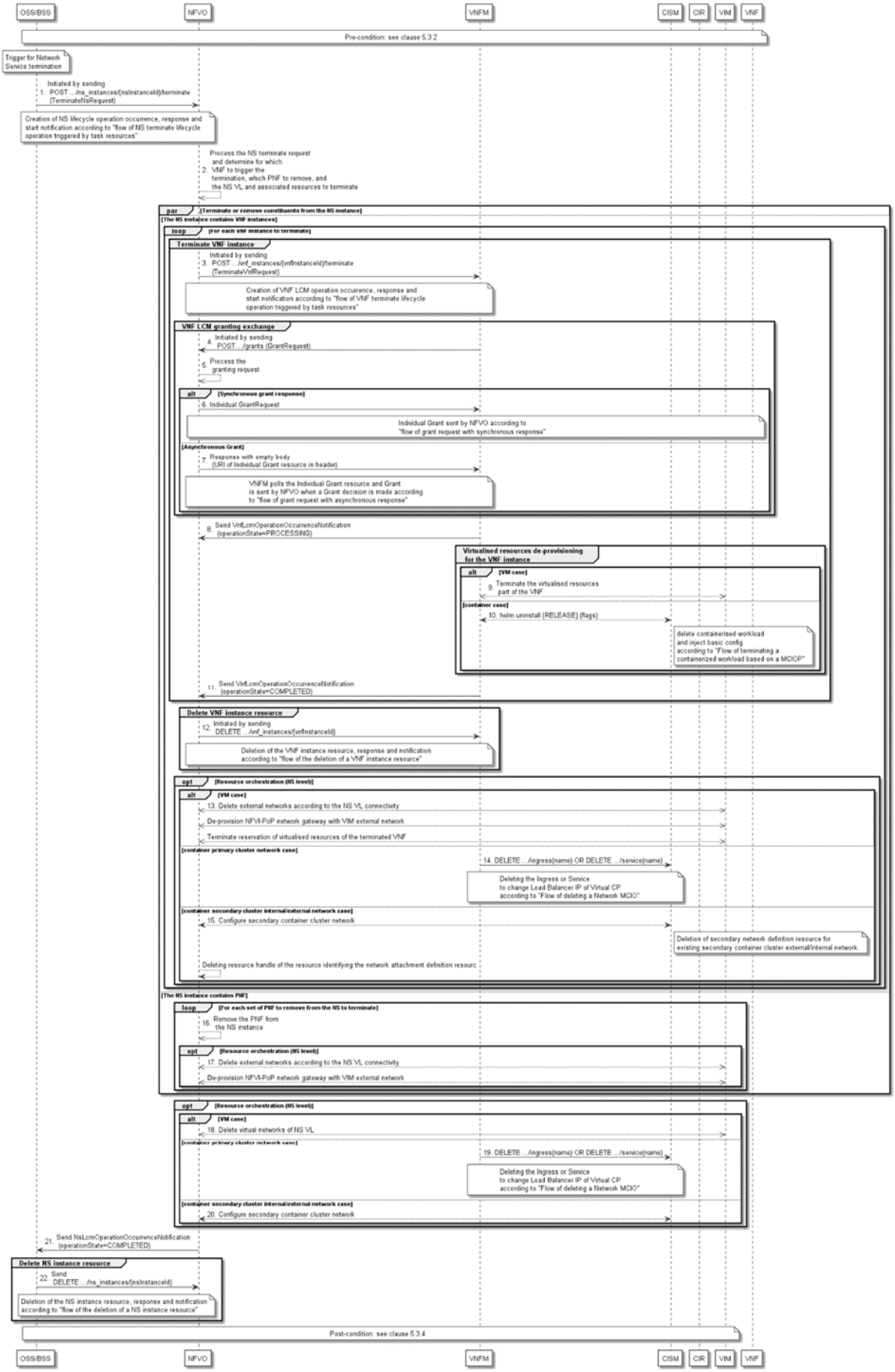


**Figure 5.3.3.3-1: Procedure of NS termination by using NS termination operation**

The NFV-MANO procedure of NS termination performed by using the NS termination operation comprises the following steps:

1. To perform the termination of the NS instance, the OSS/BSS shall first send to the NFVO a "TerminateNsRequest" in the payload of the POST request to the "Terminate NS task" resource on the NS instance identifier of the NS to terminate as specified in clause 6.4.8.3.1 of ETSI GS NFV-SOL 005 [4].

   As described in "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. The NFVO send an NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The OSS/BSS can obtain information about the ongoing operation by sending a GET request to the "Individual NS LCM operation occurrence" resource as specified in clause 6.4.10.3.2 of ETSI GS NFV-SOL 005 [4]. NFVO sets the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the termination of the NS instance as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

   Table 5.3.5.5-1 lists the key information exchanged between OSS/BSS and NFVO during the terminate of the NS instance request exchange.

2. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource, and the NS terminate request, the NFVO determines the VNF instances to be terminated, the PNF to be removed and the NS VL and associated resources to terminate. Only VNF instances that are not part of some other NS instance will be requested to be terminated as specified in table 6.5.2.12-1 of ETSI GS NFV-SOL 005 [4].

Terminating VNF instances (steps 3 to 12) and Removing PNF (steps 13 to 14) may be executed in any order or in parallel.

Following steps 3 to 11 are performed with the respective VNFM for each VNF instance to be terminated. These terminations can be performed in any order or in parallel for different VNF instances:

3. To terminate a VNF instance, the NFVO shall send to the VNFM a "TerminateVnfRequest" in the payload of the POST request to the "Terminate VNF task" resource on the VNF instance identifier of the VNF to terminate as specified in clause 5.4.8.3.1 of ETSI GS NFV-SOL 003 [3].

   As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource, and sends the response to NFVO. Clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3] specifies the requirements of the VNFM in handling the task resources that trigger VNF LCM operations.

   Table 5.3.5.2-1 lists the key information exchanged between NFVO and VNFM to terminate the VNF instance.

   The VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

   The NFVO can poll the "Individual VNF LCM operation occurrence" resource to obtain information about the ongoing operation by sending a GET request to the "Individual VNF LCM operation occurrence" resource as specified in clause 5.4.13.3.2 of ETSI GS NFV-SOL 003 [3].

   The VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

4. As part of the VNF termination, the NFVO and VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle terminate operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the payload of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.3.5.3-1 lists the key information exchanged between NFVO and VNFM during the VNF LCM operation grant process.

5. The NFVO processes the granting request. Based on the NSD information, the current information and state of "Individual NS instance" resource, and the input information from the granting request, the NFVO makes a decision about the VNF LCM operation granting request related to the VNF termination.

6. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]), the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code 201 (Created) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

7. For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code 202 (Accepted) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   For the case of "asynchronous mode". as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code 202 (Accepted) which indicates that the grant processing is in progress . When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code 200 (OK) with the content of the Grant.

NOTE 1: The grant processing and message exchanges specified in the steps above only describe the success cases.

8. Upon completion of the VNF LCM operation granting exchange (steps 4 to 7), if there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM shall send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

9. Based on the type of VNF termination request (forceful or graceful), the VNFM will determine when the virtualised resources associated to the VNF can be released, as specified in clause 5.5.2.8 of ETSI GS NFV-SOL 003 [3]. In the case of virtualised resources management in direct mode, the VNFM shall request the VIM the termination of the virtualised resources for the VNF instance that is being terminated.

10. In the case of containerized VNF, the VNFM shall request the CISM the termination of the container workload that is being terminated, as specified in clause 7.3.4 of ETSI GS NFV-SOL 018 [11]. Table 5.3.5.8-1 lists the key information exchanged between VNFM and CISM during the VNF termination process.

11. Upon completion of the VNF termination by the VNFM, the VNFM shall send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM. The VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clauses 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. Once the VNFM has successfully completed the underlying VNF LCM operation occurrence, the VNFM will set the "instantiationState" attribute in the representation of the "Individual VNF instance" resource to the value "NOT_INSTANTIATED" as specified in clause 5.4.8.3.1 of ETSI GS NFV-SOL 003 [3].

12. To perform the deletion of the "Individual VNF instance" resource, the NFVO shall send to the VNFM a DELETE request to the "Individual VNF instance" resource as specified in clause 5.4.3.3.5 of ETSI GS NFV-SOL 003 [3].

    As described in the "Flow of the deletion of a VNF instance resource" (see clause 5.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM deletes the "Individual VNF instance" resource. If there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM sends a "VnfIdentifierDeletionNotification" to the NFVO. If there is an applicable subscription for VNF LCM notifications to the EM, the VNFM sends a "VnfIdentifierDeletionNotification" to the EM.

13. As part of the VNF termination, resource orchestration can be performed by the NFVO for the resource fulfilment.

Based on the NSD information, the current information and state of the "Individual NS instance" resource, and the outcomes from the VNF termination, the NFVO and VIM may terminate unused external networks (from the VNF instance point of view) and/or link ports associated to the VNF that has been terminated. This also includes the de-provision of the NFVI-PoP network gateway(s) based on the number of SAPs associated with the VNF that have been terminated.

The NFVO and VIM shall perform the termination of the unused reservations of the virtualised resources, when it is determined that the reservation of virtualised resources associated to the VNF are required to be inactive.

14. In the case of containerized VNF and primary container cluster network, the VNFM shall request the CISM the termination of the ingress or service that is being terminated, as specified in clause 10.4 of ETSI GS NFV-SOL 018 [11].

15. In the case of containerized VNF and secondary container cluster network, the NFVO may request to the CISM to configure secondary container cluster network that is being terminated and delete resource handle of the resource.

16. If the NS instance to be terminated includes PNFs, and these need to be removed (see step 2), the NFVO removes the PNF from the NS instance.

17. As part of the PNF removal from the NS instance, resource orchestration can be performed by the NFVO for the resource fulfilment.

    Based on the NSD information, the current information and state of the "Individual NS instance" resource, and the outcomes from the PNF removal, the NFVO and VIM may terminate unused external networks (from the PNF instance point of view) and/or link ports used to connect the PNF within the NS instance associated to the PNF that is removed from the NS instance. This also includes the de-provisioning of the NFVI-PoP network gateway(s) based on the number of SAPs associated with the PNF that is removed.

18. If the NS instance contains NS VL and associated resources, as part of the NS instance termination, resource orchestration is performed by the NFVO for the resource fulfilment. The NFVO and VIM shall terminate external networks (from the VNF/PNF instance point of view) and/or link ports realizing the one or more unused NS VL instances that are still part of the NS instance.

NOTE 2: The referenced ETSI GS NFV-SOL 005 [4] does not provide the capability for the OSS/BSS to control when network resources used by an NS instance can be terminated or whether to remain instantiated, if such network resources are not shared among NS instances and have been completely dissociated from the NS instance that is being terminated. Because of this, and in order to avoid an unspecified behaviour with respect to such type of network resources, in the above step, the NFVO and VIM terminate the external network and/or links ports realizing the one or more unused NS VL instances.

19. In the case of containerized VNF and primary container cluster network, the VNFM shall request the CISM the termination of the ingress or service that is being terminated, as specified in clause 10.4 of ETSI GS NFV-SOL 018 [11].

20. In the case of containerized VNF and secondary container cluster network, the NFVO may request to the CISM to configure secondary container cluster network that is being terminated and delete resource handle of the resource.

21. Upon completion of the termination of the NS instance and its resources, the NFVO shall send to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

22. To complete the procedure, the OSS/BSS shall send to the NFVO a DELETE request to the "Individual NS instance" resource as specified in clause 6.4.3.3.5 of ETSI GS NFV-SOL 005 [4].

    As described in the "Flow of the deletion of a NS instance resource" (see clause 6.3.2 of ETSI GS NFV-SOL 005 [4]), the NFVO deletes the "Individual NS instance" resource. If there is an applicable subscription for NS LCM notifications to the OSS/BSS, the NFVO sends a "NsIdentifierDeletionNotification" to the OSS/BSS.

#### 5.3.3.4 Procedure flow using combination of terminating individual NS constituents and using NS termination operation

The NS termination may be realized as a combination of terminating individual NS constituents and using the NS termination operation. For instance, the network operator might want to disconnect first the PNF instances by requesting its individual termination and use the NS termination operation for terminating the remaining NS constituents such as VNF instances of the NS instance to terminate.

To realize this type of NS termination procedure flow, the following stages take place:

- First, the termination of the individual NS constituents shall be executed by applying the steps 1 to 20 of the procedure flow specified in clause 5.3.3.2.
- Second, the termination of the remaining constituents of the NS instance and the termination of the NS instance itself shall be executed by applying the procedure flow specified in clause 5.3.3.3.

### 5.3.4 Post-conditions

Table 5.3.4-1 specifies the post-conditions applicable to the NS termination procedure.

**Table 5.3.4-1: NS termination procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The NS instance has been terminated. | N/A |

### 5.3.5 Key information exchanged in the procedure

#### 5.3.5.1 Update NS instance to terminate specific VNF instances

Table 5.3.5.1-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the Update NS request to terminate specific VNF instance(s). The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.3.5.1-1: Key information exchanged during update NS to terminate specific VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set by the OSS/BSS to the "id" attribute of "NsInstance" representation of the "Individual NS instance" resource created by NFVO in which the specific VNF instance(s) to terminate is (are) part of. |
| UpdateNsRequest in the request | updateType | Shall be set by the OSS/BSS to "REMOVE_VNF". |
| | removeVnfInstanceId | Shall be set by the OSS/BSS to the "id" attribute of VnfInstance(s) in the "NsInstance" representation of the "Individual NS instance" resource to be removed from the NS instance. |
| | terminateVnfData | If additional information is provided for terminating VNF instance(s), this shall be set by the OSS/BSS to the additional VNF termination data (one entry per VNF instance), as specified in clause 6.5.3.Y of ETSI GS NFV-SOL 005 [4]. |

#### 5.3.5.2 Terminate VNF instance

Table 5.3.5.2-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the terminate VNF request. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.3.5.2-1: Key information exchanged during terminate VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO to the "id" attribute of VnfInstance created by VNFM. |
| TerminateVnfRequest in the request | terminationType | Shall be set by the NFVO to the same value of terminationType of terminateVnfData, if such value is provided in the UpdateNsRequest or TerminateNsRequest.<br><br>If details are not specified in the UpdateNsRequest or TerminateNsRequest, the attribute value may be set to "FORCEFUL" or "GRACEFUL" by NFVO. See note. |
| | gracefulTerminationTimeout | Shall be set by the NFVO to the same value of gracefulTerminationTimeout of terminateVnfData, if such value is provided in the UpdateNsRequest or TerminateNsRequest.<br><br>If details are not specified in the UpdateNsRequest or TerminateNsRequest, the attribute value may be set by the NFVO based on the minimum and maximum timeout values for graceful termination are defined in the VNFD, as specified in ETSI GS NFV-SOL 001 [1] and ETSI GS NFV-SOL 006 [5]. Clause 5.5.2.8 of ETSI GS NFV-SOL 003 [3] specifies provisions for setting the value of this attribute. |
| NOTE: If the VNF is still in service, requesting forceful termination can adversely impact network service. | | |

## 5.3.5.3 VNF LCM granting exchange for VNF termination

Table 5.3.5.3-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the granting exchange related to the VNF termination. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.3.5.3-1: Key information exchanged during terminate VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| GrantRequest in the request | vnfInstanceId | Shall be set by the VNFM to the same "id" attribute of "VnfInstance" created by the VNFM that has been requested to be terminated. |
| | vnfLcmOpOccId | Shall be set by the VNFM to the identifier of the VNF lifecycle management operation occurrence associated to the GrantRequest. |
| | vnfdId | Shall be set by the VNFM to the "vnfdId" attribute of "VnfInstance" created by the VNFM that has been requested to be terminated. |
| | operation | Shall be set by the VNFM to "TERMINATE". |
| | isAutomaticInvocation | Shall be set by the VNFM to false. |
| | removeResources | Shall be set by the VNFM to the list of resources to be removed by the LCM operation which is related to this grant request, with one entry per resource. |
| | removeResources ->resource | Shall be set by the VNFM to the information that addresses the existing resource to be removed. |
| Grant in the response | vnfInstanceId | Set by the NFVO to the same value of the "id" attribute of "VnfInstance" to be teminated by the VNFM as provided in the GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | vnfLcmOpOccId | Set by the NFVO to the same value of the "vnfLcmOpOccId" attribute of GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | removeResources | Set by the NFVO to indicate the list of resources that are approved to be removed, with one entry per resource, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |

### 5.3.5.4 Update NS instance to remove PNFs from the NS instance

Table 5.3.5.4-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the Update NS request to remove PNFs from the NS instance. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.3.5.4-1: Key information exchanged during update NS to remove PNFs**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set to the "id" attribute of NsInstance resource created by NFVO in which the specific PNF instance(s) to remove is (are) part of. |
| UpdateNsRequest in the request | updateType | Shall be set to "REMOVE_PNF". |
| | removePnfId | Shall be set to the "pnfId" attribute of the "PnfInfo" in the NsInstance resource which are requested to be removed from the NS instance. |

### 5.3.5.5 Terminate NS instance

Table 5.3.5.5-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the Terminate NS request. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.3.5.5-1: Key information exchanged during terminate NS instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set to the "id" attribute of NsInstance resource created by NFVO corresponding to the NS instance which is requested to be terminated. |
| TerminateNsRequest in the request | terminateVnfData | If additional information is provided for terminating VNF instance(s), this shall be set by the OSS/BSS to the terminateVnfData additional VNF termination data (one entry per VNF instance), as specified in clause 6.5.3.Y of ETSI GS NFV-SOL 005 [4]. |

### 5.3.5.6 VNF Lifecycle change notifications

Table 5.3.5.6-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of the VNF lifecycle change notifications corresponding to the VNF termination, in the context of the present NFV-MANO procedure.

The full set of notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO as recipient of the notifications and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.3.5.6-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.3.5.6-1: Key information exchanged during VNF lifecycle change notifications**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfLcmOperationOccurrenceNotification payload in the request | notificationType | Set by the VNFM to "VnfLcmOperationOccurrenceNotification", as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | subscriptionId | Set by the VNFM to the value of the "id" attribute of the associated "LccnSubscription" representing the "Individual subscription" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | notificationStatus | Set by the VNFM to either "START" or "RESULT", depending on whether the notification relates to start, final or intermediate result of the VNF LCM operation occurrence, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | operationState | Set by the VNFM to the value of the "operationState" attribute in the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence", as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "TERMINATE" for the present VNF termination procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |
| | vnfLcmOpOccId | Set by the VNFM to the value of the "id" attribute of associated "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |

### 5.3.5.7 VNF lifecycle management operation occurrences

Table 5.3.5.7-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of reading the VNF lifecycle management operation occurrence corresponding to the VNF termination, in the context of the present NFV-MANO procedure.

The full set of data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.3.5.7-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.3.5.7-1: Key information exchanged during reading VNF lifecycle management operation occurrences**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfLcmOpOccId | Shall be set by the NFVO to the "id" attribute of the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource to read. |
| VnfLcmOpOcc in the response | operationState | Set by the VNFM to the state value of the VNF LCM operation occurrence, as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | vnfInstanceId | Set by the VNFM to the value of the "id" attribute of the "VnfInstance" representing the associated "Individual VNF instance" resource, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | grantId | Set by the VNFM to the value of the "id" attribute in the "Grant" representing the associated "Individual grant" resource, if such a grant exists, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "TERMINATE" for the present VNF termination procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |

#### 5.3.5.8 Containerized resources de-provisioning for the VNF Instance

This clause applies if the CISM's consumer communicates with the CISM using Deployment object of Kubernetes® resource object kind defined in ETSI GS NFV-SOL 018 [11]. This clause describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 018 [11].

Table 5.3.5.8-1 lists the selected key information sent towards the CISM(s) for provisioning of the compute resource.

**Table 5.3.5.8-1: Key information for compute resource de-provisioning**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| instantiating a containerized workload based on a MCIOP | name | Shall be set by the VNFM to be de-provisioned as specified in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11]. |

Table 5.3.5.8-2 lists the selected key information sent towards the CISM(s) for provisioning of the storage resource.

**Table 5.3.5.8-2: Key information for storage resource de-provisioning**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| PersistentVolumeClaim | name | Shall be set by the VNFM to be de-provisioned as specified in clause 6.2.4.1 of ETSI GS NFV-SOL 018 [11]. |

### 5.3.6 Execution of dependent and non-dependent side procedures

#### 5.3.6.1 Introduction

Side procedures (i.e. other management functionality, supported via the NFV-MANO interfaces, which does not form the core of functionality specified in the main procedure flow) related to VNF Package management, NSD management, NS LCM, PM and FM; VNF LCM, PM and FM; VNF lifecycle granting; and VNF Indicators can have a dependency (i.e. be impacted) or be independent from the NS termination.

The following clauses specify the considerations of these other side procedures with respect to the NS termination.

#### 5.3.6.2 Non-dependent side procedures

##### 5.3.6.2.1 VNF Package management

Operations about management of subscriptions to notifications (request to create a new subscription, delete and existing subscription, query and read existing subscriptions) related to VNF Package management of VNF Packages associated to the VNFs which are part of the NS instance that is being terminated may be executed by the OSS/BSS (as specified in clauses 9.4.8 and 9.4.9 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clauses 10.4.7 and 10.4.8 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS termination procedure.

Operations about management of the VNF packages, and their content (retrieval of the VNF package content, query and read VNF packages information, update of information of a VNF package, and request to delete an onboarded VNF Package), corresponding to VNFs which are part of the NS instance that is being terminated may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS termination procedure.

##### 5.3.6.2.2 NSD management

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, and query and read of existing subscriptions) of the NSD and PNFD related to the NS instance that is being terminated may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS termination procedure.

Operations about management of the NSD and PNFD, and their content (retrieval of the NSD and PNFD content, query and read information about NSD and PNFD, and request to delete and onboarded NSD or PNFD), corresponding to NSD related to, and PNF which are part of, the NS instance that is being terminated, may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.2.3 NS lifecycle management

Operations about management of subscriptions to notifications related to NS lifecycle management (request to create a new subscription, delete and existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being terminated may be executed by the OSS/BSS (as specified in clauses 6.4.16 and 6.4.17 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS termination procedure.

Operations about querying and reading information about NS instances, including the NS being terminated, may be executed by the OSS/BSS (as specified in clauses 6.4.2 and 6.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.2.4 NS fault management

Operations about management of subscriptions to notifications related to NS fault management (request to create a new subscription, delete and existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being terminated may be executed by the OSS/BSS (as specified in clauses 8.4.4 and 8.4.5 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS termination procedure.

The request by the OSS/BSS to terminate the subscription from the NFVO to notifications related to NS fault management corresponding to the NS instance to be terminated may be executed before, in parallel, or after the steps of NS termination. Nonetheless, in order to avoid an overflow of alarms due to the termination of the NS instance and its constituents, the OSS/BSS should unsubscribe from receiving notifications from the NFVO related to NS fault management of the NS instance that is being terminated before initiating the NS termination procedure.

Depending on the NsInstanceSubscriptionFilter used to create the subscription to notifications related to NS fault management, such a subscription can also apply to an NS instance that is not requested to be terminated, in which case, the subscription need not be terminated.

Operations about querying, reading and acknowledging alarms about NS instances, including the NS being terminated, may be executed by the OSS/BSS (as specified in clauses 8.4.2 and 8.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.2.5 NS performance management

The request by the OSS/BSS to terminate "Individual PM job" and "Individual threshold", as specified in clauses 7.4.3.3.5 and 7.4.6.3.5 of ETSI GS NFV-SOL 005 [4] respectively, related to the NS instance that is being terminated may be executed in parallel to any of the steps in the NS termination procedure.

The request by the OSS/BSS of other operations about management of "Individual PM job" (query PM jobs, reading single PM job, and updating associated PM job callback URI), reading an "Individual performance report" and other operations about management of "Individual thresholds" (query thresholds, reading a single threshold, and updating associated threshold callback URI) (as specified in clauses 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 005 [4]) related to the NS instance that is being terminated may be executed in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.2.6 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete and existing subscription, and query and read existing subscriptions) corresponding to a VNF instance to be terminated may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18, 5.4.19, 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS termination procedure.

Operations about querying and reading information about VNF instances, including VNFs being terminated as part of the NS termination, may be executed by the NFVO (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 003 [3]) and by the EM (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.2.7 VNF fault management

The request by the NFVO to terminate the subscription from the VNFM to notifications related to VNF fault management, as specified in clause 7.4.5.3.5 of ETSI GS NFV-SOL 003 [3], of the VNF instance that is being terminated may be executed before, in parallel, or after the steps of VNF termination. Nonetheless, in order to avoid an overflow of alarms due to the termination of the VNF instances, the NFVO should unsubscribe from receiving such notifications from the VNFM related to VNF fault management of the VNF instance that is being terminated before initiating the VNF termination.

Likewise, in case the EM has subscriptions with the VNFM to notifications about VNF fault management of the VNF instance that is being terminated as part of the NS termination, the request by the EM to terminate the subscription with the VNFM to notifications about VNF fault management, as specified in clause 7.4.6.3.5 of ETSI GS NFV-SOL 002 [2], of the VNF instance that is being terminated as part of the NS termination may be executed in parallel or after the steps of VNF termination. Nonetheless, in order to avoid an overflow of alarms due to the termination, the EM should unsubscribe from receiving such notifications from the VNFM related to VNF fault management of the VNF instance that is being terminated as soon as the start of the VNF termination is known to the EM.

Depending on the VnfInstanceSubscriptionFilter used to create the subscription to notifications related to VNF fault management, such a subscription can also apply to a VNF instance that is not requested to be terminated, in which case, the subscription need not be terminated.

Operations about querying, reading and acknowledging alarms about VNF instances, including VNFs being terminated as part of the NS termination, may be executed by the NFVO (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS termination procedure.

In addition, operations to escalate the perceived severity of an alarm about a VNF instance, including VNFs being terminated as part of the NS termination, may be executed by the EM (as specified in clause 7.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.2.8 VNF performance management

The request by the NFVO to terminate "Individual PM job" and "Individual threshold", as specified in clauses 6.4.3.3.5 and 6.4.6.3.5 of ETSI GS NFV-SOL 003 [3], respectively, related to the VNF instance that is being terminated as part of the NS termination, may be executed before, in parallel or after the steps of VNF termination.

Likewise, the request by the EM to terminate "Individual PM job" and "Individual threshold", as specified in clauses 6.4.3.3.5 and 6.4.6.3.5 of ETSI GS NFV-SOL 002 [2], respectively, related to the VNF instance that is being terminated as part of the NS termination, may be executed before, in parallel or after the steps of VNF termination.

In addition, the request by the NFVO or EM of other operations about management of "Individual PM job" (query PM jobs, reading single PM job, and updating associated PM job callback URI), reading an "Individual performance report" and other operations about management of "Individual thresholds" (query thresholds, reading a single threshold, and updating associated threshold callback URI) (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 003 [3] and ETSI GS NFV-SOL 002 [2]) related to the VNF instance that is being terminated as part of the NS termination, may be executed before, in parallel or after the steps of VNF termination.

#### 5.3.6.2.9 VNF indicators

A potential request by the NFVO to terminate the subscription to notifications related to VNF indicators, as specified in clause 8.4.6.3.5 of ETSI GS NFV-SOL 003 [3], of the VNF instance that is being terminated as part of the NS termination, may be executed before, in parallel or after the steps of VNF termination.

Likewise, a potential request by the VNFM to terminate the subscription to notifications related to VNF indicators, as specified in clause 8.4.6.3.5 of ETSI GS NFV-SOL 002 [2], of the VNF instance that is being terminated as part of the NS termination, may be executed before, in parallel or after the steps of VNF termination.

Operations about querying and reading VNF indicators information, including of VNFs being terminated as part of the NS termination, may be executed by the NFVO (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the NS termination procedure.

Likewise, operations about querying and reading VNF indicators information, including of VNFs being terminated as part of the NS termination, may be executed by the VNFM (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the NS termination procedure.

#### 5.3.6.3 Dependent side procedures

##### 5.3.6.3.1 VNF Package management

The "usageState" value "NOT_IN_USE" in the representation of the "Individual VNF package" resource of a particular VNF package reflects the fact that no VNF instance resources referring to such a VNF Package exist, as defined in clause B.2.2 in ETSI GS NFV-SOL 005 [4]. The VNF termination and deletion of the "individual VNF instance" resource are included as sub-procedure steps in the NS termination procedure specified in clause 5.3.

##### 5.3.6.3.2 NSD management

The "nsdUsageState" value "NOT_IN_USE" in the representation of the "Individual NS Descriptor" resource of a particular NSD reflects the fact that no NS instance resources referring to such an NSD exist, as defined in clause B.1.2 of ETSI GS NFV-SOL 005 [4]. The NS termination and deletion of the "individual NS instance" resource are included as sub-procedure steps in the NS termination procedure specified in clause 5.3.

##### 5.3.6.3.3 NS lifecycle management

In order to avoid leaving unused subscriptions to notifications related to NS lifecycle management specific to the NS instance that is being terminated, such unused subscriptions shall be terminated by the OSS/BSS requesting towards the NFVO the termination of the "Individual subscription" associated to such NS instance after the completion of the NS termination.

NOTE: It is assumed that the NFVO performs "garbage collection" of subscriptions to notifications related to NS lifecycle management that become inactive due to the termination of the related NS instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the NsInstanceSubscriptionFilter used to create the subscription to notifications related to NS lifecycle management, such a subscription can also apply to an NS instance that is not requested to be terminated, in which case, the subscription need not be terminated.

##### 5.3.6.3.4 NS fault management

In order to avoid leaving unused subscriptions to notifications related to NS fault management due to the termination of the NS instance and its constituents, such unused subscriptions shall be terminated by the OSS/BSS requesting towards the NFVO the termination of the "Individual subscription" associated to such NS instance after the completion of the NS termination procedure, if the termination of the subscriptions has not been done before or in parallel to the NS termination.

NOTE: It is assumed that the NFVO performs "garbage collection" of subscriptions to notifications related to NS fault management that become inactive due to the termination of the related NS instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the NsInstanceSubscriptionFilter used to create the subscription to notifications related to NS fault management, such a subscription can also apply to an NS instance that is not requested to be terminated, in which case, the subscription need not be terminated.

#### 5.3.6.3.5 NS performance management

In order to avoid leaving unused PM jobs and Thresholds related to the NS instance that is being terminated, the unused PM jobs and Thresholds shall be terminated by the OSS/BSS requesting towards the NFVO termination of the "Individual PM job" and "Individual threshold" associated specifically to such NS instance.

NOTE: It is assumed that the NFVO performs "garbage collection" of PM jobs and Thresholds related to NS performance management that become inactive due to the termination of the NS instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the list of objectInstanceIds used to create the PM job (see clause 7.5.2.6 of ETSI GS NFV-SOL 005 [4]), such a PM job can also apply to an NS instance that is not requested to be terminated, in which case, the PM job need not be terminated.

#### 5.3.6.3.6 VNF lifecycle management

In order to avoid leaving unused subscriptions to notifications related to VNF lifecycle management specific to the VNF instance that is being terminated, the unused subscriptions shall be terminated by the NFVO requesting towards the VNFM the termination of the "Individual subscription" associated to such VNF instance after the completion of the VNF termination.

Likewise, unused subscriptions shall be terminated by the EM requesting towards the VNFM the termination of the "Individual subscription" associated to such VNF instance after the completion of the VNF termination.

NOTE: It is assumed that the VNFM performs "garbage collection" of subscriptions to notifications related to VNF lifecycle management that become inactive due to the termination of the VNF instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the VnfInstanceSubscriptionFilter used to create the subscription to notifications related to VNF lifecycle management, such a subscription can also apply to a VNF instance that is not requested to be terminated, in which case, the subscription need not be terminated.

#### 5.3.6.3.7 VNF fault management

In order to avoid leaving unused subscriptions to notifications related to VNF fault management due to the termination of the VNF instance, unused subscriptions shall be terminated by the NFVO requesting towards the VNFM the termination of the "Individual subscription" associated to the VNF instance after the completion of the VNF termination, if the termination of the subscriptions has not been done before or in parallel to the VNF termination.

In order to avoid leaving unused subscriptions to notifications related to VNF fault management due to the termination of the VNF instance, unused subscriptions shall be terminated by the EM requesting towards the VNFM the termination of the "Individual subscription" associated to the VNF instance after the completion of the VNF termination is known to the EM if the termination of the subscriptions has not been done before or in parallel to the VNF termination.

NOTE: It is assumed that the VNFM performs "garbage collection" of subscriptions to notifications related to VNF fault management that become inactive due to the termination of the related VNF instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the VnfInstanceSubscriptionFilter used to create the subscription to notifications related to VNF fault management, such a subscription can also apply to a VNF instance that is not requested to be terminated, in which case, the subscription need not be terminated.

#### 5.3.6.3.8 VNF performance management

In order to avoid leaving unused PM jobs and Thresholds related to the VNF instance that is being terminated, unused PM jobs and Thresholds shall be terminated by the NFVO requesting towards the VNFM the termination of the "Individual PM job" and "Individual threshold" associated specifically to such VNF instance.

In order to avoid leaving unused PM jobs and Thresholds related to the VNF instances that is being terminated, unused PM jobs and Thresholds shall be terminated by the EM requesting towards the VNFM the termination of the "Individual PM job" and "Individual threshold" associated specifically to such VNF instance.

NOTE: It is assumed that the VNFM performs "garbage collection" of PM jobs and Thresholds related to VNF performance management that become inactive due to the termination of the related VNF instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the list of objectInstanceIds used to create the PM job (see clauses 6.5.2.6 of ETSI GS NFV-SOL 003 [3]), such a PM job can also apply to a VNF instance that is not requested to be terminated, in which case, the PM job need not be terminated.

#### 5.3.6.3.9 VNF indicators

In order to avoid leaving unused subscriptions to notifications related to VNF indicators of the VNF instance that is being terminated, unused subscriptions shall be terminated by the NFVO requesting towards the VNFM the termination of the "Individual subscription" associated specifically to such VNF instance.

In order to avoid leaving unused subscriptions to notifications related to VNF indicators of the VNF instance that is being terminated, unused subscriptions shall be terminated by the VNFM requesting towards the EM the termination of the "Individual subscription" associated specifically to such VNF instance.

NOTE: It is assumed that the VNFM performs "garbage collection" of subscriptions to notifications related to VNF indicators that become inactive due to the termination of the related VNF instance(s). How this "garbage collection" is performed is not specified in the present document.

Depending on the VnfInstanceSubscriptionFilter used to create the subscription to notifications related to VNF indicators, such a subscription can also apply to a VNF instance that is not requested to be terminated, in which case, the subscription need not be terminated.

### 5.3.6.4 Error cases and other considerations

#### 5.3.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "NS termination procedure" is the same as the one defined in clause 5.1.6.4.1.

#### 5.3.6.4.2 NSD management

The handling of the request by the OSS/BSS to delete an onboarded NSD or PNFD during the "NS termination procedure" is the same as the one defined in clause 5.2.6.4.2.

## 5.4 VNF scaling triggered through scale NS procedure

### 5.4.1 Introduction

Clause 5.4 specifies the NFV-MANO procedure for VNF scaling triggered through Scale NS operation.

NOTE: In the present procedure, the use of virtualised resource management in indirect mode is not defined because the referenced version of ETSI GS NFV-SOL 003 [3] lacks such a specification, as opposed to the remaining NFV-MANO APIs which are fully specified and specific references in the procedure flow and key information exchanges can be provided. In addition, the procedure flows, while specifying the steps and stages at which virtualised resource management interactions take place, do not provide any reference to protocol and data model solutions of NFV-MANO APIs concerning to virtualised resource management, since these are not available at the time the present document is published.

### 5.4.2 Pre-conditions

Table 5.4.2-1 specifies the pre-conditions applicable to the VNF scaling triggered through scale NS procedure.

**Table 5.4.2-1: VNF scaling triggered through scale NS procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | The VNF instance(s) to scale is/are in INSTANTIATED state. | N/A |
| 2 | The NS instance, that includes the VNF instance(s) to scale, is in INSTANTIATED state. | N/A |

## 5.4.3 Procedure flow

Figure 5.4.3-1 shows the procedure when the consumer uses the Scale NS operation of the NS LCM interface on an individual NS instance to perform the scaling of specific VNF instance(s).

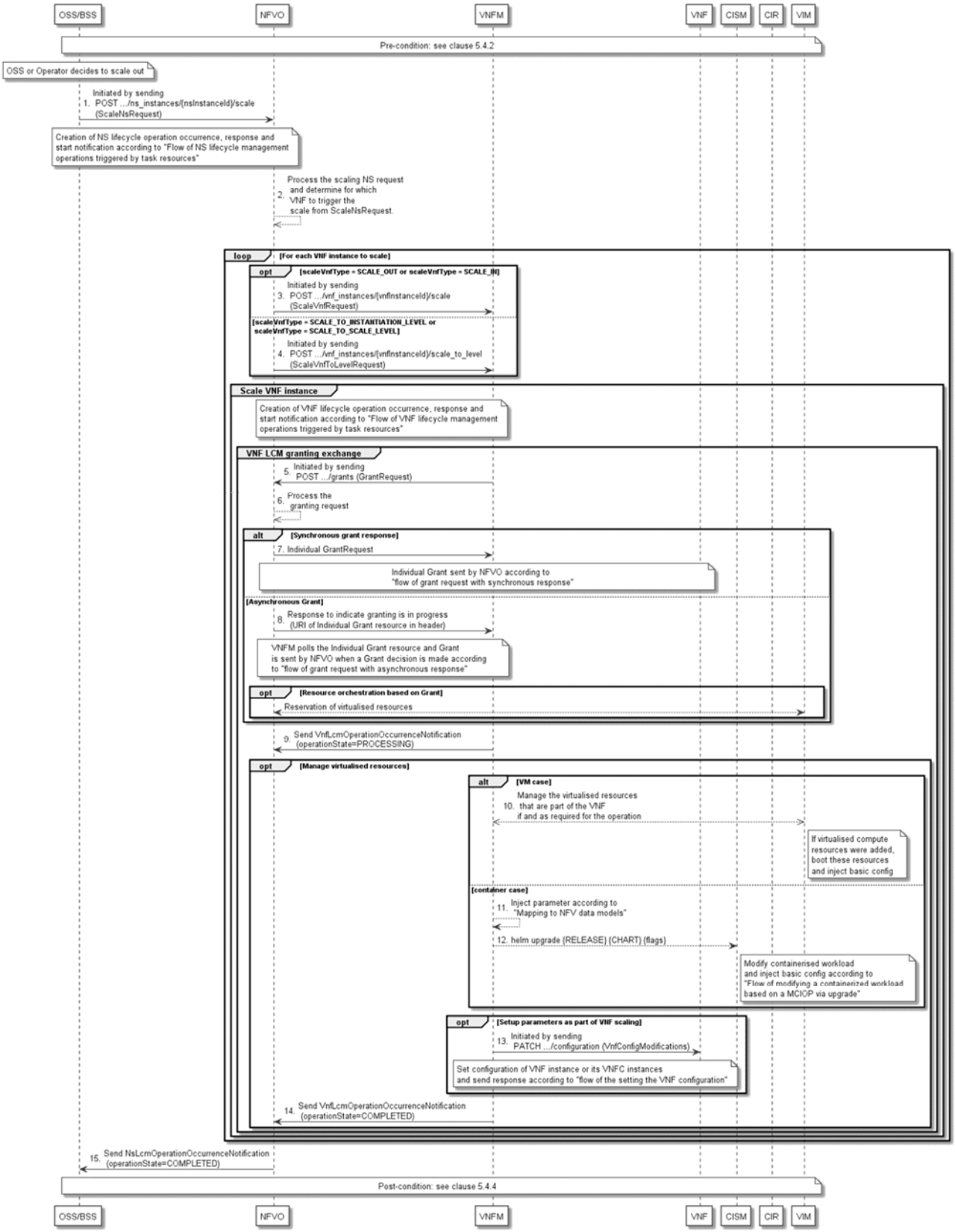


**Figure 5.4.3-1: Procedure of VNF Scaling by scaling individual NS**

The NFV-MANO procedure of VNF scaling by scaling individual NS comprises the following steps:

1. To perform the scaling of individual VNF instances part of the NS instance, the OSS/BSS shall send to the NFVO a "ScaleNsRequest" in the payload of the POST request to the "Scale NS task" resource on the NS instance identifier of the NS to scale as specified in clause 6.4.5.3.1 of ETSI GS NFV-SOL 005 [4].

The ScaleNsRequest specifies the "scaleType" as VNF scaling and includes the list of VNF instances to be scaled from the NS instance.

As described in "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response back to the OSS/BSS. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. The NFVO sends an NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The OSS/BSS can obtain information about the ongoing operation by sending a GET request to the "Individual NS LCM operation occurrence" resource as specified in clause 6.4.10.3.2 of ETSI GS NFV-SOL 005 [4]. The NFVO sets the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the scaling of the required VNF instances as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

Table 5.4.5.1-1 lists the key information exchanged between OSS/BSS and NFVO during the scaling of the NS instance to scale one or more individual VNF instance(s).

2. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource and the scale NS request, the NFVO determines the VNF instances to be scaled. Only VNF instances that are part of the NS instance will be requested to be scaled as specified in table 6.5.2.14-1 of ETSI GS NFV-SOL 005 [4].

Following steps 3 to 14 are performed with the respective VNFM for each VNF instance to be scaled. These steps can be performed in parallel for different VNF instances:

3. When "scaleVnfType" (within the "scaleVnfData" for the specific VNF instance) in the "ScaleNsRequest" is "SCALE_OUT" or "SCALE_IN", the NFVO shall send to the VNFM a "ScaleVnfRequest" in the payload of the POST request to the "Scale VNF task" resource on the VNF instance identifier of the VNF to be scaled as specified in clause 5.4.5.3.1 of ETSI GS NFV-SOL 003 [3].

4. When "scaleVnfType" (within the "scaleVnfData" for the specific VNF instance) in the "ScaleNsRequest" is "SCALE_TO_INSTANTIATION_LEVEL" or "SCALE_TO_SCALE_LEVEL", the NFVO shall send to the VNFM a "ScaleVnfToLevelRequest" in the payload of the POST request to the "Scale VNF to level task" resource on the VNF instance identifier of the VNF to be scaled as specified in clause 5.4.6.3.1 of ETSI GS NFV-SOL 003 [3].

   As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource and sends the response to NFVO. Clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3] specifies the requirements of the VNFM in handling the task resources that trigger VNF LCM operations.

   Tables 5.4.5.2-1 and 5.4.5.3-1 list the key information exchanged between NFVO and VNFM to scale the VNF instance.

   The VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

   The NFVO can obtain information about the ongoing operation by sending a GET request to the "Individual VNF LCM operation occurrence" resource as specified in clause 5.4.13.3.2 of ETSI GS NFV-SOL 003 [3].

   The VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

5. As part of the scaling VNF, the NFVO and VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle scaling operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the payload of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.4.5.4-1 lists the key information exchanged between NFVO and VNFM during the VNF LCM operation grant process.

6. The NFVO processes the granting request. Based on the NSD information, the current information and state of "Individual NS instance" resource, and the input information from the granting request, the NFVO makes a decision (i.e. whether to grant or not) about the VNF LCM operation granting request related to the VNF scaling.

7. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]), the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code 201 (Created) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

8. For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code 202 (Accepted) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   For the case of "asynchronous mode", as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code 202 (Accepted) which indicates that the grant processing is in progress. When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code 200 (OK) with the content of the Grant.

NOTE: The grant processing and message exchanges specified in the steps above only describe the success cases.

   As part of granting, resource orchestration is performed by the NFVO as required for the resource fulfilment part of the scaling. In case that reservation of virtualised resources is required for the VNF to be scaled, the NFVO and VIM shall perform the reservation of the virtualised resources that have not been reserved so far (if this is the case), before making the "Individual grant" resource available.

9. After successful completion of the VNF LCM operation granting exchange (steps 5 to 8), if there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM sends to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state, as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

10. Based on the type of VNF scaling request, as specified in clause 5.5.2.5 or 5.5.2.6 of ETSI GS NFV-SOL 003 [3], the VNFM will determine the virtualised resources associated to the VNF instance that need to be added, removed, modified, or created temporarily. In the case of virtualised resources management is direct mode, the VNFM shall request to the VIM the applicable management operations of the virtualised resources for the VNF instance. During this step, if the VNFD contains boot data information for the added compute resources, the VNFM shall provide initial configuration while requesting the instantiation of these compute resources according to the specified boot data information in the VNFD and other data held by the VNFM.

    Table 5.2.5.10-1 lists key information exchange between VNFM and VIM for compute resource provisioning and Table 5.2.5.10-2 lists key information exchange between VNFM and VIM for storage resource provisioning. The listed key information applies only in case the VIM's consumer communicates with the VIM using the descriptor based approach as defined in ETSI GS NFV-SOL 014 [9], and if the VNFM requests the VIM to provision compute and storage resource(s) during the step 10.

11. In the case of containerized VNF, VNFM creates input parameter as specified in clause 6.2 of ETSI GS NFV-SOL 018 [11].

12. VNFM request to CISM to modify containerized workload part of VNF as described in clause 7.3.2 of ETSI GS NFV-SOL 018 [11]. Table 5.4.5.8-1 lists the key information exchanged between VNFM and CISM during the VNF scaling process.

13. In the case that certain configuration needs to be setup into the VNF after the virtualised resources have been created or terminated, and before completing the VNF scaling (e.g. as controlled by the workflows/scripts declared in the VNFD), and the VNF supports the VNF configuration interface as specified in clause 9 of ETSI GS NFV-SOL 002 [2], the VNFM shall send to the VNF a "VnfConfigModifications" in the payload of the PATCH request to the "configuration" resource as specified in clause 9.4.2.3.4 of ETSI GS NFV-SOL 002 [2].

As described in the "Flow of setting the VNF configuration" (see clause 9.3.1 of ETSI GS NFV-SOL 002 [2]), the VNF sets the configuration of the VNF instance and/or its VNFC instances. If VNF configuration is supported by means of LCM scripts, VNFM invokes these LCM scripts as part of VNF configuration.

14. After successful completion of the VNF scaling by the VNFM, the VNFM sends to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM. VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clauses 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3].

15. After successful completion of the scaling of the NS instance and its constituents, the NFVO sends to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS. The NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

## 5.4.4 Post-conditions

Table 5.4.4-1 specifies the post-conditions applicable to the VNF scaling triggered through scale NS procedure.

**Table 5.4.4-1: VNF Scaling triggered through scale NS procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The specified VNF instances in the NS instance are scaled | N/A |

## 5.4.5 Key information exchanged in the procedure

### 5.4.5.1 Scale NS instance to scale specific VNF instances

Table 5.4.5.1-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the Scale NS request to scale specific VNF instance(s). The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.4.5.1-1: Key information exchanged during scale NS to scale specific VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set by the OSS/BSS to the "id" attribute of "NsInstance" representing the "Individual NS instance" resource created by NFVO in which the specific VNF instance(s) to scale is (are) part of. |
| ScaleNsRequest in the request | scaleType | Shall be set by the OSS/BSS to "SCALE_VNF". |
| | scaleVnfData | Shall be set by the OSS/BSS to the specific scaling details of all VNF instances that need to be scaled, with one entry per VNF instance to scale. See note. |
| NOTE: The scaleVnfData can either provide information for scaling the VNF instance by steps or to a given instantiation or scale level. Related key exchanged information is further detailed in clauses 5.4.5.2 and 5.4.5.3 as part of the information exchange between the NFVO and VNFM. | | |

### 5.4.5.2 Scale VNF instance

Table 5.4.5.2-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the scale VNF request. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.4.5.2-1: Key information exchanged during scale VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO to the same "vnfInstanceId" attribute of scaleVnfData in ScaleNsRequest. |
| ScaleVnfRequest in the request | type | Shall be set by the NFVO to the same value of scaleVnfType of scaleVnfData in ScaleNsRequest. |
| | aspectId | Shall be set by the NFVO to the same value of aspectId of scaleByStepData in ScaleNsRequest. |
| | numberOfSteps | Shall be set by the NFVO to the same value of numberOfSteps of scaleByStepData, if such value is provided in the ScaleNsRequest. |

### 5.4.5.3 Scale VNF instance to level

Table 5.4.5.3-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the scale VNF instance to level request. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.4.5.3-1: Key information exchanged during scale VNF instance to level**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO to the same "vnfInstanceId" attribute of scaleVnfData in ScaleNsRequest. |
| ScaleVnfToLevelRequest in the request | instantiationLevelId | Shall be set by the NFVO to the same value of vnfInstantiationLevelId of scaleToLevelData, if such value is provided in the ScaleNsRequest. |
| | scaleInfo | Shall be set by the NFVO to the same object of vnfScaleInfo of scaleToLevelData, if such value is provided in the ScaleNsRequest. |

### 5.4.5.4 VNF LCM granting exchange for VNF scaling

Table 5.4.5.4-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the granting exchange related to the VNF scaling. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.4.5.4-1: Key information exchanged during VNF LCM granting exchange**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| GrantRequest in the request | vnfInstanceId | Shall be set by the VNFM to the same "id" attribute of "VnfInstance" that is to be scaled. |
| | vnfLcmOpOccId | Shall be set by the VNFM to the identifier of the VNF lifecycle management operation occurrence associated to the GrantRequest. |
| | vnfdId | Shall be set by the VNFM to the "vnfdId" attribute of "VnfInstance" created by the VNFM that has been requested to be scaled. |
| | operation | Shall be set by the VNFM to "SCALE_TO_LEVEL" if the scaling associated to the GrantRequest is triggered by the "Scale VNF to Level" operation (i.e. POST request to "Scale VNF to Level task" resource) or "SCALE", if triggered by the "Scale VNF" operation (i.e. POST request to "Scale VNF task" resource). |
| | isAutomaticInvocation | Shall be set by the VNFM to false. |
| | addResources | Shall be set by the VNFM to the list of resource definitions in the VNFD for resources to be added by the LCM operation, which is related to this grant request, with one entry per resource. See note. |
| | removeResources | Shall be set by the VNFM to the list of resources to be removed by the LCM operation, which is related to this grant request, with one entry per resource. See note. |

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| | removeResources<br><br>->resource | Shall be set by the VNFM to the information that addresses the existing resource to be removed. |
| Grant in the response | vnfInstanceId | Set by the NFVO to the same value of the "id" attribute of "VnfInstance" that is to be scaled as provided in the GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | vnfLcmOpOccId | Set by the NFVO to the same value of the "vnfLcmOpOccId" attribute of GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | addResources | Set by the NFVO to indicate the list of resources that are approved to be added, with one entry per resource, as defined in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3]. |
| | removeResources | Set by the NFVO to indicate the list of resources that are approved to be removed, with one entry per resource, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| NOTE: Depending on its kind, the scaling operation might imply only adding resources, only removing resources, or both. Additionally, resource updates and/or use of temporary resources might occur. | | |

### 5.4.5.5 VNF lifecycle change notifications

Table 5.4.5.5-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of the VNF lifecycle change notifications corresponding to the VNF scaling, in the context of the present NFV-MANO procedure.

The full set of notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO as recipient of the notifications and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.4.5.5-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.4.5.5-1: Key information exchanged during VNF lifecycle change notifications**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfLcmOperationOccurrenceNotification payload in the request | notificationType | Set by the VNFM to "VnfLcmOperationOccurrenceNotification", as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | subscriptionId | Set by the VNFM to the value of the "id" attribute of the associated "LccnSubscription" representing the "Individual subscription" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | notificationStatus | Set by the VNFM to either "START" or "RESULT", depending on whether the notification relates to start, final or intermediate result of the VNF LCM operation occurrence, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | operationState | Set by the VNFM to the value of the "operationState" attribute in the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence", as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "SCALE" if the scaling operation is triggered by the "Scale VNF" operation (i.e. POST request to "Scale VNF task" resource), or to "SCALE_TO_LEVEL" if the scaling is triggered by the "Scale VNF to Level" operation (i.e. POST request to "Scale VNF to Level task" resource). |
| | isAutomaticInvocation | Set by the VNFM to false. |
| | vnfLcmOpOccId | Set by the VNFM to the value of the "id" attribute of associated "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |

### 5.4.5.6 VNF lifecycle management operation occurrences

Table 5.4.5.6-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of reading the VNF lifecycle management operation occurrence corresponding to the VNF scaling, in the context of the present NFV-MANO procedure.

The full set of data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.4.5.6-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.4.5.6-1: Key information exchanged during reading VNF lifecycle management operation occurrences**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfLcmOpOccId | Shall be set by the NFVO to the "id" attribute of the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource to read. |
| VnfLcmOpOcc in the response | operationState | Set by the VNFM to the state value of the VNF LCM operation occurrence, as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | vnfInstanceId | Set by the VNFM to the value of the "id" attribute of the "VnfInstance" representing the associated "Individual VNF instance" resource, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | grantId | Set by the VNFM to the value of the "id" attribute in the "Grant" representing the associated "Individual grant" resource, if such a grant exists, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "SCALE" if the scaling operation is triggered by the "Scale VNF" operation (i.e. POST request to "Scale VNF task" resource), or to "SCALE_TO_LEVEL" if the scaling is triggered by the "Scale VNF to Level" operation (i.e. POST request to "Scale VNF to Level task" resource). |
| | isAutomaticInvocation | Set by the VNFM to false. |

### 5.4.5.7 Manage virtualised resources

This clause applies if the VIM's consumer communicates with the VIM using the descriptor-based approach defined in ETSI GS NFV-SOL 014 [9]. ETSI GS NFV-SOL 014 [9] specifies a set of request/response/notification data types and attributes for a descriptor-based approach and clause 5.2.5.10 describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 014 [9].

Table 5.2.5.10-1 lists the selected key information sent towards the VIM(s) for provisioning of the compute resource.

Table 5.2.5.10-2 lists the selected key information sent towards the VIM(s) for provisioning of the storage resource.

### 5.4.5.8 containerized resources modifying for the VNF Instance

This clause applies if the CISM's consumer communicates with the CISM using Deployment object of Kubernetes® resource object kind defined in ETSI GS NFV-SOL 018 [11]. This clause describes how to set the values of these attributes/parameters defined in ETSI GS NFV-SOL 018 [11].

Table 5.4.5.8-1 lists the selected key information sent towards the CISM(s) for modifying of the compute resource.

**Table 5.4.5.8-1: Key information for compute resource modifying**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| Modify a containerized workload based on a MCIOP. | replicas | Shall be set by the VNFM to be modified as specified in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11]. |

## 5.4.6 Execution of dependent and non-dependent side procedures

### 5.4.6.1 Introduction

Side procedures (i.e. other management functionality, supported via the NFV-MANO interfaces, which does not form the core of functionality specified in the main procedure flow) related to VNF Package management, NSD management, NS LCM, PM and FM; VNF LCM, PM and FM; VNF lifecycle granting; and VNF Indicators can have a dependency (i.e. be impacted) or be independent from the VNF scaling triggered through scale NS.

The following clauses specify the considerations of these other side procedures with respect to the VNF scaling triggered through scale NS.

### 5.4.6.2 Non-dependent side procedures

#### 5.4.6.2.1 VNF Package management

Operations about management of subscriptions to notifications (request to create a new subscription, delete and existing subscription, query and read existing subscriptions) related to VNF Package management of VNF Packages associated to the VNF instance(s) that is (are) being scaled may be executed by the OSS/BSS (as specified in clauses 9.4.8 and 9.4.9 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clauses 10.4.7 and 10.4.8 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about management of the VNF packages, and their content (retrieval of the VNF package content, query and read VNF packages information, update of information of a VNF package, and request to delete an onboarded VNF Package), corresponding to VNF instance(s) that is (are) being scaled may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.2 NSD management

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, and query and read of existing subscriptions) of the NSD and PNFD related to the NS instance that is being scaled (by scaling individual VNF instance(s)) may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about management of the NSD and PNFD, and their content (retrieval of the NSD and PNFD content, query and read information about NSD and PNFD, and request to delete and onboarded NSD or PNFD), corresponding to NSD related to, and PNF which are part of, the NS instance that is being scaled (by scaling individual VNF instance(s)), may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.3 NS lifecycle management

Operations about management of subscriptions to notifications related to NS lifecycle management (request to create a new subscription, delete and existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being scaled (by scaling individual VNF instance(s)) may be executed by the OSS/BSS (as specified in clauses 6.4.16 and 6.4.17 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about querying and reading information about NS instances, including the NS being scaled, may be executed by the OSS/BSS (as specified in clauses 6.4.2 and 6.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.4 NS fault management

Operations about management of subscriptions to notifications related to NS fault management (request to create a new subscription, delete and existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being scaled (by scaling individual VNF instance(s)) may be executed by the OSS/BSS (as specified in clauses 8.4.4 and 8.4.5 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about querying, reading and acknowledging alarms about NS instances, including the NS being scaled, may be executed by the OSS/BSS (as specified in clauses 8.4.2 and 8.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.5 NS performance management

The request by the OSS/BSS to terminate "Individual PM job" and "Individual threshold", as specified in clauses 7.4.3.3.5 and 7.4.6.3.5 of ETSI GS NFV-SOL 005 [4] respectively, related to the NS instance that is being scaled (by scaling individual VNF instance(s)) may be executed in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

The request by the OSS/BSS of other operations about management of "Individual PM job" (query PM jobs, reading single PM job, and updating associated PM job callback URI), reading an "Individual performance report" and other operations about management of "Individual thresholds" (query thresholds, reading a single threshold, and updating associated threshold callback URI) (as specified in clauses 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 005 [4]) related to the NS instance that is being updated may be executed in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.6 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to a VNF instance(s) to be scaled may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18, 5.4.19, 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about querying and reading information about VNF instances, including VNFs being scaled as part of the scale NS operation, may be executed by the NFVO (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 003 [3]) and by the EM (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.7 VNF fault management

Operations about management of subscriptions from the VNFM to notifications related to VNF fault management of the VNF instance(s) that is (are) being scaled may be executed by the NFVO (as specified in clauses 7.4.3 and 7.4.5 of ETSI GS NFV-SOL 003 [3]) and EM (as specified in clauses 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about querying, reading and acknowledging alarms about VNF instances, including VNFs being scaled as part of the scale NS, may be executed by the NFVO (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

In addition, operations to escalate the perceived severity of an alarm about a VNF instance, including VNFs being scaled as part of the scale NS, may be executed by the EM (as specified in clause 7.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.8 VNF performance management

Operations about management of "Individual PM job" (create a PM job, query PM jobs, reading single PM job, deleting a PM job, and updating associated PM job callback URI), reading an "Individual performance report" and management of "Individual threshold" (create a threshold, query thresholds, reading a single threshold, deleting a threshold, and updating associated threshold callback URI) related to the VNF instance(s) that is (are) being scaled may be executed by the NFVO (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 003 [3]) and by EM (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

#### 5.4.6.2.9 VNF indicators

Potential operations about management of subscriptions from the VNFM to notifications related to notifications related to VNF indicators of the VNF instance(s) that is (are) being scaled may be executed by the NFVO (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 003 [3]) before, in parallel or after any of the steps in the VNF scaling triggered through scale NS procedure.

Likewise, potential operations about management of subscriptions from the VNF/EM to notifications related to VNF indicators of the VNF instance(s) that is (are) being scaled may be executed by the VNFM(as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 002 [2]) before, in parallel or after any of the steps in the VNF scaling triggered through scale NS procedure.

Operations about querying and reading VNF indicators information, including of VNFs being scaled as part of the scale NS, may be executed by the NFVO (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

Likewise, operations about querying and reading VNF indicators information, including of VNFs being scaled as part of the scale NS, may be executed by the VNFM (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF scaling triggered through scale NS procedure.

### 5.4.6.3 Dependent side procedures

#### 5.4.6.3.1 NS performance management

Depending on the values used to create the thresholds and the scale status of the NS instance that is being scaled, such thresholds can either not trigger any threshold crossing notification or create a storm of threshold crossing notifications. The OSS/BSS (as API consumer of the ThresholdCrossedNotifications concerning the NS instance that is being scaled) should request to the NFVO, after completing the NS scaling, updating the relevant thresholds by deleting existing thresholds and creating new thresholds with the new appropriate "ThresholdCriteria", deleting non-applicable existing thresholds, or creating new relevant ones (as specified in clauses 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 005 [4]) to adjust to the potentially changed performance monitoring objectives.

#### 5.4.6.3.2 VNF performance management

Depending on the values used to create the thresholds and the scale status of the VNF instance(s) that is (are) being scaled, such thresholds can either not trigger any threshold crossing notification or create a storm of unwanted threshold crossing notifications. The NFVO and/or EM (as API consumer of the ThresholdCrossedNotifications concerning the VNF instance that is being scaled) should request to the VNFM, after completing the VNF scaling, updating the relevant thresholds by deleting existing thresholds and creating new thresholds with the new appropriate "ThresholdCriteria", deleting non-applicable existing thresholds, or creating new relevant ones (as specified in clauses 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 003 [3], for the NFVO, and clauses 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 002 [2], for the EM) to adjust to the potentially changed performance monitoring objectives.

### 5.4.6.4 Error cases and other considerations

#### 5.4.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "VNF scaling triggered through NS scale procedure" is the same as the one defined in clause 5.1.6.4.1.

#### 5.4.6.4.2 NSD management

The handling of the request by the OSS/BSS to delete an onboarded NSD or PNFD during the "VNF scaling triggered through NS scale procedure" is the same as the one defined in clause 5.2.6.4.2.

# 5.5 Change external VNF connectivity triggered through NS update procedure

## 5.5.1 Introduction

Clause 5.5 specifies the NFV-MANO procedure for changing external connectivity of VNF. The change of external VNF connectivity is triggered though NS update by providing the change in external virtual links.

NOTE: In the present procedure, the use of virtualised resource management in indirect mode is not defined because the referenced version of ETSI GS NFV-SOL 003 [3] lacks such a specification, as opposed to the remaining NFV-MANO APIs which are fully specified and specific references in the procedure flow and key information exchanges can be provided. In addition, the procedure flows, while specifying the steps and stages at which virtualised resource management interactions take place, do not provide any reference to protocol and data model solutions of NFV-MANO APIs concerning to virtualised resource management, since these are not available at the time the present document is published.

## 5.5.2 Pre-conditions

Table 5.5.2-1 specifies the pre-conditions applicable to the change of external VNF connectivity procedure triggered through NS update procedure.

**Table 5.5.2-1: Change external VNF connectivity procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | Preconditions listed in NS instantiation procedure are applicable for this procedure as well. | Refer to clause 5.2.2. |
| 2 | The VNF instance for which change in external connectivity needed is in INSTANTIATED state. | |

## 5.5.3 Procedure flow

For the change of external VNF connectivity of NS instance, the consumer may choose to update the NS instance by using the NS update operation of the NS LCM interface.

Figure 5.5.3-1 shows the procedure that uses the update external connectivity of individual NS constituents.

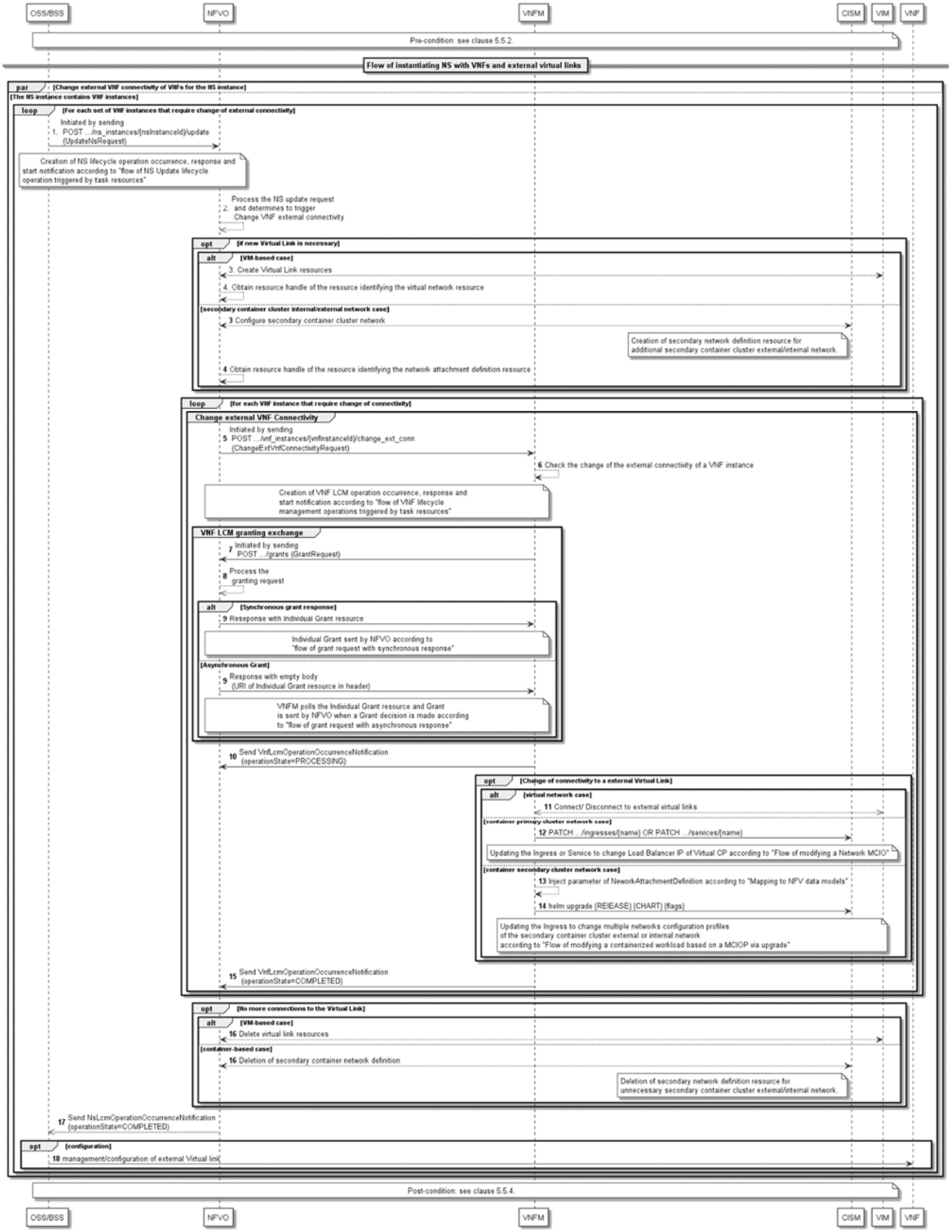


**Figure 5.5.3-1: Procedure flow of NS update changing the external VNF connectivity**

The NFV-MANO procedure of Change external VNF connectivity triggered by NS update comprises the following steps. The steps of changing external connectivity of VNF instances (steps 4 to 11) may be executed in parallel:

1. To perform external VNF connectivity change, the OSS/BSS shall send to the NFVO an "UpdateNsRequest" in the message content of the POST request to the "NS instance" resource as specified in clause 6.4.6.3.1 of ETSI GS NFV-SOL 005 [4]. As described in the "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. The NFVO sends NS LCM start notification to the OSS/BSS if there is an applicable subscription for the NS LCM notifications to the OSS/BSS. The NFVO will set the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of changing the external connectivity for the required VNF instances as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

   Table 5.5.5.1-1 lists the key information exchanged between the OSS/BSS and the NFVO to update the NS instance.

2. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource and the NS update request with external VNF connectivity data as specified in clause 6.5.3.33 of ETSI GS NFV-SOL 005 [4], the NFVO determines the VNF instances that require changes to the external connectivity.

3. If it is necessary to add or update the Virtual Links and if VIM or CISM can support modifying network resource, the NFVO requests to create or update the Virtual Links to VIM in VM-based case, or to configure secondary container cluster network to CISM in container-based case as indicated in clause 6.11 of ETSI GR NFV-IFA 038 [i.4].

NOTE 1: Primary container cluster internal/external network is not modifiable and controlled by the CISM in the present document as indicated in clause 6.11.4.2 of ETSI GR NFV-IFA 038 [i.4].

4. The NFVO obtains the resource handle of the resource identifying the virtual network resource for VM-based case and the network attachment definition resource for container-based case.

Following steps 5 to 15 are performed with the respective VNFM for each VNF instance whose external connectivity is changed as part of the NS update operation. These steps can be performed in parallel for different VNF instances:

5. To change the external connectivity of VNF instance, the NFVO shall send to the VNFM a "ChangeExtVnfConnectivityRequest" in the message content of the POST request to the "Individual VNF instance" resource as specified in clause 5.4.11.3.1 of ETSI GS NFV-SOL 003 [3]. As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource and sends the response to NFVO. The VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for the VNF LCM notifications to the NFVO. The VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

   The VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.5.5.2-1 lists the key information exchanged between the NFVO and the VNFM to change the external connectivity of the VNF instance.

6. The VNFM checks the change of the external connectivity of the VNF instance.

7. As part of the VNF external connectivity change, the NFVO and the VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle change external VNF connectivity operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the message content of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.5.5.3-1 lists the key information exchanged between the NFVO and the VNFM during the VNF LCM operation grant process.

8. The NFVO processes the granting request. Based on the NSD information, the current information and state of "Individual NS instance" resource, and the input information from the granting request, the NFVO makes a decision about the VNF LCM operation granting request related to the VNF termination.

9. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]), the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code "201 Created" as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code "202 Accepted" as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   For the case of "asynchronous mode", as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from the NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code "202 Accepted" which indicates that the grant processing is in progress. When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code "200 OK" with the content of the Grant.

NOTE 2: The grant processing and message exchanges specified in the steps above only describe the success cases.

10. Upon successful completion of the VNF LCM operation granting exchange (steps 7 to 9), if there is an applicable subscription for the VNF LCM notifications to the NFVO, the VNFM will send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for the VNF LCM notifications to the EM.

11. In the virtual network and VM based VNF case, the VNFM changes (connect/disconnect) the network connectivity with the external virtual links to the VIM.

12. In the container primary cluster network case and container-based VNF case, the VNFM requests to modify the VirtualCp realizing the VNF external CP by modifying the desired or actual state of a corresponding Network MCIO, either an "Individual Ingress instance" resource or an "Individual Service instance" as defined in clause 10.4 of ETSI GS NFV-SOL 018 [11].

13. In the container secondary cluster network case and container based VNF case, the VNFM injects the NeworkAttachmentDefinition parameter according to "Mapping to NFV data models" as defined in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11].

14. The VNFM sends a "helm upgrade" command, including the name of the Helm™ release to be modified as {RELEASE}, a reference to the modified MCIOP as {CHART} and the optional command {flags}, as defined in clause 7.3.2 of ETSI GS NFV-SOL 018 [11].

15. Upon successful completion of the Change External VNF connectivity by the VNFM, the VNFM will send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for the VNF LCM operation occurrence notifications to the NFVO, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. The VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for the VNF LCM notifications to the EM. The VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clauses 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3].

16. As part of the VNF external connectivity change, resource orchestration can be performed by the NFVO for the resource fulfilment.

    Based on the NSD information, the current information and state of the "Individual NS instance" resource, and the outcomes from the VNF external connectivity change, the NFVO and the VIM or CISM may terminate unused external networks (from the VNF instance point of view) and/or link ports associated to the VNF.

17. Upon successful completion of the change in external connectivity for all involved VNF instances in the Update NS request, the NFVO shall send to the OSS/BSS an NsLcmOperationOccurrenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for the NS LCM notifications to the OSS/BSS. The NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

18. The OSS/BSS may configure the external Virtual link changes on the VNF e.g. with the configuration over the EM interface.

## 5.5.4 Post-conditions

Table 5.5.4-1 specifies the post-conditions applicable to the NS update procedure related to change external VNF connectivity.

**Table 5.5.4-1: Change external VNF connectivity procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The constituent VNF instances of the NS instance are in INSTANTIATED state and external connectivity of one or more VNFs is changed. | The change in external connectivity of the constituent VNF instances may include disconnecting the external CPs that are connected to a particular external VL and connect them to a different external VL. The update may change the connectivity parameters of the existing external CPs, including changing addresses. |

## 5.5.5 Key information exchanged in the procedure

### 5.5.5.1 Update NS instance to change external connectivity of specific VNF instances

Table 5.5.5.1-1 lists the source and mapping of key information exchanged between OSS/BSS and NFVO during the Update NS request to change external connectivity of specific VNF instance(s). The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.5.5.1-1: Key information exchanged during update NS to change external connectivity of specific VNF instance(s)**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set by the OSS/BSS to the "id" attribute of "NsInstance" representing the "Individual NS instance" resource created by NFVO in which the specific VNF instance(s) to change external connectivity is (are) part of. |
| UpdateNsRequest in the request | updateType | Shall be set by the OSS/BSS to "CHANGE_EXTERNAL_VNF_CONNECTIVITY". |
| | changeExtVnfConnectivityData | Shall be set by the OSS/BSS to the specific values of external connectivity data of all VNF instances for which the external connectivity is required to be changed, with one entry per VNF instance. |

### 5.5.5.2 Change external connectivity of VNF instance

Table 5.5.5.2-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM during the change external VNF connectivity request. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.5.5.2-1: Key information exchanged during change VNF external connectivity of VNF instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO to the same "vnfInstanceId" attribute of changeExtVnfConnectivityData in "UpdateNsRequest" structure. |
| ChangeExtVnfConnectivityRequest in the request | extVirtualLinks | In order to change the connectivity, shall be set by the NFVO to the same "extVirtualLinks" attribute of changeExtVnfConnectivityData in "UpdateNsRequest" structure. |
| | extVirtualLinks.extCps | In order to change the connectivity parameters of existing external CPs, shall be set by the NFVO to the same "extCps" attribute of "extVirtualLinks" attribute with data structure "ExtVirtualLinkData" of changeExtVnfConnectivityData in the "UpdateNsRequest" structure. |
| | extVirtualLinks.cpConfig | In order to change the connectivity to different external VL for container secondary cluster network, shall be set by the NFVO to the same "cpConfig" attribute of "extVirtualLinks" attribute with data structure "ExtVirtualLinkData" of changeExtVnfConnectivityData in "UpdateNsRequest" structure. |
| | extVirtualLinks.netAttDefResourceId | In order to change the connectivity to different external VL for container secondary cluster network, shall be set by the NFVO to the same "netAttDefResourceId" attribute of "extVirtualLinks" attribute with data structure "ExtVirtualLinkData" of changeExtVnfConnectivityData in "UpdateNsRequest" structure. |

### 5.5.5.3 VNF LCM granting exchange for change external VNF connectivity

Table 5.5.5.3-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the granting exchange related to change external VNF connectivity. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.5.5.3-1: Key information exchanged during VNF LCM granting exchange**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| GrantRequest in the request | vnfInstanceId | Shall be set by the VNFM to the same "id" attribute of "VnfInstance" created by the VNFM for which external connectivity change has been requested. |
| | vnfLcmOpOccId | Shall be set by the VNFM to the identifier of the VNF lifecycle management operation occurrence associated to the GrantRequest. |
| | vnfdId | Shall be set by the VNFM to the "vnfdId" attribute of "VnfInstance" created by the VNFM for which external connectivity change has been requested. |
| | operation | Shall be set by the VNFM to "CHANGE_EXT_CONN". |
| | isAutomaticInvocation | Shall be set by the VNFM to false. |
| Grant in the response | vnfInstanceId | Set by the NFVO to the same value of the "id" attribute of "VnfInstance" for which external connectivity change has been requested as provided in the GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | vnfLcmOpOccId | Set by the NFVO to the same value of the "vnfLcmOpOccId" attribute of GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | vimConnectionInfo | Set by NFVO the VIM and/or CISM connections that are approved to be used by the VNFM to allocate resources and provides parameters of these VIM and/or CISM connections, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | cirConnectionInfo | Set by NFVO the CIR connection that is approved to be used by the VNFM to obtain information about OS container images, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |
| | mciopRepositoryInfo | Set by NFVO the information regarding a MCIOP repository, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |

### 5.5.5.4 VNF lifecycle change notifications

Table 5.5.5.4-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of the VNF lifecycle change notifications corresponding to the change of external VNF connectivity, in the context of the present NFV-MANO procedure.

The full set of notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO as recipient of the notifications and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.5.5.4-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.5.5.4-1: Key information exchanged during VNF lifecycle change notifications**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfLcmOperationOccurrenceNotification message content in the request | notificationType | Set by the VNFM to "VnfLcmOperationOccurrenceNotification", as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | subscriptionId | Set by the VNFM to the value of the "id" attribute of the associated "LccnSubscription" representing the "Individual subscription" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | notificationStatus | Set by the VNFM to either "START" or "RESULT", depending on whether the notification relates to start, final or intermediate result of the VNF LCM operation occurrence, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | operationState | Set by the VNFM to the value of the "operationState" attribute in the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence", as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "CHANGE_EXT_CONN" for the present change of external VNF connectivity procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |
| | vnfLcmOpOccId | Set by the VNFM to the value of the "id" attribute of associated "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |

### 5.5.5.5 VNF lifecycle management operation occurrences

Table 5.5.5.5-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of reading the VNF lifecycle management operation occurrence corresponding to the change of external VNF connectivity, in the context of the present NFV-MANO procedure.

The full set of data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.5.5.5-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.5.5.5-1: Key information exchanged during reading VNF lifecycle management operation occurrences**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfLcmOpOccId | Shall be set by the NFVO to the "id" attribute of the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence" resource to read. |
| VnfLcmOpOcc in the response | operationState | Set by the VNFM to the state value of the VNF LCM operation occurrence, as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | vnfInstanceId | Set by the VNFM to the value of the "id" attribute of the "VnfInstance" representing the associated "Individual VNF instance" resource, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | grantId | Set by the VNFM to the value of the "id" attribute in the "Grant" representing the associated "Individual grant" resource, if such a grant exists, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "CHANGE_EXT_CONN" for the present change of external VNF connectivity procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |

### 5.5.5.6 Network connectivity

Table 5.5.5.6-1 lists the pattern and reference about information exchanged between the VNFM and the CISM as part of reading the VNF lifecycle management operation occurrence corresponding to the change of external VNF connectivity, in the context of the present NFV-MANO procedure.

**Table 5.5.5.6-1: Information for changing network connectivity**

| Pattern | Reference |
|---|---|
| Changing primary container cluster external network | PATCH /ingresses/{name} to modify IngressSpec v1 networking>rules, as defined in clause 6.2.3.1 of ETSI GS NFV-SOL 018 [11]. |
| Changing secondary container cluster external network | PATCH deployments/{name} to modify PodTemplateSpec v1 core>metadata>>annotations>>>k8s.cni.cncf.io/networks, as defined in clause 6.2.2.1 of ETSI GS NFV-SOL 018 [11]. |

## 5.5.6 Execution of dependent and non-dependent side procedures

### 5.5.6.1 Introduction

Side procedures (i.e. other management functionality, supported via the NFV-MANO interfaces, which does not form the core of functionality specified in the main procedure flow) related to VNF Package management, NSD management, NS LCM, PM and FM; VNF LCM, PM and FM; VNF lifecycle granting; and VNF Indicators can have a dependency (i.e. be impacted) or be independent from the change external VNF connectivity triggered through NS update.

The following clauses specify the considerations of these other side procedures with respect to the change external VNF connectivity through NS update.

#### 5.5.6.2 Non-dependent side procedures

##### 5.5.6.2.1 VNF Package management

Operations about management of subscriptions to notifications (request to create a new subscription, delete an existing subscription, query and read existing subscriptions) related to VNF Package management of VNF Packages associated to the VNF instance(s) whose external connectivity is changed, may be executed by the OSS/BSS (as specified in clauses 9.4.8 and 9.4.9 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clauses 10.4.7 and 10.4.8 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

Operations about management of the VNF packages, and their content (retrieval of the VNF package content, query and read VNF packages information, update of information of a VNF package, and request to delete an onboarded VNF Package), corresponding to VNF instance(s) whose external connectivity is changed, may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

##### 5.5.6.2.2 NSD management

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, and query and read of existing subscriptions) of the NSD and PNFD related to the NS instance that is being updated for external VNF connectivity change, may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

Operations about management of the NSD and PNFD, and their content (retrieval of the NSD and PNFD content, query and read information about NSD and PNFD, and request to delete and onboarded NSD or PNFD), corresponding to NSD related to, and PNF which are part of, the NS instance that is being updated for external VNF connectivity change, may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

##### 5.5.6.2.3 NS lifecycle management

Operations about management of subscriptions to notifications related to NS lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being updated for external VNF connectivity change may be executed by the OSS/BSS (as specified in clauses 6.4.16 and 6.4.17 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

Operations about querying and reading information about NS instances, including the NS being updated, may be executed by the OSS/BSS (as specified in clauses 6.4.2 and 6.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

##### 5.5.6.2.4 NS fault management

Operations about management of subscriptions to notifications related to NS fault management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being updated for external VNF connectivity change may be executed by the OSS/BSS (as specified in clauses 8.4.4 and 8.4.5 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

Operations about querying, reading and acknowledging alarms about NS instances, including the NS being updated, may be executed by the OSS/BSS (as specified in clauses 8.4.2 and 8.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

#### 5.5.6.2.5 NS performance management

The request by the OSS/BSS to terminate "Individual PM job" and "Individual threshold", as specified in clauses 7.4.3.3.5 and 7.4.6.3.5 of ETSI GS NFV-SOL 005 [4] respectively, related to the NS instance that is being updated for external VNF connectivity change may be executed in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

The request by the OSS/BSS of other operations about management of "Individual PM job" (query PM jobs, reading single PM job, and updating associated PM job callback URI), reading an "Individual performance report" and other operations about management of "Individual thresholds" (query thresholds, reading a single threshold, and updating associated threshold callback URI) (as specified in clauses 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 005 [4]) related to the NS instance that is being updated may be executed in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

#### 5.5.6.2.6 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to a VNF instance for which external VNF connectivity is updated may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18, 5.4.19, 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the Change external VNF connectivity triggered through NS update procedure.

Operations about querying and reading information about VNF instances, including the VNF instance for which external VNF connectivity is updated, may be executed by the NFVO (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 003 [3]) and by the EM (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

#### 5.5.6.2.7 VNF fault management

Operations about management of subscriptions from the VNFM to notifications related to VNF fault management of the VNF instance(s) for which external VNF connectivity is updated may be executed by the NFVO (as specified in clauses 7.4.3 and 7.4.5 of ETSI GS NFV-SOL 003 [3]) and EM (as specified in clauses 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

Operations about querying, reading and acknowledging alarms about VNF instances, including the VNF instance for which external VNF connectivity is updated, may be executed by the NFVO (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

In addition, operations to escalate the perceived severity of an alarm about a VNF instance, including the VNF instance for which external VNF connectivity is updated, may be executed by the EM (as specified in clause 7.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

#### 5.5.6.2.8 VNF performance management

Operations about management of "Individual PM job" (create a PM job, query PM jobs, reading single PM job, deleting a PM job, and updating associated PM job callback URI), reading an "Individual performance report" and management of "Individual threshold" (create a threshold, query thresholds, reading a single threshold, deleting a threshold, and updating associated threshold callback URI) related to the VNF instance(s) for which external VNF connectivity is updated may be executed by the NFVO (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 003 [3]) and by EM (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

#### 5.5.6.2.9 VNF indicators

Potential operations about management of subscriptions from the VNFM to notifications related to notifications related to VNF indicators of the VNF instance(s) for which external VNF connectivity is updated may be executed by the NFVO (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 003 [3]) before, in parallel or after any of the steps in the change external VNF connectivity triggered through NS update procedure.

Likewise, potential operations about management of subscriptions from the VNF/EM to notifications related to VNF indicators of the VNF instance(s) for which external VNF connectivity is updated may be executed by the VNFM (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 002 [2]) before, in parallel or after any of the steps in the change external VNF connectivity triggered through NS update procedure.

Operations about querying and reading VNF indicators information, including the VNF instance for which external VNF connectivity is updated, may be executed by the NFVO (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

Likewise, operations about querying and reading VNF indicators information, including the VNF instance for which external VNF connectivity is updated, may be executed by the VNFM (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the change external VNF connectivity triggered through NS update procedure.

### 5.5.6.3 Dependent side procedures

None.

### 5.5.6.4 Error cases and other considerations

#### 5.5.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "Change VNF external connectivity triggered through NS Update procedure" is the same as the one defined in clause 5.1.6.4.1.

#### 5.5.6.4.2 NSD management

The handling of the request by the OSS/BSS to delete an onboarded NSD or PNFD during the "Change VNF external connectivity triggered through NS Update procedure" is the same as the one defined in clause 5.2.6.4.2.

#### 5.5.6.4.3 VNF performance management

In order to avoid leaving unused PM jobs and Thresholds related to the measurement object(s) that are being deleted by by change in external connectivity procedure (ex. connection points), the NFVO should request terminating the "Individual PM job" and "Individual threshold" associated specifically to such measurement object(s).

In order to avoid leaving unused PM jobs and Thresholds related to the measurement object(s) that are being deleted by by change in external connectivity procedure (ex. connection points), the EM should request terminating the "Individual PM job" and "Individual threshold" associated specifically to such measurement object(s).

Depending on the list of objectInstanceIds used to create the PM job (see clause 6.5.2.6 of ETSI GS NFV-SOL 003 [3]), such a PM job can also apply to a connection point that is not deleted, in which case, the PM job need not be terminated.

## 5.6 VNF snapshot creation through NS update procedure

### 5.6.1 Introduction

Clause 5.6 specifies the NFV-MANO procedure for creating a VNF snapshot through NS update operation.

NOTE 1: In the present procedure, the use of virtualised resource management in indirect mode is not defined because the referenced version of ETSI GS NFV-SOL 003 [3] lacks such a specification, as opposed to the remaining NFV-MANO APIs which are fully specified and specific references in the procedure flow and key information exchanges can be provided. In addition, the procedure flows, while specifying the steps and stages at which virtualised resource management interactions take place, do not provide any reference to protocol and data model solutions of NFV-MANO APIs concerning to virtualised resource management, since these are not available at the time the present document is published.

NOTE 2: The creation of a VNF snapshot of a container-based VNF instance is not supported in this version of the present document.

## 5.6.2 Pre-conditions

Table 5.6.2-1 specifies the pre-conditions applicable to the VNF snapshot creation procedure.

**Table 5.6.2-1: VNF snapshot creation procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | Preconditions listed in NS instantiation procedure are applicable for this procedure as well. | Refer to clause 5.2.2. |
| 2 | The VNF instance to be snapshotted is in INSTANTIATED state. | |

## 5.6.3 Procedure flow

Figure 5.6.3-1 shows the procedure when the consumer uses the NS update operation of the NS LCM interface on an individual NS instance to perform the snapshotting of a specific VNF instance part of the NS instance.

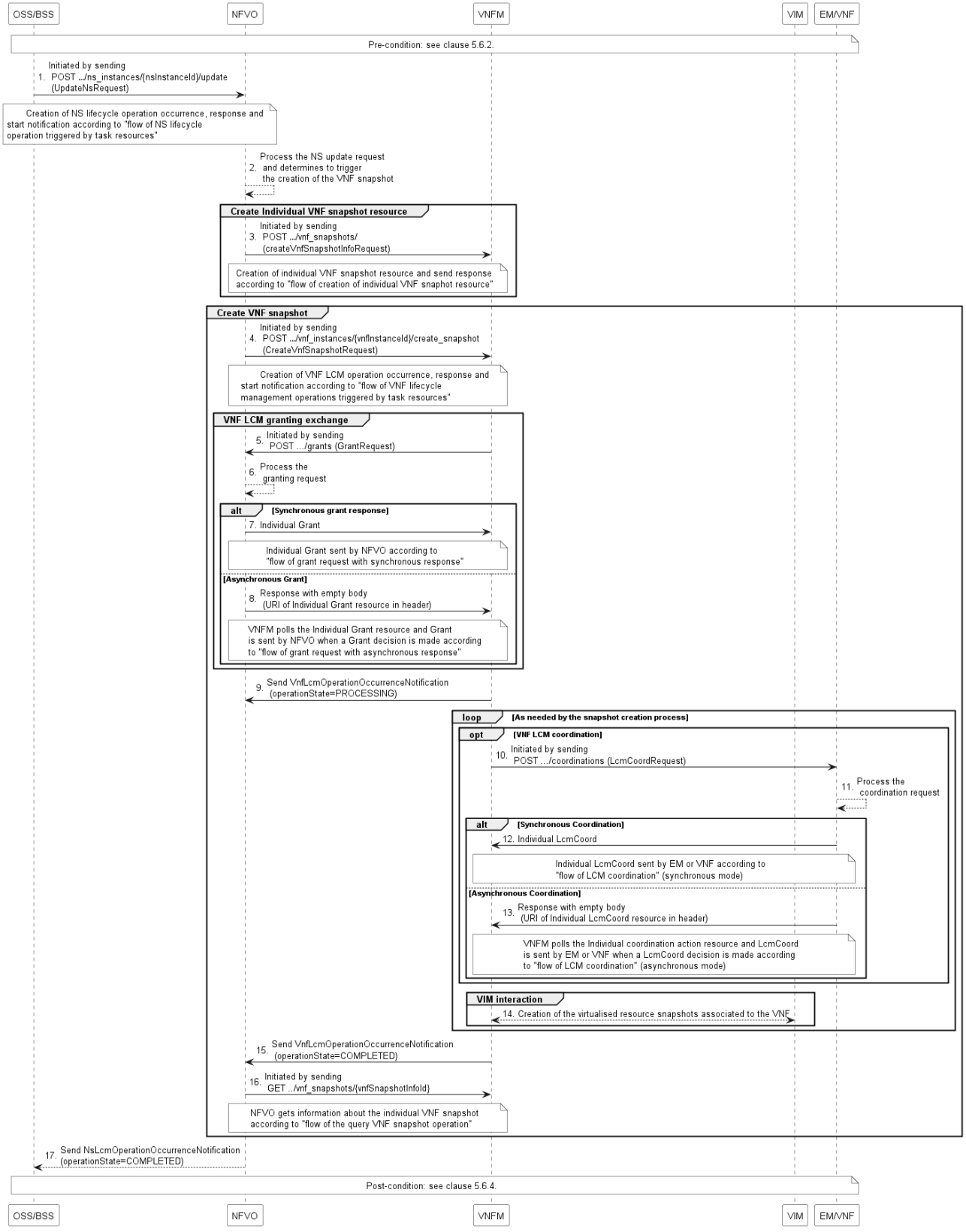


**Figure 5.6.3-1: Procedure flow of NS update creating a VNF snapshot**

The NFV-MANO procedure of VNF snapshot creation triggered by NS update comprises the following steps:

1. To perform the snapshotting of a specific VNF instance, the OSS/BSS shall send to the NFVO an "UpdateNsRequest" in the message content of the POST request to the "NS instance" resource as specified in clause 6.4.6.3.1 of ETSI GS NFV-SOL 005 [4].

As described in "Flow of NS lifecycle operations triggered by task resources" (see clause 6.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the NS lifecycle operation occurrence resource, and sends the response. Clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4] specifies the requirements of the NFVO in handling the task resources that trigger NS LCM operations. NFVO sends NS LCM start notification to the OSS/BSS if there is an applicable subscription for NS LCM notifications to the OSS/BSS. NFVO will set the "operationState" of "NsLcmOpOcc" to "PROCESSING" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. The NFVO keeps the "operationState" of "NsLcmOpOcc" to "PROCESSING" until the completion of the creation of the VNF snapshot of the VNF instance as specified in clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4]. Any NS LCM operation error will be handled as per clause 6.6.2 of ETSI GS NFV-SOL 005 [4].

Table 5.6.5.1-1 lists the key information exchanged between OSS/BSS and NFVO to update the NS instance.

2. Based on the information contained in the NSD, the current information and state of the "Individual NS instance" resource and the NS update request with create snapshot data as specified in clause 6.5.3.76 of ETSI GS NFV-SOL 005 [4], the NFVO determines the appropriate VNFM and the VNF instance to be snapshotted.
3. To create an "Individual VNF snapshot resource" of the VNF instance, the NFVO shall send to the VNFM a "CreateVnfSnapshotInfoRequest" in the message content of the POST request to the "VNF snapshots" resource as specified in clause 5.4.23.3.1 of ETSI GS NFV-SOL 003 [3].
   As described in the "Flow of the creation of a VNF snapshot resource" (see clause 5.3.14 of ETSI GS NFV-SOL 003 [3]), the VNFM creates the "Individual VNF snapshot" resource.

   Table 5.6.5.2-1 lists the key information exchanged between NFVO and VNFM for the create VNF snapshot info operation.

4. To create the VNF snapshot, the NFVO shall send to the VNFM a "CreateVnfSnapshotRequest" in the message content of the POST request to the "Individual VNF instance" resource as specified in clause 5.4.21.3.1 of ETSI GS NFV-SOL 003 [3].

   As described in the "Flow of VNF lifecycle management operations triggered by task resources" (see clause 5.3.3 of ETSI GS NFV-SOL 003 [3]), the VNFM creates an "Individual VNF LCM operation occurrence" resource and sends the response to NFVO. VNFM sends a VnfLcmOperationOccurrenceNotification to the NFVO if there is an applicable subscription for VNF LCM notifications to the NFVO. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

   VNFM will set the "operationState" of "VnfLcmOpOcc" to "STARTING" state as per clause 5.6.2.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.6.5.3-1 lists the key information exchanged between NFVO and VNFM for the create VNF snapshot operation.

5. As part of the VNF snapshot creation, the NFVO and VNFM perform the VNF LCM operation granting exchange for granting authorization of the VNF lifecycle create VNF snapshot operation. To initiate the VNF LCM operation granting procedure, the VNFM shall send to the NFVO a "GrantRequest" in the message content of the POST request to the "Grants" resource as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

   Table 5.6.5.4-1 lists the key information exchanged between NFVO and VNFM during the VNF LCM operation grant process.

6. The NFVO processes the granting request. Based on the NSD information, the current information and state of "Individual NS instance" resource, and the input information from the granting request, the NFVO makes a decision about the VNF LCM operation granting request related to the VNF snapshot creation.

7. For the case of "synchronous mode", as described in the "Flow of grant request with synchronous response" (see clause 9.3.1 of ETSI GS NFV-SOL 003 [3]), the NFVO will create the "Individual grant" that contains the grant information and responds to the VNFM with Response code 201 (Created) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

8. For the case of "asynchronous mode", the NFVO will respond to the VNFM with the URI of the "Individual grant" resource that will be created once the granting decision will be made on NFVO, and with Response code 202 (Accepted) as specified in clause 9.4.2.3.1 of ETSI GS NFV-SOL 003 [3].

For the case of "asynchronous mode", as described in the "Flow of grant request with asynchronous response" (see clause 9.3.2 of ETSI GS NFV-SOL 003 [3]), the VNFM shall keep polling the progress of the grant processing at the NFVO by sending a GET request to the URI of the "Individual grant" resource received from NFVO as specified in clause 9.4.3.3.2 of ETSI GS NFV-SOL 003 [3], as long as the VNFM receives a response code 202 (Accepted) which indicates that the grant processing is in progress. When the VNF LCM grant processing is complete, the NFVO will send back a response to the VNFM with response code 200 (OK) with the content of the Grant.

NOTE 1: The grant processing and message exchanges specified in the steps above only describe the success cases.

9. Upon successful completion of the VNF LCM operation granting exchange (steps 5 to 8), if there is an applicable subscription for VNF LCM notifications to the NFVO, the VNFM will send to the NFVO a VnfLcmOperationOccurrenceNotification to indicate that the VNF LCM operation occurrence enters the "PROCESSING" state, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurrenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM.

   The following steps 10 to 14 can loop based on the number of LCM coordination actions declared in the VNFD and their associated virtualised resource management interactions.

10. If needed for the VNF LCM operation for VNF snapshot creation and declared in the VNFD, the VNFM shall send to the EM/VNF a "LcmCoordRequest" in the message content of the POST request to the "Coordinations" resource as specified in clause 10.4.2.3.1 of ETSI GS NFV-SOL 002 [2].

11. The EM/VNF processes the LCM coordination request.

12. For the case of "synchronous mode", as described in the "Flow of LCM coordination" (see clause 10.3.1 of ETSI GS NFV-SOL 002 [2]), the EM/VNF will create the "Individual LcmCoord" that contains the result of the coordination action and responds to the VNFM with Response code 201 (Created) as specified in clause 10.4.2.3.1 of ETSI GS NFV-SOL 002 [2].

13. For the case of "asynchronous mode", as described in the "Flow of LCM coordination" (see clause 10.3.1 of ETSI GS NFV-SOL 002 [2]), the VNFM shall keep polling the progress of the LCM coordination processing at the EM/VNF by sending a GET request to the URI of the "Individual coordination action" resource received from EM/VNF as specified in clause 10.4.3.3.2 of ETSI GS NFV-SOL 002 [2], as long as the VNFM receives a response code 202 (Accepted) which indicates that the LCM coordination processing is in progress. When the LCM coordination processing is complete, the EM/VNF will send back a response to the VNFM with response code 200 (OK) with the content of the LcmCoord. If the LCM coordination result is equal to "CONTINUE", the VNFM can then continue processing the related LCM operation occurrence.

NOTE 2: The LCM coordination processing and message exchanges specified in the steps above only describe the success cases. The "Flow of LCM coordination" described in clause 10.3.1 of ETSI GS NFV-SOL 002 [2] provides additional information regarding the cancelation of LCM coordination actions and error/failure cases.

   Table 5.6.5.7-1 lists the key information exchanged between EM/VNF and VNFM for the LCM coordination operation.

14. Based on the VNF snapshot creation request, as specified in clause 5.5.2.21 of ETSI GS NFV-SOL 003 [3], and the outcome of the VNF LCM coordination in case it takes place, the VNFM will determine the virtualized resources associated to the VNF that need to be snapshotted or managed in this step and iteration (in case of entering a loop as indicated before entering step 10). In the case of virtualised resources management in direct mode, the VNFM shall request to the VIM the creation of the virtualised resource snapshots associated to the VNF instance or the virtualised resource management action on existing virtualised resources. The VNFM will update the representation of the "Individual VNF snapshot" as described in the clause 5.4.21.3.1 of ETSI GS NFV-SOL 003 [3] to reflect the outcomes of the virtualised resource management interaction.

15. Upon successful completion of the VNF snapshot creation by the VNFM, the VNFM will send to the NFVO a VnfLcmOperationOccurenceNotification to indicate that the VNF LCM operation occurrence has been "COMPLETED", if there is an applicable subscription for VNF LCM operation occurrence notifications to the NFVO, as per clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. VNFM sends same type of VnfLcmOperationOccurenceNotification to the EM if there is an applicable subscription for VNF LCM notifications to the EM. VNFM will set the "operationState" of "VnfLcmOpOcc" to "COMPLETED" state as per clause 5.6.2.1 and 5.4.1.2 of ETSI GS NFV-SOL 003 [3].

16. To ensure that NFVO's information about the individual VNF snapshot is in sync with the information hold by the VNFM, the NFVO shall send to the VNFM a GET request to the "Individual VNF snapshot" resource as specified in clause 5.4.24.3.2 of ETSI GS NFV-SOL 003 [3] and as described in the "Flow of the Query VNF snapshot operation" (see clause 5.3.15 of ETSI GS NFV-SOL 003 [3]).

17. Upon successful completion of the VNF snapshot creation request in the Update NS request, the NFVO shall send to the OSS/BSS an NsLcmOperationOccurenceNotification to indicate that the NS LCM operation has been "COMPLETED", if there is an applicable subscription for NS LCM notifications to the OSS/BSS, NFVO will set the "operationState" of "NsLcmOpOcc" to "COMPLETED" state as per clause 6.4.1.2 of ETSI GS NFV-SOL 005 [4].

## 5.6.4 Post-conditions

Table 5.6.4-1 specifies the post-conditions applicable to the VNF snapshot creation procedure.

**Table 5.6.4-1: VNF snapshot procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The VNF snapshot has been created and is available for further operation and management. | |

## 5.6.5 Key information exchanged in the procedure

### 5.6.5.1 Update NS instance to create VNF snapshot of VNF instance belonging to the NS instance

Table 5.6.5.1-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the Update NS request to create VNF snapshot of VNF instance belonging to the NS instance. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.6.5.1-1: Key information exchanged during update NS to create VNF snapshot of VNF instance belonging to the NS instance**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | nsInstanceId | Shall be set by the OSS/BSS to the "id" attribute of "NsInstance" representing the "Individual NS instance" resource created by NFVO in which the specific VNF instance to be snapshotted is part of. |
| UpdateNsRequest in the request | updateType | Shall be set by the OSS/BSS to "CREATE_VNF_SNAPSHOT". |
| | createSnapshotData | Shall be set by the OSS/BSS to the specific values of create snapshot data of the VNF instance to be snapshotted. |

### 5.6.5.2 Create Individual VNF snapshot resource

Table 5.6.5.2-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the creation of the "Individual VNF snapshot" resource in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.6.5.2-1: Key information exchanged during create Individual VNF snapshot resource**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfSnapshotInfo in the response | id | Set by the VNFM to the identifier of the "Individual VNF snapshot" resource created by VNFM. |

### 5.6.5.3 Create VNF snapshot

Table 5.6.5.3-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the creation of VNF snapshot in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.6.5.3-1: Key information exchanged during create VNF snapshot**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfInstanceId | Shall be set by the NFVO to the same "vnfInstanceId" attribute of createSnapshotData in UpdateNsRequest. |
| CreateVnfSnapshotRequest in the request | additionalParams | Shall be set by the NFVO to the same "additionalParams" attribute of createSnapshotData in UpdateNsRequest. |

### 5.6.5.4 VNF LCM granting exchange for creating VNF snapshot

Table 5.6.5.4-1 lists the source and mapping of selected key information exchanged between NFVO and VNFM during the granting exchange related to the creation of VNF snapshot. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3].

**Table 5.6.5.4-1: Key information exchanged during VNF LCM granting exchange**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| GrantRequest in the request | vnfInstanceId | Shall be set by the VNFM to the same "id" attribute of "VnfInstance" created by the VNFM for which VNF snapshot creation has been requested. |
| | vnfLcmOpOccId | Shall be set by the VNFM to the identifier of the VNF lifecycle management operation occurrence associated to the GrantRequest. |
| | vnfdId | Shall be set by the VNFM to the "vnfdId" attribute of "VnfInstance" created by the VNFM for which VNF snapshot creation has been requested. |
| | operation | Shall be set by the VNFM to "CREATE_SNAPSHOT". |
| | isAutomaticInvocation | Shall be set by the VNFM to false. |
| Grant in the response | vnfInstanceId | Set by the NFVO to the same value of the "id" attribute of "VnfInstance" for which VNF snapshot creation has been requested as provided in the GrantRequest as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3] |
| | vnfLcmOpOccId | Set by the NFVO the same value of the "vnfLcmOpOccId" attribute of GrantRequest, as defined in clause 9.5.2.3 of ETSI GS NFV-SOL 003 [3]. |

### 5.6.5.5 VNF lifecycle change notifications

Table 5.6.5.5-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of the VNF lifecycle change notifications corresponding to the creation of VNF snapshot, in the context of the present NFV-MANO procedure.

The full set of notification data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO as recipient of the notifications and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.6.5.5-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.6.5.5-1: Key information exchanged during VNF lifecycle change notifications**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| VnfLcmOperationOccurenceNotification message content in the request | notificationType | Set by the VNFM to "VnfLcmOperationOccurenceNotification", as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | subscriptionId | Set by the VNFM to the value of the "id"attribute of the associated "LccnSubscription" representing the "Individual subscription" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | notificationStatus | Set by the VNFM to either "START" or "RESULT", depending on whether the notification relates to start, final or intermediate result of the VNF LCM operation occurrence, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |
| | operationState | Set by the VNFM to the value of the "operationState" attribute in the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurrence", as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "CREATE_SNAPSHOT" for the present VNF snapshot creation procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |
| | vnfLcmOpOccId | Set by the VNFM to the value of the "id" attribute of associated "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurence" resource, as defined in clause 5.5.2.17 of ETSI GS NFV-SOL 003 [3]. |

### 5.6.5.6 VNF lifecycle management operation occurrences

Table 5.6.5.6-1 lists the source and mapping of selected key information exchanged between the NFVO and VNFM and the EM/VNF and VNFM as part of reading the VNF lifecycle management operation occurrence corresponding to the creation of VNF snapshot, in the context of the present NFV-MANO procedure.

The full set of data types and attributes are specified in ETSI GS NFV-SOL 003 [3] for the NFVO and ETSI GS NFV-SOL 002 [2] for the EM/VNF case.

NOTE: References in table 5.6.5.6-1 are only provided to ETSI GS NFV-SOL 003 [3] to simplify the content of the table.

**Table 5.6.5.6-1: Key information exchanged during reading VNF licecycle management operation occurrences**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfLcmOpOccId | Shall be set by the NFVO to the "id" attribute of the "VnfLcmOpOcc" representing the "Individual VNF lifecycle management operation occurence" resource to read. |
| VnfLcmOpOcc in the response | operationState | Set by the VNFM to the state value of the VNF LCM operation occurrence, as defined in clause 5.4.1.2 of ETSI GS NFV-SOL 003 [3]. |
| | vnfInstanceId | Set by the VNFM to the value of the "id" attribute of the "VnfInstance" representing the associated "Individual VNF instance" resource, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| | grantId | Set by the VNFM to the value of the "id" attribute in the "Grant" representing the associated "Individual grant" resource, if such a grant exists, as defined in clause 5.5.2.13 of ETSI GS NFV-SOL 003 [3]. |
| | operation | Set by the VNFM to "CREATE_SNAPSHOT" for the present VNF snapshot creation procedure. |
| | isAutomaticInvocation | Set by the VNFM to false. |

### 5.6.5.7 LCM coordination

Table 5.6.5.7-1 lists the source and mapping of selected key information exchanged between EM/VNF and VNFM during the LCM coordination related to the creation of VNF snapshot. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 002 [2].

**Table 5.6.5.7-1: Key information exchanged during LCM coordination**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| LcmCoordRequest in the request | vnfInstanceId | Shall be set by the VNFM to the same "id" attribute of "VnfInstance" created by the VNFM for which VNF snapshot creation has been requested. |
| | vnfLcmOpOccId | Shall be set by the VNFM to the identifier of the VNF lifecycle management operation occurrence related to the coordination. |
| | lcmOperationType | Shall be set by the VNFM to "CREATE_SNAPSHOT". |
| | coordinationActionName | Shall be set by the VNFM based on the LCM coordination action name defined in the VNFD, as specified in ETSI GS NFV-SOL 001 [1] and ETSI GS NFV-SOL 006 [5]. |
| LcmCoord in the response | vnfInstanceId | Set by the EM/VNF to the same value of the "id" attribute of "VnfInstance" for which VNF snapshot creation has been requested as provided in the LcmCoordRequest as defined in clause 10.5.2.3 of ETSI GS NFV-SOL 002 [2] |
| | vnfLcmOpOccId | Set by the EM/VNF to the same value of the "vnfLcmOpOccId" attribute of LcmCoordRequest, as defined in clause 10.5.2.3 of ETSI GS NFV-SOL 002 [2]. |
| | lcmOperationType | Set by the EM/VNF to "CREATE_SNAPSHOT". |
| | coordinationActionName | Set by the EM/VNF to the same value of the "coordinationActionName" attribute of LcmCoordRequest as defined in clause 10.5.2.3 of ETSI GS NFV-SOL 002 [2]. |
| | coordinationResult | Set by the EM/VNF to a corresponding value representing the result of executing the coordination action as defined in clause 10.5.2.3 of ETSI GS NFV-SOL 002 [2]. |

## 5.6.6 Execution of dependent and non-dependent side procedures

### 5.6.6.1 Introduction

Side procedures (i.e. other management functionality, supported via the NFV-MANO interfaces, which does not form the core of functionality specified in the main procedure flow) related to VNF Package management, NSD management, NS LCM, PM and FM; VNF LCM, PM and FM; VNF lifecycle granting; and VNF Indicators can have a dependency (i.e. be impacted) or be independent from the creation of VNF snapshot triggered through NS update.

The following clauses specify the considerations of these other side procedures with respect to the VNF snapshot creation through NS update.

#### 5.6.6.2 Non-dependent side procedures

##### 5.6.6.2.1 VNF Package management

Operations about management of subscriptions to notifications (request to create a new subscription, delete and existing subscription, query and read existing subscriptions) related to VNF Package management of a VNF Package associated to the VNF instance that is being snapshotted may be executed by the OSS/BSS (as specified in clauses 9.4.8 and 9.4.9 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clauses 10.4.7 and 10.4.8 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF snapshot creation procedure.

Operations about management of the VNF packages, and their content (retrieval of the VNF package content, query and read VNF packages information and update of information of a VNF package), corresponding to the VNF instance that is being snapshotted may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF snapshot creation procedure.

##### 5.6.6.2.2 NSD management

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, and query and read of existing subscriptions) of the NSD and PNFD related to the NS instance that is being updated, and that includes the VNF instance to create a VNF snapshot from, may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

Operations about management of the NSD and PNFD, and their content (retrieval of the NSD and PNFD content, query and read information about NSD and PNFD, and request to delete an onboarded NSD or PNFD), corresponding to NSD related to, and PNF which are part of, the NS instance that is being updated, and that includes the VNF instance to create a VNF snapshot from, may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

##### 5.6.6.2.3 NS lifecycle management

Operations about management of subscriptions to notifications related to NS lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being updated, and that includes the VNF instance to create a VNF snapshot from, may be executed by the OSS/BSS (as specified in clauses 6.4.16 and 6.4.17 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

Operations about querying and reading information about NS instances, including the NS being updated, may be executed by the OSS/BSS (as specified in clauses 6.4.2 and 6.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

##### 5.6.6.2.4 NS fault management

Operations about management of subscriptions to notifications related to NS fault management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to the NS instance that is being updated, and that includes the VNF instance to create a VNF snapshot from, may be executed by the OSS/BSS (as specified in clauses 8.4.4 and 8.4.5 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

Operations about querying, reading and acknowledging alarms about NS instances, including the NS being updated, may be executed by the OSS/BSS (as specified in clauses 8.4.2 and 8.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

##### 5.6.6.2.5 NS performance management

The request by the OSS/BSS to terminate "Individual PM job" and "Individual threshold", as specified in clauses 7.4.3.3.5 and 7.4.6.3.5 of ETSI GS NFV-SOL 005 [4] respectively, related to the NS instance that is being updated, and that includes the VNF instance to create a VNF snapshot from, may be executed in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

The request by the OSS/BSS of other operations about management of "Individual PM job" (query PM jobs, reading single PM job, and updating associated PM job callback URI), reading an "Individual performance report" and other operations about management of "Individual thresholds" (query thresholds, reading a single threshold, and updating associated threshold callback URI) (as specified in clauses 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 005 [4]) related to the NS instance that is being updated may be executed in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

#### 5.6.6.2.6 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to a VNF instance that is being snapshotted may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18, 5.4.19, 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

Operations about querying and reading information about VNF instances, including the VNF instance that is being snapshotted, may be executed by the NFVO (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 003 [3]) and by the EM (as specified in clauses 5.4.2 and 5.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

#### 5.6.6.2.7 VNF fault management

Operations about management of subscriptions from the VNFM to notifications related to VNF fault management of the VNF instance to be snapshotted may be executed by the NFVO (as specified in clauses 7.4.3 and 7.4.5 of ETSI GS NFV-SOL 003 [3]) and EM (as specified in clauses 7.4.5 and 7.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

Operations about querying, reading and acknowledging alarms about VNF instances, including the VNF instance that is being snapshotted may be executed by the NFVO (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 7.4.2 and 7.4.3 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

In addition, operations to escalate the perceived severity of an alarm about a VNF instance, including the VNF instance to be snapshotted, may be executed by the EM (as specified in clause 7.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

#### 5.6.6.2.8 VNF performance management

Operations about management of "Individual PM job" (create a PM job, query PM jobs, reading single PM job, deleting a PM job, and updating associated PM job callback URI), reading an "Individual performance report" and management of "Individual threshold" (create a threshold, query thresholds, reading a single threshold, deleting a threshold, and updating associated threshold callback URI) related to the VNF instance that is being snapshotted may be executed by the NFVO (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 003 [3]) and by EM (as specified in clauses 6.4.2, 6.4.3, 6.4.4, 6.4.5 and 6.4.6 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

#### 5.6.6.2.9 VNF indicators

Potential operations about management of subscriptions from the VNFM to notifications related to VNF indicators of the VNF instance to be snapshotted may be executed by the NFVO (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 003 [3]) before, in parallel or after any of the steps in the VNF snapshot creation triggered through NS update procedure.

Likewise, potential operations about management of subscriptions from the VNF/EM to notifications related to VNF indicators of the VNF instance to be snapshotted may be executed by the VNFM (as specified in clauses 8.4.5 and 8.4.6 of ETSI GS NFV-SOL 002 [2]) before, in parallel or after any of the steps in the VNF snapshot creation triggered through NS update procedure.

Operations about querying and reading VNF indicators information, including the VNF instance to be snapshotted, may be executed by the NFVO (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

Likewise, operations about querying and reading VNF indicators information, including the VNF instance to be snapshotted may be executed by the VNFM (as specified in clauses 8.4.2, 8.4.3 and 8.4.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot creation triggered through NS update procedure.

#### 5.6.6.3 Void

#### 5.6.6.4 Error cases and other considerations

##### 5.6.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "VNF snapshot creation procedure" is the same as the one defined in clause 5.1.6.4.1.

##### 5.6.6.4.2 NSD management

The handling of the request by the OSS/BSS to delete an onboarded NSD or PNFD during the "VNF snapshot creation procedure" is the same as the one defined in clause 5.2.6.4.2.

## 5.7 VNF snapshot package creation

### 5.7.1 Introduction

Clause 5.7 specifies the NFV-MANO procedure for creating a VNF snapshot package based on a snapshotted VNF instance.

NOTE 1: The procedure flows, while specifying the steps and stages at which virtualised resource management interactions take place, do not provide any reference to protocol and data model solutions of NFV-MANO APIs concerning to virtualised resource management, since these are not available at the time the present document is published.

NOTE 2: The creation of a VNF snapshot package based on a snapshotted container-based VNF instance is not supported in this version of the present document.

### 5.7.2 Pre-conditions

Table 5.7.2-1 specifies the pre-conditions applicable to the VNF snapshot package creation procedure.

**Table 5.7.2-1: VNF snapshot package creation procedure pre-conditions**

| # | Pre-condition | Additional description |
|---|---|---|
| 1 | A VNF snapshot to be packaged is available. | |

## 5.7.3 Procedure flow

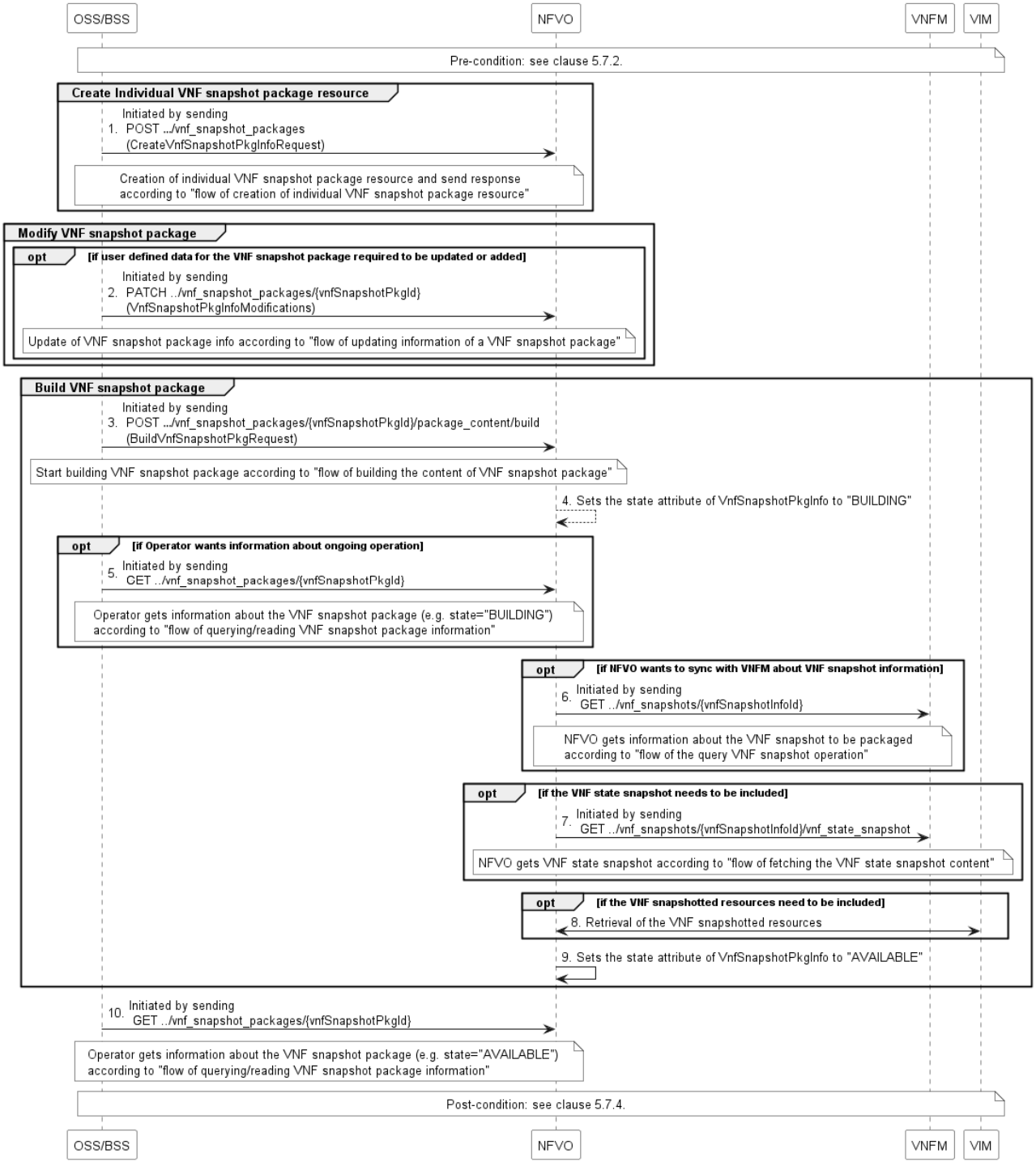


**Figure 5.7.3-1: Procedure flow of VNF snapshot package creation**

The NFV-MANO procedure of VNF snapshot package creation based on a snapshotted VNF instance comprises the following steps:

1. To create an "Individual VNF snapshot package resource" of a snapshotted VNF instance, the OSS/BSS shall send to the NFVO a "CreateVnfSnapshotPkgInfoRequest" in the message content of the POST request to the "VNF snapshot packages" resource as specified in clause 11.4.2.3.1 of ETSI GS NFV-SOL 005 [4].

As described in the "Flow of the creation of an Individual VNF snapshot package resource" (see clause 11.3.1 of ETSI GS NFV-SOL 005 [4]), the NFVO creates the "Individual VNF snapshot package" resource and sends the response.

Table 5.7.5.1-1 lists the key information exchanged between OSS/BSS and NFVO for the create VNF snapshot package info operation.

2. In the case that user defined data for the VNF snapshot package need to be updated or added, the OSS/BSS requests to the NFVO the modification of VNF snapshot package information by sending a "VnfSnapshotPkgInfoModifications" in the message content of the PATCH request to the "Individual VNF snapshot package" resource as specified in clause 11.4.3.3.4 of ETSI GS NFV-SOL 005 [4].

   As described in the "Flow of updating information of a VNF snapshot package" (see clause 11.3.3 of ETSI GS NFV-SOL 005 [4]), the NFVO updates the information of the VNF snapshot package and sends the response.

   Table 5.7.5.2-1 lists the key information exchanged between OSS/BSS and NFVO for the modify VNF snapshot package operation.

3. To build the content of a VNF snapshot package, the OSS/BSS shall send to the NFVO a "BuildVnfSnapshotPkgRequest" in the message content of the POST request to the "Build VNF snapshot package".

4. As described in the "Flow of building the content of VNF snapshot package" (see clause 11.3.8 of ETSI GS NFV-SOL 005 [4]), the NFVO processes the VNF snapshot package creation request.

   The NFVO sets the "state" attribute of "VnfSnapshotPkgInfo" to "BUILDING" as specified in clause 11.6.2 of ETSI GS NFV-SOL 005 [4].

   Based on the information provided by the OSS/BSS in step 3, the NFVO determines if a full or partial VNF snapshot packaging needs to be performed and if the VNF snapshotted resources on the NFVI need to be included into the VNF snapshot package file as specified in clause 11.5.2.6 of ETSI GS NFV-SOL 005 [4].

   Table 5.7.5.3-1 lists the key information exchanged between OSS/BSS and NFVO for the build VNF snapshot package operation.

5. Optionally, the OSS/BSS can obtain information about the ongoing operation by sending a GET request to the "Individual VNF snapshot package" resource as specified in clause 11.4.2.3.2 of ETSI GS NFV-SOL 005 [4] and as described in the "Flow of querying/reading VNF snapshot package information" (see clause 11.3.2 of ETSI GS NFV-SOL 005 [4]).

6. Optionally, and with the purpose to ensure that NFVO's information about VNF snapshots is in sync with the information hold by the VNFM, the NFVO may send to the VNFM a GET request to the "Individual VNF snapshot" resource as specified in clause 5.4.24.3.2 of ETSI GS NFV-SOL 003 [3] and as described in the "Flow of the Query VNF snapshot operation" (see clause 5.3.15 of ETSI GS NFV-SOL 003 [3]).

7. In case the content of the VNF specific state data associated to the VNF snapshot is to be included into the VNF snapshot package, the NFVO shall send to the VNFM a GET request to the "VNF state snapshot" resource as specified in clause 5.4.25.3.2 of ETSI GS NFV-SOL 003 [3] and as described in the "Flow of fetching the VNF state snapshot content" (see clause 5.3.17 of ETSI GS NFV-SOL 003 [3]).

8. In case the VNF snapshotted resources on the NFVI are to be included into the VNF snapshot package file, the NFVO shall request to the VIM the retrieval of the resources,

9. Once the NFVO has successfully completed the building and validation of the VNF snapshot package, the NFVO sets the "state" attribute of "VnfSnapshotPkgInfo" to "AVAILABLE" as specified in clause 11.6.2 of ETSI GS NFV-SOL 005 [4].

10. For the OSS/BSS to determine that the operation is completed and to obtain information about the completed operation, the OSS/BSS shall send a GET request to the "Individual VNF snapshot package" resource as specified in clause 11.4.2.3.2 of ETSI GS NFV-SOL 005 [4] and as described in the "Flow of querying/reading VNF snapshot package information" (see clause 11.3.2 of ETSI GS NFV-SOL 005 [4]). This step should be repeated until the OSS/BSS gets a confirmation of the completion of the operation (see note 1).

NOTE 1: The VNF snapshot package management API specified in clause 11 of ETSI GS NFV-SOL 005 [4] does not specify notifications related to VNF snapshot package events, and the only mechanism by which the API consumer can know about the completion of the operation is by reading the VNF snapshot package information, more precisely, the "state" attribute of the individual VNF snapshot package resource.

NOTE 2: The VNF snapshot package processing and message exchanges specified in the steps above only describe the success cases. The "Flow of cancelling the operation with the VNF snapshot package content" described in clause 11.3.10 of ETSI GS NFV-SOL 005 [4] provides additional information regarding the cancelation of the VNF snapshot packager creation and error/failure cases.

## 5.7.4 Post-conditions

Table 5.7.4-1 specifies the post-conditions applicable to the VNF snapshot package creation procedure.

**Table 5.7.4-1: VNF snapshot package procedure post-conditions**

| # | Post-condition | Additional description |
|---|---|---|
| 1 | The VNF snapshot package has been created and is available for further operation and management. | |

## 5.7.5 Key information exchanged in the procedure

### 5.7.5.1 Create VNF snapshot package info

Table 5.7.5.1-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the creation of the "Individual VNF snapshot package" resource in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.7.5.1-1: Key information exchanged during VNF snapshot package info creation**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| CreateVnfSnapshotPkgInfoRequest in the request | N/A | |
| VnfSnapshotPkgInfo in the response | id | Package identifier assigned by the NFVO for this VNF snapshot package. |
| | state | Set by the NFVO to "CREATED" as defined in clause 11.6.2 of ETSI GS NFV-SOL 005 [4]. |

### 5.7.5.2 Modify VNF snapshot package

Table 5.7.5.2-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the modification of the VNF snapshot package in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.7.5.2-1: Key information exchanged during VNF snapshot package modification**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfSnapshotPkgId | Shall be set by the OSS/BSS in the request to the same "id" attribute of VnfSnapshotPkgInfo created by NFVO. |
| VnfSnapshotPkgInfoModifications in the request | userDefinedData | Set by the OSS/BSS to update existing or add additional user defined data for the VNF snapshot package. |

#### 5.7.5.3 Build VNF snapshot package

Table 5.7.5.3-1 lists the source and mapping of selected key information exchanged between OSS/BSS and NFVO during the building of the VNF snapshot in the context of the NFV-MANO procedure. The full set of request/response/notification data types and attributes are specified in ETSI GS NFV-SOL 005 [4].

**Table 5.7.5.3-1: Key information exchanged during VNF snapshot package building**

| Context | Attribute/parameter name | Specific use and/or provisions |
|---|---|---|
| URI variable of the resource in the request | vnfSnapshotPkgId | Shall be set by the OSS/BSS in the request to the same "id" attribute of VnfSnapshotPkgInfo created by NFVO. |
| BuildVnfSnapshotPkgRequest in the request | vnfSnapshotInfoId | Shall be set by the OSS/BSS in the request to the same identifier held by the NFVO about a specific VNF snapshot to be packaged into the VNF snapshot package. |
| | importSnapshotResource | Shall be set by the OSS/BSS in the request to "FALSE" if none (or subset) of the snapshotted resources from the NFVI are to be included into the VNF snapshot package. |

### 5.7.6 Execution of dependent and non-dependent side procedures

#### 5.7.6.1 Introduction

Side procedures (i.e. other management functionality, supported via the NFV-MANO interfaces, which does not form the core of functionality specified in the main procedure flow) can have a dependency (i.e. be impacted) or be independent from the creation of VNF snapshot package.

The following clauses specify the considerations of these other side procedures with respect to the VNF snapshot package creation.

#### 5.7.6.2 Non-dependent side procedures

##### 5.7.6.2.1 VNF package management

Operations about management of subscriptions to notifications (request to create a new subscription, delete and existing subscription, query and read existing subscriptions) related to VNF Package management of VNF package associated to VNF instances from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, may be executed by the OSS/BSS (as specified in clauses 9.4.8 and 9.4.9 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clauses 10.4.7 and 10.4.8 of ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF snapshot package creation procedure.

Operations about management of the VNF packages, and their content (retrieval of the VNF package content, query and read VNF packages information and update of information of a VNF package) corresponding to VNF instances from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, may be executed by the OSS/BSS (as specified in clause 9.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 10.4 in ETSI GS NFV-SOL 003 [3]) in parallel to any of the steps in the VNF snapshot package creation procedure.

##### 5.7.6.2.2 NSD management

Operations about management of subscriptions to notifications related to NSD management (request to create a new subscription, delete an existing subscription, and query and read of existing subscriptions) of the NSD associated to an NS instance with VNF instances from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, may be executed by the OSS/BSS (as specified in clauses 5.4.8 and 5.4.9 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot package creation procedure.

Operations about management of the NSD, and their content (retrieval of the NSD content, query and read information about NSD, and request to delete an onboarded NSD) may be executed by the OSS/BSS (as specified in clause 5.4 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot package creation procedure.

#### 5.7.6.2.3 VNF lifecycle management

Operations about management of subscriptions to notifications related to VNF lifecycle management (request to create a new subscription, delete an existing subscription, query and read existing subscriptions) corresponding to VNF instances from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, may be executed by the NFVO (as specified in clauses 5.4.18, 5.4.19, 5.4.16 and 5.4.17 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clauses 5.4.18, 5.4.19, 5.4.18 and 5.4.19 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot package creation procedure.

Operations about querying, reading information about VNF instances, including a VNF instance from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, and any other VNF lifecycle management operation not involving the modification of the individual VNF snapshot to be packaged, may be executed by the NFVO (as specified in clause 5.4 of ETSI GS NFV-SOL 003 [3]), EM and VNF (as specified in clause 5.4 of ETSI GS NFV-SOL 002 [2]) in parallel to any of the steps in the VNF snapshot package creation procedure.

#### 5.7.6.2.4 NS lifecycle management

Operations about management of subscriptions to notifications related to NS lifecycle management (request to create a new subscription, delete an existing subscription, and query and read existing subscriptions) corresponding to NS instances, including an NS instance with VNF instances from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, may be executed by the OSS/BSS (as specified in clauses 6.4.16 and 6.4.17 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot package creation procedure.

Operations about querying, reading information about NS instances, including the NS instance with VNF instances from which a VNF snapshot has been taken and is requested to be packaged as part of the VNF snapshot package creation procedure, may be executed by the OSS/BSS (as specified in clause 6.4.2 and 6.4.3 of ETSI GS NFV-SOL 005 [4]) in parallel to any of the steps in the VNF snapshot package creation procedure.

### 5.7.6.3 Dependent side procedures

#### 5.7.6.3.1 VNF snapshot package management

Operations about management of the VNF snapshot package content (fetching the content of the VNF snapshot package and fetching the content of an artifact within the VNF snapshot package), corresponding to the VNF snapshot package that is being created may be executed by the OSS/BSS (as specified in clause 11.4 of ETSI GS NFV-SOL 005 [4]) and VNFM (as specified in clause 12.4 of ETSI GS NFV-SOL 003 [3]) only after the VNF snapshot package has been successfully created.

### 5.7.6.4 Error cases and other considerations

#### 5.7.6.4.1 VNF Package management

The handling of the request by the OSS/BSS to delete an onboarded VNF Package during the "VNF snapshot package creation procedure" is the same as the one defined in clause 5.1.6.4.1.

#### 5.7.6.4.2 NSD management

The handling of the request by the OSS/BSS to delete an onboarded NSD or PNFD during the "VNF snapshot package creation procedure" is the same as the one defined in clause 5.2.6.4.2.

# Annex A (normative): Authorization scope values

## A.1 Overview

This annex references authorization scope values for the use of the APIs specified in ETSI GS NFV-SOL 002 [2], ETSI GS NFV-SOL 003 [3] and ETSI GS NFV-SOL 005 [4] in the context of the NFV-MANO procedures in the present document.

## A.2 VNF Package on-boarding procedures

This clause references the authorization scope values for the API consumers involved in the VNF Package on-boarding procedures specified in clause 5.1.

These authorization scope values are defined in Annex G of ETSI GS NFV-SOL 003 [3] and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.2-1: Applicable authorization scope values for VNF package on-boarding procedures**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| vnfpkgm:<vn>:vnf_package_info | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.6 |
| vnfpkgm:<vn>:package_content | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.6 |
| vnfpkgm:<vn>:ext_artifacts_access | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.6 |
| vnfpkgm:<vn>:upload_from_uri | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.6 |
| vnfpkgm:<vn>:subscriptions | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.6 |
| vnfpkgm:<vn>:vnfd:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.7 |
| vnfpkgm:<vn>:bulk_artifacts:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.7 |
| vnfpkgm:<vn>:artifact:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.7 |
| vnfpkgm:<vn>:package_content:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.7 |
| vnfpkgm:<vn>:vnf_package_info:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.7 |
| vnfpkgm:<vn>:subscriptions | VNFM | ETSI GS NFV-SOL 003 [3] | G.7 |

## A.3 NS instantiation procedures

This clause references the authorization scope values for the API consumers involved in the NS instantiation procedures specified in clause 5.2.

These authorization scope values are defined in the specifications in Annex F of of ETSI GS NFV-SOL 002 [2], Annex G of of ETSI GS NFV-SOL 003 [3] and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.3-1: Applicable authorization scope values for NS instantiation procedures**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| nsd:<vn>:ns_descriptors | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.2 |
| nsd:<vn>:ns_descriptors | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.2 |
| nsd:<vn>:subscriptions | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.2 |
| nslcm:<vn>:ns_instance_info | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| nslcm:<vn>:instantiate | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:op_occs | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| vnflcm:<vn>:vnf_instance_info | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:instantiate | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:change_ext_conn | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:op_occs | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| grant:<vn>:all | VNFM | ETSI GS NFV-SOL 003 [3] | G.6 |
| configuration:<vn>:all | VNFM | ETSI GS NFV-SOL 002 [2] | F.6 |
| vnfpkgm:<vn>:vnfd:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.3 |
| vnfpkgm:<vn>:bulk_artifacts:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.3 |
| vnfpkgm:<vn>:artifact:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.3 |
| vnfpkgm:<vn>:package_content:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.3 |
| vnfpkgm:<vn>:vnf_package_info:readonly | VNFM | ETSI GS NFV-SOL 003 [3] | G.3 |
| vnflcm:<vn>:subscriptions | EM | ETSI GS NFV-SOL 002 [2] | F.2 |

## A.4 NS termination procedure

This clause references the authorization scope values for the API consumers involved in the NS termination procedure specified in clause 5.3.

These authorization scope values are defined in Annex F of ETSI GS NFV-SOL 002 [2], Annex G of ETSI GS NFV-SOL 003 [3], and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.4-1: Applicable authorization scope values for NS termination procedures**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| nslcm:<vn>:update | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:terminate | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:ns_instance_info | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:op_occs | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| vnflcm:<vn>:terminate | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:vnf_instance_info | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:op_occs | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| grant:<vn>:all | VNFM | ETSI GS NFV-SOL 003 [3] | G.6 |
| vnflcm:<vn>:subscriptions | EM | ETSI GS NFV-SOL 002 [2] | F.2 |

## A.5 VNF scaling triggered through scale NS procedure

This clause references the authorization scope values for the API consumers involved in the VNF scaling triggered through scale NS procedure specified in clause 5.4.

These authorization scope values are defined in Annex F of ETSI GS NFV-SOL 002 [2], Annex G of ETSI GS NFV-SOL 003 [3], and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.5-1: Applicable authorization scope values for VNF scaling triggered through scale NS procedure**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| nslcm:<vn>:scale | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:op_occs | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| vnflcm:<vn>:scale | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:scale_to_level | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:op_occs | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| grant:<vn>:all | VNFM | ETSI GS NFV-SOL 003 [3] | G.6 |
| configuration:<vn>:all | VNFM | ETSI GS NFV-SOL 002 [2] | F.6 |
| vnflcm:<vn>:subscriptions | EM | ETSI GS NFV-SOL 002 [2] | F.2 |

## A.6 Change external VNF connectivity triggered through NS update procedure

This clause references the authorization scope values for the API consumers involved in the Change external VNF connectivity triggered through NS update procedure specified in clause 5.5.

These authorization scope values are defined in Annex F of ETSI GS NFV-SOL 002 [2], Annex G of ETSI GS NFV-SOL 003 [3], and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.6-1: Applicable authorization scope values for Change external VNF connectivity triggered through NS update procedure**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| nslcm:<vn>:update | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:op_occs | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| vnflcm:<vn>:change_ext_conn | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:op_occs | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| grant:<vn>:all | VNFM | ETSI GS NFV-SOL 003 [3] | G.6 |
| vnflcm:<vn>:subscriptions | EM | ETSI GS NFV-SOL 002 [2] | F.2 |

## A.7 VNF snapshot creation through NS update procedure

This clause references the authorization scope values for the API consumers involved in the VNF snapshot creation through NS update procedure specified in clause 5.6.

These authorization scope values are defined in Annex F of ETSI GS NFV-SOL 002 [2], Annex G of ETSI GS NFV-SOL 003 [3], and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.7-1: Applicable authorization scope values for VNF snapshot creation through NS update procedure**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| nslcm:<vn>:update | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| nslcm:<vn>:op_occs | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.3 |
| vnflcm:<vn>:vnf_snapshot_info | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:create_snapshot | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:op_occs | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| grant:<vn>:all | VNFM | ETSI GS NFV-SOL 003 [3] | G.6 |
| lcmcoord:<vn>:all | VNFM | ETSI GS NFV-SOL 002 [2] | F.7 |
| vnflcm:<vn>:subscriptions | EM | ETSI GS NFV-SOL 002 [2] | F.2 |

# A.8 VNF snapshot package creation procedure

This clause references the authorization scope values for the API consumers involved in the VNF snapshot package creation procedure specified in clause 5.7.

These authorization scope values are defined in Annex G of ETSI GS NFV-SOL 003 [3] and Annex F of ETSI GS NFV-SOL 005 [4].

**Table A.8-1: Applicable authorization scope values for VNF snapshot package creation procedure**

| Authorization scopes | API consumer | Referenced specification | Referenced clause |
|---|---|---|---|
| vnfsnapshotpkgm:<vn>: vnf_snapshot_packages | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.8 |
| vnfsnapshotpkgm:<vn>:build | OSS/BSS | ETSI GS NFV-SOL 005 [4] | F.8 |
| vnflcm:<vn>:vnf_snapshot_info | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |
| vnflcm:<vn>:vnf_state_snapshot | NFVO | ETSI GS NFV-SOL 003 [3] | G.2 |

# Annex B (informative): Change History

| Date | Version | Information about changes |
|---|---|---|
| July 2019 | 0.0.1 | Initial skeleton draft from Rapporteur |
| November 2019 | 0.0.2 | Implementation of contributions approved at SOL#117 and post EA:<br>- NFVSOL(19)000397r12 - SOL016 - Clause 5.2 NS instantiate procedure<br>Rapporteur changes:<br>Removed Annex on Authors & contributors |
| December 2019 | 0.1.0 | Implementation of contributions approved at SOL#121<br>- NFVSOL(19)000398r7: SOL016 - Clause 5.1 VNF Package on-boarding procedure<br>- NFVSOL(19)000728r5: SOL016 Clause 5.3 NS termination procedure<br>- NFVSOL(19)000742r3: SOL016 Specification of dependency for the NS termination procedure<br>- NFVSOL(19)000621r3: SOL016 - Clause 5.5 Change external VNF connectivity triggered through NS update procedure<br>- NFVSOL(19)000810r2: SOL016 Clause 5.4 VNF scaling via NS scaling procedure |
| January 2020 | 0.2.0 | Implementation of the below approved contributions<br>- NFVSOL(19)000855: SOL016 Editorial corrrections<br>- NFVSOL(20)000003r1: SOL016 Specification of dependency for the VNF scaling<br>- NFVSOL(20)000004r1: SOL016 VNF on-boarding procedure flow update<br>- NFVSOL(20)000005r2: SOL016 Filling the tables of key information exchanged in the procedures of NS termination and scaling<br>- NFVSOL(20)000006r3: SOL016 NS instantiation procedure key information exchange<br>- NFVSOL(20)000009r2: SOL016 Clause 5.2 NS Instantiation procedure flow update<br>- NFVSOL(19)000856r3: SOL016 Specification of dependency for the NS instantiation procedure<br>- NFVSOL(19)000857r5: SOL016 Specification of dependency for the VNF package on-boarding procedure<br>- NFVSOL(19)000858r3: SOL016 Specification of dependency for the Change external VNF connectivity procedure |
| February 2020 | 0.3.0 | Implementation of the below contributions<br>- NFVSOL(20)000102r1: SOL016 VNF lifecycle granting dependent and non-dependent aspects<br>- NFVSOL(20)000101r2: SOL016 Add dependent side procedures<br>- NFVSOL(20)000079r2: SOL016 Resolving editor notes in key information exchanged tables in clauses 5.1.5 and 5.5.5<br>- NFVSOL(20)000078r1: SOL016 removal of clauses with no content |

| Date | Version | Information about changes |
|---|---|---|
| April 2020 | 0.4.0 | Implementation of the below contributions<br>- NFVSOL(20)000219r1: SOL016 Review EN and improvements related to networking<br>- NFVSOL(20)000225: SOL016 Review EN dual NS termination<br>- NFVSOL(20)000227: SOL016 Review EN NSD dependencies<br>- NFVSOL(20)000236: SOL016 Review Relationship with security procedures<br>- NFVSOL(20)000255: SOL016 Review Adding missing EM interactions or references<br><br>[EA#132 Round-1]<br>- NFVSOL(20)000200r1: SOL016 - Addressing editor's note - part1<br>- NFVSOL(20)000218: SOL016 Review NS LCM steps with references to SOL005<br>- NFVSOL(20)000220: SOL016 Review EN about virtualised resource mgmt in direct mode<br>- NFVSOL(20)000256: SOL016 Review Aligning the use of will<br>- NFVSOL(20)000257: SOL016 Review Removing decision terminology<br><br>[EA#132 Round-2]<br>- NFVSOL(20)000216r3: SOL016 Review Deletion of ENs and small improvements<br>- NFVSOL(20)000217: SOL016 Review Key information alignments to SOL005<br>- NFVSOL(20)000222r1: SOL016 Review EN VNF indicator dependencies and NS instantiation procedure split<br>- NFVSOL(20)000223r1: SOL016 Review Key information alignments to SOL003<br>- NFVSOL(20)000224: SOL016 Review EN non-and-dependent associated to VNF package mgmt<br>- NFVSOL(20)000231: SOL016 Review EN about merging of content in dependencies and error clauses<br>- NFVSOL(20)000258r2: SOL016 Review Introduction and scope<br><br>[NFVSOL#133]<br>- NFVSOL(20)000221r1: SOL016 Review EN configuration mgmt aspects<br>- NFVSOL(20)000226: SOL016 Review EN PM specification alignments<br>- NFVSOL(20)000232r2: SOL016 Review Adding more key exchanged information<br><br>[EA#133]<br>- NFVSOL(20)000312: SOL016 Review Correction on top of 256<br>- NFVSOL(20)000313r1: SOL016 Review Correction on top of 257 |
| June 2020 | 0.5.0 | Implementation of the below contributions<br>- NFVSOL(20)000228r4: SOL016 Review EN related to the VNF and should vs shall in NS termination<br>- NFVSOL(20)000262r5: SOL016 Nokia review comments<br>- NFVSOL(20)000507r2: SOL016 Unresolved Nokia review comments from 262r2<br>- Rapporteur corrections to table headings<br>- NFVSOL(20)000604r1: SOL016 Review query read resources, and VNF scaling |
| August 2020 | V2.8.1 | Version update for publication. |
| November 2020 | V3.0.2 | First draft for ed351 |
| February 2021 | V3.0.3 | Implementation of the below contributions<br>- NFVSOL(21)000028r1: SOL016ed351 SW image distribution |
| March 2021 | V3.0.4 | Implementation of the below contributions<br>- NFVSOL(21)000150r1: SOL016ed351 Adding additional attributes to Update and Terminate NS operations to terminate VNF |
| September 2021 | V3.0.5 | Implementation of the below contributions in ed361<br>- NFVSOL(21)000461: SOL016 VNF snapshot creation procedure<br>- NFVSOL(21)000284r7: SOL016 Key information exchanged for Upload SoftwareImages in VNF Package on-boarding procedure<br>- NFVSOL(21)000342r4: SOL016 Key information exchange for Resource orchestration in NS instantiation |

| Date | Version | Information about changes |
|---|---|---|
| December 2021 | V3.0.6 | Implementation of the below contributions:<br>- Rapporteur corrections changing document reference to ed371<br>- NFVSOL(21)000569r4: SOL016 Key information exchange for compute and storage resource provisioning in NS instantiation and VNF scaling triggered through NS scale procedure<br>- NFVSOL(21)000623r2: SOL016ed361 Resolution of LCM Coordination related editor's note<br>- NFVSOL(21)000652: SOL016 2.1 2.2 Reference document version update. |
| April 2022 | V3.0.7 | Implementation of the below contributions:<br>- NFVSOL(21)000668r1: SOL016 VNF snapshot package creation procedure<br>- NFVSOL(22)000023: SOL016ed371 Resolution of VNF snapshot creation sync related editor's note<br>- NFVSOL(22)000091r1: SOL016 Consideration on interface security information |
| June 2022 | V3.0.8 | Implementation of the below contributions:<br>- NFVSOL(22)000193_SOL016_Resolution_of_ENs_in_clause_5_2_5_10<br>- NFVSOL(22)000246_SOL016ed371_Resolution_of_the_VNF_snapshot_creation_related_editor's_note_in_clause_5_6_6_2<br>- NFVSOL(22)000258_SOL016ed361_Resolution_of_the_editorr_s_notes_in_clauses_5_6_6_3 and_5_6_6_4<br>- NFVSOL(22)000282r1_SOL016ed371_Resolution_of_the_remaining_editor_s_notes_in_clause 5.7.6 |
| June 2022 | V4.0.1 | Release 4 baseline version created from V3.0.8 |
| October 2022 | V4.0.2 | Implementation of the below contributions:<br>- NFVSOL(22)000379r1_SOL016ed441_ENH02_05_Add_targetScaleLevelInfo_to_complement_ instantiationLevelId<br>- NFVSOL(22)000401r1_SOL016ed441_Add_missing_key_attribute_to_Table_5_2_5_10-1 |
| April 2023 | V4.0.3 | Implementation of the below contributions:<br>- NFVSOL(23)000024r3 : SOL016ed441 OAuth scope value Annex<br>- NFVSOL(23)000055r2 : SOL016ed441 OAuth scope value for procedure in 5.3 - 5.7<br>- NFVSOL(23)000076: SOL016ed441 Review comments for VNF snapshot creation procedure<br>- NFVSOL(23)000077: SOL016ed441 Review comments for VNF snapshot package creation procedure<br>- NFVSOL(23)000073r3: SOL016ed441 FEAT17 Addition of container-based VNF support in Change external VNF connectivity |
| October 2023 | V4.0.4 | Implementation of the below contributions:<br>- NFVSOL(23)000152: SOL016ed451 Update OAuth scope value for ed451<br>- NFVSOL(23)000285r3: SOL016ed441 FEAT17 Addition of container-based VNF support in NS instantiation<br>- NFVSOL(23)000297r1: SOL016ed441 FEAT17 Addition of container-based VNF support in NS termination<br>- NFVSOL(23)000317: SOL016ed441 FEAT17 Addition of container-based VNF support in VNF scaling<br>- NFVSOL(23)000318: SOL016ed441 FEAT17 Addition of container-based VNF support in on-boarding<br>- NFVSOL(23)000319r1: SOL016ed441 Enh01.01 Addition of certificate management<br>- NFVSOL(23)000322: SOL016ed451 FEAT21 Addition of PaaS<br>Rapporteur changes:<br>- Updated reference number in A2-A8<br>- Deleted editor's note that indicates to update reference number in A3 and A8. |

# History

| Document history | | |
|---|---|---|
| V4.5.1 | January 2024 | Publication |
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