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Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model 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).

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1 Scope

The present document specifies the interfaces supported over the Or-Vnfm reference point of the Network Functions Virtualisation Management and Orchestration (NFV-MANO) architectural framework ETSI GS NFV-MAN 001 [i.7] as well as the information elements exchanged over those interfaces.

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-IFA 006: "Network Functions Virtualisation (NFV); Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[2] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV); Management and Orchestration; Functional Requirements Specification".

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

[4] Recommendation ITU-T X. 733: "Information technology - Open Systems Interconnection - Systems Management: Alarm reporting function".

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 GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".

[i.2] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.3] ISO/IEC 9646-7: "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 7: Implementation Conformance Statements".

[i.4] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV); Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".

[i.5] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV); Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[i.6] ETSI GS NFV-IFA 009: "Network Functions Virtualisation (NFV); Management and Orchestration; Report on Architectural Options".

[i.7] ETSI GS NFV-MAN 001: "Network Functions Virtualisation (NFV); Management and Orchestration".

[i.8] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV); Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI GS NFV 003 [i.2] apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 003 [i.2] and the following apply:

NOTE: An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in ETSI GS NFV 003 [i.2].

CP	Connection Point
CPD	Connection Point Descriptor
DF	Deployment Flavour
FB	Functional Block
NFVI-PoP	Network Function Virtualisation Infrastructure Point of Presence
NFVI-Node	Network Functions Virtualisation Infrastructure Node
VDU	VNF Deployment Unit
VL	Virtual Link
VLD	Virtual Link Descriptor

4 Overview of interfaces and information elements associated to the Or-Vnfm reference point

4.1 Introduction

This clause provides an overview of interfaces and information elements associated to the Or-Vnfm reference point.

The Or-Vnfm reference point is used for exchanges between Network Functions Virtualization Orchestrator (NFVO) and Virtualised Network Function Manager (VNFM), and supports the following interfaces:

- Virtualised Network Function (VNF) Package Management (produced by NFVO, consumed by VNFM).
- VNF Lifecycle Operation Granting (produced by NFVO, consumed by VNFM).
- Virtualised Resources Management (produced by NFVO, consumed by VNFM).
- Virtualised Resources Quota Available Notification (produced by NFVO, consumed by VNFM).
- VNF Lifecycle Management (produced by VNFM, consumed by NFVO).
- VNF Performance Management (produced by VNFM, consumed by NFVO).
- VNF Fault Management (produced by VNFM, consumed by NFVO).

- VNF Indicator (produced by VNFM, consumed by NFVO).

The information elements exchanged by the interfaces above are also part of the present document.

4.2 Relation to other NFV Group Specifications

The present document is referencing information from the following NFV Group Specifications:

- Report on Architectural Options ETSI GS NFV-IFA 009 [i.6]:
  - This report describes architectural options that can influence the way some of the Or-Vnfm interfaces are used or might even suggest the need for extension.
- Functional Requirements Specification ETSI GS NFV-IFA 010 [2]:
  - Interfaces associated with the Or-Vnfm reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [2] for the NFVO and VNFM functional blocks (FBs).
- Vi-Vnfm reference point - Interface and Information Model Specification ETSI GS NFV-IFA 006 [1]:
  - The interfaces related to Virtualised Resources Management defined in ETSI GS NFV-IFA 006 [1] are also used on the Or-Vnfm reference point.
- Ve-Vnfm reference point - Interface and Information Model Specification ETSI GS NFV-IFA 008 [i.5]:
  - VNF Fault Management, VNF Performance Management and VNF Indicator interfaces defined in ETSI GS NFV-IFA 008 [i.5] are also used on the Or-Vnfm reference point.
- VNF Packaging Specification ETSI GS NFV-IFA 011 [3]:
  - The specification of the Virtualised Network Function Descriptor (VNFD) in ETSI GS NFV-IFA 011 [3] defines information elements that are also relevant in the present document.
- Os-Ma-nfvo reference point - Interface and Information Model Specification ETSI GS NFV-IFA 013 [i.8]:
  - The VNF Package Management interface defined in ETSI GS NFV-IFA 013 [i.8] is also used on the Or-Vnfm reference point.

Information about the reference points in the ETSI NFV architecture can be found in ETSI GS NFV 002 [i.1].

4.3 Conventions

The following notations, defined in ISO/IEC 9646-7 [i.3], are used for the qualifier column of interface information elements:

- M mandatory - the capability is required to be supported;
- O optional - the capability may be supported or not;
- CM conditional mandatory - the capability is required to be supported and is conditional on the support of some condition. This condition shall be specified in the Description column;
- CO conditional optional - the capability may be supported or not and is conditional on the support of some condition. This condition shall be specified in the Description column.

The following notation is used for parameters that represent identifiers, and for attributes that represent identifiers in information elements and notifications:

- If parameters are referring to an identifier of an actual object, their type is "Identifier".
- If an object (information element or notification) contains an attribute that identifies the object, the type of that attribute is "Identifier" and the description states that the attribute is the identifier of that particular notification or information element.

EXAMPLE 1: Identifier "resourceId" of the "NetworkSubnet information element" has type "Identifier" and description "Identifier of this NetworkSubnet information element".

- If an object (information element or notification) contains an attribute that references another object or objects defined in an ETSI NFV GS, the type of the attribute is "Identifier", followed by the list of objects it references.

EXAMPLE 2: "Identifier (Reference to Vnfc)" or "Identifier (Reference to Vnfc, VirtualLink or VirtualStorage)".

If the type of a parameter or attribute has been marked as "Not specified" in the "Content" column, this means that its specification is left for the protocol design/data model design stage.

5 Reference point and interface requirements

5.1 Introduction

This clause defines or references requirements applicable to interfaces in the specific context of the Or-Vnfm reference point.

5.2 Or-Vnfm reference point requirements

Table 5.2-1 specifies requirements applicable to the Or-Vnfm reference point.

Table 5.2-1: Or-Vnfm reference point requirements

Number	Requirement
Or-Vnfm.001	The Or-Vnfm reference point shall support the VNF Package Management interface produced by the NFVO.
Or-Vnfm.002	The Or-Vnfm reference point shall support the VNF Lifecycle Operation Granting interface produced by the NFVO.
Or-Vnfm.003	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Information Management interfaces produced by the NFVO.
Or-Vnfm.004	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Management interfaces produced by the NFVO.
Or-Vnfm.005	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Change Notification interfaces produced by the NFVO.
Or-Vnfm.006	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Reservation interfaces produced by the NFVO.
Or-Vnfm.007	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Reservation Change Notification interface produced by the NFVO.
Or-Vnfm.008	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Performance Management interface produced by the NFVO.
Or-Vnfm.009	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Fault Management interface produced by the NFVO.
Or-Vnfm.010	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Quota Management interfaces produced by the NFVO.
Or-Vnfm.011	When VNF-related resource management in indirect mode is applicable, the Or-Vnfm reference point shall support the Virtualised Resources Quota Change Notification interface produced by the NFVO.
Or-Vnfm.012	The Or-Vnfm reference point shall support the VNF Lifecycle Management interface produced by the VNFM.
Or-Vnfm.013	Void.
Or-Vnfm.014	The Or-Vnfm reference point shall support the VNF Performance Management interface produced by the VNFM.
Or-Vnfm.015	The Or-Vnfm reference point shall support the VNF Fault Management interface produced by the VNFM.
Or-Vnfm.016	Void.
Or-Vnfm.017	The Or-Vnfm reference point shall support the VNF Indicator interface produced by the VNFM.
Or-Vnfm.018	The Or-Vnfm reference point should support the Virtualised Resources Quota Available Notification interface produced by the NFVO.

5.3 Interface requirements

5.3.1 VNF Package Management interface requirements

Table 5.3.1-1 specifies requirements applicable to the VNF Package Management interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.1-1: VNF Package Management interface requirements

Numbering	Requirement
Or-Vnfm.VnfPkgm.001	The VNF Package Management interface produced by the NFVO on the Or-Vnfm reference point shall support querying VNF Package information (see note).
Or-Vnfm.VnfPkgm.002	The VNF Package Management interface produced by the NFVO on the Or-Vnfm reference point shall support providing notifications as a result of changes on VNF Package states, and managing subscriptions to such notifications.
Or-Vnfm.VnfPkgm.003	The VNF Package Management interface produced by the NFVO on the Or-Vnfm reference point shall support providing notifications about the on-boarding of VNF Packages, and managing subscriptions to such notifications.
Or-Vnfm.VnfPkgm.004	The VNF Package Management interface produced by the NFVO on the Or-Vnfm reference point shall support fetching a VNF Package, or selected artifacts contained in a VNF Package.
NOTE: VNF Package information can include information such as release date, vendor info, manifest, VNFD, SW image meta-data, files contained in the VNF Package, etc.	

5.3.2 VNF Lifecycle Operation Granting interface requirements

Table 5.3.2-1 specifies requirements applicable to the VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.2-1: VNF Lifecycle Operation Granting interface requirements

Numbering	Requirement
Or-Vnfm.VnfLcog.001	The VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point shall support granting lifecycle operations.
Or-Vnfm.VnfLcog.002	The VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point shall support indicating the type of the lifecycle event for which a granting is being requested for a VNF instance, together with an identifier of the lifecycle operation occurrence.
Or-Vnfm.VnfLcog.003	The VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point shall enable the VNFM to indicate the virtualised resources impacted by the VNF lifecycle operation (e.g. allocated or released).
Or-Vnfm.VnfLcog.004	The VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point shall enable the VNFM obtaining information about the identification and configuration information to access the Virtualised Infrastructure Manager (VIM).
Or-Vnfm.VnfLcog.005	The VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point shall enable the VNFM obtaining, if a reservation is applicable, resource reservation identification information applicable for consuming virtualised resources as part of the lifecycle operation.
Or-Vnfm.VnfLcog.006	The VNF Lifecycle Operation Granting interface produced by the NFVO on the Or-Vnfm reference point shall enable the VNFM to provide information to identify the VNF Instance and VNFD for the intended lifecycle operation.

5.3.3 Virtualised Resources Management interfaces requirements

5.3.3.1 Virtualised Resources Information Management interfaces requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Information Management interfaces as produced by the VIM on the Vi-Vnfm reference point are produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.1-1 specifies requirements applicable to the Virtualised Resources Information Management interfaces produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.1-1: Virtualised Resources Information Management interfaces requirements

Numbering	Requirements
Or-Vnfm.Vrim.01	The Virtualised Resources Information Management interfaces produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to invoke the virtualised resources information management operations towards the appropriate VIM (see notes 1 and 2).
NOTE 1: The Virtualised Resources Information Management interface requirements defined clause 5.3.2 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.2 Virtualised Resources Management interfaces requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Management interfaces as produced by the VIM on the Vi-Vnfm reference point are produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.2-1 specifies requirements applicable to the Virtualised Resources Management interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.2-1: Virtualised Resources Management interfaces requirements

Numbering	Requirement
Or-Vnfm.Vrm.01	The Virtualised Resources Management interfaces produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to invoke the virtualised resources management operations towards the appropriate VIM (see notes 1 and 2).
NOTE 1: The Virtualised Resources Management interfaces requirements defined in clause 5.3.3 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.3 Virtualised Resources Reservation Management interface requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Reservation Management interface as produced by the VIM on the Vi-Vnfm reference point is produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.3-1 specifies requirements applicable to the Virtualised Resources Reservation Management interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.3-1: Virtualised Resources Reservation Management interface requirements

Numbering	Requirement
Or-Vnfm.Vrrm.01	The Virtualised Resources Reservation Management interface produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to invoke the virtualised resources reservation management operations towards the appropriate VIM (see notes 1 and 2).
NOTE 1: The Virtualised Resources Reservation Management interfaces requirements defined in clause 5.3.4 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.4 Virtualised Resources Reservation Change Notification interface requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Reservation Change Notification interface as produced by the VIM on the Vi-Vnfm reference point is produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.4-1 specifies requirements applicable to the Virtualised Resources Reservation Change Notification interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.4-1: Virtualised Resources Reservation Change Notification interface requirements

Numbering	Requirement
Or-Vnfm.Vrrcn.01	The Virtualised Resources Reservation Change Notification interface produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to identify the original provider of notifications, and to allow the VNFM to uniquely determine the virtualised resource reservation(s) to which a change notification applies (see notes 1 and 2).
NOTE 1: The Virtualised Resources Reservation Change Notification interface requirements defined in clause 5.3.6 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.5 Virtualised Resources Change Notification interfaces requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Change Notification interface as produced by the VIM on the Vi-Vnfm reference point are produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.5-1 specifies requirements applicable to the Virtualised Resources Change Notification interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.5-1: Virtualised Resources Change Notification interface requirements

Numbering	Requirement
Or-Vnfm.Vrcn.01	The Virtualised Resources Change Notification interfaces produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to identify the original provider of notifications, and to allow the VNFM to uniquely determine the virtualised resource(s) to which a change notification applies (see notes 1 and 2).
NOTE 1: The Virtualised Resources Change Notification interface requirements defined in clause 5.3.5 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.6 Virtualised Resources Performance Management interface requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Performance Management interface as produced by the VIM on the Vi-Vnfm reference point is produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.6-1 specifies requirements applicable to the Virtualised Resources Performance Management interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.6-1: Virtualised Resources Performance Management interface requirements

Numbering	Requirement
Or-Vnfm.Vrpm.01	The Virtualised Resources Performance Management interface produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to identify the original provider of PM information, and to allow the VNFM to uniquely determine the virtualised resource(s) to which such PM information applies (see notes 1 and 2).
NOTE 1: The Virtualised Resources Performance Management interface requirements defined in clause 5.3.8 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.7 Virtualised Resources Fault Management interface requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Fault Management interface as produced by the VIM on the Vi-Vnfm reference point is produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.7-1 specifies requirements applicable to the Virtualised Resources Fault Management interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.7-1: Virtualised Resources Fault Management interface requirements

Numbering	Requirement
Or-Vnfm.Vrfm.01	The Virtualised Resources Fault Management interface produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to identify the original provider of alarms, and to allow the VNFM to uniquely determine the virtualised resource(s) to which an alarm applies (see notes 1 and 2).
NOTE 1: The Virtualised Resources Fault Management interface requirements defined in clause 5.3.9 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources.	

5.3.3.8 Virtualised Resources Quota Management interfaces requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Quota Management interfaces as produced by the VIM on the Vi-Vnfm reference point are produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.8-1 specifies requirements applicable to the Virtualised Resources Quota Management interfaces produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.8-1: Virtualised Resources Quota Management interface requirements

Numbering	Requirement
Or-Vnfm.Vrqm.01	The Virtualised Resources Quota Management interfaces produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to invoke the virtualised resources quota management operations towards the appropriate VIM (see notes 1 and 2).
NOTE 1: The Virtualised Resources Quota Management interfaces requirements defined in clause 5.3.7 in ETSI GS NFV-IFA 006 [1] are applicable in the present clause too, in addition to the requirement(s) above. NOTE 2: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources quota.	

5.3.3.9 Virtualised Resources Quota Change Notification interface requirements

When VNF-related resource management in indirect mode is applicable, the Virtualised Resources Quota Change Notification interface as produced by the VIM on the Vi-Vnfm reference point is produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.9-1 specifies requirements applicable to the Virtualised Resources Quota Change Notification interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.9-1: Virtualised Resources Quota Change Notification interface requirements

Numbering	Requirement
Or-Vnfm.Vrcn.01	The Virtualised Resources Quota Change Notification interface produced by the NFVO on the Or-Vnfm reference point shall support notification of changes related to virtualised resource quotas.
Or-Vnfm.Vrcn.02	The Virtualised Resources Quota Change Notification interface produced by the NFVO on the Or-Vnfm reference point shall support the NFVO receiving indication information to enable the NFVO to identify the original provider of notifications, and to allow the VNFM to uniquely determine the virtualised resources quota to which a change notification applies (see note).
NOTE: The indication information is used by the NFVO to determine the entity responsible for the management of the virtualised resources quota.	

5.3.3.10 Virtualised Resources Quota Available Notification interface requirements

Table 5.3.3.10-1 specifies requirements applicable to the Virtualised Resources Quota Available Notification interface produced by the NFVO on the Or-Vnfm reference point.

Table 5.3.3.10-1: Virtualised Resources Quota Available Notification interface requirements

Numbering	Requirement
Or-Vnfm.Vrqan.01	The Virtualised Resources Quota Available Notification interface produced by the NFVO on the Or-Vnfm reference point should support the capability to notify the availability of virtualised resource quota(s) applicable to this VNFM or the VNF(s) which the VNFM manages and to manage subscriptions to notifications about the availability of such quota.

5.3.4 VNF Lifecycle Management interface requirements

Table 5.3.4-1 specifies requirements applicable to the VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point.

Table 5.3.4-1: VNF Lifecycle Management interface requirements

Numbering	Requirement
Or-Vnfm.VnfLcm.001	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support instantiating a VNF.
Or-Vnfm.VnfLcm.002	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support terminating a VNF instance.
Or-Vnfm.VnfLcm.003	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support scaling a VNF instance.
Or-Vnfm.VnfLcm.004	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support querying information about a VNF instance.
Or-Vnfm.VnfLcm.005	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support requesting VNF healing.
Or-Vnfm.VnfLcm.006	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support requesting to change the state of a VNF instance (see note 1).
Or-Vnfm.VnfLcm.007	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support querying the status of a VNF lifecycle management operation.
Or-Vnfm.VnfLcm.008	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support changing the deployment flavour (DF) of a VNF instance.
Or-Vnfm.VnfLcm.009	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support modifying information about a VNF instance (see note 2).
Or-Vnfm.VnfLcm.010	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support creating a VNF instance identifier and the associated instance of a VNF information element.
Or-Vnfm.VnfLcm.011	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support deleting a VNF instance identifier and the associated instance of a VNF information element.

Numbering	Requirement
Or-Vnfm.VnfLcm.012	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support providing to the NFVO notifications about changes of a VNF instance that are related to VNF lifecycle management operation occurrences, further referred to as VNF lifecycle management operation occurrence notifications.
Or-Vnfm.VnfLcm.013	VNF lifecycle management operation occurrence notifications provided on the VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall contain information about the type of VNF lifecycle management operation, the identification of the VNF instance, and the identification of the lifecycle management operation occurrence.
Or-Vnfm.VnfLcm.014	VNF lifecycle management operation occurrence notifications provided on the VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall contain information about the addition/deletion of VNFCs, and about the changes on virtualised resources associated to Virtualised Network Function Component(s) (VNFC(s)) as result of the VNF lifecycle management operation occurrence.
Or-Vnfm.VnfLcm.015	VNF lifecycle management operation occurrence notifications provided on the VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall contain information about the virtual networks and Connection Points (CPs) that are added/deleted as part of the VNF lifecycle management operation occurrence (see note 3).
Or-Vnfm.VnfLcm.016	VNF lifecycle management operation occurrence notifications provided on the VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support indicating the start of the lifecycle management operation occurrence the end and the results of the lifecycle management operation occurrence including any error produced from the lifecycle management operation occurrence.
Or-Vnfm.VnfLcm.017	VNF lifecycle management operation occurrence notifications provided on the VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support indicating updates to the VNF instance information including configurable properties.
Or-Vnfm.VnfLcm.018	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support providing to the NFVO notifications about creation and deletion of a VNF identifier and the associated instance of a VNF information element, further referred to as VNF identifier creation/deletion notifications.
Or-Vnfm.VnfLcm.019	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support managing subscriptions to VNF lifecycle management operation occurrence notifications and to VNF identifier creation/deletion notifications.
Or-Vnfm.VnfLcm.020	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support providing to the VNFM configuration parameters for a VNF instance. See note 4.
Or-Vnfm.VnfLcm.021	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support requesting to change the external connectivity of a VNF instance.
Or-Vnfm.VnfLcm.022	The VNF Lifecycle Management interface produced by the VNFM on the Or-Vnfm reference point shall support the capability to invoke VNF error handling operations after the VNF life cycle operation occurrence fails. See notes 5 and 6.

NOTE 1: Changing the state of a VNF instance refers to starting or stopping a VNF instance. These operations are complementary to instantiating or terminating a VNF.
NOTE 2: The requirement refers to the information that is writable.
NOTE 3: This provides information about virtual networks and connections points that are internal to the VNF and whose creation was triggered by the VNFM.
NOTE 4: Configuration parameters referred in this clause include those set at initial configuration and any other configurable parameter declared in the VNFD.
NOTE 5: It is up to the protocol design stage to design the detailed error handling operations.
NOTE 6: It depends on the VNF capabilities whether and how the operations are supported by a particular VNF.

5.3.5 Void

5.3.6 VNF Performance Management interface requirements

Table 5.3.6-1 specifies requirements applicable to the VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point.

Table 5.3.6-1: VNF Performance Management interface requirements

Numbering	Requirement
Or-Vnfm.VnfPm.001	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the NFVO to control the collection and reporting of VNF performance information, resulting from virtualised resources performance information, on the VNF(s) it manages (see note 1).
Or-Vnfm.VnfPm.002	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the capability to notify the availability of VNF performance information.
Or-Vnfm.VnfPm.003	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the NFVO to create a PM job specifying the VNF performance information that the NFVO requires from the VNFM.
Or-Vnfm.VnfPm.004	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the NFVO to delete one or more PM job(s).
Or-Vnfm.VnfPm.005	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall enable the NFVO to receive notifications of data availability for a PM job, and to manage subscriptions to such notifications.
Or-Vnfm.VnfPm.006	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the NFVO to query the details of one or more PM job(s).
Or-Vnfm.VnfPm.007	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the NFVO to manage the thresholds on specified VNF performance information and VNF(s) (see note 2).
Or-Vnfm.VnfPm.008	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall support the capability to notify about a threshold defined for a specified metric of a VNF being crossed.
Or-Vnfm.VnfPm.009	The VNF Performance Management interface produced by the VNFM on the Or-Vnfm reference point shall enable the NFVO to receive notifications related to threshold crossing, and to manage subscriptions to such notifications.
NOTE 1: Performance information on a given VNF results from collected performance information of the virtualised resources that are mapped to this VNF instance. NOTE 2: Management of thresholds include creation, deletion and query the thresholds on specified VNF performance information and VNF(s).	

5.3.7 VNF Fault Management interface requirements

Table 5.3.7-1 specifies requirements applicable to the VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point.

Table 5.3.7-1: VNF Fault Management interface requirements

Numbering	Requirement
Or-Vnfm.VnfFm.001	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support collecting VNF fault information (see note).
Or-Vnfm.VnfFm.002	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support providing alarm notifications related to faults on VNF instances.
Or-Vnfm.VnfFm.003	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support providing notification when there is a change in alarm information on VNF instances.
Or-Vnfm.VnfFm.004	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support the sending of notification to the NFVO when an alarm on a VNF instance has been created.
Or-Vnfm.VnfFm.005	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support the sending of notification to the NFVO when an alarm on a VNF instance has been cleared.
Or-Vnfm.VnfFm.006	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall allow unambiguous identification of the alarm on a VNF instance sent to the NFVO.
Or-Vnfm.VnfFm.007	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall allow unambiguous identification of the VNF instance causing the alarm.
Or-Vnfm.VnfFm.008	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall allow unambiguous identification of the alarm cause.
Or-Vnfm.VnfFm.009	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support providing to the NFVO notifications about alarms on a VNF instance as a consequence of state changes in the virtualised resources used by the VNF.

Numbering	Requirement
Or-Vnfm.VnfFm.010	Notifications related to the alarms associated with state changes of virtualised resources of a VNF instance provided on the VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall contain information necessary to identify the VNF and the VNFC(s), the origin (VIM and virtualised resource(s)) of the virtualised resource change notification(s), the type of alarm, and information about the cause of the alarm.
Or-Vnfm.VnfFm.011	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall enable the NFVO to manage subscriptions to notifications related to alarms.
Or-Vnfm.VnfFm.012	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support alarm acknowledgement.
Or-Vnfm.VnfFm.013	The VNF Fault Management interface produced by the VNFM on the Or-Vnfm reference point shall support the sending of notification(s) to the NFVO when the alarm list has been rebuilt.
NOTE: Fault information on a given VNF instance can include the information related to the alarm (e.g. alarm created, alarm cleared, etc.), alarm causes and identification of this VNF instance and fault information concerning the virtualised resources supporting the constituent VNF instance.	

5.3.8 Void

5.3.9 VNF Indicator interface requirements

Table 5.3.9-1 specifies requirements applicable to the VNF Indicator interface produced by the VNFM on the Or-Vnfm reference point.

Table 5.3.9-1: VNF Indicator interface requirements

Numbering	Requirement
Or-Vnfm.VnfInd.001	The VNF Indicator interface produced by the VNFM on the Or-Vnfm reference point shall support providing notifications related to indicator value change, and to manage subscriptions related to such notifications.
Or-Vnfm.VnfInd.002	The VNF Indicator interface produced by the VNFM on the Or-Vnfm reference point shall support retrieving indicator values.

6 NFVO exposed interfaces

6.1 Introduction

This clause defines the interfaces exposed by the NFVO towards the VNFM over the Or-Vnfm reference point.

NOTE: The fact that information elements and attributes are presented in tabular form does not preclude protocol designs in which these information elements and attributes are encoded in different parts of request and response messages. For example, in a RESTful interface, parts of them can be encoded in the URL, in the message header, in the message body or any combination thereof.

6.2 VNF Package Management interface

6.2.1 Description

This interface allows the VNFM to access VNF Package information.

The interface also includes a notify operation for new VNF Package on-boarding or for VNF Package changes, and operations to manage subscriptions to such notifications.

6.2.2 Query On-boarded VNF Package Information operation

6.2.2.1 Description

When a VNF Package is on-boarded by the NFVO, the NFVO creates and stores information associated with this VNF Package. It maintains this information during the VNF Package's operational lifecycle. This operation will enable the VNFM to query the NFVO for information it has stored about one or more VNF Packages. Table 6.2.2.1-1 lists the information flow exchanged between the NFVO and the VNFM.

The operation allows querying specific components of the information stored in the NFVO about a VNF Package, for instance, retrieving the VNFD.

NOTE: The VNFD is an attribute of the OnboardedVnfPkgInfo.

Table 6.2.2.1-1: Query On-boarded VNF Package Information operation

Message	Requirement	Direction
QueryOnboardedVnfPkgInfoRequest	Mandatory	VNFM → NFVO
QueryOnboardedVnfPkgInfoResponse	Mandatory	NFVO → VNFM

6.2.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.2.2-1.

Table 6.2.2.2-1: Query On-boarded VNF Package Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the VNF Packages on which the query applies, based on attributes of the OnboardedVnfPkgInfo. It can also be used to specify one or more VNF Packages to be queried by providing their vnfdId or onboardedVnfPkgInfoId. See note.
attributeSelector	M	0..N	String	It provides a list of attribute names of OnboardedVnfPkgInfo. If present, only these attributes are returned for the OnboardedVnfPkgInfo matching the filter. If absent, the complete OnboardedVnfPkgInfo is returned.
NOTE: The vnfdId, which is managed by the VNF provider, identifies the VNF Package and the VNFD in a globally unique way. See ETSI GS NFV-IFA 011 [3], clause 7.1.2.2. The onboardedVnfPkgInfoId identifies the information related to the onboarding of a VNF package into the NFVO, which implies that it also identifies an onboarded VNF package.				

6.2.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.2.3-1.

Table 6.2.2.3-1: Query On-boarded VNF Package Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	OnboardedVnfPkgInfo	Details of the on-boarded VNF Packages available to the VNFM matching the input filter. If attributeSelector is present, only the attributes listed in attributeSelector are returned for the selected entities.

6.2.2.4 Operation results

After successful operation, the NFVO has queried the internal VNF Package information objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the VNF Package that the consumer has access to and that are matching the filter shall be returned.

6.2.3 Subscribe operation

6.2.3.1 Description

This operation enables the VNFM to subscribe with a filter for the notifications related to new VNF Package on-boarded or to changes of VNF Packages sent by the NFVO.

NOTE: Specification of filtering mechanism is left for the protocol design stage.

Table 6.2.3.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.2.3.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	VNFM → NFVO
SubscribeResponse	Mandatory	NFVO → VNFM

6.2.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.3.2-1.

Table 6.2.3.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for subscribing new VNF Package on-boarded notification or for selecting the VNF Package(s) and the related change notifications to subscribe to. This filter can indicate for subscribing new VNF Package on-boarded, or can contain information about specific types of changes to subscribe to, or attributes of the VNF Package.

6.2.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.3.3-1.

Table 6.2.3.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription realized.

6.2.3.4 Operation results

After successful subscription, the VNFM is registered to receive notifications related to changes of VNF Packages sent by the NFVO. The result of the operation shall indicate if the subscription has been successful or not with a standard success/error result. For a particular subscription, only notifications matching the filter will be delivered to the VNFM.

6.2.4 Notify operation

6.2.4.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the NFVO that cannot be invoked as an operation by the consumer (VNFM).

In order to receive notifications, the VNFM shall have a subscription.

Table 6.2.4.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.2.4.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFVO → VNFM

The following notifications can be notified/sent by this operation:

- VnfPackageOnBoardingNotification (see clause 8.2.4).
- VnfPackageChangeNotification (see clause 8.2.5).

6.2.5 Void

6.2.6 Fetch On-boarded VNF Package operation

6.2.6.1 Description

This operation enables the VNFM to fetch a whole on-boarded VNF Package. The package is addressed using an identifier of information held by the NFVO about the specific on-boarded VNF Package. This identifier is contained within the VnfPackageOnBoardingNotification.

Table 6.2.6.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.2.6.1-1: Fetch On-boarded VNF Package operation

Message	Requirement	Direction
FetchOnboardedVnfPackageRequest	Mandatory	VNFM → NFVO
FetchOnboardedVnfPackageResponse	Mandatory	NFVO → VNFM

6.2.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.6.2-1.

Table 6.2.6.2-1: Fetch On-boarded VNF Package operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
onboardedVnfPkgInfoId	M	1	Identifier	Identifier of information held by the NFVO about the specific on-boarded VNF Package. This identifier was allocated by the NFVO.

6.2.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.6.3-1.

Table 6.2.6.3-1: Fetch On-boarded VNF Package operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfPackage	M	1	Binary	The VNF Package.

6.2.6.4 Operation results

After successful operation, the NFVO has provided to the VNFM a copy of the requested VNF Package.

6.2.7 Fetch On-boarded VNF Package Artifacts operation

6.2.7.1 Description

This operation enables the VNFM to fetch selected artifacts contained in an on-boarded VNF Package. Artifacts are addressed using selector information that can be obtained using the QueryOnboardedVnfPkgInfo operation.

NOTE: The VNFD is an attribute of the OnboardedVnfPkgInfo and it is retrieved, if queried individually, with the QueryVnfPackage operation. Fetching the whole VNF Package will also return the VNFD, which is part of the VNF Package.

Table 6.2.7.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.2.7.1-1: Fetch On-boarded VNF Package Artifacts operation

Message	Requirement	Direction
FetchOnboardedVnfPackageArtifactsRequest	Mandatory	VNFM → NFVO
FetchOnboardedVnfPackageArtifactsResponse	Mandatory	NFVO → VNFM

6.2.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.7.2-1.

Table 6.2.7.2-1: Fetch On-boarded VNF Package Artifacts operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
onboardedVnfPkgInfoId	M	1	Identifier	Identifier of information held by the NFVO about the specific on-boarded VNF Package. This identifier was allocated by the NFVO.
artifactSelector	M	1..N	Not specified	Selector to address an individual VNF package artifact, or list of selectors to address multiple of those. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to obtain multiple artifacts in one go, or as a series of operations that obtain one artifact at a time.				

6.2.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.7.3-1.

Table 6.2.7.3-1: Fetch On-boarded VNF Package Artifacts operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfPackageArtifact	M	1..N	Not specified	A VNF package artifact (e.g. files). or multiple thereof. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to obtain multiple artifacts in one go, or as a series of operations that obtain one artifact at a time.				

6.2.7.4 Operation results

After successful operation, the NFVO has provided to the VNFM a copy/ copies of the requested artifact(s) contained in the on-boarded VNF Package.

6.2.8 Terminate Subscription operation

6.2.8.1 Description

This operation enables the VNFM to terminate a particular subscription.

Table 6.2.8.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.2.8.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	VNFM → NFVO
TerminateSubscriptionResponse	Mandatory	NFVO → VNFM

6.2.8.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.8.2-1.

Table 6.2.8.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

6.2.8.3 Output parameters

None.

6.2.8.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the VNFM will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

6.2.9 Query Subscription Info operation

6.2.9.1 Description

This operation enables the VNFM to query information about subscriptions.

Table 6.2.9.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.2.9.1-1: Query Subscription operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	VNFM → NFVO
QuerySubscriptionInfoResponse	Mandatory	NFVO → VNFM

6.2.9.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.9.2-1.

Table 6.2.9.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. Details are left for the protocol design stage.

6.2.9.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.9.3-1.

Table 6.2.9.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query. Details are left for the protocol design stage.

6.2.9.4 Operation results

After successful operation, the NFVO has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to VNF package onboarding or VNF package changes that the VNFM has access to and that are matching the filter shall be returned.

6.3 VNF Lifecycle Operation Granting interface

6.3.1 Description

This interface defines one operation that allows the NFVO to grant lifecycle operations.

6.3.2 Grant VNF Lifecycle Operation operation

6.3.2.1 Description

This operation allows the VNFM to request a grant for authorization of a VNF lifecycle operation. This interface supports multiple use cases, such as:

- The NFVO can approve or reject a request based on policies (e.g. dependencies between VNFs) and available capacity.
- When applicable, the NFVO can reserve resources based on the VNFM's virtualised resources request.
- The NFVO can provide to the VNFM information about the VIM where cloud resources are allocated. This can include additional information such as the resource zone.

When requesting resource creation or modification, the VNFM references the resource definitions that are available to the NFVO in the VNFD. When resources are to be released or modified, the VNFM provides references to the existing resources in the request.

Per each VNFM, one of the following operator policies can be selected as a configuration to determine how the NFVO and the VNFM handle resource reservations in a grant request:

1) Policy GRANT_RESERVE_MULTI: The NFVO guarantees the availability of the VIM resources to be allocated. The NFVO provides to the VNFM multiple reservation identifiers, one per granted resource requirement. Each such identifier identifies the reservation which is applicable to the resource requirements and which the VNFM shall use in the subsequent resource management operation.

2) Policy GRANT_RESERVE_SINGLE: The NFVO guarantees the availability of the VIM resources to be allocated. The NFVO provides to the VNFM a single reservation identifier per resource type (i.e. compute, network and storage). This identifier identifies the reservation which is applicable to all granted resource requirements of that type for the granted lifecycle operation.

3) Policy GRANT_APPROVE: The NFVO approves the VIM resources to be allocated by the VNFM. In general, resource availability is not guaranteed. No explicit reservation identifier is returned to the VNFM. Optionally, to guarantee resource availability, the NFVO may do a reservation and use implicit reservation identification towards the VNFM, i.e. associate the reservation to the VIM access information.

These policies are used to configure the behaviour of both the NFVO and the VNFM identically, also considering the resource reservation capabilities of the VIM:

- resource definitions refer to: either a resource template in the VNFD (VnfVirtualLinkDesc, VirtualComputeDesc, VirtualStorageDesc plus Vdu, if applicable) for the creation of new resources; or

- to information about an existing resource.

In the GrantVnfLifecycleOperation response, the NFVO can return information that allows to distribute the resources of a VNF over multiple resource zones. This decision is guided by affinity/anti-affinity rules in the VNFD as well as by placement constraints passed in the GrantVnfLifecycleOperation request. The NFVO can also return information that allows to manage the resources of a VNF using multiple VIMs, guided by VIM selection constraints passed in the GrantVnfLifecycleOperation request.

NOTE: In the present document, as part of that mechanism, attributes are defined for signalling the decision to use multiple VIMs per VNF. However, to actually support VNFs that include resources managed by multiple VIMs, additionally a mechanism is needed to manage the VNF-internal Virtual Link (VL) requirements across multiple VIMs. Such functionality is not specified; neither in the present document, nor in other documents referenced by the present document. Also, the current mechanism of signalling external and externally-managed VLs in the lifecycle management operations assumes single-VIM VNFs, and does not fulfil the requirements of multi-VIM scenarios.

Table 6.3.2.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.3.2.1-1: Grant VNF Lifecycle Operation operation

Message	Requirement	Direction
GrantVnfLifecycleOperationRequest	Mandatory	VNFM → NFVO
GrantVnfLifecycleOperationResponse	Mandatory	NFVO → VNFM

6.3.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.2.2-1.

Table 6.3.2.2-1: Grant VNF Lifecycle Operation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance which this grant request is related to. Shall also be provided for VNFs that not yet exist but are planned to exist in the future, i.e. if the grant is requested for InstantiateVNF.
vnfdId	M	1	Identifier	Identifier of the VNFD that defines the VNF for which the LCM operation is to be granted.
flavourId	M	0..1	Identifier	Identifier of the VNF deployment flavour (DF) of the VNFD that defines the VNF for which the LCM operation is to be granted. Shall be provided when instantiating the VNF or changing the DF of the VNF instance.
lifecycleOperation	M	1	Enum	The lifecycle management operation for which granting is requested. Permitted values are: InstantiateVnf, ScaleVnf, ScaleVnfToLevel, ChangeVnfFlavour, TerminateVnf, HealVnf, OperateVnf, ChangeExtVnfConnectivity. See note 1.
isAutomaticInvocation	M	1	Boolean	Set to true if this VNF LCM operation occurrence has been triggered by an automated procedure inside the VNFM (i.e. ScaleVnf/ScaleVnfToLevel triggered by auto-scale, or HealVnf triggered by auto-heal). Set to false otherwise.
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence associated to the GrantVnfLifecycleOperationRequest.
instantiationLevelId	M	0..1	Identifier	If the granting request is requested for InstantiateVNF, the identifier of the instantiation level may be provided as an alternative way to define the resources to be added. This attribute shall only be used for Instantiate VNF requests. See note 2.
addResource	M	0..N	ResourceDefinition	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 2.
tempResource	M	0..N	ResourceDefinition	List of resource definitions in the VNFD for resources to be temporarily instantiated during the runtime of the LCM operation which is related to this grant request, with one entry per resource (see note 3).
removeResource	M	0..N	ResourceDefinition	Provides the definitions of resources to be removed by the LCM operation which is related to this grant request, with one entry per resource.
updateResource	M	0..N	ResourceDefinition	Provides the definitions of resources to be modified by the LCM operation which is related to this grant request, with one entry per resource.

Parameter	Qualifier	Cardinality	Content	Description
placementConstraint	M	0..N	PlacementConstraint	Placement constraints that the VNFM may send to the NFVO in order to influence the resource placement decision. If sent, the NFVO shall take the constraints into consideration when making resource placement decisions, and shall reject the grant if they cannot be honoured (see notes 4 and 5).
vimConstraint	CM	0..N	VimConstraint	Used by the VNFM to require that multiple resources are managed through the same VIM connection. If sent, the NFVO shall take the constraints into consideration when making VIM selection decisions, and shall reject the grant if they cannot be honoured. This parameter shall be supported if VNF-related Resource Management in direct mode is applicable.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the VNFM, specific to the VNF and the LCM operation.

NOTE 1: The VNF LCM operations CreateVnfIdentifier, DeleteVnfIdentifier, QueryVnf and ModifyVnfInformation can be executed by the VNFM without requesting granting.
NOTE 2: If the granting request is for InstantiateVNF, either instantiationLevel or addResource shall be present.
NOTE 3: The NFVO will assume that the VNFM will be responsible to both allocate and release the temporary resource during the runtime of the LCM operation. This means, the resource can be allocated and consumed after the "start" notification for the LCM operation is sent by the VNFM, and the resource will be released before the "result" notification of the VNF LCM operation is sent by the VNFM.
NOTE 4: The affinity/anti-affinity rules defined in the VNFD using the AffinityOrAntiAffinityGroup and the LocalAffinityOrAntiAffinityRule information elements (see ETSI GS NFV-IFA 011 [3]), and the placement constraints in the GrantVnfLifecycleOperation as defined in this clause should be conflict-free. In case of conflicts, the placement constraints in the GrantVnfLifecycleOperation shall take precedence.
NOTE 5: Passing constraints allows the VNFM or the lifecycle management scripts to influence resource placement decisions by the NFVO to ensure VNF properties such as performance or fault tolerance.

6.3.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.2.3-1.

Table 6.3.2.3-1: Grant VNF Lifecycle Operation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
vimConnection	CM	0..N	VimConnectionInfo	Provides information regarding VIM connections that are approved to be used by the VNFM to allocate resources, and provides parameters of these VIM connections. Absent in case of rejection or if the VIM information was configured to the VNFM in another way, present otherwise. This parameter shall be supported when VNF-related Resource Management in direct mode is applicable (see note 1).
zone	M	0..N	ZoneInfo	Identifies resource zones where the resources are approved to be allocated by the VNFM. Absent in case of rejection, present otherwise.

Parameter	Qualifier	Cardinality	Content	Description
zoneGroup	M	0..N	ZoneGroupInfo	Information about groups of resource zones that are related and that the NFVO has chosen to fulfil a zoneGroup constraint in the GrantVnfLifecycleOperation request. This information confirms that the NFVO has honoured the zoneGroup constraints that were passed as part of "placementConstraints" in the Grant request.
computeReservationId	M	0..1	Identifier	Information that identifies a reservation applicable to the compute resource requirements of the corresponding grant request (see note 2).
networkReservationId	M	0..1	Identifier	Information that identifies a reservation applicable to the network resource requirements of the corresponding grant request (see note 2).
storageReservationId	M	0..1	Identifier	Information that identifies a reservation applicable to the storage resource requirements of the corresponding grant request (see note 2).
addResource	M	0..N	GrantInfo	List of resources that are approved to be added, with one entry per resource.
tempResource	M	0..N	GrantInfo	List of resources that are approved to be temporarily instantiated during the runtime of the lifecycle operation, with one entry per resource.
removeResource	M	0..N	GrantInfo	List of resources that are approved to be removed, with one entry per resource.
updateResource	M	0..N	GrantInfo	List of resources that are approved to be modified, with one entry per resource.
vimAssets	M	0..1	VimAssets	Information about assets for the VNF that are managed by the NFVO in the VIM, such as software images and virtualised compute resource flavours.
extVirtualLink	M	0..N	ExtVirtualLinkData	Information about external VLs to connect the VNF to (see note 4).
extManagedVirtualLink	M	0..N	ExtManagedVirtualLinkData	Information about internal VLs that are managed by other entities than the VNFM (see notes 3 and 4).
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO, specific to the VNF and the LCM operation.

NOTE 1: This interface allows to signal the use of multiple VIM connections per VNF. However, due to the partial support of this feature in the present document (see clause 6.3.2.1), the specification for managing the VNF-internal VL requirements across multiple VIMs is needed, which is not available neither in the present document, nor in other documents referenced by the present document. Therefore, it is recommended in the present document that the number of "vimConnection" attributes in the response is not greater than 1.

NOTE 2: At least one of (computeReservationId, networkReservationId, storageReservationId) shall be present when policy is GRANT_RESERVE_SINGLE and an applicable reservation exists. None of these shall be used otherwise.

NOTE 3: The indication of externally-managed internal VLs is needed in case networks have been pre-configured for use with certain VNFs, for instance to ensure that these networks have certain properties such as security or acceleration features, or to address particular network topologies.

NOTE 4: External and/or externally-managed internal VLs can be passed in VNF lifecycle management operation requests such as InstantiateVnf or ChangeVnfFlavor, and/or in the grant response. The NFVO may choose to override in the grant response external and/or externally-managed VL instances that have been passed previously in the associated VNF lifecycle management request, if the lifecycle management request has originated from the NFVO itself.

6.3.2.4 Operation results

In case of permitting the operation, the NFVO returns to the VNFM additional information to be used in the resource management operations during the lifecycle management operation.

Once the NFVO has responded positively with a GrantVnfLifecycleOperationResponse, the VNFM executes the necessary resource management operations either towards the appropriate VIM(s) (aka VNF-related resource management in direct mode) or towards the NFVO which proxies them to the appropriate VIM(s) (aka VNF-related resource management in indirect mode).

In addition to failure situations, the NFVO can reject a GrantVnfLifecycleOperationRequest due to various reasons, such as resource unavailability or operational policy. In case of rejecting the operation or in case of failure, the NFVO returns to the VNFM appropriate error information, describing the reason of rejection or failure.

If placement constraints have been passed with the request and the NFVO cannot satisfy the constraints, it shall reject the request.

6.4 Virtualised Resources Management interfaces in indirect mode

6.4.1 Introduction

In indirect mode of VNF-related resource management, the NFVO produces towards the VNFM the virtualised resource management interfaces defined below.

These interfaces are related to the corresponding interfaces defined in ETSI GS NFV-IFA 006 [1]; however, an additional *resource provider identifier* is introduced. This identifier is used by the NFVO to determine the entity responsible for the management of the virtualised resource, the management of the virtualised resources reservation or the management of the virtualised resources quota (usually one of multiple VIMs with which the NFVO interacts). It is used by the VNFM to uniquely identify resources, resource reservations or resource quotas by means of the pair of the resource provider identifier and the actual identifier of the resource/reservation/quota.

6.4.2 Virtualised Compute interfaces

6.4.2.1 Virtualised Compute Resources Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Compute Resources Management to VNFM. This interface shall comply with the provisions in clause 7.3.1 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualCompute used in output parameters in clause 7.3.1 of ETSI GS NFV-IFA 006 [1] is replaced with ComputeResourceWithRpInfo as defined in clause 8.4.2.2 of the present document.
- For the Terminate Virtualised Compute Resource operation the content of both the input and output parameters is changed from Identifier to ComputeResourceWithRpId as defined in clause 8.4.2.3 of the present document.
- All operations except Query Virtualised Compute Resource and Terminate Virtualised Compute Resource have an additional input parameter, resourceProviderId, defined in table 6.4.2.1-1.

Table 6.4.2.1-1: Definition of the resourceProviderId input parameter for compute resources

Parameter	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, computeId].

6.4.2.2 Virtualised Compute Resources Change Notification interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Compute Resources Change Notifications to be consumed by VNFM. This interface shall comply with the provisions in clause 7.3.2 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The notification VirtualisedResourceChangeNotification sent by means of the Notify operation of clause 7.3.2.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification VirtualisedResourceWithRpChangeNotification defined in clause 8.4.5.2 of the present document.

6.4.2.3 Virtualised Compute Resources Information Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Compute Resources Information Management to VNFM. This interface shall comply with the provisions in clause 7.3.3 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualComputeResourceInformation used in output parameters for the Query Virtualised Compute Resource Information operation in clause 7.3.3.4 of ETSI GS NFV-IFA 006 [1] is replaced with VirtualComputeResourceWithRpInfo as defined in clause 8.4.2.4 of the present document.

- The notification InformationChangeNotification sent by means of the Notify operation of clause 7.3.3.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification InformationWithRpChangeNotification defined in clause 8.4.5.3 of the present document.

6.4.3 Virtualised Network interfaces

6.4.3.1 Virtualised Network Resources Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Network Resources Management to VNFM. This interface shall comply with the provisions in clause 7.4.1 of ETSI GS NFV-IFA 006 [1] with the following change(s):

- The content VirtualNetwork used in output parameters in clause 7.4.1 of ETSI GS NFV-IFA 006 [1] is replaced by NetworkResourceWithRpInfo as defined in clause 8.4.3.2 of the present document.

- For the Terminate Virtualised Network Resource operation the content of both the input and output parameter is changed from Identifier to NetworkResourceWithRpId as defined in clause 8.4.3.3 of the present document.

- All operations except Query Virtualised Network Resource and Terminate Virtualised Network Resource have an additional input parameter, resourceProviderId, defined in table 6.4.3.1-1.

Table 6.4.3.1-1: Definition of the resourceProviderId input parameter for network resources

Parameter	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, networkResourceId].

6.4.3.2 Virtualised Network Resources Change Notification interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Network Resources Change Notifications to be consumed by VNFM. This interface shall comply with the provisions in clause 7.4.2 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The notification VirtualisedResourceChangeNotification sent by means of the Notify operation of clause 7.4.2.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification VirtualisedResourceWithRpChangeNotification defined in clause 8.4.5.2 of the present document.

6.4.3.3 Virtualised Network Resources Information Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Network Resources Information Management to VNFM. This interface shall comply with the provisions in clause 7.4.3 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualNetworkResourceInformation used in output parameters for the Query Virtualised Network Resource Information operation in clause 7.4.3.4 of ETSI GS NFV-IFA 006 [1] is replaced with VirtualNetworkResourceWithRpInfo as defined in clause 8.4.3.4 of the present document.
- The notification InformationChangeNotification sent by means of the Notify operation of clause 7.4.3.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification InformationWithRpChangeNotification defined in clause 8.4.5.3 of the present document.

6.4.4 Virtualised Storage interfaces

6.4.4.1 Virtualised Storage Resources Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Storage Resources Management to VNFM. This interface shall comply with the provisions in clause 7.5.1 of ETSI GS NFV-IFA 006 [1] with the following change(s):

- The content VirtualStorage used in output parameters in clause 7.5.1 of ETSI GS NFV-IFA 006 [1] is replaced by StorageResourceWithRpInfo as defined in clause 8.4.4.2 of the present document.
- For the Terminate Virtualised Storage Resource operation the content of both the input and output parameter is changed from Identifier to StorageResourceWithRpId as defined in clause 8.4.4.3 of the present document.
- All operations except Query Virtualised Storage Resource and Terminate Virtualised Storage Resource have an additional input parameter, resourceProviderId, defined in table 6.4.4.1-1.

Table 6.4.4.1-1: Definition of the resourceProviderId input parameter for storage resources

Parameter	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, storageId].

6.4.4.2 Virtualised Storage Resources Change Notification interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Storage Resources Change Notifications to be consumed by VNFM. This interface shall comply with the provisions in clause 7.5.2 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The notification VirtualisedResourceChangeNotification sent by means of the Notify operation of clause 7.5.2.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification VirtualisedResourceWithRpChangeNotification defined in clause 8.4.5.2 of the present document.

6.4.4.3 Virtualised Storage Resources Information Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Storage Resources Information Management to VNFM. This interface shall comply with the provisions in clause 7.5.3 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualStorageResourceInformation used in output parameters for the Query Virtualised Storage Resources Information operation in clause 7.5.3.4 of ETSI GS NFV-IFA 006 [1] is replaced with VirtualStorageResourceWithRpInfo as defined in clause 8.4.4.4 of the present document.

- The notification InformationChangeNotification sent by means of the Notify operation of clause 7.5.3.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification InformationWithRpChangeNotification defined in clause 8.4.5.3 of the present document.

6.4.5 Virtualised Resource Performance Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Resource Performance Management to be consumed by VNFM. This interface shall comply with the provisions in clause 7.7 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The operations Create PM Job and Create Threshold have an additional input element, resourceProviderId, defined in table 6.4.5-1, with the value received in the response to the GrantVnfLifecycleOperation request.

- The notification PerformanceInformationAvailableNotification notified/sent by means of the Notify operation of clause 7.7.6 of ETSI GS NFV-IFA 006 [1] is replaced with the notification PerformanceInformationWithRpAvailableNotification defined in clause 8.4.6.2 of the present document.

- The notification ThresholdCrossedNotification notified/sent by means of the Notify operation of clause 7.7.6 of ETSI GS NFV-IFA 006 [1] is replaced with the notification ThresholdCrossedWithRpNotification defined in clause 8.4.6.3 of the present document.

Table 6.4.5-1: Definition of the resourceProviderId input parameter for virtual resource performance information

Parameter	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the virtualised resource performance information and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, storageId].

6.4.6 Virtualised Resource Fault Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Resource Fault Management to be consumed by VNFM. This interface shall comply with the provisions in clause 7.6 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The content Alarm used in the output parameters of the Get Alarm List operation of clause 7.6.4 of ETSI GS NFV-IFA 006 [1] is replaced with AlarmWithRpInfo as defined in clause 8.4.7.2 of the present document in order to distinguish between alarms from different VIM instances managed by the NFVO.

- The notification AlarmNotification published/notified/sent by means of the Notify operation of clause 7.6.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification AlarmWithRpNotification defined in clause 8.4.7.3 of the present document.

- The notification AlarmClearedNotification published/notified/sent by means of the Notify operation of clause 7.6.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification AlarmClearedWithRpNotification defined in clause 8.4.7.4 of the present document.

6.4.7 Virtualised Resources Quota Management interfaces

6.4.7.1 Virtualised Compute Resources Quota Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Compute Resources Quota Management to the VNFM. This interface shall comply with the provisions in clause 7.9.1 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualComputeQuota used in output parameters in clause 7.9.1 of ETSI GS NFV-IFA 006 [1] is replaced with VirtualComputeQuotaWithRpInfo as defined in clause 8.4.8.2 of the present document.

6.4.7.2 Virtualised Network Resources Quota Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Network Resources Quota Management to the VNFM. This interface shall comply with the provisions in clause 7.9.2 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualNetworkQuota used in output parameters in clause 7.9.2 of ETSI GS NFV-IFA 006 [1] is replaced with VirtualNetworkQuotaWithRpInfo as defined in clause 8.4.8.3 of the present document.

6.4.7.3 Virtualised Storage Resources Quota Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Storage Resources Quota Management to the VNFM. This interface shall comply with the provisions in clause 7.9.3 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content VirtualStorageQuota used in output parameters in clause 7.9.3 of ETSI GS NFV-IFA 006 [1] is replaced with VirtualStorageQuotaWithRpInfo as defined in clause 8.4.8.4 of the present document.

6.4.7.4 Virtualised Resources Quota Change Notification interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Resources Quota Change Notification to be consumed by the VNFM. This interface shall comply with the provisions in clause 7.9.4 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The notification VirtualisedResourceQuotaChangeNotification sent by means of the Notify operation of clause 7.9.4.3 of ETSI GS NFV-IFA 006 [1] is replaced with notification VirtualisedResourceQuotaWithRpChangeNotification defined in clause 8.4.8.5 of the present document.

6.4.8 Virtualised Resource Reservation interfaces

6.4.8.1 Virtualised Compute Resources Reservation Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Compute Resources Reservation Management to VNFM. This interface shall comply with the provisions in clause 7.8.1 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content ReservedVirtualCompute used in output parameters in clause 7.8.1 of ETSI GS NFV-IFA 006 [1] is replaced with ReservedVirtualComputeWithRpInfo as defined in clause 8.4.9.2 of the present document.

6.4.8.2 Virtualised Network Resources Reservation Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Network Resources Reservation Management to VNFM. This interface shall comply with the provisions in clause 7.8.2 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content ReservedVirtualNetwork used in output parameters in clause 7.8.2 of ETSI GS NFV-IFA 006 [1] is replaced with ReservedVirtualNetworkWithRpInfo as defined in clause 8.4.9.3 of the present document.

6.4.8.3 Virtualised Storage Resources Reservation Management interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Storage Resources Reservation Management to VNFM. This interface shall comply with the provisions in clause 7.8.3 of ETSI GS NFV-IFA 006 [1] with the following changes:

- The content ReservedVirtualStorage used in output parameters in clause 7.8.3 of ETSI GS NFV-IFA 006 [1] is replaced with ReservedVirtualStorageWithRpInfo as defined in clause 8.4.9.4 of the present document.

6.4.8.4 Virtualised Resources Reservation Change Notification interface

In indirect resource management mode, the NFVO produces an interface for Virtualised Resources Reservation Change Notifications to be consumed by the VNFM. This interface shall comply with the provisions in clause 7.8.4 of ETSI GS NFV-IFA 006 [1] and the related information elements with the following changes:

- The notification VirtualisedResourceReservationChangeNotification sent by means of the Notify operation of clause 7.8.4.3 of ETSI GS NFV-IFA 006 [1] is replaced with the notification VirtualisedResourceReservationWithRpChangeNotification defined in clause 8.4.9.5 of the present document.

6.5 Virtualised Resources Quota Available Notification interface

6.5.1 Description

This interface allows an authorized consumer FB to manage subscriptions regarding information on the availability of the virtualised resources quota(s), and to provide such notification to the subscribed consumer.

Support for this interface is optional.

The VNFM needs to issue a Subscribe request for VirtualisedResourceQuotaAvailable notifications in order to know when a quota applicable to the VNFM is available.

When a quota applicable to the consumer is available, the consumer is notified using the notification VirtualisedResourceQuotaAvailableNotification (see clause 8.11.2).

6.5.2 Subscribe operation

6.5.2.1 Description

This operation enables the VNFM to subscribe with a filter for the notifications related to the availability of quota on virtualised resources sent by the NFVO. Specification of filtering mechanism is left for the protocol design specification.

Table 6.5.2.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.5.2.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	VNFM → NFVO
SubscribeResponse	Mandatory	NFVO → VNFM

6.5.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.2.2-1.

Table 6.5.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting notifications to subscribe to. This filter can contain information about specific attributes of the virtualised resources quota.

6.5.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.5.2.3-1.

Table 6.5.2.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription realized.

6.5.2.4 Operation results

After successful subscription, the VNFM is registered to receive notifications sent by the NFVO when a virtualised resources quota applicable to the VNFM is available. The result of the operation shall indicate if the subscription has been successful or not with a standard success/error result. For a particular subscription, only notifications matching the filter will be delivered to the VNFM.

6.5.3 Notify operation

6.5.3.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the NFVO that cannot be invoked as an operation by the consumer (VNFM).

In order to receive notifications, the VNFM shall have a subscription.

Table 6.5.3.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.5.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFVO → VNFM

The following notification is sent by this operation:

- VirtualisedResourceQuotaAvailableNotification. See clause 8.11.2.

6.5.4 Terminate Subscription operation

6.5.4.1 Description

This operation enables the VNFM to terminate a particular subscription.

Table 6.5.4.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.5.4.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	VNFM → NFVO
TerminateSubscriptionResponse	Mandatory	NFVO → VNFM

6.5.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.4.2-1.

Table 6.5.4.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

6.5.4.3 Output parameters

None.

6.5.4.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the VNFM will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

6.5.5 Query Subscription Info operation

6.5.5.1 Description

This operation enables the VNFM to query information about subscriptions.

Table 6.5.5.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 6.5.5.1-1: Query Subscription operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	VNFM → NFVO
QuerySubscriptionInfoResponse	Mandatory	NFVO → VNFM

6.5.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.5.2-1.

Table 6.5.5.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. Details are left for the protocol design stage.

6.5.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.5.5.3-1.

Table 6.5.5.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query. Details are left for the protocol design stage.

6.5.5.4 Operation results

After successful operation, the NFVO has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to VNF quota availability that the VNFM has access to and that are matching the filter shall be returned.

7 VNFM exposed interfaces

7.1 Introduction

This clause defines the interfaces exposed by the VNFM towards the NFVO over the Or-Vnfm reference point.

NOTE: The fact that information elements and attributes are presented in tabular form does not preclude protocol designs in which these information elements and attributes are encoded in different parts of request and response messages. For example, in a RESTful interface, parts of them can be encoded in the URL, in the message header, in the message body or any combination thereof.

7.2 VNF Lifecycle Management interface

7.2.1 Description

This interface allows the NFVO to invoke VNF lifecycle management operations towards the VNFM.

The following operations are defined:

- Create VNF Identifier.
- Instantiate VNF.
- Scale VNF.
- Scale VNF to Level.
- Change VNF Flavour.
- Terminate VNF.
- Delete VNF Identifier.
- Query VNF.
- Heal VNF.
- Operate VNF.
- Modify VNF Information.
- Get Operation Status.
- Change External VNF connectivity.

An identifier (i.e. lifecycleOperationOccurrenceId) is generated for each VNF lifecycle operation occurrence, except for Query VNF, Create VNF Identifier, Delete VNF Identifier and Get Operation Status.

Furthermore, this interface allows the NFVO to manage subscriptions to notifications sent by the VNFM which inform about changes of a VNF instance that are related to VNF lifecycle management operation occurrences, related to updates of VNF information attributes as well as related to the creation/deletion of a VNF instance identifier and the associated instance of a VnfInfo information element. It further allows the VNFM to provide such notifications to the subscriber.

7.2.2 Create VNF Identifier operation

7.2.2.1 Description

This operation creates a VNF instance identifier, and an associated instance of a VnfInfo information element, identified by that identifier, in the NOT_INSTANTIATED instantiation state without instantiating the VNF or doing any additional lifecycle operation(s). It allows returning right away a VNF instance identifier that can be used in subsequent lifecycle operations, like the Instantiate VNF operation.

This operation shall be supported for all VNFs.

Table 7.2.2.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.2.1-1: Create VNF Identifier operation

Message	Requirement	Direction
CreateVnfIdentifierRequest	Mandatory	NFVO → VNFM
CreateVnfIdentifierResponse	Mandatory	VNFM → NFVO

7.2.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.2.2-1.

Table 7.2.2.2-1: Create VNF Identifier operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfdId	M	1	Identifier	Identifier that identifies the VNFD which defines the VNF instance to be created. See note.
vnfInstanceName	M	0..1	String	Human-readable name of the VNF instance to be created.
vnfInstanceDescription	M	0..1	String	Human-readable description of the VNF instance to be created.
NOTE: This identifier, which is managed by the VNF provider, identifies the VNF Package and the VNFD in a globally unique way. See ETSI GS NFV-IFA 011 [3], clause 7.1.2.2				

7.2.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.2.3-1.

Table 7.2.2.3-1: Create VNF Identifier operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	VNF instance identifier just created.

7.2.2.4 Operation results

In case of success, an instance of a VnfInfo information element, in the NOT_INSTANTIATED instantiation state, has been created and can be used in subsequent lifecycle operations and the corresponding VnfIdentifierCreationNotification has been sent. In case of failure, appropriate error information is returned.

7.2.3 Instantiate VNF operation

7.2.3.1 Description

This operation instantiates a particular DF of a VNF that has been in the NOT_INSTANTIATED instantiation state, based on the definition in the VNFD.

This operation shall be supported for all VNFs.

Table 7.2.3.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.3.1-1: Instantiate VNF operation

Message	Requirement	Direction
InstantiateVnfRequest	Mandatory	NFVO → VNFM
InstantiateVnfResponse	Mandatory	VNFM → NFVO

7.2.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.3.2-1.

Table 7.2.3.2-1: Instantiate VNF operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance.
flavourId	M	1	Identifier	Identifier of the VNF DF to be instantiated.
instantiationLevelId	M	0..1	Identifier	Identifier of the instantiation level of the DF to be instantiated. If not present, the default instantiation level as declared in the VNFD shall be instantiated.
extVirtualLink	M	0..N	ExtVirtualLinkData	Information about external VLs to connect the VNF to.
extManagedVirtualLink	M	0..N	ExtManagedVirtualLink Data	Information about internal VLs that are managed by other entities than the VNFM (see note).
vimConnectionInfo	CM	0..N	VimConnectionInfo	Information about VIM connection(s) for managing resources for the VNF instance, or external/externally-managed virtual links. This attribute shall be supported if VNF-related resource management in direct mode is applicable. In that case, this attribute shall be present if there is the need to communicate VIM connection information for external or externally-managed virtual links.
localizationLanguage	M	0..1	Not specified	Localization language of the VNF to be instantiated. The localization languages supported by a VNF can be declared in the VNFD. If this parameter is not provided and the "defaultLocalizationLanguage" attribute is declared in the VNFD, the "defaultLocalizationLanguage" shall be used to determine the localization language VNF to be instantiated.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the instantiation process, specific to the VNF being instantiated as declared in the VNFD (see clause 7.1.5.3 in ETSI GS NFV-IFA 011 [3]).
NOTE: The indication of externally-managed internal VLs is needed in case networks have been pre-configured for use with certain VNFs, for instance to ensure that these networks have certain properties such as security or acceleration features, or to address particular network topologies.				

7.2.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.3.3-1.

Table 7.2.3.3-1: Instantiate VNF operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.3.4 Operation results

In case of success, the VNF has been instantiated and initially configured, and the associated instance of a VnfInfo information element has been updated. The VNF instance is in the INSTANTIATED instantiation state. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The VNFM shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.4 Scale VNF operation

7.2.4.1 Description

This operation provides methods to request scaling a VNF in multiple ways:

- horizontal scaling:
  - scale out: adding additional VNFC instances to the VNF to increase capacity;
  - scale in: removing VNFC instances from the VNF, in order to release unused capacity.
- vertical scaling (not supported in the present document):
  - scale up*:* adding further resources to existing VNFC instances, e.g. increase memory, Central Processing Unit (CPU) capacity or storage size of the virtualisation container hosting a VNFC instance, in order to increase VNF capacity;
  - scale down: removing resources from existing VNFC instances, e.g. decrease memory, CPU capacity or storage size of the virtualisation container hosting a VNFC instance, in order to release unused capacity.

Potentially, different aspects of a VNF can be scaled independently. For example, a VNF could be designed to provide static capacity such as database nodes and dynamic capacity such as query processing nodes. Such a VNF might be scaled w.r.t. two separate aspects: the 'static capacity' aspect can be scaled by adding VNFCs from VNF Deployment Units (VDUs) defining database nodes, and the 'dynamic capacity' aspect can be scaled by adding VNFCs from VDUs defining query processing nodes.

In complex VNF designs, scaling a VNF often requires adding/removing a number of related VNFC instances of several different types, possibly based on multiple VDUs. For example, in a high availability configuration, it might be required to add in each scaling step a pair of VNFC instances, one in active and one in standby configuration.

The ScaleVnfRequest in the interface allows the consumer to specify the scaling aspect. The scaling aspects valid for a particular VNF are defined in the VNFD. After receiving a scale request, the VNFM will figure out the necessary set of VNFCs and the related set of resources based on VNF-specific rules, for instance using the lifecycle management script associated to the Scale VNF event.

When scaling a VNF for a particular aspect, the number of scaling steps to apply to that aspect can be provided as a parameter. A scaling step is the smallest unit by which a particular aspect of a VNF can be scaled, and is mapped by the VNFM to the addition (or removal) of a certain number of resources, based on one or more VDUs. For each scaling aspect, the maximum scale level is defined in the VNFD. The minimum scale level is assumed as zero; the maximum scale level corresponds to the maximum number of steps that can be performed within this aspect, starting at the minimum scale level (i.e. zero). At each point in time between the completed VNF instantiation and the VNF termination, the "size" of the VNF w.r.t. a particular aspect can be expressed by the current scale level w.r.t. that aspect, and can be obtained, among other information, by invoking the "QueryVNF" operation. When the VNF is instantiated, the current scale level is initialized with values that are defined as part of the instantiation level in the VNFD for the associated aspect. Figure 7.2.4.1-1 illustrates the concepts described above.

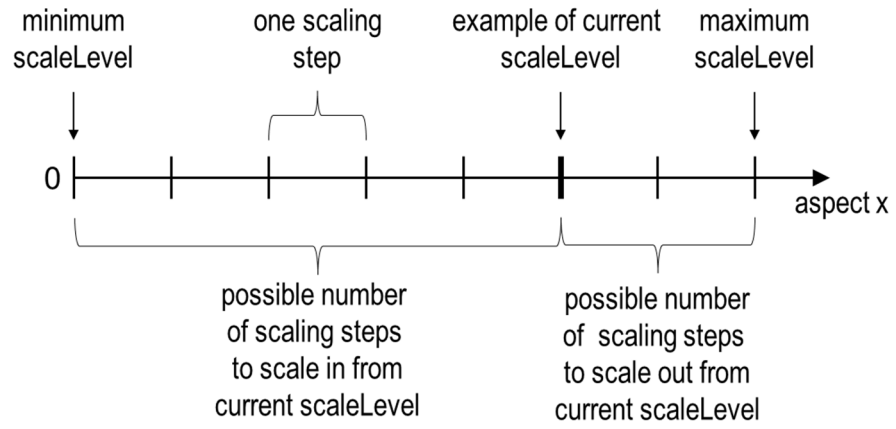

Figure 7.2.4.1-1: Illustrating the concepts of scaleLevel and scaling steps for a particular scaling aspect

The VNFM will then communicate information about the necessary resource changes via the GrantVnfLifecycleOperationRequest to the NFVO.

It depends on the VNF capabilities, and is declared in the VNFD, whether and how this operation is supported for a particular VNF.

Table 7.2.4.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.4.1-1: Scale VNF operation

Message	Requirement	Direction
ScaleVnfRequest	Mandatory	NFVO → VNFM
ScaleVnfResponse	Mandatory	VNFM → NFVO

7.2.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.4.2-1.

Table 7.2.4.2-1: Scale VNF operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance to which this scaling request is related.
type	M	1	Enum	Defines the type of the scale operation requested (scale out, scale in). The set of types actually supported depends on the capabilities of the VNF being managed, as declared in the VNFD. See note 1.
aspectId	M	1	Identifier	Identifies the aspect of the VNF that is requested to be scaled, as declared in the VNFD.

Parameter	Qualifier	Cardinality	Content	Description
numberOfSteps	M	0..1	Integer	Number of scaling steps to be executed as part of this ScaleVnf operation. It shall be a positive number. Defaults to 1. The VNF Provider defines in the VNFD whether or not a particular VNF supports performing more than one step at a time. Such a property in the VNFD applies for all instances of a particular VNF. See note 2.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the scaling process, specific to the VNF being scaled as declared in the VNFD (see clause 7.1.5.4 in ETSI GS NFV-IFA 011 [3]).
NOTE 1: ETSI GS NFV-IFA 010 [2] specifies that the lifecycle management operations that expand or contract a VNF instance include scale in, scale out, scale up and scale down. Vertical scaling (scale up, scale down) is not supported in the present document. NOTE 2: A scaling step is the smallest unit by which a VNF can be scaled w.r.t a particular scaling aspect.				

7.2.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.4.3-1.

Table 7.2.4.3-1: Scale VNF operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.4.4 Operation results

In case of success, the VNF has been scaled according to the request, and the associated instance of a VnfInfo information element has been updated. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The VNFM shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.5 Scale VNF to Level operation

7.2.5.1 Description

This operation scales an instantiated VNF of a particular DF to a target size. The target size is either expressed as an instantiation level of that DF as defined in the VNFD, or given as a list of scale levels, one per scaling aspect of that DF. Instantiation levels and scaling aspects are declared in the VNFD. Typically, the result of this operation is adding and/or removing Network Functions Virtualization Infrastructure (NFVI) resources to/from the VNF.

It depends on the VNF capabilities, and is declared in the VNFD, whether this operation is supported for a particular VNF.

Table 7.2.5.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.5.1-1: Scale VNF to Level operation

Message	Requirement	Direction
ScaleVnfToLevelRequest	Mandatory	NFVO → VNFM
ScaleVnfToLevelResponse	Mandatory	VNFM → NFVO

7.2.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.5.2-1.

Table 7.2.5.2-1: Scale VNF to Level operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance to which this scaling request is related.
instantiationLevelId	M	0..1	Identifier	Identifier of the target instantiation level of the current DF to which the VNF is requested to be scaled. Either instantiationLevelId or scaleInfo but not both shall be present.
scaleInfo	M	0..N	ScaleInfo	For each scaling aspect of the current DF, defines the target scale level to which the VNF is to be scaled. The VNF Provider defines in the VNFD whether or not a particular VNF supports scaling according to this parameter. Such a property in the VNFD applies for all instances of a particular VNF. Either instantiationLevelId or scaleInfo but not both shall be present.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the scaling process, specific to the VNF being scaled as declared in the VNFD (see clause 7.1.5.5 in ETSI GS NFV-IFA 011 [3]).

7.2.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.5.3-1.

Table 7.2.5.3-1: Scale VNF to Level operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.5.4 Operation results

In case of success, the VNF has been scaled according to the request, and the associated instance of a VnfInfo information element has been updated. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The VNFM shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.6 Change VNF Flavour operation

7.2.6.1 Description

This operation changes the DF of a VNF instance.

It depends on the VNF capabilities, and is declared in the VNFD, whether this operation is supported for a particular VNF. This operation may be service-disruptive.

Table 7.2.6.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.6.1-1: Change VNF Flavour operation

Message	Requirement	Direction
ChangeVnfFlavourRequest	Mandatory	NFVO → VNFM
ChangeVnfFlavourResponse	Mandatory	VNFM → NFVO

7.2.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.6.2-1.

Table 7.2.6.2-1: Change VNF Flavour operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance to be modified.
newFlavourId	M	1	Identifier	Identifier of the new VNF DF to apply to this VNF instance.
instantiationLevelId	M	0..1	Identifier	Identifier of the instantiation level of the DF to be used. If not present, the default instantiation level as declared in the VNFD shall be used.
extVirtualLink	M	0..N	ExtVirtualLinkData	Information about external VLs to connect the VNF to.
extManagedVirtualLink	M	0..N	ExtManagedVirtualLinkData	Information about internal VLs that are managed by other entities than the VNFM (see note).
vimConnectionInfo	CM	0..N	VimConnectionInfo	Information about VIM connection(s) for managing resources for the VNF instance, or external/externally-managed virtual links. This attribute shall be supported and present if VNF-related resource management in direct mode is applicable. In that case, this attribute shall be present if there is the need to communicate VIM connection information for external or externally-managed virtual links.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the flavour change process, specific to the VNF being modified as declared in the VNFD (see clause 7.1.5.9 in ETSI GS NFV-IFA 011 [3]).
NOTE: The indication of externally-managed internal VLs is needed in case networks have been pre-configured for use with certain VNFs, for instance to ensure that these networks have certain properties such as security or acceleration features, or to address particular network topologies.				

7.2.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.6.3-1.

Table 7.2.6.3-1: Change VNF Flavour operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.6.4 Operation results

In case of success, the VNF has been modified to use the new DF and initially configured, and the associated instance of a VnfInfo information element has been updated. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The VNFM shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.7 Terminate VNF operation

7.2.7.1 Description

This operation terminates a VNF instance that has been in the INSTANTIATED instantiation state.

A VNF can be terminated gracefully or forcefully. Graceful termination means that the VNFM arranges to take the VNF out of service, e.g. by asking the VNF's EM to take the VNF out of service, and only after that shuts down the VNF and releases the resources. Forceful termination means that the VNFM immediately shuts down the VNF and releases the resources. A time interval can be specified for taking the VNF out of service, after which the VNF is shut down if taking it out of service has not completed.

Terminating a VNF instance does not delete the instance of the VnfInfo information element. This operation shall be supported for all VNFs.

Table 7.2.7.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.7.1-1: Terminate VNF operation

Message	Requirement	Direction
TerminateVnfRequest	Mandatory	NFVO → VNFM
TerminateVnfResponse	Mandatory	VNFM → NFVO

7.2.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.7.2-1.

Table 7.2.7.2-1: Terminate VNF operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance to be terminated.
terminationType	M	1	Enum	Signals whether forceful or graceful termination is requested. In case of forceful termination, the VNF is shut down immediately, and resources are released (see note 1). In case of graceful termination, the VNFM first arranges to take the VNF out of service (by means out of scope of the present specification, e.g. involving interaction with EM, if required). Once this was successful, or after a timeout, the VNFM shuts down the VNF and releases the resources.

Parameter	Qualifier	Cardinality	Content	Description
gracefulTerminationTimeout	M	0..1	TimeDuration	The time interval to wait for the VNF to be taken out of service during graceful termination, before shutting down the VNF and releasing the resources. If not given, it is expected that the VNFM waits for the successful taking out of service of the VNF, no matter how long it takes, before shutting down the VNF and releasing the resources (see note 2). Minimum timeout or timeout range are specified by the VNF Provider (e.g. defined in the VNFD or communicated by other means). Not relevant in case of forceful termination.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the Terminate VNF operation, specific to the VNF being terminated as declared in the VNFD (see clause 7.1.5.7 in ETSI GS NFV-IFA 011 [3]).
NOTE 1: If the VNF is still in service, this can adversely impact network service, and therefore, operator policies apply to determine if forceful termination is allowed in the particular situation. NOTE 2: This implies that no VNF shutdown and resource release will be attempted if taking the VNF out of service fails or hangs.				

7.2.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.7.3-1.

Table 7.2.7.3-1: Terminate VNF operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.7.4 Operation results

In case of success, the VNF instance has been terminated and resources used by the VNF have been released, and the associated instance of a VnfInfo information element has been updated. The VNF instance is in the NOT_INSTANTIATED instantiation state. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The VNFM shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.8 Delete VNF Identifier operation

7.2.8.1 Description

This operation deletes a VNF instance identifier and the associated instance of a VnfInfo information element in the NOT_INSTANTIATED instantiation state.

This operation shall be supported for all VNFs.

Table 7.2.8.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.8.1-1: Delete VNF Identifier operation

Message	Requirement	Direction
DeleteVnfIdentifierRequest	Mandatory	NFVO → VNFM
DeleteVnfIdentifierResponse	Mandatory	VNFM → NFVO

7.2.8.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.8.2-1.

Table 7.2.8.2-1: Delete VNF Identifier operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	VNF instance identifier to be deleted

7.2.8.3 Output parameters

No output parameter.

7.2.8.4 Operation results

In case of success, the VNF instance identifier and the associated instance of the VnfInfo information element has been deleted and can no longer be used; and the corresponding VnfIdentifierDeletionNotification has been sent. If the VNF instance was not terminated (i.e. the VNF is in INSTANTIATED instantiation state), the operation shall be rejected.

In case of failure, appropriate error information is returned.

7.2.9 Query VNF operation

7.2.9.1 Description

This operation provides information about VNF instances. The applicable VNF instances can be chosen based on filtering criteria, and the information can be restricted to selected attributes.

This operation shall be supported for all VNFs.

Table 7.2.9.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.9.1-1: Query VNF operation

Message	Requirement	Direction
QueryVnfRequest	Mandatory	NFVO → VNFM
QueryVnfResponse	Mandatory	VNFM → NFVO

7.2.9.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.9.2-1.

Table 7.2.9.2-1: Query VNF operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter to select the VNF instance(s) about which information is queried.
attributeSelector	M	0..N	String	Provides a list of attribute names. If present, only these attributes are returned for the VNF instance(s) matching the filter. If absent, the complete information is returned for the VNF instance(s) matching the filter.

7.2.9.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.9.3-1.

Table 7.2.9.3-1: Query VNF operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInfo	M	0..N	VnfInfo	The information items about the selected VNF instance(s) that are returned. If attributeSelector is present, only the attributes listed in attributeSelector are returned for the selected VNF instance(s). See note.
NOTE: The lower cardinality is 0 since there may be no matches to the provided filter.				

7.2.9.4 Operation results

In case of success, information related to the VNF instances that match the filter is returned. In case of failure, appropriate error information is returned.

7.2.10 Heal VNF operation

7.2.10.1 Description

This operation enables the NFVO to request a VNFM to perform a VNF healing procedure.

It depends on the VNF capabilities, and is declared in the VNFD, whether this operation is supported for a particular VNF.

Table 7.2.10.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.10.1-1: Heal VNF operation

Message	Requirement	Direction
HealVnfRequest	Mandatory	NFVO → VNFM
HealVnfResponse	Mandatory	VNFM → NFVO

7.2.10.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.10.2-1.

Table 7.2.10.2-1: Heal VNF operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifies the VNF instance requiring a healing action.
cause	M	0..1	String	Indicates the reason why a healing procedure is required.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the healing process, specific to the VNF being healed as declared in the VNFD (see clause 7.1.5.6 in ETSI GS NFV-IFA 011 [3]). EXAMPLE: Input parameters to VNF-specific healing procedures.

7.2.10.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.10.3-1.

Table 7.2.10.3-1: Heal VNF operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.10.4 Operation results

In case of success, the VNF has been healed, and the associated instance of a VnfInfo information element has been updated. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The VNFM shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.11 Operate VNF operation

7.2.11.1 Description

This operation enables requesting to change the state of a VNF instance, including starting and stopping the VNF instance.

NOTE 1: These operations are complementary to instantiating and terminating a VNF.

NOTE 2: In the present document, only starting and stopping the VNF instance(s) are supported. Extension of this operation to support other VNF state changes is left for future specification.

A VNF instance can be in the following states:

- STARTED: the VNF instance is up and running.
- STOPPED: the VNF instance has been shut down. A VNF instance is stopped if all its VNFC instances are also stopped.

In the state STOPPED, the virtualised container(s), where the VNFC instance(s) of the VNF run, are shut down but not terminated. In addition, if the workflow requires a graceful stop, as part of this process the VNFM (producer of the interface) will interact with VNF/EM to gracefully stop the VNF application. Once a VNF is instantiated, i.e. all instantiation steps have been completed, the VNF instance is in the state STARTED.

Figure 7.2.11.1-1 illustrates the VNF operate state diagram. The desired change of state is indicated as an input in the OperateVnfRequest operation.

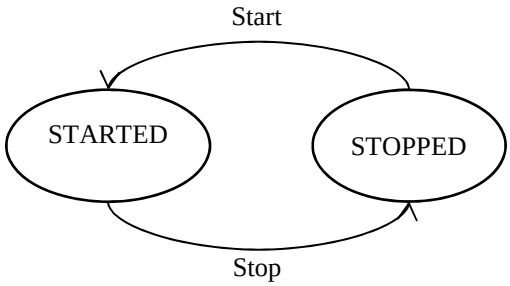

Figure 7.2.11.1-1: Operate VNF state diagram

It depends on the VNF capabilities, and is declared in the VNFD, whether this operation is supported for a particular VNF.

Table 7.2.11.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.11.1-1: Operate VNF operation

Message	Requirement	Direction
OperateVnfRequest	Mandatory	NFVO → VNFM
OperateVnfResponse	Mandatory	VNFM → NFVO

7.2.11.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.11.2-1.

Table 7.2.11.2-1: Operate VNF operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance.
changeStateTo	M	1	Enum	The desired state to change the VNF to. Permitted values are: start, stop.
stopType	M	0..1	Enum	It signals whether forceful or graceful stop is requested. Allowed values are: forceful and graceful. In case of forceful stop, the VNF is stopped immediately. Note that if the VNF is still in service, this may adversely impact network service, and therefore, operator policies apply to determine if forceful stop is allowed in the particular situation. In case of graceful stop, the VNFM first arranges to take the VNF out of service (by means out of scope of the present specification, e.g. involving interaction with EM, if required). Once this is successful, or after a timeout, the VNFM stops the VNF. Only applicable when changing state to stop.

Parameter	Qualifier	Cardinality	Content	Description
gracefulStopTimeout	M	0..1	TimeDuration	The time interval to wait for the VNF to be taken out of service during graceful stop, before stopping the VNF. If not given, it is expected that the VNFM waits for the successful taking out of service of the VNF, no matter how long it takes, before stopping the VNF (see note). Minimum timeout or timeout range are specified by the VNF vendor (e.g. defined in the VNFD or communicated by other means). The parameter is not relevant in case of forceful stop.
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the Operate VNF operation, specific to the VNF being operated as declared in the VNFD (see clause 7.1.5.8 in ETSI GS NFV-IFA 011 [3]).
NOTE: This implies that no VNF stop will be attempted if taking the VNF out of service fails or hangs.				

7.2.11.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.11.3-1.

Table 7.2.11.3-1: Operate VNF operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.11.4 Operation results

In case of success, the state of the VNF has been changed, and the associated instance of a VnfInfo information element has been updated. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The producer shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.12 Modify VNF Information operation

7.2.12.1 Description

This operation allows updating information about a VNF instance.

This operation shall be supported for all VNFs.

Table 7.2.12.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.12.1-1: Modify VNF Information operation

Message	Requirement	Direction
ModifyVnfInfoRequest	Mandatory	NFVO → VNFM
ModifyVnfInfoResponse	Mandatory	VNFM → NFVO

7.2.12.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.12.2-1.

Table 7.2.12.2-1: Modify VNF Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance for which the writeable attributes of VnfInfo are requested to be modified.
newValues	M	1..N	KeyValuePair	Contains the set of attributes to update. The key in the KeyValuePair indicates the name of an attribute that is writable through the interface whose value is to be updated. The value in the KeyValuePair indicates the new attribute value.

7.2.12.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.12.3-1.

Table 7.2.12.3-1: Modify VNF Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle operation occurrence.

7.2.12.4 Operation results

In case of success:

- if the operation handles changes to the VNF configurable properties, the configuration in the VNF has been modified according to the input parameters specified in the operation;
- if the operation handles other changes to the VNF instance information, the VNF information has been changed according to the input parameters specified in the operation.

In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification. In particular, error information shall indicate the reason why the requested attribute has not been updated, e.g. changing the value of the attribute is not supported, input attribute name is not recognized, etc.

The producer shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.2.13 Get Operation Status operation

7.2.13.1 Description

This operation provides the status of a VNF lifecycle management operation. This means, it is not a VNF lifecycle management operation itself, but an operation on VNF lifecycle management operations. Therefore, this operation shall be supported for all VNFs.

Table 7.2.13.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.13.1-1: Get Operation Status operation

Message	Requirement	Direction
GetOperationStatusRequest	Mandatory	NFVO → VNFM
GetOperationStatusResponse	Mandatory	VNFM → NFVO

7.2.13.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.13.2-1.

Table 7.2.13.2-1: Get Operation Status operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
lifecycleOperationOccurrenceId	M	1	Identifier	Identifier of the VNF lifecycle operation occurrence.

7.2.13.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.13.3-1.

Table 7.2.13.3-1: Get Operation Status operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
operationStatus	M	1	Enum	Indicates the operation status (which includes, for example: Processing, Successfully done, Failed, but can also include operation-specific states).

7.2.13.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

7.2.14 Subscribe operation

7.2.14.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications sent by the VNFM which are related to VNF lifecycle management operation occurrences, as well as creation/deletion of VNF instance identifiers and the associated VnfInfo information element instances.

NOTE: Specification of filtering mechanism is left for the protocol design stage.

Table 7.2.14.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.14.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	NFVO → VNFM
SubscribeResponse	Mandatory	VNFM → NFVO

7.2.14.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.14.2-1.

Table 7.2.14.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting e.g. the VNF instances of interest and the specific types of changes. See note.
NOTE: When subscribing for notifications regarding the creation of VNF identifiers and the associated VNF information object instances, selecting the VNF instances in the filter is not possible.				

7.2.14.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.14.3-1.

Table 7.2.14.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription realized.

7.2.14.4 Operation results

After successful subscription, the consumer (NFVO) is registered to receive notifications related to VNF lifecycle management operation occurrences, as well as creation/deletion of VNF instance identifiers and the associated VnfInfo information element instances.

The result of the operation shall indicate if the subscription has been successful or not with a standard success/error result. For a particular subscription, only notifications matching the filter will be delivered to the consumer.

7.2.15 Notify operation

7.2.15.1 Description

This operation notifies a subscriber about events related to VNF lifecycle operation occurrences, as well as creation/deletion of VNF instance identifiers and the associated VnfInfo information element instances.

This operation distributes notifications to subscribers. It is a one-way operation issued by the producer (VNFM) that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the consumer (NFVO) has to perform an explicit Subscribe operation beforehand.

Table 7.2.15.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.2.15.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → NFVO

The following notifications can be notified/sent by this operation:

- VnfLcmOperationOccurrenceNotification (see clause 8.6.2).

- VnfIdentifierCreationNotification (see clause 8.6.7).
- VnfIdentifierDeletionNotification (see clause 8.6.8).

7.2.16 Terminate Subscription operation

7.2.16.1 Description

This operation enables the NFVO to terminate a particular subscription.

Table 7.2.16.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.2.16.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	NFVO → VNFM
TerminateSubscriptionResponse	Mandatory	VNFM → NFVO

7.2.16.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.16.2-1.

Table 7.2.16.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

7.2.16.3 Output parameters

None.

7.2.16.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the NFVO will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

7.2.17 Query Subscription Info operation

7.2.17.1 Description

This operation enables the NFVO to query information about subscriptions.

Table 7.2.17.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.2.17.1-1: Query Subscription operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	NFVO → VNFM
QuerySubscriptionInfoResponse	Mandatory	VNFM → NFVO

7.2.17.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.17.2-1.

Table 7.2.17.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. Details are left for the protocol design stage.

7.2.17.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.2.17.3-1.

Table 7.2.17.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query. Details are left for the protocol design stage.

7.2.17.4 Operation results

After successful operation, the VNFM has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to VNF lifecycle management that the NFVO has access to and that are matching the filter shall be returned.

7.2.18 Change External VNF Connectivity operation

7.2.18.1 Description

This operation enables changing the external connectivity of a VNF instance. The types of changes that this operation supports are:

- Disconnect the external CPs that are connected to a particular external VL, and connect them to a different external VL.
- Change the connectivity parameters of the existing external CPs, including changing addresses.

NOTE: Depending on the capabilities of the underlying VIM resources, certain changes (e.g. modifying the IP address assignment) might not be supported without deleting the resource and creating another one with the modified configuration.

VNFs shall support this operation. This operation may be service-disruptive.

Table 7.2.18.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.2.18.1-1: Change External VNF Connectivity

Message	Requirement	Direction
ChangeExtVnfConnectivityRequest	Mandatory	NFVO → VNFM
ChangefExtVnfConnectivityResponse	Mandatory	VNFM → NFVO

7.2.18.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.2.18.2-1. The parameters passed for this operation override those passed at instantiation time.

Table 7.2.18.2-1: Change External VNF Connectivity operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance.
extVirtualLink	M	1..N	ExtVirtualLinkData	Information about external VLs to change (e.g. connect the VNF to).
additionalParam	M	0..N	KeyValuePair	Additional parameters passed by the NFVO as input to the Change External VNF Connectivity operation, specific to the VNF of which the external VLs are being changed as declared in the VNFD (see clause 7.1.5.10 in ETSI GS NFV-IFA 011 [3]).
vimConnectionInfo	CM	0..N	VimConnectionInfo	Information about VIM connection(s) for managing resources for the VNF instance, or external virtual links. This attribute shall be supported if VNF-related resource management in direct mode is applicable. In that case, this attribute shall be present if there is the need to communicate VIM connection information for external virtual links.

The following behaviour applies for the changes that can be performed with this operation:

- To change the connection of external CP instances based on certain external CPDs from a "source" external VL to a different "target" external VL, the identifier of the "target" external VL shall be sent in the "extVirtualLinkId" attribute of the "extVirtualLink" parameter, and the "extCp" attributes of that parameter shall refer via the "cpdId" attribute to the external CPDs of the corresponding external connection point instances that are to be reconnected to the target external VL.

NOTE: This means that all CP instances based on a given external CPD will be reconnected. See clause A.3 in Annex A for an illustration.

- To change the connectivity parameters of the external CPs connected to a particular external VL, including changing addresses, the identifier of that external VL shall be sent in the "extVirtualLinkId" attribute of the "extVirtualLink" parameter, and the "extCp" attribute of that parameter shall contain at least those entries with modified parameters.

7.2.18.3 Output parameters

None.

7.2.18.4 Operation results

In the case of success, the connectivity of the VNF has been changedaccording to the input parameters, and the associated instance of a VnfInfo information element has been updated. In case of failure, appropriate error information is provided in the "result" LCM Operation Occurrence Notification.

The producer shall first return the lifecycleOperationOccurrenceId and second send the "start" LCM Operation Occurrence Notification before additional notifications or messages as part of this operation are issued, or operations towards the NFVO or VIM are invoked.

On successful as well as unsuccessful completion of the operation, the VNFM shall send the "result" LCM Operation Occurrence Notification.

7.3 Void

7.4 VNF Performance Management interface

7.4.1 Description

This interface allows providing performance management (measurement results collection and notifications) related to VNFs. Performance information on a given VNF results from performance information of the virtualised resources that is collected from the VIM and mapped to this VNF instance.

Collection and reporting of performance information is controlled by a PM job that groups details of performance collection and reporting information.

When new performance information is available, the consumer is notified using the notification PerformanceInformationAvailableNotification (see clause 8.7.8). The details of the performance measurements are provided using the PerformanceReport information element (see clause 8.7.5).

NOTE: Delivery mechanism for the performance reports is left for later specification.

The following operations are defined for this interface which will be consumed by the NFVO:

- Create PM Job operation.
- Delete PM Jobs operation.
- Subscribe operation.
- Notify operation.
- Query PM Job operation.
- Create Threshold operation.
- Delete Thresholds operation.
- Query Threshold operation.
- Terminate Subscription operation.
- Query Subscription Info operation.

7.4.2 Create PM Job operation

7.4.2.1 Description

This operation will create a PM job, enabling an NFVO to specify a VNF or set of VNFs, that the VNFM is managing, for which it wants to receive performance information. This will allow the requesting NFVO to specify its performance information requirements with the VNFM.

The VNFM needs to issue a Subscribe request for PerformanceInformationAvailable notifications in order to know when new collected performance information is available.

Table 7.4.2.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.2.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	NFVO → VNFM
CreatePmJobResponse	Mandatory	VNFM → NFVO

7.4.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.2.2-1.

Table 7.4.2.2-1: Create PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfSelector	M	1	ObjectSelection	Defines the VNFs for which performance information is requested to be collected.
performanceMetric	M	0..N	String	This defines the type of performance metric(s) for the specified VNFs. At least one of the two attributes (performance metric or group) shall be present.
performanceMetricGroup	M	0..N	String	Group of performance metrics. A metric group is a pre-defined list of metrics, known to the producer that it can decompose to individual metrics. At least one of the two attributes (performance metric or group) shall be present.
collectionPeriod	M	1	Enum	Specifies the periodicity at which the VNFM will collect performance information (see note).
reportingPeriod	M	1	Enum	Specifies the periodicity at which the VNFM will report to the NFVO about performance information (see note).
reportingBoundary	O	0..1	Not specified	Identifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE: At the end of each reportingPeriod, the VNFM will inform NFVO about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reportingPeriod is left for further protocol specification, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

7.4.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.2.3-1.

Table 7.4.2.3-1: Create PM Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobId	M	1	Identifier	Identifier of the created PM job.

7.4.2.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

The pmJobId is returned when the operations has been successful.

7.4.3 Delete PM Jobs operation

7.4.3.1 Description

This operation will delete one or more PM job(s).

Table 7.4.3.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.3.1-1: Delete PM Jobs operation

Message	Requirement	Direction
DeletePmJobsRequest	Mandatory	NFVO → VNFM
DeletePmJobsResponse	Mandatory	VNFM → NFVO

7.4.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.3.2-1.

Table 7.4.3.2-1: Delete PM Jobs operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobId	M	1..N	Identifier	Identifiers of the PM jobs to be deleted.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to delete multiple PM Jobs in one request, or as a series of requests that delete one PM Job at a time.				

7.4.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.3.3-1.

Table 7.4.3.3-1: Delete PM Jobs operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedPmJobId	M	1..N	Identifier	Identifiers of the PM jobs successfully deleted.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to delete multiple PM Jpbs in one request, or as a series of requests that delete one PM Job at a time.				

7.4.3.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

7.4.4 Subscribe operation

7.4.4.1 Description

This operation enables the NFVOs to subscribe with a filter for the notifications related to performance information with the VNFM.

NOTE: Specification of filtering mechanism is left for the protocol design stage.

Table 7.4.4.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.4.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	NFVO → VNFM
SubscribeResponse	Mandatory	VNFM → NFVO

7.4.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.4.2-1.

Table 7.4.4.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting notifications. The filter can be on VNF, type of notification or attribute of the notification.

7.4.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.4.3-1.

Table 7.4.4.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription returned.

7.4.4.4 Operation results

As a result of this operation, the VNFM shall indicate to the NFVO in the subscribeResponse message whether the subscription was successful or not.

For a particular subscription, only notifications matching the filter will be delivered to the consumer.

7.4.5 Notify operation

7.4.5.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VNFM that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the NFVO shall have a subscription.

Table 7.4.5.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.5.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → NFVO

The following notifications can be notified/sent by this operation:

- PerformanceInformationAvailableNotification (see clause 8.7.8).
- ThresholdCrossedNotification (see clause 8.7.9).

7.4.6 Query PM Job operation

7.4.6.1 Description

This operation will enable the NFVO to solicit from the VNFM the details of one or more PM job(s).

This operation is not returning performance reports.

Table 7.4.6.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.6.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	NFVO → VNFM
QueryPmJobResponse	Mandatory	VNFM → NFVO

7.4.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.6.2-1.

Table 7.4.6.2-1: Query PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the PM Jobs on which the query applies. It can be a single identifier, multiple identifiers or a wildcard.

7.4.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.6.3-1.

Table 7.4.6.3-1: Query PM Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJob	M	0..N	PmJob	Details of PM jobs matching the input filter.

7.4.6.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

7.4.7 Create Threshold operation

7.4.7.1 Description

This operation will allow the NFVO to create a threshold to specify threshold levels on specified performance metric and VNF(s) for which notifications will be generated when crossed.

Creating a threshold does not trigger collection of metrics. In order for the threshold to be active, there needs to be a PM job collecting the needed metric for the selected entities.

Table 7.4.7.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.7.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	NFVO → VNFM
CreateThresholdResponse	Mandatory	VNFM → NFVO

7.4.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.7.2-1.

Table 7.4.7.2-1: Create Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
vnfSelector	M	1	ObjectSelection	Defines the VNFs for which the threshold will be defined.
performanceMetric	M	1	String	Defines the performance metric on which the threshold will be defined.
thresholdType	M	1	Enum	Defines the type of threshold. The list of possible values is left for the protocol design stage and might include: single/multi valued threshold, static/dynamic threshold, template based threshold, etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, and direction in which it is crossed, details on the notification to be generated, etc.

7.4.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.7.3-1.

Table 7.4.7.3-1: Create Threshold operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier	Identifier of created threshold.

7.4.7.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

The thresholdId is returned when the operations has been successful.

7.4.8 Delete Thresholds operation

7.4.8.1 Description

This operation will allow the NFVO to delete one or more existing threshold(s).

Table 7.4.8.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.8.1-1: Delete Thresholds operation

Message	Requirement	Direction
DeleteThresholdsRequest	Mandatory	NFVO → VNFM
DeleteThresholdsResponse	Mandatory	VNFM → NFVO

7.4.8.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.8.2-1.

Table 7.4.8.2-1: Delete Thresholds operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdId	M	1..N	Identifier	Identifiers of the thresholds to be deleted.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to delete multiple thresholds in one request, or as a series of requests that delete one threshold at a time.				

7.4.8.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.8.3-1.

Table 7.4.8.3-1: Delete Thresholds operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedThresholdId	M	1..N	Identifier	Identifiers of the thresholds that have been deleted successfully.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to delete multiple thresholds in one request, or as a series of requests that delete one threshold at a time.				

7.4.8.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

7.4.9 Query Threshold operation

7.4.9.1 Description

This operation will allow the NFVO to query the details of an existing threshold.

Table 7.4.9.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.4.9.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	NFVO → VNFM
QueyThresholdResponse	Mandatory	VNFM → NFVO

7.4.9.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.9.2-1.

Table 7.4.9.2-1: Query Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the thresholds on which the query applies. It can be a single identifier, multiple identifiers or a wildcard.

7.4.9.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.9.3-1.

Table 7.4.9.3-1: Query Threshold operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
threshold	M	0..N	Threshold	List of threshold details matching the input filter.

7.4.9.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

7.4.10 Terminate Subscription operation

7.4.10.1 Description

This operation enables the NFVO to terminate a particular subscription.

Table 7.4.10.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.4.10.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	NFVO → VNFM
TerminateSubscriptionResponse	Mandatory	VNFM → NFVO

7.4.10.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.10.2-1.

Table 7.4.10.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

7.4.10.3 Output parameters

None.

7.4.10.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the NFVO will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

7.4.11 Query Subscription Info operation

7.4.11.1 Description

This operation enables the NFVO to query information about subscriptions.

Table 7.4.11.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.4.11.1-1: Query Subscription operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	NFVO → VNFM
QuerySubscriptionInfoResponse	Mandatory	VNFM → NFVO

7.4.11.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.4.11.2-1.

Table 7.4.11.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. Details are left for the protocol design stage.

7.4.11.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.4.11.3-1.

Table 7.4.11.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query. Details are left for the protocol design stage.

7.4.11.4 Operation results

After successful operation, the VNFM has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to VNF fault management that the NFVO has access to and that are matching the filter shall be returned.

7.5 VNF Fault Management interface

7.5.1 Description

This interface shall allow the VNFM to provide alarms related to the VNFs visible to the consumer.

Virtualised resource alarms collected by the VNFM will be filtered, correlated and modified by the VNFM and mapped to the corresponding VNF instance, resulting in alarms on the corresponding VNF.

The fault management interface shall support the following operations:

- Subscribe operation (Subscription of NFVOs with the VNFM for the notifications related to the alarms).
- Notify operation (Notifications of alarms or alarm state change from VNFM to NFVO).
- Get alarm list operation (Accessing active alarms bythe NFVO).
- Acknowledge alarms operation (Acknowledging alarms by the NFVO).
- Terminate Subscription operation.
- Query Subscription Info operation.

7.5.2 Subscribe operation

7.5.2.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications related to VNF alarms sent by the VNFM.

NOTE: Specification of filtering mechanism is left for the protocol design stage.

Table 7.5.2.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.5.2.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	NFVO → VNFM
SubscribeResponse	Mandatory	VNFM → NFVO

7.5.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.5.2.2-1.

Table 7.5.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting VNFs and related alarms. This can contain the VNF information, fault type, severity and cause of the alarm.

7.5.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.5.2.3-1.

Table 7.5.2.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription returned.

7.5.2.4 Operation results

As a result of this operation, the VNFM shall indicate to the NFVO in the SubscribeResponse message whether the subscription was successful or not.

For a particular subscription, only notifications matching the filter will be delivered to the consumer.

7.5.3 Notify operation

7.5.3.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VNFM towards the NFVO that cannot be invoked as an operation by the consumer (NFVO).

In order to receive notifications, the NFVO shall have a subscription.

Table 7.5.3.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.5.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → NFVO

The following notifications can be notified/sent by this operation:

- AlarmNotification (see clause 8.8.2).
- AlarmClearedNotification (see clause 8.8.3).
- AlarmListRebuiltNotification (see clause 8.8.6).

7.5.4 Get Alarm List operation

7.5.4.1 Description

This operation enables the NFVOs to query the active alarms from the VNFM.

Table 7.5.4.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.5.4.1-1: Get Alarm List operation

Message	Requirement	Direction
GetAlarmListRequest	Mandatory	NFVO → VNFM
GetAlarmListResponse	Mandatory	VNFM → NFVO

7.5.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.5.4.2-1.

Table 7.5.4.2-1: Get Alarm List operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting alarms. This can contain the list of the VNF Identifiers, fault type, severity and cause.

7.5.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.5.4.3-1.

Table 7.5.4.3-1: Get Alarm List operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
alarm	M	0..N	Alarm	Information about alarms including alarmId, affected VNF identifier, and FaultDetails. The cardinality can be "0" to indicate that no Alarm could be retrieved based on the input Filter information (e.g. no matching alarm).

7.5.4.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular request, only alarms matching the filter are delivered to the NFVO.

7.5.5 Terminate Subscription operation

7.5.5.1 Description

This operation enables the NFVO to terminate a particular subscription.

Table 7.5.5.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.5.5.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	NFVO → VNFM
TerminateSubscriptionResponse	Mandatory	VNFM → NFVO

7.5.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.5.5.2-1.

Table 7.5.5.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

7.5.5.3 Output parameters

None.

7.5.5.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the NFVO will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

7.5.6 Query Subscription Info operation

7.5.6.1 Description

This operation enables the NFVO to query information about subscriptions.

Table 7.5.6.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.5.6.1-1: Query Subscription operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	NFVO → VNFM
QuerySubscriptionInfoResponse	Mandatory	VNFM → NFVO

7.5.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.5.6.2-1.

Table 7.5.6.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. Details are left for the protocol design stage.

7.5.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.5.6.3-1.

Table 7.5.6.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query. Details are left for the protocol design stage.

7.5.6.4 Operation results

After successful operation, the VNFM has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to VNF fault management that the NFVO has access to and that are matching the filter shall be returned.

7.5.7 Acknowledge alarms operation

7.5.7.1 Description

This operation enables the NFVO to acknowledge alarms at VNFM.

Table 7.5.7.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.5.7.1-1: Acknowledge alarms operation

Message	Requirement	Direction
AcknowledgeAlarmsRequest	Mandatory	NFVO → VNFM
AcknowledgeAlarmsResponse	Mandatory	VNFM → NFVO

7.5.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.5.7.2-1.

Table 7.5.7.2-1: Acknowledge alarms operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
alarmId	M	1..N	Identifier (Reference to Alarm)	Identifier of an individual alarm to be acknowledged, or multiple identifiers of the alarms to be acknowledged. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to acknowledge multiple alarms in one request, or as a series of requests that acknowledge one alarm at a time.				

7.5.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.5.7.3-1.

Table 7.5.7.3-1: Acknowledge alarms operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
acknowledgedAlarmId	M	1..N	Identifier (Reference to Alarm)	Identifier of an individual alarm that is acknowledged, or multiple identifiers of the alarms that are acknowledged. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to acknowledge multiple alarms in one request, or as a series of requests that acknowledge one alarm at a time.				

7.5.7.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

7.6 Void

7.7 VNF Indicator interface

7.7.1 Description

This interface allows the VNFM to provide information on value changes of VNF related indicators. VNF related indicators are declared in the VNFD. This interface is originally produced by the EM and/or VNF on the Ve-Vnfm-em and/or Ve-Vnfm-vnf reference point respectively (see ETSI GS NFV-IFA 008 [i.5]) and is re-exposed by the VNFM.

The following operations are defined for this interface:

- Subscribe.
- Notify.
- Get Indicator Value.

- Terminate Subscription.
- Query Subscription Info.

7.7.2 Subscribe operation

7.7.2.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications related to VNF indicator value changes sent by the VNFM.

NOTE: Specification of filtering mechanism is left for the protocol design stage.

Table 7.7.2.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.7.2.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	NFVO → VNFM
SubscribeResponse	Mandatory	VNFM →NFVO

7.7.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.7.2.2-1.

Table 7.7.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting VNFs and related indicators.

7.7.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.7.2.3-1.

Table 7.7.2.3-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription returned.

7.7.2.4 Operation results

As a result of this operation, the VNFM shall indicate to the NFVO in the SubscribeResponse message whether the subscription was successful or not. For a particular subscription, only notifications matching the filter will be delivered to the consumer.

7.7.3 Notify operation

7.7.3.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VNFM towards the NFVO that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the NFVO shall have a subscription.

Table 7.7.3.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.7.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → NFVO

The following notification can be notified/sent by this operation:

- IndicatorValueChangeNotification (see clause 8.10.2).

7.7.4 Get Indicator Value operation

7.7.4.1 Description

This operation enables NFVO to request the actual value of a given indicator from the VNFM.

Table 7.7.4.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.7.4.1-1: Get Indicator Value operation

Message	Requirement	Direction
GetIndicatorValueRequest	Mandatory	NFVO → VNFM
GetIndicatorValueResponse	Mandatory	VNFM → NFVO

7.7.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.7.4.2-1.

Table 7.7.4.2-1: Get Indicator Value operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting VNFs and related indicators.

7.7.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.7.4.3-1.

Table 7.7.4.3-1: Get Indicator Value operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
indicatorInformation	M	0..N	IndicatorInformation	The requested indicator values as complex structures having the VNF Instance ID, Indicator and the value of the Indicator.

7.7.4.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular request, only indicators matching the filter will be delivered to the NFVO.

7.7.5 Terminate Subscription operation

7.7.5.1 Description

This operation enables the NFVO to terminate a particular subscription.

Table 7.7.5.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.7.5.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	NFVO → VNFM
TerminateSubscriptionResponse	Mandatory	VNFM → NFVO

7.7.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.7.5.2-1.

Table 7.7.5.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

7.7.5.3 Output parameters

None.

7.7.5.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the NFVO will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

7.7.6 Query Subscription Info operation

7.7.6.1 Description

This operation enables the NFVO to query information about subscriptions.

Table 7.7.6.1-1 lists the information flow exchanged between the NFVO and the VNFM.

Table 7.7.6.1-1: Query Subscription operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	NFVO → VNFM
QuerySubscriptionInfoResponse	Mandatory	VNFM → NFVO

7.7.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.7.6.2-1.

Table 7.7.6.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. Details are left for the protocol design stage.

7.7.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.7.6.3-1.

Table 7.7.6.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query. Details are left for the protocol design stage.

7.7.6.4 Operation results

After successful operation, the VNFM has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to VNF indicator value changes that the NFVO has access to and that are matching the filter shall be returned.

8 Information elements exchanged

8.1 Introduction

This clause defines, or references, definitions of information elements used in the interfaces defined in the present document.

The specification of the following information elements is left for the protocol design stage:

- String.
- Integer.
- Identifier.
- Filter.
- DateTime.
- Value.
- Version.
- KeyValuePair.

8.2 Information elements and notifications related to VNF Package Management

8.2.1 Introduction

This clause defines information elements related to VNF Package Management.

8.2.2 OnboardedVnfPkgInfo information element

8.2.2.1 Description

This information element provides the details of an on-boarded VNF Package, which the NFVO creates and stores as part of the on-boarding and ongoing operational management process.

NOTE: The definition below is aligned with the definition of the OnboardedVnfPkgInfo information element in ETSI GS NFV-IFA 013 [i.8].

8.2.2.2 Attributes

The OnboardedVnfPkgInfo information element shall follow the indications provided in table 8.2.2.2-1.

Table 8.2.2.2-1: Attributes of the OnboardedVnfPkgInfo information element

Attribute	Qualifier	Cardinality	Content	Description
onboardedVnfPkgInfoId	M	1	Identifier	Identifier of information held by the NFVO about the specific on-boarded VNF Package. This identifier was allocated by the NFVO.
vnfdId	M	1	Identifier	Identifier that identifies the VNF Package. See note.
vnfProvider	M	1	String	See note.
vnfProductName	M	1	String	See note.
vnfSoftwareVersion	M	1	Version	See note.
vnfdVersion	M	1	Version	See note.
checksum	M	1	Not specified	Checksum of the on-boarded VNF Package.
vnfd	M	1	Vnfd	VNFD contained in the on-boarded VNF Package.
softwareImage	M	1..N	VnfPackageSoftwareImageInformation	Information about VNF Package artifacts that are software images.
additionalArtifact	M	0..N	VnfPackageArtifactInformation	Information about VNF Package artifacts contained in the VNF Package that are not software images.
operationalState	M	1	OperationState: Enum {Enabled, Disabled}	Operational state of the on-boarded instance of the VNF Package.
usageState	M	1	UsageState: Enum {InUse, NotInUse}	Usage state of the on-boarded instance of the VNF Package.
deletionPending	M	1	Boolean	Indicates if deletion of this instance of the VNF Package has been requested but the VNF Package is still being used by created VNFs. This instance of the VNF Package will be deleted once all VNFs instantiated from this package are deleted.
userDefinedData	O	0..N	KeyValuePair	User defined data for the VNF Package.
NOTE: This identifier, which is managed by the VNF provider, identifies the VNF Package and the VNFD in a globally unique way. See ETSI GS NFV-IFA 011 [3], clause 7.1.2.2. This information is copied from the VNFD of the on-boarded VNF Package.				

8.2.3 Vnfd information element

8.2.3.1 Description

This information element provides the details of the VNFD.

8.2.3.2 Attributes

The structure of the Vnfd information element shall comply with the provisions for the Vnfd information element as defined in ETSI GS NFV-IFA 011 [3], clause 7.1.2.

8.2.4 VnfPackageOnBoardingNotification

8.2.4.1 Description

This notification indicates the on-boarding of a VNF Package. Support of this notification is mandatory.

8.2.4.2 Trigger Conditions

- New VNF Package on-boarded.

8.2.4.3 Attributes

The VnfPackageOnBoardingNotification shall follow the indications provided in table 8.2.4.3-1.

Table 8.2.4.3-1: Attributes of the VnfPackageOnBoardingNotification

Attribute	Qualifier	Cardinality	Content	Description
onboardedVnfPackageInfoId	M	1	Identifier	Identifier of information held by the NFVO about the specific on-boarded VNF Package. This identifier was allocated by the NFVO.
vnfdId	M	1	Identifier	Identifier that identifies the VNF Package (see note).
NOTE: This identifier, which is managed by the VNF provider, identifies the VNF Package and the VNFD in a globally unique way. See ETSI GS NFV-IFA 011 [3], clause 7.1.2.2. This information is copied from the VNFD of the on-boarded VNF Package.				

8.2.5 VnfPackageChangeNotification

8.2.5.1 Description

This notification indicates a change of status in a VNF Package. Only changes in operational state and deletion pending attribute will be reported. Change in usage state is not reported.

Support of this notification is mandatory.

8.2.5.2 Trigger Conditions

- Change of the status (operational state and deletion pending) of an on-boarded VNF Package.
- Deletion of an on-boarded VNF Package.

8.2.5.3 Attributes

The VnfPackageChangeNotification shall follow the indications provided in table 8.2.5.3-1.

Table 8.2.5.3-1: Attributes of the VnfPackageChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
onboardedVnfPkgInfoId	M	1	Identifier	Identifier of information held by the NFVO about the specific on-boarded VNF Package. This identifier was allocated by the NFVO.
vnfdId	M	1	Identifier	Identifier that identifies the VNF Package (see note).
changeType	M	1	Enum	It categorizes the type of change. Possible values can be change of operational state of an on-boarded VNF Package, entering or leaving the deletion pending state, and deletion of a VNF Package.
operationalState	M	0..1	OperationalState: Enum {Enabled, Disabled}	New operational state of the VNF Package. Only present when changeType is change of operational state.
deletionPending	M	0..1	Boolean	Indicates if the deletion instance of the VNF Package has been requested but the VNF Package is still being used by instantiated VNFs. Only present when changeType is VNF Package in deletion pending.
NOTE: This identifier, which is managed by the VNF provider, identifies the VNF Package and the VNFD in a globally unique way. See ETSI GS NFV-IFA 011 [3], clause 7.1.2.2. This information is copied from the VNFD of the on-boarded VNF Package.				

8.2.6 VnfPackageSoftwareImageInformation information element

8.2.6.1 Description

This information element represents an artifact contained in a VNF Package which represents a Software Image.

8.2.6.2 Attributes

The VnfPackageSoftwareImageInformation information element shall follow the indications provided in table 8.2.6.2-1.

Table 8.2.6.2-1: Attributes of the VnfPackageSoftwareImageInformation information element

Attribute	Qualifier	Cardinality	Content	Description
softwareImageInformation	M	1	SoftwareImageInformation	Information on the software image(s). Refer to clause 8.2.7.
accessInformation	M	1	Not specified	Information (such as a URL, a path in the VNF Package, or an identifier) that allows to access a copy of this software image artifact. Definition of the format is left to protocol design.

8.2.7 SoftwareImageInformation information element

8.2.7.1 Description

This information element represents Software Image Information.

NOTE: The definition below is aligned with the definition of the SoftwareImageInformation information element in ETSI GS NFV-IFA 005 [i.4].

8.2.7.2 Attributes

The SoftwareImageInformation information element shall follow the indications provided in table 8.2.7.2-1.

Table 8.2.7.2-1: Attributes of the SoftwareImageInformation information element

Attribute	Qualifier	Cardinality	Content	Description
softwareImageId	M	1	Identifier	The identifier of this software image.
name	M	1	Not specified	The name of this software image.
provider	M	1	Not specified	The provider of this software image.
version	M	1	Not specified	The version of this software image.
checksum	M	1	Not specified	The checksum of the software image file.
containerFormat	M	1	Not specified	The container format indicates whether the software image is in a file format that also contains metadata about the actual software.
diskFormat	M	1	Not specified	The disk format of a software image is the format of the underlying disk image.
createdAt	M	1	Not specified	The time when this software image was created.
minDisk	M	1	Not specified	The minimal Disk for this software image.
minRam	M	1	Not specified	The minimal RAM for this software image.
size	M	1	Not specified	The size of this software image.
userMetadata	M	0..N	KeyValuePair	User-defined metadata.

8.2.8 VnfPackageArtifactInformation information element

8.2.8.1 Description

This information element represents an artifact other than a Software Image which is contained in the VNF Package.

8.2.8.2 Attributes

The VnfPackageArtifactInformation information element shall follow the indications provided in table 8.2.8.2-1.

Table 8.2.8.2-1: Attributes of the VnfPackageArtifactInformation information element

Attribute	Qualifier	Cardinality	Content	Description
selector	M	1	Not specified	Information (such as a path) that identifies/addresses this artifact in the VNF Package. Definition of the format is left to protocol design.
metadata	M	1	Not specified	The metadata of the artifact that are available in the VNF Package, such as Content type, size, creation date, etc.

8.2.9 Void

8.3 Information elements related to VNF Lifecycle Operation Granting

8.3.1 Introduction

This clause defines information elements related to VNF Lifecycle Operation Granting.

8.3.2 ResourceDefinition information element

8.3.2.1 Description

This information element provides information of an existing or proposed resource used by the VNF.

8.3.2.2 Attributes

The ResourceDefinition information element shall follow the indications provided in table 8.3.2.2-1.

Table 8.3.2.2-1: Attributes of the ResourceDefinition information element

Attribute	Qualifier	Cardinality	Content	Description
resourceDefinitionId	M	1	Identifier	Identifier of this ResourceDefinition information element, unique at least within the scope of the grant request.
type	M	1	Enum	Type of the resource definition referenced (e.g. Compute, VL, LinkPort, Storage, etc.).
vduId	M	0..1	Identifier (Reference to Vdu)	Reference to the related Vdu applicable to this resource in the VNFD. Shall only be present if a VDU is applicable to this resource in the VNFD.
resourceTemplateId	M	0..1	Identifier (Reference to VnfVirtualLinkDesc, VirtualComputeDesc, VnfExtCpd or VirtualStorageDesc)	Reference to a resource template (VnfVirtualLinkDesc, VirtualComputeDesc, VnfExtCpd, VirtualStorageDesc) in the VNFD. Shall be present for the planned creation of new resources, including temporary resources, and for the modification of existing resources. Shall be absent otherwise.
resourceHandle	M	0..1	ResourceHandle	Resource information for an existing resource. Shall be present for resources that are planned to be deleted or modified. Shall be absent otherwise.

8.3.3 GrantInfo information element

8.3.3.1 Description

This information element contains information about a Compute, storage or network resource whose addition/update/deletion was granted in a GrantVnfLifecycleOperationResponse.

8.3.3.2 Attributes

The GrantInfo information element shall follow the indications provided in table 8.3.3.2-1.

Table 8.3.3.2-1: Attributes of the GrantInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceDefinitionId	M	1	Identifier (Reference to ResourceDefinition)	Identifier of the related ResourceDefinition information element from the grant request.
reservationId	M	0..1	Identifier (Reference to ReservedVirtualCompute, ReservedVirtualNetwork or ReservedVirtualStorage)	The reservation identifier applicable to the VNFC/VirtualLink/VirtualStorage. It shall be present for new resources when policy is GRANT_RESERVE_MULTI and an applicable reservation exists; shall not be present otherwise.

Attribute	Qualifier	Cardinality	Content	Description
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Reference to the identifier of the VimConnectionInfo information element defining the VIM connection to be used to manage this resource. Shall be present for new resources, and shall be absent for resources that have already been allocated. This attribute shall be supported when VNF-related Resource Management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifies the entity responsible for the management of the virtualised resource. Shall be present for new resources, and shall be absent for resources that have already been allocated. This attribute shall be supported when VNF-related Resource Management in indirect mode is applicable.
zoneId	M	0..1	Identifier (Reference to ZoneInfo)	Reference to the identifier of the ZoneInfo information element defining the resource zone into which this resource is to be placed. Shall be present for new resources, and shall be absent for resources that have already been allocated.
resourceGroupId	M	0..1	Identifier	Identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain, to be provided when allocating the resource. If the VIM connection referenced by "vimConnectionId" applies to multiple infrastructure resource groups, this attribute shall be present for new resources. If the VIM connection referenced by "vimConnectionId" applies to a single infrastructure resource group, this attribute may be present for new resources. This attribute shall be absent for resources that have already been allocated.

8.3.4 ZoneInfo information element

8.3.4.1 Description

This information element provides information regarding a resource zone.

8.3.4.2 Attributes

The ZoneInfo information element shall follow the indications provided in table 8.3.4.2-1.

Table 8.3.4.2-1: Attributes of the ZoneInfo information element

Attribute	Qualifier	Cardinality	Content	Description
zoneInfoId	M	1	Identifier	The identifier of this ZoneInfo instance, for the purpose of referencing it from other information elements.
zoneId	M	1	Identifier	The identifier of the resource zone, as managed by the resource management layer (typically, the VIM).
vimConnectionId	CM	1	Identifier (Reference to VimConnectionInfo)	The identifier of the connection to the VIM that manages the resource zone. This attribute shall be supported when VNF-related Resource Management in direct mode is applicable.
resourceProviderId	CM	1	Identifier	Identifies the entity responsible for the management the resource zone. This attribute shall be supported when VNF-related Resource Management in indirect mode is applicable.

8.3.5 ZoneGroupInfo information element

8.3.5.1 Description

This information element provides information regarding a resource zone group. A resource zone group is a group of one or more related resource zones which can be used in resource placement constraints. To fulfil such constraint, the NFVO may decide to place a resource into any zone that belongs to a particular group.

NOTE: A resource zone group can be used to support overflow from one resource zone into another, in case a particular deployment supports only non-elastic resource zones.

8.3.5.2 Attributes

The ZoneGroupInfo information element shall follow the indications provided in table 8.3.5.2-1.

Table 8.3.5.2-1: Attributes of the ZoneGroupInfo information element

Attribute	Qualifier	Cardinality	Content	Description
zoneId	M	1..N	Identifier (Reference to ZoneInfo)	References of identifiers of ZoneInfo instances, each of which provides information about a resource zone that belongs to this group.

8.3.6 PlacementConstraint information element

8.3.6.1 Description

This information element provides information regarding a resource placement constraint. A set of such constraints may be sent by the VNFM to the NFVO to influence the resource placement decisions made by the NFVO as part of the granting process. A placement constraint defines a condition to the placement of new resources, considering other new resources as well as existing resources.

EXAMPLE: The following rules influence the placement of a set of resources such that they are placed in the same Network Function Virtualisation Infrastructure Point of Presence (NFVI-PoP) but in different resource zones:

```
{type="affinity"; scope="NFVI-PoP"; {resource1,resource2}}
{type="anti-affinity"; scope="Zone"; {resource1,resource2}}
```

8.3.6.2 Attributes

The PlacementConstraint information element shall follow the indications provided in table 8.3.6.2-1.

Table 8.3.6.2-1: Attributes of the PlacementConstraint information element

Attribute	Qualifier	Cardinality	Content	Description
affinityOrAntiAffinity	M	1	Enum	The type of the constraint: "affinity" or "anti-affinity".
scope	M	1	Enum	The scope of the placement constraint indicating the category of the "place" where the constraint applies. Possible values are "NFVI-PoP", "Zone", "ZoneGroup", "NFVI-node".
resource	M	1..N	ConstraintResourceRef	References to resources in the constraint rule.

8.3.7 VimConstraint information element

8.3.7.1 Description

This information element provides information regarding a VIM selection constraint. A set of such constraints may be sent by the VNFM to the NFVO to influence the VIM selection decisions made by the NFVO as part of the granting process.

8.3.7.2 Attributes

The VimConstraint information element shall follow the indications provided in table 8.3.7.2-1.

Table 8.3.7.2-1: Attributes of the VimConstraint information element

Attribute	Qualifier	Cardinality	Content	Description
sameResourceGroup	M	0..1	Boolean	If present and set to true, this signals that the constraint applies not only to the same VIM connection, but also to the same infrastructure resource group.
resource	M	1..N	ConstraintResourceRef	References to resources in the constraint rule. The NFVO shall ensure that all resources in this list are managed through the same VIM connection. If "sameResourceGroup" is set to true, the NFVO shall further ensure that all resources in this list are part of the same infrastructure resource group in that VIM connection.

8.3.8 ConstraintResourceRef information element

8.3.8.1 Description

This information element references a resource either by its VIM-level identifier for existing resources, or by the identifier of a resourceDefinition information element in the grant request for new resources.

8.3.8.2 Attributes

The ConstraintResourceRef information element shall follow the indications provided in table 8.3.8.2-1.

Table 8.3.8.2-1: Attributes of the ConstraintResourceRef information element

Attribute	Qualifier	Cardinality	Content	Description
idType	M	1	Enum	The type of the identifier: "ResMgmt" (Resource-management-level identifier; this identifier is managed by the VIM in direct mode and is managed by the NFVO in indirect mode) or "Grant" (reference to identifier in the ResourceDefinition in the grant request).
resourceId	M	1	Identifier	An actual resource-management-level identifier (idType=ResMgmt), or an identifier that references the ResourceDefinition in the related grant request (idType=Grant).
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Identifier of the VIM Connection. It shall only be present when idType = ResMgmt. It shall be supported when VNF-related resource management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifier of the resource provider. It shall only be present when idType = ResMgmt. It shall be supported when VNF-related resource management in indirect mode is applicable.

8.3.9 VimAssets information element

8.3.9.1 Description

This information element contains references to the asset which are defined in VNFD and managed in the VIM by the NFVO, such as compute resource flavours and/or software images.

8.3.9.2 Attributes

The VimAssets information element shall follow the indications provided in table 8.3.9.2-1.

Table 8.3.9.2-1: Attributes of the VimAssets information element

Attribute	Qualifier	Cardinality	Content	Description
computeResourceFlavour	M	0..N	VimComputeResourceFlavour	Mappings between virtual compute descriptors defined in the VNFD and compute resource flavours managed in the VIM.
softwareImage	M	0..N	VimSoftwareImage	Mappings between software images defined in the VNFD and software images managed in the VIM.

8.3.10 VimComputeResourceFlavour information element

8.3.10.1 Description

If the VIM requires the use of virtual compute resource flavours during compute resource instantiation, it is assumed that such flavours are selected or created by the NFVO based on the information in the VirtualComputeDesc information elements defined in the VNFD.

This information element defines the mapping between a VirtualComputeDesc in the VNFD and the corresponding compute resource flavour managed by the NFVO in the VIM.

8.3.10.2 Attributes

The VimComputeResourceFlavour information element shall follow the indications provided in table 8.3.10.2-1.

Table 8.3.10.2-1: Attributes of the VimComputeResourceFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Identifier of the VIM connection to access the flavour referenced in this information element. Shall be supported and present if VNF-related resource management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifies the entity responsible for the management of the virtualised resource. Shall be supported and present if VNF-related resource management in indirect mode is applicable.
vnfdVirtualComputeDescId	M	1	Identifier (Reference to VirtualComputeDesc)	Identifier which references the VirtualComputeDesc in the VNFD that maps to this flavour.
vimFlavourId	M	1	Identifier	Identifier of the compute resource flavour in the resource management layer (i.e. VIM).

8.3.11 VimSoftwareImage information element

8.3.11.1 Description

This information element contains a mapping between a software image definition the VNFD and the corresponding software image managed by the NFVO in the VIM which is needed during compute resource instantiation.

8.3.11.2 Attributes

The VimSoftwareImage information element shall follow the indications provided in table 8.3.11.2-1.

Table 8.3.11.2-1: Attributes of the VimSoftwareImage information element

Attribute	Qualifier	Cardinality	Content	Description
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Identifier of the VIM connection to access the software image referenced in this information element. Shall be supported and present if VNF-related resource management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifier used by NFVO to determine the entity responsible for the management of the VIM asset. Shall be supported and present if VNF-related resource management in indirect mode is applicable.
vnfdSoftwareImageId	M	1	Identifier (Reference to SwImageDesc)	Identifier of the software image descriptor in the VNFD.
vimSoftwareImageId	M	1	Identifier	Identifier of the software image in the resource management layer (i.e. VIM).

8.4 Information elements and notifications related to Virtualised Resources Management in indirect mode

8.4.1 Introduction

This clause defines information elements related to Virtualised Resources Management. These information elements shall be supported when VNF-related resource management in indirect mode is applicable.

8.4.2 Information elements related to Virtualised Compute

8.4.2.1 Introduction

The clauses below define information elements related to the management of virtualised compute resources and virtualised compute resources information.

8.4.2.2 ComputeResourceWithRpInfo information element

8.4.2.2.1 Description

The ComputeResourceWithRpInfo information element encapsulates data of an instantiated virtualised compute resource in indirect mode.

8.4.2.2.2 Attributes

The ComputeResourceWithRpInfo information element shall comply with the provisions in clause 8.4.3.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.2.2.2-1. All attributes of the VirtualCompute are also attributes of the ComputeResourceWithRpInfo.

Table 8.4.2.2.2-1: Attributes of the ComputeResourceWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, computeId].
(inherited attributes)				All attributes inherited from VirtualCompute.

8.4.2.3 ComputeResourceWithRpId information element

8.4.2.3.1 Description

This information element defines the identity of a virtualised compute resource in indirect mode.

8.4.2.3.2 Attributes

The ComputeResourceWithRpId information element shall follow the indications provided in table 8.4.2.3.2-1.

Table 8.4.2.3.2-1: Attributes of the ComputeResourceWithRpId information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, computeId].
computeId	M	1	Identifier	Identifier of the compute resource within the VIM.

8.4.2.4 VirtualComputeResourceWithRpInfo information element

8.4.2.4.1 Description

The VirtualComputeResourceWithRpInfo information element defines the characteristics of a consumable virtualised compute resources in indirect mode.

8.4.2.4.2 Attributes

The VirtualComputeResourceWithRpInfo information element shall comply with the provisions in clause 8.3.3.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.2.4.2-1. All attributes of the VirtualComputeResourceInformation are also attributes of the VirtualComputeResourceWithRpInfo.

Table 8.4.2.4.2-1: Attributes of the VirtualComputeResourceWithRpInfo information element.

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the consumable virtualised resource and is used by the VNFM to uniquely identify consumable compute type resources by means of the tuple [resourceProviderId, computeResourceTypeId].
(inherited attributes)				All attributes inherited from VirtualComputeResourceInformation.

8.4.3 Information elements related to Virtualised Network

8.4.3.1 Introduction

The clauses below define information elements related to the management of virtualised network resources and virtualised network resources information.

8.4.3.2 NetworkResourceWithRpInfo information element

8.4.3.2.1 Description

The NetworkResourceWithRpInfo information element encapsulates data of an instantiated virtualised network resource in indirect mode.

8.4.3.2.2 Attributes

The NetworkResourceWithRpInfo information element shall comply with the provisions in clause 8.4.5.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.3.2.2-1. All attributes of the VirtualNetwork are also attributes of the NetworkResourceWithRpInfo.

Table 8.4.3.2.2-1: Attributes of the NetworkResourceWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, networkResourceId].
(inherited attributes)				All attributes inherited from VirtualNetwork.

8.4.3.3 NetworkResourceWithRpId information element

8.4.3.3.1 Description

This information element defines the identity of a virtualised network resource in indirect mode.

8.4.3.3.2 Attributes

The NetworkResourceWithRpId information element shall follow the indications provided in table 8.4.3.3.2-1.

Table 8.4.3.3.2-1: Attributes of the NetworkResourceWithRpId information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, networkResourceId].
networkResourceId	M	1	Identifier	Identifier of the network resource within the VIM.

8.4.3.4 VirtualNetworkResourceWithRpInfo information element

8.4.3.4.1 Description

The VirtualNetworkResourceWithRpInfo information element defines the characteristics of a consumable virtualised network resource in indirect mode.

8.4.3.4.2 Attributes

The VirtualNetworkResourceWithRpInfo information element shall comply with the provisions in clause 8.3.5 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.3.4.2-1. All attributes of the VirtualNetworkResourceInformation are also attributes of the VirtualNetworkResourceWithRpInfo.

Table 8.4.3.4.2-1: Attributes of the VirtualNetworkResourceWithRpInfo information element.

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the consumable virtualised resource and is used by the VNFM to uniquely identify consumable network type resources by means of the tuple [resourceProviderId, networkResourceTypeId].
(inherited attributes)				All attributes inherited from VirtualNetworkResourceInformation.

8.4.4 Information elements related to Virtualised Storage

8.4.4.1 Introduction

The clauses below define information elements related to the management of virtualised storage resources and virtualised storage resources information.

8.4.4.2 StorageResourceWithRpInfo information element

8.4.4.2.1 Description

The StorageResourceWithRpInfo information element encapsulates data of an instantiated virtualised storage resource.

8.4.4.2.2 Attributes

The StorageResourceWithRpInfo information element shall comply with the provisions in clause 8.4.7.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.4.2.2-1. All attributes of the VirtualStorage are also attributes of the StorageResourceWithRpInfo.

Table 8.4.4.2.2-1: Attributes of the StorageResourceWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, storageId].
(inherited attributes)				All attributes inherited from StorageResourceWithRpInfo.

8.4.4.3 StorageResourceWithRpId information element

8.4.4.3.1 Description

This information element defines the identity of a virtualised storage resource in indirect mode.

8.4.4.3.2 Attributes

The StorageResourceWithRpId information element shall follow the indications provided in table 8.4.4.3.2-1.

Table 8.4.4.3.2-1: Attributes of the StorageResourceWithRpId information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, storageId].
storageId	M	1	Identifier	Identifier of the storage resource within the VIM.

8.4.4.4 VirtualStorageResourceWithRpInfo information element

8.4.4.4.1 Description

The VirtualStorageResourceWithRpInfo information element defines the characteristics of a consumable virtualised storage resource in indirect mode.

8.4.4.4.2 Attributes

The VirtualStorageResourceWithRpInfo information element shall comply with the provisions in clause 8.3.4 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.4.4.2-1. All attributes of the VirtualStorageResourceInformation are also attributes of the VirtualStorageResourceWithRpInfo.

Table 8.4.4.4.2-1: Attributes of the VirtualStorageResourceWithRpInfo information element.

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the consumable virtualised resource and is used by the VNFM to uniquely identify consumable storage type resources by means of the tuple [resourceProviderId, storageResourceTypeId].
(inherited attributes)				All attributes inherited from VirtualStorageResourceInformation.

8.4.5 Notifications related to changes of virtualised resources

8.4.5.1 Introduction

The clauses below define notifications related to changes of virtualised resources.

8.4.5.2 VirtualisedResourceWithRpChangeNotification

8.4.5.2.1 Description

This notification informs the receiver of changes in the virtualised resources that are allocated and is applicable in the indirect mode of VNF-related resource reservation management.

Support of this notification is mandatory.

8.4.5.2.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the VirtualisedResourceChangeNotification in clause 8.4.9 of ETSI GS NFV-IFA 006 [1].

8.4.5.2.3 Attributes

The VirtualisedResourceWithRpChangeNotification shall comply with the indications in clause 8.4.9 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.5.2.3-1. All attributes of the VirtualisedResourceChangeNotification are also attributes of the VirtualisedResourceWithRpChangeNotification.

Table 8.4.5.2.3-1: Attributes of the VirtualisedResourceWithRpChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the change notification and is used by the VNFM to uniquely identify the resource by means of the tuple [resourceProviderId, resourceTypeId].
(inherited attributes)				All attributes inherited from VirtualisedResourceChangeNotification.

8.4.5.3 InformationWithRpChangeNotification

8.4.5.3.1 Description

This notification informs the receiver that information related to consumable virtualised resources is changed and is applicable in the indirect mode.

Support of this notification is mandatory.

8.4.5.3.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the InformationChangeNotification in clause 8.3.2 of ETSI GS NFV-IFA 006 [1].

8.4.5.3.3 Attributes

The InformationWithRpChangeNotification shall comply with the indications in clause 8.3.2 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.5.3.3-1. All attributes of the InformationChangeNotification are also attributes of the InformationWithRpChangeNotification.

Table 8.4.5.3.3-1: Attributes of the InformationWithRpChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the change notification and is used by the VNFM to uniquely identify the consumable resource by means of the tuple [resourceProviderId, resourceTypeId].
(inherited attributes)				All attributes inherited from InformationChangeNotification.

8.4.6 Notifications related to Virtualised Resource Performance Management

8.4.6.1 Introduction

The clauses below define notifications related of virtualised resource performance management.

8.4.6.2 PerformanceInformationWithRpAvailableNotification

8.4.6.2.1 Description

This notification informs the receiver that performance information is available and is applicable in the indirect mode of VNF-related resource reservation management.

Support of this notification is mandatory.

8.4.6.2.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the PerformanceInformationAvailableNotification in clause 8.5.8 of ETSI GS NFV-IFA 006 [1].

8.4.6.2.3 Attributes

The PerformanceInformationWithRpAvailableNotification shall comply with the indications in clause 8.5.8 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.6.2.3-1. All attributes of the PerformanceInformationAvailableNotification are also attributes of the PerformanceInformationWithRpAvailableNotification.

Table 8.4.6.2.3-1: Attributes of the PerformanceInformationWithRpAvailableNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the resources and is used by the VNFM to uniquely identify the resources for which information is available by means of the tuple [resourceProviderId, objectInstanceId].
(inherited attributes)				All attributes inherited from PerformanceInformationAvailableNotification.

8.4.6.3 ThresholdCrossedWithRpNotification

8.4.6.3.1 Description

This notification informs the receiver that a threshold value has been crossed and is applicable in the indirect mode of VNF-related resource reservation management.

Support of this notification is mandatory.

8.4.6.3.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the PerformanceInformationAvailableNotification in clause 8.5.9 of ETSI GS NFV-IFA 006 [1].

8.4.6.3.3 Attributes

The ThresholdCrossedWithRpNotification shall comply with the indications in clause 8.5.9 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.6.3.3-1. All attributes of the ThresholdCrossedNotification are also attributes of the ThresholdCrossedWithRpNotification.

Table 8.4.6.3.3-1: Attributes of the ThresholdCrossedWithRpNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the resources and is used by the VNFM to uniquely identify the resources for which the threshold is crossed by means of the tuple [resourceProviderId, objectInstanceId].
(inherited attributes)				All attributes inherited from ThresholdCrossedNotification.

8.4.7 Information elements and notifications related to Virtualised Resource Fault Management

8.4.7.1 Introduction

The clauses below define notifications related to virtualised resources fault management.

8.4.7.2 AlarmWithRpInfo information element

8.4.7.2.1 Description

The AlarmWithRpInfo information element encapsulates data of a virtualised resource alarm in indirect mode.

8.4.7.2.2 Attributes

The AlarmWithRpInfo information element shall comply with the provisions in clause 8.6.4 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.7.2.2-1. All attributes of the Alarm are also attributes of the AlarmWithRpInfo.

Table 8.4.7.2.2-1: Attributes of the AlarmWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for issuing the alarm, and is used by the VNFM to uniquely identify resources by means of the tuple [resourceProviderId, managedObjectId].
(inherited attributes)				All attributes inherited from Alarm.

8.4.7.3 AlarmWithRpNotification

8.4.7.3.1 Description

This notification encapsulates information on an alarm and is applicable in the indirect mode of VNF-related resource reservation management.

Support of this notification is mandatory.

8.4.7.3.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the AlarmNotification in clause 8.6.2 of ETSI GS NFV-IFA 006 [1].

8.4.7.3.3 Attributes

The AlarmWithRpNotification shall comply with the indications in clause 8.6.2 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.7.3.3-1. All attributes of the AlarmNotification are also attributes of the AlarmWithRpNotification.

Table 8.4.7.3.3-1: Attributes of the AlarmWithRpNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the alarm and is used by the VNFM to uniquely identify the alarm by means of the tuple [resourceProviderId, alarmId].
(inherited attributes)				All attributes inherited from AlarmNotification.

8.4.7.4 AlarmClearedWithRpNotification

8.4.7.4.1 Description

This notification encapsulates information on a cleared alarm and is applicable in the indirect mode of VNF-related resource reservation management.

Support of this notification is mandatory.

8.4.7.4.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the AlarmClearedNotification in clause 8.6.3 of ETSI GS NFV-IFA 006 [1].

8.4.7.4.3 Attributes

The AlarmClearedWithRpNotification shall comply with the indications in clause 8.6.3 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.7.4.3-1. All attributes of the AlarmClearedNotification are also attributes of the AlarmClearedWithRpNotification.

Table 8.4.7.4.3-1: Attributes of the AlarmClearedWithRpNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the alarm and is used by the VNFM to uniquely identify the alarm by means of the tuple [resourceProviderId, alarmId].
(inherited attributes)				All attributes inherited from AlarmClearedNotification.

8.4.8 Information elements and notifications related to Virtualised Resources Quota

8.4.8.1 Introduction

The clauses below define information elements and notifications related to the management of virtualised resources quota.

8.4.8.2 VirtualComputeQuotaWithRpInfo information element

8.4.8.2.1 Description

The VirtualComputeQuotaWithRpInfo information element encapsulates information about a quota for virtualised compute resources.

8.4.8.2.2 Attributes

The VirtualComputeQuotaWithRpInfo information element shall comply with the provisions in clause 8.8.2.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.8.2.2-1. All attributes of the VirtualComputeQuota are also attributes of the VirtualComputeQuotaWithRpInfo.

Table 8.4.8.2.2-1: Attributes of the VirtualComputeQuotaWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by the NFVO to determine the entity responsible for the management of the virtualised resources quota and is used by the VNFM to uniquely identify resources quota by means of the tuple [resourceProviderId, resourceGroupId].
(inherited attributes)				All attributes inherited from VirtualComputeQuota.

8.4.8.3 VirtualNetworkQuotaWithRpInfo information element

8.4.8.3.1 Description

The VirtualNetworkQuotaWithRpInfo information element encapsulates information about a quota for virtualised network resources.

8.4.8.3.2 Attributes

The VirtualNetworkQuotaWithRpInfo information element shall comply with the provisions in clause 8.8.3.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.8.3.2-1. All attributes of the VirtualNetworkQuota are also attributes of the VirtualNetworkQuotaWithRpInfo.

Table 8.4.8.3.2-1: Attributes of the VirtualNetworkQuotaWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by the NFVO to determine the entity responsible for the management of the virtualised resources quota and is used by the VNFM to uniquely identify resources quota by means of the tuple [resourceProviderId, resourceGroupId].
(inherited attributes)				All attributes inherited from VirtualNetworkQuota.

8.4.8.4 VirtualStorageQuotaWithRpInfo information element

8.4.8.4.1 Description

The VirtualStorageQuotaWithRpInfo information element encapsulates information about a quota for virtualised storage resources.

8.4.8.4.2 Attributes

The VirtualStorageQuotaWithRpInfo information element shall comply with the provisions in clause 8.8.4.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.8.4.2-1. All attributes of the VirtualStorageQuota are also attributes of the VirtualStorageQuotaWithRpInfo.

Table 8.4.8.4.2-1: Attributes of the VirtualStorageQuotaWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by the NFVO to determine the entity responsible for the management of the virtualised resources quota and is used by the VNFM to uniquely identify resources quota by means of the tuple [resourceProviderId, resourceGroupId].
(inherited attributes)				All attributes inherited from VirtualStorageQuota.

8.4.8.5 VirtualisedResourceQuotaWithRpChangeNotification

8.4.8.5.1 Description

This notification indicates a change in a virtualised resource quota and is applicable in the indirect mode of resource quota management. Support of this notification is mandatory.

8.4.8.5.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the VirtualisedResourceQuotaChangeNotification in clause 8.8.5.2 of ETSI GS NFV-IFA 006 [1].

8.4.8.5.3 Attributes

The VirtualisedResourceQuotaWithRpChangeNotification shall comply with the provisions in clause 8.8.5 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.8.5.3-1. All attributes of the VirtualisedResourceQuotaChangeNotification are also attributes of the VirtualisedResourceQuotaWithRpChangeNotification.

Table 8.4.8.5.3-1: Attributes of the VirtualisedResourceQuotaWithRpChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the change notification and is used by the VNFM to uniquely identify the resource quota by means of the tuple [resourceProviderId, resourceTypeId].
(inherited attributes)				All attributes inherited from VirtualisedResourceQuotaChangeNotification.

8.4.9 Information elements and notifications related to Virtualised Resources Reservation

8.4.9.1 Introduction

The clauses below define information elements and notifications related to the management of virtualised resources reservations.

8.4.9.2 ReservedVirtualComputeWithRpInfo information element

8.4.9.2.1 Description

The ReservedVirtualComputeWithRpInfo information element encapsulates information about a reservation for virtualised compute resources.

8.4.9.2.2 Attributes

The ReservedVirtualComputeWithRpInfo information element shall comply with the provisions in clause 8.7.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.9.2.2-1. All attributes of the ReservedVirtualCompute are also attributes of the ReservedVirtualComputeWithRpInfo.

Table 8.4.9.2.2-1: Attributes of the ReservedVirtualComputeWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources reservation by means of the tuple [resourceProviderId, reservationId].
(inherited attributes)				All attributes inherited from ReservedVirtualCompute.

8.4.9.3 ReservedVirtualNetworkWithRpInfo information element

8.4.9.3.1 Description

The ReservedVirtualNetworkWithRpInfo information element encapsulates information about a reservation for virtualised network resources.

8.4.9.3.2 Attributes

The ReservedVirtualNetworkWithRpInfo information element shall comply with the provisions in clause 8.7.4.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.9.3.2-1. All attributes of the ReservedVirtualNetwork are also attributes of the ReservedVirtualNetworkWithRpInfo.

Table 8.4.9.3.2-1: Attributes of the ReservedVirtualNetworkWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources reservation by means of the tuple [resourceProviderId, reservationId].
(inherited attributes)				All attributes inherited from ReservedVirtualNetwork.

8.4.9.4 ReservedVirtualStorageWithRpInfo information element

8.4.9.4.1 Description

The ReservedVirtualStorageWithRpInfo information element encapsulates information about a reservation for virtualised storage resources.

8.4.9.4.2 Attributes

The ReservedVirtualStorageWithRpInfo information element shall comply with the provisions in clause 8.7.6.2 of ETSI GS NFV-IFA 006 [1] with additional attributes provided in table 8.4.9.4.2-1. All attributes of the ReservedVirtualStorage are also attributes of the ReservedVirtualStorageWithRpInfo.

Table 8.4.9.4.2-1: Attributes of the ReservedVirtualStorageWithRpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the management of the Virtualised resource and is used by the VNFM to uniquely identify resources reservation by means of the tuple [resourceProviderId, reservationId].
(inherited attributes)				All attributes inherited from ReservedVirtualStorage.

8.4.9.5 VirtualisedResourceReservationWithRpChangeNotification

8.4.9.5.1 Description

This notification indicates a change in a virtualised resource reservation and is applicable in the indirect mode of VNF-related resource reservation management.

Support of this notification is mandatory.

8.4.9.5.2 Trigger conditions

This notification is triggered with the same trigger conditions applicable to the VirtualisedResourceReservationChangeNotification in clause 8.7.7.2 of ETSI GS NFV-IFA 006 [1].

8.4.9.5.3 Attributes

The VirtualisedResourceReservationWithRpChangeNotification shall comply with the provisions in clause 8.7.7 of ETSI GS NFV-IFA 006 [1] with additional attributes of the notification according to table 8.4.9.5.3-1. All attributes of the VirtualisedResourceReservationChangeNotification are also attributes of the VirtualisedResourceReservationWithRpChangeNotification.

Table 8.4.9.5.3-1: Attributes of the VirtualisedResourceReservationWithRpChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceProviderId	M	1	Identifier	It is used by NFVO to determine the entity responsible for the change notification and is used by the VNFM to uniquely identify the resource reservation by means of the tuple [resourceProviderId, reservationId].
(inherited attributes)				All attributes inherited from VirtualisedResourceReservationChangeNotification.

8.5 Information elements related to VNF Lifecycle Management

8.5.1 Introduction

This clause defines information elements related to VNF Lifecycle Management.

8.5.2 VnfInfo information element

8.5.2.1 Description

The VnfInfo information element provides run-time information about a VNF instance.

NOTE: In ETSI GS NFV-MAN 001 [i.7], the concept of the VNF record (VNFR) was introduced which is a model for the totality of information managed by the VNFM regarding a running VNF instance. VNFR is not used in the present document.

8.5.2.2 Attributes

The VnfInfo information element shall follow the indications provided in table 8.5.2.2-1.

Table 8.5.2.2-1: Attributes of the VnfInfo information element

Attribute	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance that is represented by this VnfInfo information element.
vnfInstanceName	M	0..1	String	VNF instance name. See note 1.
vnfInstanceDescription	M	0..1	String	Human-readable description of the VNF instance. See note 1.
vnfdId	M	1	Identifier	Identifier of the VNFD on which the VNF instance is based. See note 2 and note 3.
vnfProvider	M	1	String	See note 3.
vnfProductName	M	1	String	See note 3.
vnfSoftwareVersion	M	1	Version	See note 3.
vnfdVersion	M	1	Version	See note 3.
onboardedVnfPkgInfoId	M	1	Identifier	Identifier of information held by the NFVO about the specific VNF Package on which the VNF is based. This identifier was allocated by the NFVO. See notes 1 and 4.
vnfConfigurableProperty	M	0..N	KeyValuePair	Current values of the configurable properties of the VNF instance. Configurable properties referred in this attribute are declared in the VNFD (see clause 7.1.12 in ETSI GS NFV-IFA 011 [3]). They include those set as initial configuration, and/or those that modify a running configuration. See note 1 and note 5.
vimConnectionInfo	CM	0..N	VimConnectionInfo	Information about VIM connection(s) for managing resources for the VNF instance. Shall be supported and present if VNF-related resource management in direct mode is applicable. See note 1.
instantiationState	M	1	Enum	The instantiation state of the VNF instance. Possible values: NOT_INSTANTIATED (VNF instance is terminated or not instantiated, and the identifier of the VNF instance exists), INSTANTIATED (VNF instance is instantiated).

Attribute	Qualifier	Cardinality	Content	Description
instantiatedVnfInfo	M	0..1	InstantiatedVnfInfo	Information specific to an instantiated VNF instance. Shall be present if the VNF is in INSTANTIATED instantiation state.
metadata	M	0..N	KeyValuePair	Additional VNF-specific metadata describing the VNF instance. Metadata that are writeable are declared in the VNFD (see clause 7.1.14.2 in ETSI GS NFV-IFA 011 [3]). See note 1.
extension	M	0..N	KeyValuePair	VNF-specific attributes that affect the lifecycle management of this VNF instance by the VNFM, or the lifecycle management scripts. Extensions that are writeable are declared in the VNFD (see clause 7.1.14.2 in ETSI GS NFV-IFA 011 [3]). See note 1.

NOTE 1: This attribute in the VnfInfo shall be writable through the Modify VNF information operation (refer to clause 7.2.12).
NOTE 2: This identifier, which is managed by the VNF provider, identifies the VNF Package and the VNFD in a globally unique way.
NOTE 3: See ETSI GS NFV-IFA 011 [3], clause 7.1.2.2. This information is copied from the VNFD of the on-boarded VNF Package which was used to instantiate the VNF instance.
NOTE 4: Modifying the value of this attribute can be performed when no conflicts exist between the previous and the newly referred VNF Package, e.g. when the new VNFD is not changed with respect to the previous VNFD apart from referencing to other VNF software image(s). In order to avoid misalignment of the VnfInfo with the current VNF's on-boarded VNF Package, the values copied from the VNFD of the on-boarded VNF Package (see note 3) need to be kept in sync.
NOTE 5: VNF configurable properties are sometimes also referred to as configuration parameters applicable to a VNF. Some of these are set prior to instantiation and cannot be modified if the VNF is instantiated, some are set prior to instantiation (are part of initial configuration) and can be modified later, and others can be set only after instantiation. The applicability of certain configuration may depend on the VNF and the required operation of the VNF at a certain point in time.

8.5.3 InstantiatedVnfInfo information element

8.5.3.1 Description

This information element provides run-time information specific to an instantiated VNF instance.

Annex A provides examples illustrating the relationship among the different run-time information elements (CP, VL and link ports) used to represent the connectivity of a VNF.

8.5.3.2 Attributes

The InstantiatedVnfInfo information element shall follow the indications provided in table 8.5.3.2-1.

Table 8.5.3.2-1: Attributes of the InstantiatedVnfInfo information element

Attribute	Qualifier	Cardinality	Content	Description
flavourId	M	1	Identifier (Reference to VnfDf)	Identifier of the VNF DF applied to this VNF instance. See note 1.
vnfState	M	1	Enum	The state of the VNF instance. Permitted values include: STARTED, STOPPED.
scaleStatus	M	0..N	ScaleInfo	Scale status of the VNF, one entry per aspect. Shall be present if the VNF supports scaling. Represents for every scaling aspect how "big" the VNF has been scaled w.r.t. that aspect. See note 2.
extCpInfo	M	1..N	VnfExtCpInfo	External CPs exposed by the VNF instance.
extVirtualLinkInfo	M	0..N	ExtVirtualLinkInfo	External VLs the VNF instance is connected to.

Attribute	Qualifier	Cardinality	Content	Description
extManagedVirtualLinkInfo	M	0..N	ExtManagedVirtualLinkInfo	Externally-managed internal VLs of the VNF instance.
monitoringParameter	M	0..N	Not specified	Performance metrics tracked by VNFM (e.g. for auto-scaling purposes) and their current (as known to the VNFM) values. See note 3.
localizationLanguage	M	0..1	Not specified	Information about localization language of the VNF (includes e.g. strings in the VNFD). The localization languages supported by a VNF can be declared in the VNFD, and localization language selection can take place at instantiation time.
vnfcResourceInfo	M	0..N	VnfcResourceInfo	Information on the virtualised compute and storage resource(s) used by the VNFCs of the VNF instance.
vnfVirtualLinkResourceInfo	M	0..N	VnfVirtualLinkResourceInfo	Information on the virtualised network resource(s) used by the VLs of the VNF instance.
virtualStorageResourceInfo	M	0..N	VirtualStorageResourceInfo	Information on the virtualised storage resource(s) used as storage for the VNF instance.

NOTE 1: The VnfDf information element is defined in ETSI GS NFV-IFA 011 [3], clause 7.1.8.2.
NOTE 2: For every scaling aspect, together with the information provided by the "maxScaleLevel" attribute of the "ScalingAspect" information element in the VNFD, this allows an external entity to derive how many scaling steps are possible for scaling in or scaling out a VNF instance. Per aspect, the number of steps possible to scale in corresponds to the "scaleLevel" attribute for that aspect in the "scaleStatus" information element, and the possible number of steps to scale out corresponds to the difference between "maxScaleLevel" for that aspect, and the "scaleLevel" attribute for that aspect in the "scaleStatus" information element.
NOTE 3: The monitoring parameters to be tracked by VNFM are identified by VNF provider in the VNFD. The VNFM collects the values of identified performance metrics using one or more locally initiated PM Jobs.

8.5.4 VnfcResourceInfo information element

8.5.4.1 Description

This information element provides information on virtualised compute and storage resources used by a VNFC in a VNF instance.

8.5.4.2 Attributes

The VnfcResourceInfo information element shall follow the indications provided in table 8.5.4.2-1.

Table 8.5.4.2-1: Attributes of the VnfcResourceInfo information element

Attribute	Qualifier	Cardinality	Content	Description
vnfcInstanceId	M	1	Identifier	Identifier of this VNFC instance.
vduId	M	1	Identifier (Reference to Vdu)	Reference to the applicable Vdu information element in the VNFD.
computeResource	M	1	ResourceHandle	Reference to the VirtualCompute resource. Detailed information about the resource is available from the Virtualised Compute Resource Management interface.
storageResourceId	M	0..N	Identifier (Reference to VirtualStorageResourceInfo)	Reference(s) to the VirtualStorage resource(s). Information about the resource(s) is available from the Virtualised Storage Resource Management interface.
reservationId	M	0..1	Identifier	The reservation identifier applicable to the resource. It shall be present when an applicable reservation exists.
metadata	M	0..N	KeyValuePair	Metadata about this resource.
vnfcCpInfo	M	0..N	VnfcCpInfo	CP(s) of the VNFC instance. Shall be present when that particular CP of the VNFC instance is associated to an external CP of the VNF instance. May be present otherwise.

8.5.5 VnfVirtualLinkResourceInfo information element

8.5.5.1 Description

This information element provides information on virtualised network resources used by an internal VL instance in a VNF.

8.5.5.2 Attributes

The VnfVirtualLinkResourceInfo information element shall follow the indications provided in table 8.5.5.2-1.

Table 8.5.5.2-1: Attributes of the VnfVirtualLinkResourceInfo information element

Attribute	Qualifier	Cardinality	Content	Description
virtualLinkInstanceId	M	1	Identifier	Identifier of this VL instance.
vnfVirtualLinkDescId	M	1	Identifier (Reference to VnfVirtualLinkDesc)	Identifier of the VNF Virtual Link Descriptor (VLD) in the VNFD.
networkResource	M	1	ResourceHandle	Reference to the VirtualNetwork resource. Information about the resource is available from the Virtualised Network Resource Management interface.
reservationId	M	0..1	Identifier	The reservation identifier applicable to the resource. It shall be present when an applicable reservation exists.
metadata	M	0..N	KeyValuePair	Metadata about this resource.
vnfLinkPort	M	0..N	VnfLinkPort	Links ports of this VL. Shall be present when the linkPort is used for external connectivity by the VNF (refer to VnfLinkPort in clause 8.5.11). May be present otherwise.

8.5.6 VirtualStorageResourceInfo information element

8.5.6.1 Description

This information element provides information on virtualised storage resources used by a storage instance in a VNF.

8.5.6.2 Attributes

The VirtualStorageResourceInfo information element shall follow the indications provided in table 8.5.6.2-1.

Table 8.5.6.2-1: Attributes of the VirtualStorageResourceInfo information element

Attribute	Qualifier	Cardinality	Content	Description
virtualStorageInstanceId	M	1	Identifier	Identifier of this virtual storage resource instance.
virtualStorageDescId	M	1	Identifier (Reference to VirtualStorageDesc)	Identifier of the VirtualStorageDesc in the VNFD.
storageResource	M	1	ResourceHandle	Reference to the VirtualStorage resource. Information about the resource is available from the Virtualised Storage Resource Management interface.
reservationId	M	0..1	Identifier	The reservation identifier applicable to the resource. It shall be present when an applicable reservation exists.
metadata	M	0..N	KeyValuePair	Metadata about this resource.

8.5.7 ResourceHandle information element

8.5.7.1 Description

This information element provides information that allows addressing a resource that is used by a VNF instance.

Information about the resource is available from the corresponding Virtualised Compute/Storage/Network Resource Management interfaces. Table 8.5.7.1-1 shows the relationship between the resourceId attribute of ResourceHandle specified in the present document and the resource identifiers used in the aforementioned interfaces specified in ETSI GS NFV-IFA 005 [i.4] and ETSI GS NFV-IFA 006 [1].

Table 8.5.7.1-1: Relationship between resource identifiers

Attribute in Or-Vnfm ref. point	Type, Interface, information element and attribute in ETSI GS NFV-IFA 005 [i.4] and ETSI GS NFV-IFA 006 [1]		
	Type	Interface	Information element and attribute
ResourceHandle:resourceId	Compute	Virtualised Compute Resource Management	VirtualCompute:computeId
	Storage	Virtualised Storage Resource Management	VirtualStorage:storageId
	Network	Virtualised Network Resource Management	VirtualNetwork:networkResourceId

8.5.7.2 Attributes

The ResourceHandle information element shall follow the indications provided in table 8.5.7.2-1.

Table 8.5.7.2-1: Attributes of the ResourceHandle information element

Attribute	Qualifier	Cardinality	Content	Description
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Reference to the identifier of the VimConnectionInfo information element defining the VIM Connection to manage this resource. This attribute shall be supported when VNF-related Resource Management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifies the entity responsible for the management of the virtualised resource. This attribute shall be supported when VNF-related Resource Management in indirect mode is applicable.
resourceId	M	1	Identifier	Identifier of the resource in the scope of the VIM or the resource provider.
vimLevelResourceType	M	0..1	Not specified	Type of the resource in the scope of the VIM or the resource provider. See note.
NOTE: The value set of the "vimLevelResourceType" attribute is within the scope of the VIM or the resource provider and can be used as information that complements the ResourceHandle. This value set is different from the value set of the "type" attribute in the ResourceDefinition (refer to clause 8.3.2).				

8.5.8 ScaleInfo information element

8.5.8.1 Description

This information element provides information about the scale level of a VNF instance w.r.t. one scaling aspect.

8.5.8.2 Attributes

The ScaleInfo information element shall follow the indications provided in table 8.5.8.2-1.

Table 8.5.8.2-1: Attributes of the ScaleInfo information element

Attribute	Qualifier	Cardinality	Content	Description
aspectId	M	1	Identifier (Reference to ScalingAspect)	Reference to the scaling aspect.
scaleLevel	M	1	Integer	The scale level for that aspect. Minimum value 0, maximum value maxScaleLevel as declared in the VNFD (see ETSI GS NFV-IFA 011 [3], clause 7.1.10.2.2).

8.5.9 ExtVirtualLinkInfo information element

8.5.9.1 Description

This information element provides a reference to an external VL.

8.5.9.2 Attributes

The ExtVirtualLinkInfo information element shall follow the indications provided in table 8.5.9.2-1.

Table 8.5.9.2-1: Attributes of the ExtVirtualLinkInfo information element

Attribute	Qualifier	Cardinality	Content	Description
extVirtualLinkId	M	1	Identifier	Identifier of this external VL.
resourceHandle	M	1	ResourceHandle	Reference to the resource realizing this VL.
linkPort	M	0..N	ExtLinkPort	Link ports of this VL.

8.5.10 ExtManagedVirtualLinkInfo information element

8.5.10.1 Description

This information element provides a reference to an externally-managed internal VL.

8.5.10.2 Attributes

The ExtManagedVirtualLinkInfo information element shall follow the indications provided in table 8.5.10.2-1.

Table 8.5.10.2-1: Attributes of the ExtManagedVirtualLinkInfo information element

Attribute	Qualifier	Cardinality	Content	Description
extManagedVirtualLinkId	M	1	Identifier	Identifier of this externally-managed internal VL.
vnfVirtualLinkDescId	M	1	Identifier (Reference to VnfVirtualLinkDesc)	Identifier of the VNF Virtual Link Descriptor (VLD) in the VNFD.
networkResource	M	1	ResourceHandle	Reference to the VirtualNetwork resource.
vnfLinkPort	M	0..N	VnfLinkPort	Link ports of this VL.

8.5.11 VnfLinkPort information element

8.5.11.1 Description

This information element provides information about a port of a VNF's internal VL. See also VnfVirtualLinkResourceInfo in clause 8.5.5.

8.5.11.2 Attributes

The attributes of the VnfLinkPort information element shall follow the indications provided in table 8.5.11.2-1.

Table 8.5.11.2-1: Attributes of the VnfLinkPort information element

Attribute	Qualifier	Cardinality	Content	Description
vnfLinkPortId	M	1	Identifier	Identifier of this link port as provided by the entity that has created the link port.
resourceHandle	M	1	ResourceHandle	Reference to the virtualised network resource realizing this link port.
cpInstanceId	M	0..1	Identifier (Reference to VnfExtCpInfo or VnfcCpInfo)	External CP of the VNF to be connected to this link port. Shall be present when the link port is used for external connectivity by the VNF. May be present if used to reference a VNFC CP. See note.
NOTE: There shall be at most one link port associated with any external connection point instance or internal connection point (i.e. VNFC CP) instance.				

8.5.12 VnfExtCpInfo information element

8.5.12.1 Description

This information element provides information related to an external CP.

8.5.12.2 Attributes

The VnfExtCpInfo information element shall follow the indications provided in table 8.5.12.2-1.

Table 8.5.12.2-1: Attributes of the VnfExtCpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
cpInstanceId	M	1	Identifier	Identifier of this external CP instance and of this VnfExtCpInfo information element.
cpdId	M	1	Identifier (Reference to VnfExtCpd)	Identifier of the external Connection Point Descriptor (CPD), VnfExtCpd, in the VNFD.
address	M	0..N	Not specified	List of network addresses that have been configured (statically or dynamically) on the CP.

8.5.13 ExtLinkPort information element

8.5.13.1 Description

This information element provides information about a port of an external VL, i.e. a port providing connectivity for the VNF to an NS VL.

8.5.13.2 Attributes

The attributes of the ExtLinkPort information element shall follow the indications provided in table 8.5.13.2-1.

Table 8.5.13.2-1: Attributes of the ExtLinkPort information element

Attribute	Qualifier	Cardinality	Content	Description
extLinkPortId	M	1	Identifier	Identifier of this link port as provided by the entity that has created the link port.
resourceHandle	M	1	ResourceHandle	Reference to the virtualised network resource realizing this link port.
cpInstanceId	M	0..1	Identifier (Reference to VnfExtCpInfo)	External CP of the VNF to be connected to this link port. See note.
NOTE: There shall be at most one link port associated with any external connection point instance.				

8.5.14 VnfcCpInfo information element

8.5.14.1 Description

This information element provides information related to a CP of a VNFC.

8.5.14.2 Attributes

The VnfcCpInfo information element shall follow the indications provided in table 8.5.14.2-1.

Table 8.5.14.2-1: Attributes of the VnfcCpInfo information element

Attribute	Qualifier	Cardinality	Content	Description
cpInstanceId	M	1	Identifier	Identifier of this VnfcCpInfo information element.
cpdId	M	1	Identifier (Reference to VduCpd)	Identifier of the VDU CPD, cpdId, in the VNFD.
vnfExtCpId	M	0..1	Identifier (Reference to VnfExtCpInfo)	When the VNFC CP is exposed as external CP of the VNF, the identifier of this external VNF CP.
address	M	0..N	Not specified.	List of network addresses that have been configured (statically or dynamically) on the CP.

8.6 Information elements and notifications related to VNF Lifecycle Changes

8.6.1 Introduction

This clause defines notifications related to VNF lifecycle changes and update of VNF information.

8.6.2 VnfLcmOperationOccurrenceNotification

8.6.2.1 Description

This notification informs the receiver of changes in the VNF lifecycle caused by VNF lifecycle management operation occurrences. The support of the notification is mandatory.

8.6.2.2 Trigger conditions

This notification is produced when there is a change in the VNF lifecycle caused by a VNF lifecycle management operation occurrence, including:

- Instantiation of the VNF.
- Scaling of the VNF instance (including auto-scaling).
- Healing of the VNF instance (including auto-healing).
- Change of the state of the VNF instance (i.e. Operate VNF).
- Change of the DF of the VNF instance.
- Changing the external connectivity of the VNF instance.
- Termination of the VNF instance.
- Modification of VNF instance information and/or VNF configurable properties explicitly through Modify VNF Information operation.

If this is a notification about the start of an LCM operation occurrence, the notification shall be sent before any action (including sending the grant request) is taken, however, after acknowledging the LCM operation request to the consumer.

If this is a notification about the result of an LCM operation, the notification shall be sent after all other actions of the LCM operation have been executed.

8.6.2.3 Attributes

The VnfLcmOperationOccurrenceNotification shall follow the indications provided in table 8.6.2.3-1.

Table 8.6.2.3-1: Attributes of the VnfLcmOperationOccurrenceNotification

Attribute	Qualifier	Cardinality	Content	Description
status	M	1	Enum	Indicates whether this notification reports about the start of a lifecycle management operation occurrence or the result of a lifecycle management operation occurrence.
vnfInstanceId	M	1	Identifier	The identifier of the VNF instance affected.
operation	M	1	String	The lifecycle management operation.
isAutomaticInvocation	M	1	Boolean	Set to true if this VNF LCM operation occurrence has been triggered by an automated procedure inside the VNFM (i.e. ScaleVnf/ScaleVnfToLevel triggered by auto-scale, or HealVnf triggered by auto-heal). Set to false otherwise.
lifecycleOperationOccurrenceId	M	1	Identifier	The identifier of the VNF lifecycle management operation occurrence associated to the notification.
affectedVnfc	M	0..N	AffectedVnfc	Information about VNFC instances that were affected during the execution of the lifecycle management operation, if this notification represents the result of a lifecycle management operation occurrence.
affectedVirtualLink	M	0..N	AffectedVirtualLink	Information about VL instances that were affected during the execution of the lifecycle management operation, if this notification represents the result of a lifecycle management operation occurrence.
affectedVirtualStorage	M	0..N	AffectedVirtualStorage	Information about virtualised storage instances that were affected during the execution of the lifecycle management operation, if this notification represents the result of a lifecycle management operation occurrence.
changedInfo	M	0..1	Not specified	Information about the changed VNF information, including changed VNF configurable properties, if this notification represents the result of a lifecycle management operation occurrence.
changedExtConnectivity	M	0..N	ExtVirtualLinkInfo	Information about changed external connectivity, if this notification represents the result of a lifecycle management operation occurrence. Only relevant for the "Change External VNF Connectivity" operation.
NOTE: If this notification represents the result of a lifecycle management operation occurrence that was not successful, the notification shall contain appropriate error information.				

8.6.3 AffectedVnfc information element

8.6.3.1 Description

This information element provides information about added, deleted modified and temporary VNFCs.

8.6.3.2 Attributes

The AffectedVnfc information element shall follow the indications provided in table 8.6.3.2-1.

Table 8.6.3.2-1: Attributes of the AffectedVnfc information element

Attribute	Qualifier	Cardinality	Content	Description
vnfcInstanceId	M	1	Identifier (Reference to VnfcResourceInfo)	Identifier of the VNFC instance.
vduId	M	1	Identifier (Reference to Vdu)	Identifier of the VDU in the VNFD.
changeType	M	1	Enum	Signals the type of change (added, removed, modified, temporary). For a temporary resource, an AffectedVnfc IE exists as long as the temporary resource exists.
computeResource	M	1	ResourceHandle	Reference to the VirtualCompute resource. Detailed information is (for new and modified resources) or has been (for removed resources) available from the Virtualised Compute Resource Management interface.
addedStorageResourceIds	M	0..N	Identifier	Reference(s) to VirtualStorage resource(s) that were added. Each value refers to a VirtualStorageResourceInfo item in the VnfInfo that was added to the VNFC. It shall be provided if at least one storage resource was added to the VNFC.
removedStorageResourceIds	M	0..N	Identifier	Reference(s) to VirtualStorage resource(s) that were removed. The value contains the identifier of a VirtualStorageResourceInfo item that has been removed from the VNFC, and might no longer exist in the VnfInfo. It shall be provided if at least one storage resource was removed from the VNFC.

8.6.4 AffectedVirtualLink information element

8.6.4.1 Description

This information element provides information about added, deleted, modified and temporary VLs, as well as about link port changes.

8.6.4.2 Attributes

The AffectedVirtualLink information element shall follow the indications provided in table 8.6.4.2-1.

Table 8.6.4.2-1: Attributes of the AffectedVirtualLink information element

Attribute	Qualifier	Cardinality	Content	Description
virtualLinkInstanceId	M	1	Identifier (Reference to VirtualLinkResourceInfo)	Identifier of the VL instance.
virtualLinkDescId	M	1	Identifier (Reference to VnfVirtualLinkDesc)	Identifier of the VLD in the VNFD.
changeType	M	1	Enum	Signals the type of change including, not limited to, changes made to the characteristics of the existing VL, new VL added, existing VL removed, temporary VL exists, link port added, link port removed. For a temporary resource, an AffectedVirtualLink IE exists as long as the temporary resource exists.
networkResource	M	1	ResourceHandle	Reference to the VirtualNetwork resource. Detailed information is (for new and modified resources) or has been (for removed resources) available from the Virtualised Network Resource Management interface.

8.6.5 AffectedVirtualStorage information element

8.6.5.1 Description

This information element provides information about added, deleted, modified and temporary virtual storage resources.

8.6.5.2 Attributes

The AffectedVirtualStorage information element shall follow the indications provided in table 8.6.5.2-1.

Table 8.6.5.2-1: Attributes of the AffectedVirtualStorage information element

Attribute	Qualifier	Cardinality	Content	Description
virtualStorageInstanceId	M	1	Identifier (Reference to VirtualStorageResourceInfo)	Identifier of the virtual storage instance.
virtualStorageDescId	M	1	Identifier (Reference to VirtualStorageDesc)	Identifier of the VirtualStorageDesc in the VNFD.
changeType	M	1	Enum	Signals the type of change (added, removed, modified, temporary). For a temporary resource, an AffectedVirtualStorage IE exists as long as the temporary resource exists.
storageResource	M	1	ResourceHandle	Reference to the VirtualStorage resource. Detailed information is (for new and modified resources) or has been (for removed resources) available from the Virtualised Storage Resource Management interface.

8.6.6 Void

8.6.7 VnfIdentifierCreationNotification

8.6.7.1 Description

This notification informs the receiver of the creation of a new VNF instance identifier and the associated instance of a VnfInfo information element, identified by that identifier. The support of the notification is mandatory.

8.6.7.2 Trigger conditions

- Creation of a VNF instance identifier and the associated instance of a VnfInfo information element.

8.6.7.3 Attributes

The VnfIdentifierCreationNotification shall follow the indications provided in table 8.6.7.3-1.

Table 8.6.7.3-1: Attributes of the VnfIdentifierCreationNotification

Attribute	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	The newly created VNF instance identifier.

8.6.8 VnfIdentifierDeletionNotification

8.6.8.1 Description

This notification informs the receiver of the deletion of a VNF instance identifier and the associated instance of a VnfInfo information element identified by that identifier. The support of the notification is mandatory.

8.6.8.2 Trigger conditions

- Deletion of a VNF instance identifier and the associated instance of a VnfInfo information element.

8.6.8.3 Attributes

The VnfIdentifierDeletionNotification shall follow the indications provided in table 8.6.8.3-1.

Table 8.6.8.3-1: Attributes of the VnfIdentifierDeletionNotification

Attribute	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	The VNF instance identifier that has been deleted.

8.7 Information elements and notifications related to VNF Performance Management

8.7.1 Introduction

This clause defines information elements and notifications related to VNF Performance Management.

8.7.2 ObjectSelection information element

8.7.2.1 Description

This information element allows to specify VNF instances on which performance information will be provided.

The ObjectSelection is a pattern to select object instances. The pattern is used in multiple interfaces. In the present interface, the ObjectSelection pattern is used to select VNF instances.

The pattern proposes 2 exclusive options:

1) Provide a list of object types and a filter to specify object properties.

2) Provide a list of object instances.

In the present interface, the object type will be VNF (represented by VNFD), and the filter will be based on some VNF properties.

8.7.2.2 Attributes

The ObjectSelection information element shall follow the indications provided in table 8.7.2.2-1.

Table 8.7.2.2-1: Attributes of the ObjectSelection information element

Attribute	Qualifier	Cardinality	Content	Description
objectType	M	0..N	String	Defines the object types. The object types for this information element will be the VNFDs. One of the two attributes (objectType + objectFilter or objectInstanceId) shall be present.
objectFilter	M	0..1	Filter	The filter will apply on the object types to specify on which object instances the performance information is requested to be collected. One of the two attributes (objectType + objectFilter or objectInstanceId) shall be present.
objectInstanceId	M	0..N	Identifier	Identifies the object instances for which performance information is requested to be collected. The object instances for this information element will be VNF instances. One of the two attributes (objectType+ objectFilter or objectInstanceId) shall be present.

8.7.3 PmJob information element

8.7.3.1 Description

This information element provides the details of the PM Job. The object instances for this information element will be VNF instances.

8.7.3.2 Attributes

The PmJob information element shall follow the indications provided in table 8.7.3.2-1.

Table 8.7.3.2-1: Attributes of the PmJob information element

Attribute	Qualifier	Cardinality	Content	Description
pmJobId	M	1	Identifier	Identifier of this PM job.
objectSelector	M	1	ObjectSelection	Defines the object instances for which performance information is requested to be collected. The object instances for this information element will be VNF instances.

Attribute	Qualifier	Cardinality	Content	Description
performanceMetric	M	0..N	String	This defines the type(s) of performance metric(s) for the specified object instances. At least one of the two attributes (performance metric or group) shall be present.
performanceMetricGroup	M	0..N	String	Group of performance metrics. A metric group is a pre-defined list of metrics, known to the producer that it can decompose to individual metrics. At least one of the two attributes (performance metric or group) shall be present.
collectionPeriod	M	1	Enum	Specifies the periodicity at which the producer will collect performance information (see note).
reportingPeriod	M	1	Enum	Specifies the periodicity at which the producer will report to the consumer about performance information (see note).
reportingBoundary	O	0..1	Not specified	Identifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE: At the end of each reportingPeriod, the producer will inform the consumer about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reportingPeriod is left for further specification, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

8.7.4 Threshold information element

8.7.4.1 Description

This information element provides the details of a threshold. The object instances for this information element will be VNF instances.

8.7.4.2 Attributes

The Threshold information element shall follow the indications provided in table 8.7.4.2-1.

Table 8.7.4.2-1: Attributes of the Threshold information element

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier	Identifier of this Threshold information element.
objectSelector	M	1	ObjectSelection	Defines the object instances associated with the threshold. The object instances for this information element will be VNF instances.
performanceMetric	M	1	String	Defines the performance metric associated with the threshold.
thresholdType	M	1	Enum	Type of threshold. The list of possible values is left for the protocol design stage and might include: single/ multi valued threshold, static/dynamic threshold, template based threshold, etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, details on the notification to be generated, etc.

8.7.5 PerformanceReport information element

8.7.5.1 Description

This information element defines the format of a performance report provided by the producer to the consumer on a specified object instance or a set of them. The object instances for this information element will be VNF instances.

8.7.5.2 Attributes

The PerformanceReport information element shall follow the indications provided in table 8.7.5.2-1.

Table 8.7.5.2-1: Attributes of the PerformanceReport information element

Attribute	Qualifier	Cardinality	Content	Description
performanceReport	M	1..N	PerformanceReportEntry	List of performance information entries.

8.7.6 PerformanceReportEntry information element

8.7.6.1 Description

This information element defines a single performance report entry. This performance report entry is for a given metric of a given object instance, but can include multiple collected values. The object instances for this information element will be VNF instances.

8.7.6.2 Attributes

The PerformanceReportEntry information element shall follow the indications provided in table 8.7.6.2-1.

Table 8.7.6.2-1: Attributes of the PerformanceReportEntry information element

Attribute	Qualifier	Cardinality	Content	Description
objectType	M	1	String	Defines the object type. The object types for this information element will be the VNFDs.
objectInstanceId	M	1	Identifier	The object instance for which the performance metric is reported. The object instances for this information element will be VNF instances.
performanceMetric	M	1	String	Name of the metric collected.
performanceValue	M	1..N	PerformanceValueEntry	List of performance values with associated timestamp.

8.7.7 PerformanceValueEntry information element

8.7.7.1 Description

This information element defines a single performance value with its associated time stamp.

8.7.7.2 Attributes

Table 8.7.7.2-1 lists the attributes of the PerformanceValueEntry information element.

Table 8.7.7.2-1: Attributes of the PerformanceValueEntry information element

Attribute	Qualifier	Cardinality	Content	Description
timeStamp	M	1	DateTime	Timestamp indicating when the data was collected.
performanceValue	M	1	Value	Value of the metric collected.

8.7.8 PerformanceInformationAvailableNotification

8.7.8.1 Description

This notification informs the receiver that performance information is available. Delivery mechanism for the performance reports is left for later specification. The object instances for this information element will be VNF instances.

8.7.8.2 Trigger Conditions

- New performance information is available.

8.7.8.3 Attributes

The PerformanceInformationAvailableNotification shall follow the indications provided in table 8.7.8.3-1.

Table 8.7.8.3-1: Attributes of the PerformanceInformationAvailableNotification

Attribute	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1..N	Identifier	Object instance(s) for which performance information is available. The object instances for this information element will be VNF instances.

8.7.9 ThresholdCrossedNotification

8.7.9.1 Description

This notification informs the receiver that a threshold value has been crossed. The object instances for this information element will be VNF instances.

8.7.9.2 Trigger Condition

A Threshold has been crossed. Depending on threshold type, there might be a single or multiple crossing values.

8.7.9.3 Attributes

The ThresholdCrossedNotification shall follow the indications provided in table 8.7.9.3-1.

Table 8.7.9.3-1: Attributes of the ThresholdCrossedNotification

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier (Reference to Threshold)	Threshold which has been crossed.
crossingDirection	M	1	Enum	An indication of whether the threshold was crossed in upward or downward direction. Values: UP, DOWN.
objectInstanceId	M	1	Identifier	Object instance for which the threshold has been crossed. The object instances for this information element will be VNF instances.
performanceMetric	M	1	String	Performance metric associated with the threshold.
performanceValue	M	1	Value	Value of the metric that resulted in threshold crossing.

8.8 Information elements and notifications related to VNF Fault Management

8.8.1 Introduction

This clause defines information elements and notifications related to VNF Fault Management.

8.8.2 AlarmNotification

8.8.2.1 Description

This notification informs the receiver of alarms related to the VNFs managed by the VNFM. Alarms are created in response to:

- faults detected by the VNFM; and
- faults generated due to changes in the state of virtualised resources used by the VNF instances managed by the VNFM.

The notification is mandatory.

8.8.2.2 Trigger conditions

- An alarm has been created.
- An alarm has been updated, e.g. if the severity of the alarm has changed.

8.8.2.3 Attributes

The AlarmNotification shall follow the indications provided in table 8.8.2.3-1.

Table 8.8.2.3-1: Attributes of the AlarmNotification

Attribute	Qualifier	Cardinality	Content	Description
alarm	M	1	Alarm	Information about an alarm including AlarmId, affected VNF identifier, and FaultDetails. For notifications related to changes in the state of virtualised resources (indicated using the attribute faultType), the alarm shall indicate: • The cause for the state change of the virtualised resource using the attribute probableCause, with possible values such as: maintenance of NFVI component, evacuation of NFVI component, etc. • The identifier of the origin (VIM) responsible for the management of the virtualised resource with state change using the attribute faultDetails.

8.8.3 AlarmClearedNotification

8.8.3.1 Description

This notification informs the receiver of the clearing of an alarm related to the VNFs managed by the VNFM, e.g. the alarm's perceived severity is set to "cleared" since the corresponding fault has been solved. The notification is mandatory.

8.8.3.2 Trigger conditions

- An alarm has been cleared.

8.8.3.3 Attributes

The AlarmClearedNotification shall follow the indications provided in table 8.8.3.3-1.

Table 8.8.3.3-1: Attributes of the AlarmClearedNotification

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier (Reference to Alarm)	Alarm identifier.
alarmClearedTime	M	1	DateTime	The timestamp indicating when the alarm was cleared.

8.8.4 Alarm information element

8.8.4.1 Description

The Alarm information element encapsulates information about an alarm.

The Managed Objects for this information element will be VNF instances.

8.8.4.2 Attributes

The Alarm information element shall follow the indications provided in table 8.8.4.2-1.

Table 8.8.4.2-1: Attributes of the Alarm information element

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier	Identifier of this Alarm information element.
managedObjectId	M	1	Identifier	Identifier of the affected managed object. The managed objects for this information element will be VNF instances.
rootCauseFaultyResource	M	1	FaultyResourceInfo	The virtualised resources that are causing the VNF fault.
alarmRaisedTime	M	1	DateTime	Timestamp indicating when the alarm is raised by the managed object.
alarmChangedTime	M	0..1	DateTime	Timestamp indicating when the alarm was last changed. It shall be present if the alarm has been updated.
alarmClearedTime	M	0..1	DateTime	Timestamp indicating when the alarm was cleared. It shall be present if the alarm has been cleared.
ackState	M	1	Enum	State of the alarm, permitted values include: • Acknowledged. • Unacknowledged.
perceivedSeverity	M	1	Enum	Perceived severity of the managed object failure, legal values: • Critical. • Major. • Minor. • Warning. • Indeterminate. • Cleared.
eventTime	M	1	DateTime	Timestamp indicating when the fault was observed.
eventType	M	1	Enum	Type of the event. The allowed values for the eventType attribute use the event type defined in Recommendation ITU-T X.733 [4]: • Communication Alarm. • Processing Alarm. • Environment Alarm. • QoS Alarm. • Equipment Alarm.
faultType	M	0..1	String	Additional information related to the type of the fault.
probableCause	M	1	String	Information about the probable cause of the fault.
isRootCause	M	1	Boolean	Attribute indicating if this fault is the root for other correlated alarms. If TRUE, then the alarms listed in the attribute CorrelatedAlarmId are caused by this fault.
correlatedAlarmId	M	0..N	Identifier (Reference to Alarm)	List of identifiers of other alarms correlated to this fault.
faultDetails	M	0..N	Not specified	Provides additional information about the fault.

8.8.5 FaultyResourceInfo information element

8.8.5.1 Description

The FaultyResourceInfo information element encapsulates information about faulty resource that has a negative impact on a VNF.

8.8.5.2 Attributes

The FaultyResourceInfo information element shall follow the indications provided in table 8.8.5.2-1.

Table 8.8.5.2-1: Attributes of the FaultyResourceInfo information element

Attribute	Qualifier	Cardinality	Content	Description
faultyResource	M	1	ResourceHandle	Information that identifies the faulty resource instance and its managing entity. See clause 8.5.7.
faultyResourceType	M	1	Enum	Type of the faulty resource. Values: • COMPUTE. • STORAGE. • NETWORK.

8.8.6 AlarmListRebuiltNotification

8.8.6.1 Description

This notification informs the receiver that the active alarm list has been rebuilt by the VNFM. Upon receipt of this notification, the receiver needs to use the "Get Alarm List" operation to synchronize its view on current active alarms with that of the VNFM.

The notification is mandatory.

8.8.6.2 Trigger conditions

- Active alarm list has been rebuilt by the VNFM, e.g. if the VNFM detects its storage holding the alarm list is corrupted.

8.8.6.3 Attributes

The AlarmListRebuiltNotification does not contain any attributes.

8.9 Void

8.10 Information elements and notifications related to VNF Indicators

8.10.1 Introduction

The clauses below define information elements which represent indicator values, and notifications about changes of these.

8.10.2 IndicatorValueChangeNotification

8.10.2.1 Description

This notification informs the receiver of a value change of an indicator related to the VNF. The notification is mandatory.

8.10.2.2 Trigger conditions

- The value of an indicator has changed.

8.10.2.3 Attributes

The IndicatorValueChangeNotification information element shall follow the indications provided in table 8.10.2.3-1.

Table 8.10.2.3-1: Attributes of the IndicatorValueChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
indicatorInformation	M	1	IndicatorInformation	This is to provide the indicator, the value of the indicator and the VNF instance the indicator is related to.

8.10.3 IndicatorInformation information element

8.10.3.1 Description

This information element provides the indicator values of a VNF instance.

8.10.3.2 Attributes

The IndicatorInformation information element shall follow the indications provided in table 8.10.3.2-1.

Table 8.10.3.2-1: Attributes of the IndicatorInformation

Attribute	Qualifier	Cardinality	Content	Description
vnfInstanceId	M	1	Identifier	Identifier of the VNF instance which provides the indicator value(s).
indicatorId	M	1	Identifier (Reference to VnfIndicator)	Identifies the indicator.
indicatorValue	M	1	Value	Provides the value of the indicator. The value format is defined in the VNFD (see ETSI GS NFV-IFA 011 [3]).
indicatorName	M	0..1	String	Human readable name of the indicator. Shall be present if defined in the VNFD.

8.11 Notifications related to Virtualised Resources Quota

8.11.1 Introduction

This clause defines notifications related to virtualised resources quota.

8.11.2 VirtualisedResourceQuotaAvailableNotification

8.11.2.1 Description

This notification indicates the availability of a quota applicable to the consumer. Support of this notification is mandatory if the Virtualised Resources Quota Available Notification interface is supported.

8.11.2.2 Trigger Conditions

- A virtualised resources quota applicable to the consumer has been set.

8.11.2.3 Attributes

The VirtualisedResourceQuotaAvailableNotification shall follow the indications provided in table 8.11.2.3-1.

Table 8.11.2.3-1: Attributes of the VirtualisedResourceQuotaAvailableNotification

Attribute	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
vimConnectionInfo	CM	0..1	VimConnectionInfo	Information about the VIM connection to manage the virtualised resources quota. This attribute shall be supported when VNF-related Resource Management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifies the entity responsible for the management of the virtualised resources quota. This attribute shall be supported when VNF-related Resource Management in indirect mode is applicable.

8.12 Information elements and notifications related to multiple interfaces

8.12.1 Introduction

This clause defines information elements that are referenced by other information elements related to multiple interfaces.

8.12.2 ExtVirtualLinkData information element

8.12.2.1 Description

This information element provides the information of an external VL to be used as a parameter passed to multiple interfaces.

8.12.2.2 Attributes

The ExtVirtualLinkData information element shall follow the indications provided in table 8.12.2.2-1.

Table 8.12.2.2-1: Attributes of the ExtVirtualLinkData information element

Attribute	Qualifier	Cardinality	Content	Description
extVirtualLinkId	M	1	Identifier	Identifier of this external VL instance.
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Identifier of the VIM connection to manage this resource. This attribute shall be supported and present if VNF-related resource management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifies the entity responsible for the management of the resource. This attribute shall be supported and present when VNF-related Resource Management in indirect mode is applicable.
resourceId	M	1	Identifier	Identifier of the resource in the scope of the VIM or the resource provider
extCp	M	1..N	VnfExtCpData	External CPs of the VNF to be connected to this external VL.

8.12.3 VnfExtCpData information element

8.12.3.1 Description

This information element provides input information related to an external CP.

8.12.3.2 Attributes

The VnfExtCpData information element shall follow the indications provided in table 8.12.3.2-1.

Table 8.12.3.2-1: Attributes of the VnfExtCpData information element

Attribute	Qualifier	Cardinality	Content	Description
cpdId	M	1	Identifier	Identifier of the CPD in the VNFD.
fixedAddresses	M	0..N	Not specified	List of (fixed) network addresses that need to be configured on the CP. It shall be provided for configuring fixed addresses.
dynamicAddresses	M	0..N	Not specified	List of parameter sets for the assignment of dynamic addresses. It should be possible to define per parameter set the number of network addresses to be assigned dynamically. Other parameters could be, e.g. valid address ranges or subnets. It shall be provided if dynamic addresses need to be configured on the CP.

8.12.4 ExtManagedVirtualLinkData information element

8.12.4.1 Description

This information element provides the information of an externally-managed internal VL to be used as a parameter passed to multiple interfaces.

8.12.4.2 Attributes

The ExtManagedVirtualLinkData information element shall follow the indications provided in table 8.12.4.2-1.

Table 8.12.4.2-1: Attributes of the ExtManagedVirtualLinkData information element

Attribute	Qualifier	Cardinality	Content	Description
extManagedVirtualLinkId	M	1	Identifier	Identifier of this externally-managed internal VL instance.
virtualLinkDescId	M	1	Identifier (Reference to VnfVirtualLinkDesc)	Identifier of the VLD in the VNFD for this VL.
vimConnectionId	CM	0..1	Identifier (Reference to VimConnectionInfo)	Identifier of the VIM connection to manage this resource. This attribute shall be supported and present if VNF-related resource management in direct mode is applicable.
resourceProviderId	CM	0..1	Identifier	Identifies the entity responsible for the management of the resource. This attribute shall be supported and present when VNF-related Resource Management in indirect mode is applicable.
resourceId	M	1	Identifier	Identifier of the resource in the scope of the VIM or the resource provider.

8.12.5 VimConnectionInfo information element

8.12.5.1 Description

This information element provides information regarding a VIM connection.

It is assumed that during the protocol design stage, VimConnectionInfo will be specified such that it allows interfacing to different VIM types.

8.12.5.2 Attributes

The VimConnectionInfo information element shall follow the indications provided in table 8.12.5.2-1.

Table 8.12.5.2-1: Attributes of the VimConnectionInfo information element

Attribute	Qualifier	Cardinality	Content	Description
vimConnectionInfoId	M	1	Identifier	The identifier of this VimConnectionInfo information element, for the purpose of referencing it from other information elements. This identifier is managed by the NFVO.
vimId	M	0..1	Identifier	The identifier of the VIM. This identifier is managed by the NFVO. Shall be present to address additional information about the VIM if such information has been configured into the VNFM by means outside the scope of the present document, and should be absent otherwise.
interfaceInfo	M	0..N	Not specified	Information about the interface(s) to the VIM, if available, including interface endpoint e.g. URL API version, and protocol type. Alternatively, such information may have been configured into the VNFM and bound to the VimId.
accessInfo	M	0..N	Not specified	Authentication credentials for accessing the VIM. Examples can include those to support different authentication schemes, e.g. OAuth, Token, Username/password, etc. See note.
extra	M	0..N	Not specified	VIM type specific additional information, if applicable.
NOTE: If needed, this attribute also provides information about the resourceGroupIds that are accessible using a particular set of credentials.				

Annex A (informative): Examples of VNF connectivity patterns

A.1 Introduction

This annex illustrates examples of possible connectivity patterns for a VNF. The purpose is to illustrate the relationship among the different information elements specified in clause 8.5 that are used to describe the connectivity of and within a VNF instance.

The present annex A also illustrates the use of the "Change External VNF Connectivity" operation to re-connect external CPs of a VNF instance to a different external VL.

NOTE: The information related to connectivity as shown in the Annex A is to be understood in the context of the present document, i.e. availability of certain information on the Or-Vnfm reference point follows the conditions that are detailed in the respective attribute descriptions and notes in the present document.

A.2 Example of a VNF with two different types of external connections points

The present example shows a regular connectivity pattern of a VNF where the two external CPs of the VNF use different connectivity patterns. Figure A.2-1 illustrates the example, from which it is highlighted the following:

- An external CP of the VNF instance (see VnfExtCp #1) that maps to an internal CP, i.e. a CP of a specific VNFC.
- An external CP of the VNF instance (see VnfExtCp #2) that refers to a link port of an internal VL of the VNF (see VnfLinkPort #2.2).
- An internal VL of the VNF instance (see VnfVirtualLink #1) that is only used for connectivity of VNFCs within the VNF.
- An internal VL of the VNF instance (see VnfVirtualLink #2) that is used as provider of a link port for connectivity of external CPs of the VNF.
- Link ports of internal VL(s) of the VNF instance (see VnfLinkPort #1.1 to #1.3 and VnfLinkPort #2.1) that are optionally exposed on Or-Vnfm reference point.
- Internal CPs, i.e. CPs of specific VNFCs (see grey VNFC CPs) that are optionally exposed on the Or-Vnfm reference point.

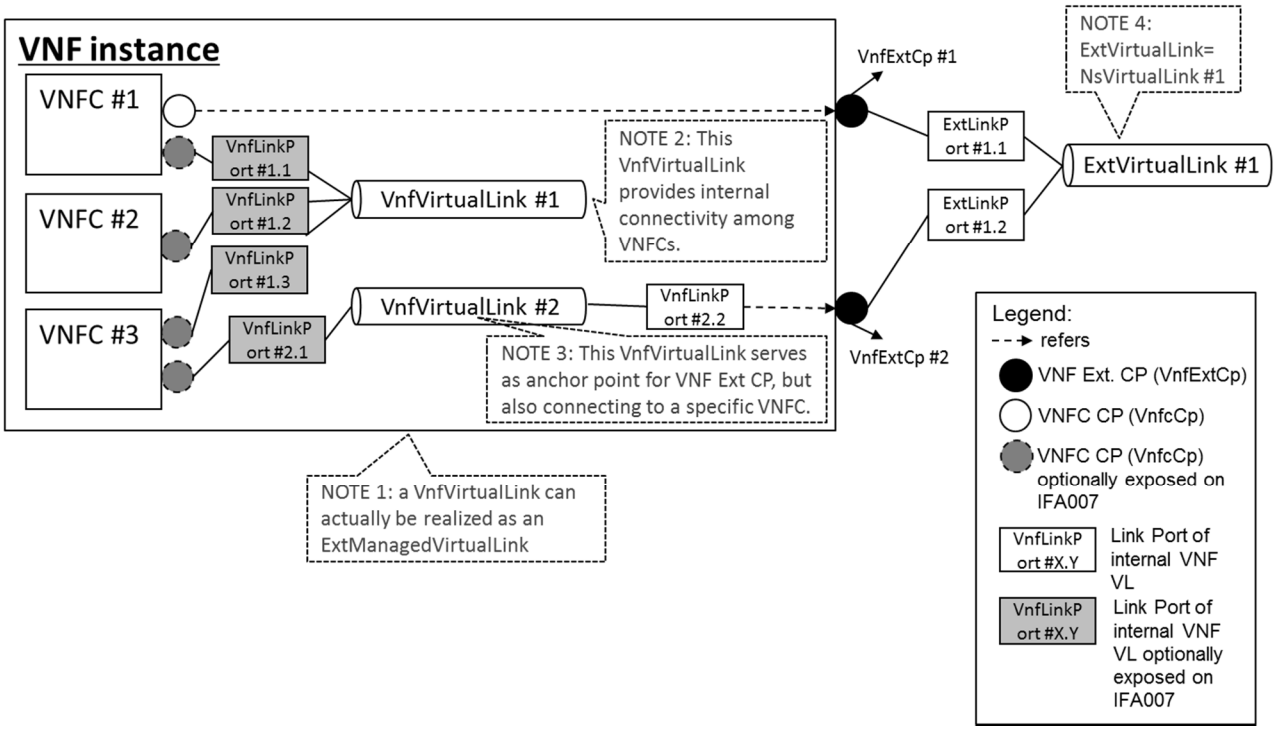

Figure A.2-1: Example of a VNF with two different types of external connection points

A.3 Example of changing VNF connectivity

This example illustrates the operation "Change external VNF connectivity" (clause 7.2.18). The scenario depicted disconnects all external CP instances that were created based on a particular CPD from a "source" external VL and connects them to a "target" external VL.

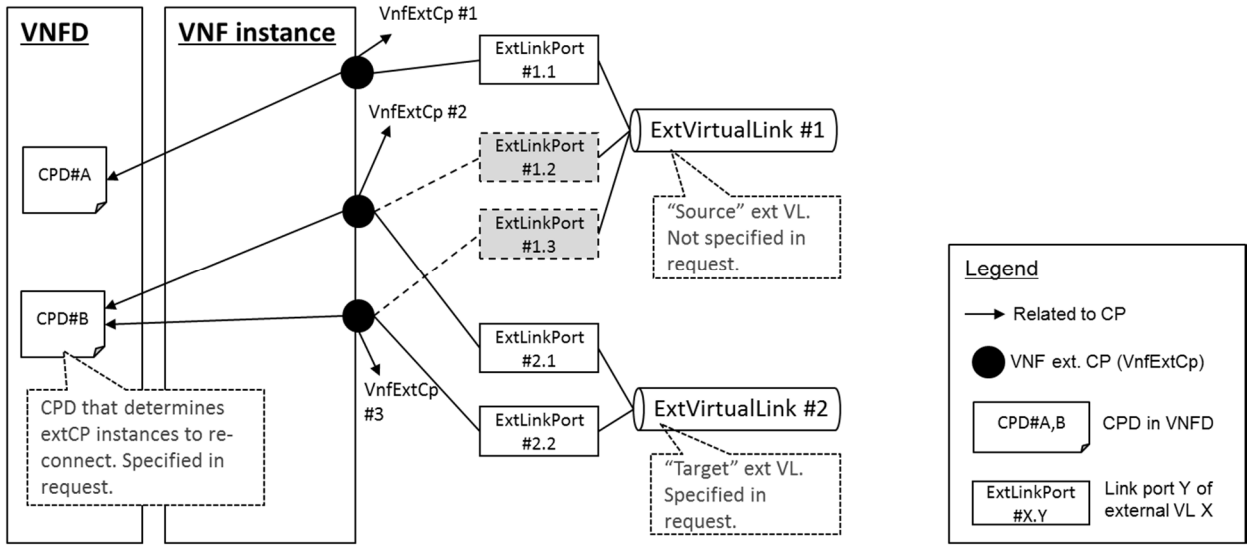

Figure A.3-1: Illustration of disconnecting external CPs from one external VL and connecting them to another external VL

Annex B (informative): Authors & contributors

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Annex C (informative): Change History

Date	Version	Information about changes
18 December 2014	V0.0.1	Skeleton and ToC
07 January 2015	V0.0.2	Updates based on NFVIFA(14)000028r4
26 January 2015	V0.1.0	Early draft after IFA Shanghai Interim Meeting, including contributions: - NFVIFA(15)000034r3_IFA007_section_4_Overview - NFVIFA(15)000036r3_IFA0nn_Interface_WIs_section_1_Scope_small_addition - NFVIFA(15)000091r3_IFA009_section_3_Definitions
23 February 2015	V0.1.1	Editorial: Title corrected for alignment
25 June 2015	V0.1.2	Contributions included: - NFVIFA(15)000066r2_IFA007_Clause_5_VNF_Package_interface_ notification_req - NFVIFA(15)000067r3_IFA007-008_Clause_5_VNF_LC_change_interface_reqs - NFVIFA(15)000189r5_VNF_Package_management_interface_Requirements - NFVIFA(15)000252r1_IFA007_interface_requirements_VNF_LCM_Granting - NFVIFA(15)0000254r4_IFA007_interface_requirements_VNF_LCM - NFVIFA(15)000256r2_IFA007_interface_requirements_VNF_Lifecycle_ Chg_Notif - NFVIFA(15)000357r1_Change_to_conventions_for_conditional_attributes - NFVIFA(15)000523r2_IFA010-007-008_Extend_VNF_lifecycle_change_notification - NFVIFA(15)000567r1_Adding_note_from_458r3_to_all_interface_GSs - NFVIFA(15)000675r1_IFA007_Section_5_Reference_Point_Requirements - NFVIFA(15)000798r1_IFA007_Add_VNF_LCM_interface_requirements Applicability of multi-document changes checked but no changes necessary: - NFVIFA(15)000035_Blueprint_Phase_1_GSs_as_Informative_References Editorial changes: - Aligned document structure with template and IFA005 and IFA006 - Information elements clause is now clause 8 - Inserted separate "Interface requirements" and "Reference point requirements" subclauses in clauses 6 and 7 - Implemented disclaimer from NFVTSC(15)000041r3
10 July 2015	V0.1.3	Contributions included: - NFVIFA(15)000845r1_IFA007_Move_VNF_LCM_Notification_ requirement_from_798r1 Editorial changes: - Aligned labels of requirements with IFA conventions as per NFVIFA(15)000853r2
13 August 2015	V0.2.0	Contributions included: - NFVIFA(15)000526r3_IFA007_LCM_operation_granting_requirements - NFVIFA(15)000939r1_IFA007_section_5_Or- Vnfm_reference_point_requirements - NFVIFA(15)000082r8_IFA007_VNF_Lifecycle_Manager_and Lifecycle_Operation_Grantin - NFVIFA(15)000722r4_IFA007_detailed_interface_design_LCM_- _InstantiateVNF - NFVIFA(15)000723r5_IFA007_detailed_interface_design_LCM_Notification - NFVIFA(15)000838r5_IFA007_VNF_PM_interface - NFVIFA(15)000933r3_IFA007_detailed_interface_design_LCM_-_ScaleVNF - NFVIFA(15)000935r1_IFA007_detailed_interface_design_LCM_-_QueryVNF
27 August 2015	V0.2.1	Incomplete implementation of NFVIFA(15)000838r5 in v0.2.0 was fixed (clause 8 content from 838r5 was missing in v0.2.0) Editorial alignments in clause 8 (structured into subclauses as done in 838r5, text from 838 adapted to latest conventions (Parameter → Attribute, Type → Content).

Date	Version	Information about changes
02 October 2015	V0.3.0	Contributions included: - NFVIFA(15)0001141r1_IFA007- 008_VNF_LCM_Healing_operation_interface_requirement - NFVIFA(15)0001197_IFA007_VNF_Package_Management_small_fix - NFVIFA(15)000837r4_IFA007_VNF_FM_interface - NFVIFA(15)0001142r2_IFA007_VNF_LCM_Healing_operation_ interface_specification - NFVIFA(15)000953r4_IFA010-007-008_VNF_FM_extra_notifications - NFVIFA(15)0001199r1_IFA007_IFA013_VNF_Package_Management_ Notification_Additional - NFVIFA(15)0001084r2_IFA007_IE_names_alignment - NFVIFA(15)0001221_IFA007_add_description_to_VNF_LCM_interface - NFVIFA(15)0001022r2_IFA007_FM_PM_interface_naming_alignment Editorial fixes, e.g. to align with latest interface template
09 November 2015	V0.4.0	Contributions included: - NFVIFA(15)0001154r2_IFA007_VNF_Package_interface_modify_and_ query_operations - NFVIFA(15)0001139r3_IFA007_7-8_IFA008_7- 9_VNF_FM_extension_for_VR_state_changes - NFVIFA(15)0001302_IFA007_Adding_VNF_performance_management_ requirements - NFVIFA(15)0001152r2_IFA007_7_X_IFA008_7_X_VNFM- produced_VNF_Config_interface - NFVIFA(15)000065r4_IFA007_5_3_3_IFA008_5_2_1_1_Operate_VNF_ interface_requiremen - NFVIFA(15)0001150r2_IFA007_7_2_IFA008_7_2_Operate_VNF_ interface_specification - NFVIFA(15)0001151r3_IFA007_4-5_IFA008_4-5_VNFM- produced_VNF_Configuration_reqs - NFVIFA(15)000638r8_IFA007_5_2__5_3_resource_management_ requirements - NFVIFA(15)0001225r1_IFA013 IFA015 Merging PM Information Elements - NFVIFA(15)0001266r2_IFA007_Exclude_Error_Cases_from_Output_ IE_Cardinality - NFVIFA(15)0001347r3_IFA010_Section_7_2_Functional_requirements_ for_VNF_LCM Editorial fixes: - Change of affiliation of Marc Flauw - Subclauses of Clauses 5 and 8 renumbered to keep sequence of IEs in sync with sequence of interfaces
21 December 2015	V0.5.0	Contributions included - NFVIFA(15)0001453r3_IFA007_rapporteur_s_cleanup_of_v040 - NFVIFA(15)000934r7_IFA007_detailed_interface_design_LCM_- _TerminateVNF - NFVIFA(15)0001290r9_IFA007_Virtualised_Compute_Interfaces - NFVIFA(15)0001291r9_IFA007_Virtualised_Network_Interfaces - NFVIFA(15)0001292r9_IFA007_Virtualised_Storage_Interfaces - NFVIFA(15)0001455r2_IFA005_IFA006_IFA007_IFA008_IFA013_ FM_PM_fixes - NFVIFA(15)0001458r1_IFA007_fixes_References_Introduction - NFVIFA(15)0001485r4_IFA007_IFA008_VNF_Scaling_Parameters - NFVIFA(15)0001495r2_IFA007_5-3-3_IFA008_5-2-1-1_VNF_LCM_extension - NFVIFA(15)0001500r1_IFA007_6_2_2_IFA013_7_7_5_Addressing_ note_VNF_Package_mgmt - NFVIFA(15)0001515r3_IFA007_Non- normative_should_and_may_separated_from_1453r1 - NFVIFA(15)0001529_IFA007- 008_7_X_Correction_to_subscribe_filter_for_VNF_FM_i_f - NFVIFA(15)0001596_IFA005_IFA006_IFA007_IFA008_IFA012_ IFA013_Remove_section_9_S - NFVIFA(15)0001608r2_IFA005_IFA006_IFA007_IFA008_IFA013_ Normative_Reference_to_IF - NFVIFA(15)0001613_IFA007_Subscribe_Notify_description_fixes Editorial fixes - Implemented the agreement regarding table numbering - Implemented the agreement regarding the text referencing the tables for input and output parameters

Date	Version	Information about changes
February 2016	V0.6.0	Contributions included - NFVIFA(15)0001454r5_IFA007_5_3_3_4_fixing_Virtualised_Resources_ Change_Notificat - NFVIFA(16)000072r2_IFA007_5_2_and_5_3_3_Additional_requirements_for_ indirect_RM - NFVIFA(15)0001519r5_IFA007_numberOfSteps_support_signaling - NFVIFA(16)000007r1_IFA007_referencing_IFA011 - NFVIFA(16)000042r2_IFA011_IFA007_VNF_LCM_related_information_in_ VNFD - NFVIFA(16)000106r1_IFA007_5_3_and_8_6_IFA008_5_2_and_9_4_1_ Identification_for_V - NFVIFA(16)000117r1_IFA007_8_5_4_Adding_basic_VnfInfo_attributes - NFVIFA(16)000119r1_IFA007- IFA008_7_2_Addressing_editor_note_on_VNF_operate - NFVIFA(16)000121r1_IFA007_5_3_3_Rapporteurs_fixes_indirect_RM - NFVIFA(16)000123r1_IFA007_7_2_6_2_Additional_params_in_healing - NFVIFA(16)000151r1_IFA007_Indicator_Interface, with editorial fixes (copy&paste error (replaced in change 2 "Ve-Vnfm-em by Or-Vnfm), "parameters" instead of "information elements" in operations, added "… and notifications" in 8.10 headline) - NFVIFA(15)000511r9_IFA007_6_3_detailed_interface_design_LCM_ Operation_Granting (with editorial fixes to align with the interface template) Editorial fixes: - Pre-processing done before TB approval E-mail: mailto:edithelp@etsi.org. Rapporteur's note: Had to undo the changes to front matter as this document is still intended for being made available through the open area. - Applied conventions according to NFVIFA(15)0001562r5_Interface_template_update, including removal of the editor's notes that stated the need to add UML diagrams to the IE clauses - Various small typo fixes
March 2016	V0.6.1	Re-created the ZIP archive due to a problem in the ZIP file of V 0.6.0. No changes to content.
21 March 2016	V0.7.0	Version to enter WG review Contributions included: - NFVIFA(16)000175r3_IFA007_Alarm_Cleared_Notification_and_Alarm_IE_ Update - NFVIFA(16)000183_IFA007_Referencing_IFA013_informatively - NFVIFA(16)000102r2_IFA007_Section7_2_Modification_on_Query_operation - NFVIFA(16)000142r6_IFA007_8_5_IFA008_9_3_current_scale_level_in_ VNFInfo - NFVIFA(16)000267r4_IFA007_IFA008_IFA011_scale_VNF_to_instantiation_ level - NFVIFA(16)000171r3_IFA007_C_D__8_G_H_8_I_J_Virtualised_Resources_ Performance_Ma - NFVIFA(16)000170r3_IFA007_A_B_8_A_B_8_C_D_8_E_F_Virtualised_ Resources_Fault_Man - NFVIFA(16)000176r3_IFA007_Fixing_normative_and_informative_references_ to_IFA_GS - NFVIFA(16)000197_IFA007_IFA008_instantiation_level_in_InstantiateVNF - NFVIFA(16)000217_IFA007_IFa008_Adding_description_to_VNF_Instance - NFVIFA(16)000219r2_IFA007_IFA008_resolving_editor_s_note_on_VnfInfo - NFVIFA(16)000220_IFA007_scaling_step_note_alignment_with_proposal_ from_ 779 - NFVIFA(16)000228r2_IFA007_editor_s_notes_on_externally_managed_ internal_VLs - NFVIFA(16)000231r1_IFA007_Adding_deployment_flavour_to_grant_request - NFVIFA(16)000232r3_IFA007_6_3_2_Adding_level_to_grant_request - NFVIFA(16)000234r2_IFA007_6_4_2- 4_X_8_X_Y_Virtualised_Resources_Change_Notifica - NFVIFA(16)000235_IFA007_Adding_deployment_flavour_to_VnfInfo - NFVIFA(16)000239_IFA007_7_5_3_Notify_operation - NFVIFA(16)000248r2_IFA007_7_2_8_Change_VNF_Flavour - NFVIFA(16)000258r1_IFA007_5_2__5_3_3_quota_management_ requirements_in_indirect_ - NFVIFA(16)000259r2_IFA007_6_x__8_x_quota_management_interfaces_in_indirect_mode - NFVIFA(16)000262r1_IFA007_5_2__5_3_virtualised_resources_quota_available_notifi - NFVIFA(16)000265r4_IFA007_8_3_2__8_5_5_Adding_ResourceInfo - NFVIFA(16)000268r2_IFA007_6_2_2_and_8_2_x_IFA013_7_7_5_and_8_7_x_ accessing_VNF_ - NFVIFA(16)000269r1_IFA007_5_3_3_Fixing_Virtualised_Resources_ Management_interfa (also applied the pattern to the newly added indirect RM interface requirements) - NFVIFA(16)000276r1_IFA007_7_6_2_7_2_X_Clarification_on_ModifyVnfConfiguration_a - NFVIFA(16)000277r1_IFA007_6_3_2_4_Clarification_of_rejection_in_granting_operat - NFVIFA(16)000279_IFA007_6_3_2_LC_operation_occurrence_identifier_in_granting - NFVIFA(16)000280r1_IFA007_6_4_and_8_4_Interface_spec_of_reservation_mgmt_in_ind - NFVIFA(16)000285_IFA007_8_3_8_adding_resourceProviderId_in_ConstraintResource

Date	Version	Information about changes
		- NFVIFA(16)000287r1_IFA007_Scaling_description - NFVIFA(16)000288r2_IFA007_6_4_2-3_Y_8_4_A-C__8_K_L_Virtualised_Resources_Inform - NFVIFA(16)000299r1_IFA007_8_3_4_Addressing_editor_note_in_VimInfo - NFVIFA(16)000300_IFA007_8_3_5_Addressing_editor_note_in_ZoneInfo - NFVIFA(16)000301r1_IFA007_8_5_5_IFA_011_7_1_X_Attributes_for_VnfInfo_and_VNFD (this document has inserted flavourId as well as doc 235. IFA agreed on 24 March by email to remove the duplicate variant of flavourId that was introduced by 301) - NFVIFA(16)000314r2_IFA007_5__6_and_8_Adding_VR_reservation_change_ notification_ - NFVIFA(16)000327r1_IFA007_Resolve_Editor_s_Notes_NFV002_reference - NFVIFA(16)000328r1_IFA007_Resolve_Editor_s_Notes__Functional_requirements_refer - NFVIFA(16)000329r1_IFA007_Resolve_Editor_s_Notes__Granting_in_ScaleVnf_Descript - NFVIFA(16)000330_IFA007_Resolve_Editor_s_Notes__Indirect_RM_IE_clause_introdu - NFVIFA(16)000331_IFA007_Resolve_quote_easy_quote_Editor_s_Notes - NFVIFA(16)000342_IFA007_8_7_VNF_PM_mirror Editorial fixes: - there were still occurrences of "input/output information element" in the GS where "input/output parameter" needs to be used. Fix as editorial - Table 7.2.4.2-1: Subscribe operation input parameters --> TerminateVnf operation input parameters - various typos - change "section" to "clause"- in FM/PM interfaces, there were still a quite few table references for input and output parameters that used the old formulation ("are listed") instead of the latest convention "shall follow the indications". Fixed. - made ToC of depth 3 instead of 4 - converted those additional Editor's Notes that were inserted during GS preparation by the rapporteur into "Rapporteur's notes". A Rapporteur's note has not been agreed by the group but represents the opinion of/tracks an action for/points out an issue detected by the rapporteur during GS preparation.
20 April 2016	V0.8.0	Contributions included (review EA part 1): - NFVIFA(16)000373_IFA007_6_2_4_Add_missed_text_for_new_VNF_ package_on-boarded - NFVIFA(16)000421r2_IFA007_7_2_10_IFA008_7_2_10_review_Modify_ Vnf_fixes - NFVIFA(16)000423_IFA007_8_2_7_2_IFA013_8_6_5_2_review_ UserMetadata_mandatory - NFVIFA(16)000424r1_IFA007_6_and_7_and_8_Remove_stage3_term - NFVIFA(16)000425r2_IFA007__many__IFA008__many__review_Small_ Technical_Alignment - NFVIFA(16)000431_IFA007_7_5_3_Editorial_change_for_ AlarmClearedNotification - NFVIFA(16)000443r1_IFA007_6_3_2_2_review_Temp_Resource_in_ Notifications_delete - NFVIFA(16)000471r1_IFA007_4_1_Alignment_listing_of_interfaces - NFVIFA(16)000473_IFA007_8_2_5_VNF_Package_mgmt__correction_on _VnfPackageChange - NFVIFA(16)000481r1_IFA007_8_5_6_and_8_5_7_VNF_LCM_updates_to _VnfInfo_and_VnfRes - NFVIFA(16)000482_IFA007_7_4_2_and_7_4_5_VNF_PM_changes - NFVIFA(16)000488r1_IFA007_5_2_edits_interface_naming_in_requirements_ and_titles - NFVIFA(16)000501r1_IFA007_6_2_2_Query_VNF_package_operation - NFVIFA(16)000503r1_IFA007_6_3_2_1_Policy_in_VNF_Lifecycle_Operation _Granting_in - NFVIFA(16)000506r2_IFA007_7_2_9_1_operate_VNF_operation - NFVIFA(16)000515r1_IFA007_7_2_3_Clarifications_on_Scale_VNF_operation - NFVIFA(16)000517r1_IFA007_8_3_2_and_8_3_3_Updates_to_IEs_related_ to_Granting - NFVIFA(16)000519_IFA007_8_7_2_and_8_7_3_Updates_IEs_related_to_ ObjectSelectio - NFVIFA(16)000521_IFA007_7_7_VNF_Indicator_interface_description_ alignment - NFVIFA(16)000529_IFA007_5_3_4_Correcting_req_on_query_VNF_operation - NFVIFA(16)000558r1_IFA007_7_2_3_2_7_2_4_2_7_2_6_2_8_5_6_2_ IFA008_7_2_7_2_7_2_8_

20 April 2016	V0.8.0	Contributions included (review EA part 2): - NFVIFA(16)000422_IFA007_7_2_11_IFA008__sect__review_ GetOperationStatus_mandat - NFVIFA(16)000476r1_IFA007_7_2_3_and_6_3_2_moving_text_about_granting - NFVIFA(16)000357r2_IFA007_Scaling_description_delta_after_Espoo - NFVIFA(16)000444r2_IFA007__many__IFA008_9_4_2_review_Removing_ Editor_s_Notes - NFVIFA(16)000418r2_IFA007_section_7_2_3_2_IFA008_section_7_2_7_2_- _Fixing_aspec - NFVIFA(16)000408r1_IFA007_Renaming_VL_and_CP_IEs Contributions included (review EA part 3): - NFVIFA(16)000441r1_IFA007_IFA008_Remove_the_definition_of_ KeyValuePair - NFVIFA(16)000478r3_IFA007_8_6_2_VNF_LC_Change_Notification_ addressing_EN_and_co - NFVIFA(16)000495_IFA007_6_4_5_VR_PM_indirect_add_missing_ resourceProviderId - NFVIFA(16)000496r1_IFA007_5_3_5_lifecycle_change_notification_ interface_require - NFVIFA(16)000502r1_IFA007_5_3_2_6_3_2_2_VNF_instance_id_for_ granting_interface - NFVIFA(16)000523r1_IFA007_5_3_4_clarification_on_VNF_instance_ information_modif - NFVIFA(16)000546r2_IFA007_5_3_5__7_3_3__8_6_1__8_6_X_Add_ new_type_notification - NFVIFA(16)000549r1_IFA007_8_2_7_8_7_7_8_8_3_ IFA008_9_3_4_9_7_7_Use_of_time Contributions included (ATL meeting): - NFVIFA(16)000398_IFA007_8_4_2_8_4_4_8_4_6_Alignment_to_inheritance _pattern - NFVIFA(16)000419_IFA007_6_3_2_1_review_Resource_types_in_Granting - NFVIFA(16)000420r2_IFA007_7_2_3_IFA008_7_2_7_IFA011_7_1_5_3_ review_Scale_up_dow - NFVIFA(16)000445r1_IFA007_8_5_6_IFA008_9_4_2_review_VnfInfo_fixes - NFVIFA(16)000450r3_IFA007_8_5_7_IFA008_9_4_4_VnfResourceInfo_IE - NFVIFA(16)000465r3_IFA007_8_3__review_VDU_reference_duplicated. Note on change in clause 8.3.2.2/resourceTemplate: The insertion of "or modification" was in the wrong place in the sentence, hinting a "modification of new resources" which is nonsense. This was corrected as an editorial action to read "modification of existing resources" - NFVIFA(16)000466r5_IFA007_6_3_2_3_review_computeFlavour_swImage_ assets_multi_VI - NFVIFA(16)000474r1_IFA007_8_3_7_and_6_3_2_2_Granting_IE_ PlacementConstraint_vs - NFVIFA(16)000504r4_IFA007_6_3_2_changes_on_VNF_Lifecycle_ Operation_Granting_int - NFVIFA(16)000513_IFA007_6_3_2_Clarifications_for_Grant_VNF_LC_ operation - NFVIFA(16)000514r3_IFA007_5_2_5_3_3_10_6_4_8_quota_available_ notification_inter - NFVIFA(16)000520_IFA007_5_3_7_VNF_FM_missing_requirements - NFVIFA(16)000522r1_IFA007_7_2_9_Operate_VNF_graceful_and_forceful _stop - NFVIFA(16)000527r1_IFA007_7_2_2_and_7_2_7_VNF_LCM_QueryVNF_ filter_and_correctio Note on change in table 7.2.7.3-1: The note in the description column is not in line with the EDR. The note has been moved to the last row of the table as an editorial action. - NFVIFA(16)000533r1_IFA007_8_5_3_Addressing_EN_on_ConnectionPoint - NFVIFA(16)000551r4_IFA007_7_2_3_IFA008_7_2_7_VNF_Scaling_ description - NFVIFA(16)000592_IFA007_8_5_6_IFA008_9_4_1_review_VimInfo_in_VnfInfo - NFVIFA(16)000597_IFA007_8_5_6_review_Remove_Error_from_OperateVnf - NFVIFA(16)000600r6_IFA007_IFA013_Add_support_for_Create_and_ Delete_VNF - NFVIFA(16)000652_IFA007_7_2_11_IFA008_7_2_9_GetOperationStatus _op_specific_st - NFVIFA(16)000676r1_IFA007_7_2_5_ext_VLs_in_ChangeVnfFlavour

Date	Version	Information about changes
		Contributions included (S1a#36 call): - NFVIFA(16)000667r1_IFA007_IFA008_small_fixes - NFVIFA(16)000721_IFA007_7_2_Adding_LCM_operation_occurrence _identifier Contributions included (S1b#50 call and EA ending 19 May): - NFVIFA(16)000453r2_IFA007_8_8_4_IFA008_9_3_4_Referencing_resources _in_alarm_IE - NFVIFA(16)000461r7_IFA007_8_6_2-5_IFA008_9_5_1-4_VnfLifecycleChangeNotification - NFVIFA(16)000720r2_IFA007_8_5_8_IFA008_9_4_5_Clarification_for_ resource_identif - NFVIFA(16)000484r9_IFA008_7_2_2_9_4_x__ IFA007_7_2_2_7_6_2_8_5_x_8_9_x_Adding_Vi Editorial fixes: - Reference i.3b renamed - "See note" harmonized - Virtualised → Virtualised - "Interface" → interface consistently - Convention enforcement: "parameter" → "attribute" in information element descriptions - "Functional requirement" → "Requirement" (table headings in Interface requirements sections) - Various minor fixes
17 June 2016	V0.9.0	Contributions included (second review EA#1, 9 June): - NFVIFA(16)000719r1_IFA007_8_5_8_Adding_back_the_reservationId - NFVIFA(16)000769r2_IFA008_7_4_2__9_2__9_8__6_2__ IFA007_7_6_2__and_IFA011_7_1_6 - NFVIFA(16)000784__IFA008_5_3_1_3_IFA007_5_3_9_renaming_VNF_ Indicator_interfac - NFVIFA(16)000786r1_IFA007_5_3_4_IFA008_5_2_1_1_Add_missing_ requirements_on_crea - NFVIFA(16)000788_IFA007_IFA008_IFA013_4_3_Removal_of_N_A_condition - NFVIFA(16)000793_IFA007_8_3_2_2nd_review_Removing_Rapp_note - NFVIFA(16)000794r1_IFA007_7_2_1_IFA008_7_2_1_2nd_review_ lcOpOccId_clarification - NFVIFA(16)000809_IFA007_Typo_Correction - NFVIFA(16)000820r1_IFA007_Resolution_of_editor_s_notes - NFVIFA(16)000835r3_IFA007_8_3_3_8_12_4_Adding_Resource_Group _Id_to_Grant_respon - NFVIFA(16)000836r2_IFA007_5_3_5_and_IFA008_5_2_1_2_Missing _req_subscription_for (note: in the change tracked version, this was implemented using the same name tag as for 835r3, i.e. r0-835r2) - NFVIFA(16)000837_IFA007_5_3_8_7_6__8_9_and_ IFA008_5_2_1_5__7_4__9_2_on_adding - NFVIFA(16)000838r2_IFA007_8_5_x_IFA008_9_4_x_Add_Info_the_ VL_and_CP_IEs - NFVIFA(16)000839_IFA007_5_3_9__IFA008_5_2_1_4_VNF_Indicator _interface_require - NFVIFA(16)000841r1_IFA007_6_2_2__6_2_5_Query___Fetch_VNF_ Package_operation - NFVIFA(16)000852_IFA007__IFA008_Editorials_and_alignments Contributions included (second review EA#2, 16 June): - NFVIFA(16)000790r5_IFA007_many_IFA008_many_2nd_review_Create_ VNF_terminology_an • Rapporteur's changes when implementing this contribution: Table 8.6.8.3-1 VnfIdentifierDeletionNotification: Used past tense in Description column, instead of future as suggested by the 790r5, as notifications are about past events, not future ones. See also the entry for NFVIFA(16)0001016. - NFVIFA(16)000857r2_IFA007_7_3_2_IFA008_7_5_2_2nd_review_ Subscribe_to_Create_Del - NFVIFA(16)000860_IFA007_8_5_7_IFA008_9_8_4_2nd_review_ ResourceHandle_fix - NFVIFA(16)000862r2_IFA007_7_2_6_8_2_12_IFA008_7_2_13_9_4_12_ 2nd_review_Aligning - NFVIFA(16)000864_IFA007_8_5_6_8_5_3_8_12_IFA008_9_4_3_9_4_11_9_4_9_2_4_2nd_ex

17 June 2016	V0.9.0	- NFVIFA(16)000887r2_IFA007_Implementing_identifier_conventions_from_614r3_in_IFA (implemented under user name r2-864 same as previous contribution) • Rapporteur's changes when implementing this contribution (mostly because the IE name is different where it is declared): – Table 8.5.2.2-1 one occurrence of "Vld" replaced by "VnfVld" ("Vld" IE does not exist) – Table 8.5.7.2-1 extVirtualLink -> extVirtualLinkId not applied since another document has modified this attribute, such that it is not of type "Identifier" any longer - hence Identifier conventions do not apply. – Table 8.6.3.2-1 VnfcResourceInformation -> VnfcResourceInfo – Table 8.6.4.2-1 VirtualLinkResourceInformation -> VlResourceInfo – Table 8.6.5.2-1 VirtualStorageResourceInformation -> VirtualStorageResourceInfo Contributions included (after NFVIFA#33, Sophia Antipolis): - NFVIFA(16)0001016_IFA007_many_IFA008_many_Create_VNF_ terminology_and_states_re (Rapporteur's comment: 790r5 has been superseded by 1016 which is in fact r6 of 790. The delta between 1016 and 790r5 is implemented in this revision, as 790r5 was implemented previsously, effectively being equivalent to having implemented 1016 directly, instead of 790r5. Also, some instances of "VNF information element" in clauses 7.2.7.1 and 7.2.2.4 were missed to be replaced by 1016; these instances were replaced too) - NFVIFA(16)000791r5_IFA007_many_IFA008_many_2nd_review_Renaming_ Vl_and_Vld_in_IE - NFVIFA(16)000795r3_IFA007_8_5_6_7_2_3_IFA008_9_4_3_7_2_3_2nd_ review_VNF_localiz - NFVIFA(16)000889r1_IFA007_inner_grouping_of_indirect_RM_IEs (Rapporteur's comment: When used in the context of "InformationChangeNotification", replaced a few occurrences of "VirtualisedResourceWithRpChangeNotification" by "InformationWithRpChangeNotification", namely in 6.4.2.3, 6.4.3.3 and 6.4.4.3, assuming this was a copy&paste error in the original contribution, and "Information***WithRp***ChangeNotification" is the correct substitute of "InformationChangeNotification" in indirect RM) - NFVIFA(16)000919r1_IFA007_IFA008_IFA011_IFA012_IFA013_IFA014_ stage_3_data_types (Rapporteur's comment: In 7.3.2.2 and 7.6.3.2, added "Filter" in the an empty content column instead of "not specified" as the parameter neme is "filter", following the convention.) - NFVIFA(16)000856_614bis_Conventions for Identifiers_UPDATED - NFVIFA(16)000869r1 IFA007 IFA008 IFA011 IFA012 IFA013 IFA014 Proposal for an update of the inheritance pattern convention - NFVIFA(16)000920r1_IFA007_6_3_2nd_review_operation_names_in_granting - NFVIFA(16)000983r2_IFA007_6_3_Ext_VLs_in_Granting - NFVIFA(16)000989_IFA007_8_11_2_3_VimInfo_in_VirtualisedResource QuotaAvailable - NFVIFA(16)0001001r3_IFA007_8_5_2_IFA008_9_4_10_Change_to_ Virtual_Lin - NFVIFA(16)0001011r2_IFA007_8_5_5_IFA008_9_4_2_Note_on_ modification_of_VnfInfo Contributions included (after EA ending 14 Jul 2016): - NFVIFA(16)0001041_IFA007_query_filter - NFVIFA(16)000806r11_IFA007_and_IFA013_identification_of_the_VNF_ Package (Rapporteur's comment: The previous changes (r0-841r1 that were applied to the Fetch VNF Package operation were moved to the "Fetch onboarded VNF Package artifacts" operation to which they apply after the change introduced by 806.) - NFVIFA(16)0001032r2_IFA007_6_3_VNF_Lifecycle_Operation_Granting_ interface_8_3_6_ - NFVIFA(16)001020r3 IFA013 Abort VnfPackage Deletion - NFVIFA(16)000922r6 Conventions for the use of abbreviations Contributions included (after S1a#43 on Jul 20): - NFVIFA(16)0001066r1_IFA007_IFA008_move_extension_and_ vnfConfigurableProperty_to_VnfInfo - NFVIFA(16)0001063r1_IFA007_IFA008_IFA013_vnfInstanceName_in_ ModifyVnfConfig Editorial fixes: - Minor typos (flavour → flavour, identifier → identifier, etc.) - Renamed extVirtualLinkLink to extVirtualLink - Changed the filename convention to use six digit version string - Replaced "GrantLifecycleOperation" by "GrantVnfLifecycleOperation" in captions in line with the name of the operation and in related message names

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		- Corrected wrong references to IFA006 from clauses 6.4 and 8.4 (indirect resource management) - In the body of clause 8.4.7.4.2, replaced "AlarmNotification" by "AlarmClearedNotification as the whole clause uses "AlarmClearedNotification" elsewhere, so this is assumed a copy&pate error. - Using plural in the description of attributes and parameters of 0..N/1..N cardinality - Aligned operation names usage (single words, all uppercase) in the table captions and clause headline. - Rapporteur action #1 from 489r1: ensure consistent use of "VNF Package" -> s/VNF package/VNF Package/
29 July 2016	V0.9.1	Contributions included (S1b call with approval power on 25 July 2016): - NFVIFA(16)0001077_IFA007 IFA008 IFA013 IFA015 ExtCP and LinkPort fixes - NFVIFA(16)0001078r2_IFA013_8_3_3__IFA007_8_5__IFA008_9_4_ Alignment_of_VnfInfo - NFVIFA(16)0001088r1_IFA007_IFA008_IFA013_virtualStorage_Alignment _with_IFA011 Contributions included (S1a call with approval power on 27 July 2016): - NFVIFA(16)001094r1-NFV-IFA007v000901-cb Editorials: - Cross-checked references to IFA011 and removed related rapporteur's notes - 4.2 using proper interface name: s/VNF Configuration/VNF Configuration Management/ - Table 6.3.2.2-1: Renamed vnfDescId --> vnfdId in line with the changes done in 806r11
01 August 2016	V 0.9.2	Editorials: - Restructured the sequence of sub-clauses of clause 8.5 to align with IFA008 (i.e. start with VnfInfo and InstantiatedVnfInfo) - Fixed some typos and editorial inconsistencies - Fixed references in 7.4.1 Description to be: • PerformanceInformationAvailableNotification (see clause 8.7.8.). • PerformanceReport information element (see clause 8.7.5).
03 August 2016	V 0.9.3	Contributions included: - NFVIFA(16)001126r3_IFA007_IFA008_inconsistency_fixes Editorials as documented in NFVIFA(16)0001129: - "Change VNF Deployment Flavor" replaced by the genereally-used term "Change VNF Flavour" - Applied convention for notifications - There are some references left to VirtualLinkDesc but in fact the IE is named VnfVirtualLinkDesc in IFA011. Fixed.
04 August 2016	V 0.9.4	Contributions included: - NFVIFA(16)000770_Replace_primitive_type_TimeStamp_by_DateTime - Extended the implementation of change 5 in NFVIFA(16)001126r3_IFA007_IFA008_inconsistency_fixes to all places where the text is applicable (Description of input/output parameters of type ExtVirtualLink and ExtManagedVirtualLink starts with "Information about", rather than "Reference to")
19 August 2016	V0.9.4b	Alignment of the Operation Result clauses: result of an operation use past tense and return parameter use passiv present tense and avoid future tense (will be). Output parameter mentioned in attribute descriptions are also changed to use "is returned" or "are returned". Other editorial bugs fixed. Replaced many occurrences of NVFO with NFVO.
05 September 2016	V0.9.5	Including NFVIFA(16)0001215
October 2016	V2.1.1	Publication
23 January 2017	V2.1.2	Specification maintenance begins CRs included: - NFVIFA(17)000010r2_IFA007ed221_Merging_LCCN_with_LCM_interface_ and_adding_subsc Editorial changes: - Changed page header to "Draft GS", added NFV's DRAFT GS disclaimer.

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03 April 2017	V2.1.3	CRs included - NFVIFA(17)000056r1_IFA007ed221_IFA013ed221_VNF_Package_Management_ modifications - NFVIFA(17)000062r4_IFA007ed221_IFA008ed221_VimInfo_fixes_without_ VimId_changes - NFVIFA(17)000094r3_IFA007ed211_Update_the_content_and_description_of_the_alarm_ - NFVIFA(17)000103r3_IFA007ed221_ModifyVnfConfig_Split_and_Merge - NFVIFA(17)000116r2_IFA007ed211_Various_small_bugfixes - NFVIFA(17)000155_IFA007ed221_LifecycleChangeNotification_terminology_ - NFVIFA(17)000176r2_IFA007ed221_IFA008ed221_VimId_changes_separated_from_62r3 - NFVIFA(17)000193_IFA007ed221_ThresholdCrossedNotification_trigger_condition_f - NFVIFA(17)000236r1_IFA007ed221_8_5_3_clarify_description_of_ MonitoringParameter - NFVIFA(17)000257r2_IFA007ed221_IFA008ed221_IFA013ed221_Fix_to_dynamic_addresses
25 May 2017	V2.1.4	CRs included - NFVIFA(17)000274r2_IFA007ed221_IFA008ed221_VNF_FM_Acknowledge_ Alarm_operation - NFVIFA(17)000275r1_IFA007ed221_IFA008ed221_VNF_FM_Alarm_List_ Rebuilt_operation - NFVIFA(17)000355_IFA007_Fix_inconsistencies_in_the_FaultyResourceInfo_IE - NFVIFA(17)000438_IFA007ed221_removing_two_attributes_from_ SoftwareImageInform - NFVIFA(17)000454r1_IFA007ed221__IFA008ed221__Add_notes_to_the_Delete_PM_Jobs_op - NFVIFA(17)000455r1_IFA007ed221__Add_notes_to_the_Delete_Thresholds_ operation_fo - NFVIFA(17)000458r3_IFA007ed221_Clarify_the_results_of_operations_implicitly_ upd - NFVIFA(17)000460_IFA007ed221_IsAutomaticInvocation_flag_for_autoscale_ and_aut - NFVIFA(17)000462r1_IFA007ed221_ChangeExtVLs_fixes - NFVIFA(17)000469_IFA007ed221_resource_metadata - NFVIFA(17)000473_IFA007ed221_identifier_changes_related_to_IFA_ document_256r1
13 June 2017	V2.1.5	CRs included - NFVIFA(17)000390r2_IFA007ed221_CR_add_error_handling_operations - NFVIFA(17)000427r2_IFA007ed221_VL_and_CP_consistency - NFVIFA(17)000450r4_IFA007ed221_ChangeExtVLs_support_status - NFVIFA(17)000468r2_IFA007ed221_Notifications_triggered_by_ModifyVnf - NFVIFA(17)000470r1_IFA007ed221_Problem_with_storage_resources_in_ AffectedVnfc (rapporteur changed "VnfInstance" to "VnfInfo", as this is a leftover from the original contribution having been targeted towards SOL003) - NFVIFA(17)000471r1_IFA007ed221_additionalParameters_missing_from_TerminateVnfRe - NFVIFA(17)000520r3_IFA007ed221_VimConstraint_for_resourceGroup - NFVIFA(17)000531_IFA007ed221_Improvement_of_attribute_usage_discription (implemented on top of the changes from NFVIFA(17)000427r2, as intended by this CR) - NFVIFA(17)000535r1_IFA007ed221_Add_VimConnectionInfo_input_parameter_ to_Change
21 June 2017	V2.1.6	Final draft for approval after NFVIFA#57 CRs included: - NFVIFA(17)000525_IFA007ed221_VimConnectionInfo_inter_stages_consistency - NFVIFA(17)000547r3_IFA007_ed221_CR_Align_the_usage_of_VNF_ instantiation_state - NFVIFA(17)000580r1_IFA007ed231_ChangedInfo_fix_of_cardinality - NFVIFA(17)000597_IFA007ed231_Small_fix_leftover_from_renaming_to_ vimConnectio Editorial fixes (table formatting, empty table rows removed.

History

Document history		
V2.1.1	October 2016	Publication
V2.3.1	August 2017	Publication