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Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Or-Vi 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-Vi reference point of the NFV-MANO architectural framework ETSI GS NFV 006 [i.3] 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 ETSI docbox.

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

[2] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Functional requirements specification".

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

[4] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Network Service Templates Specification".

[5] ETSI GS NFV-IFA 027: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Performance Measurements Specification".

[6] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

[7] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[8] ETSI GS NFV-IFA 048: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Policy Information Model Specification".

[9] ETSI GS NFV-IFA 045: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Faults and alarms modelling specification".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Void.

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

[i.3] ETSI GS NFV 006: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architectural Framework Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

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

acceleration capability: functions provided by resources (for instance a NIC or a disk controller) that can be exposed in an implementation independent manner

EXAMPLE: TCP Checksum calculation, packet dispatching amongst queues, TCP Offload, IPSec Offload and RDMA are such a capabilities for a NIC; encryption and compression are such capabilities for a disk controller.

acceleration resource: hardware or software that provide a number of Acceleration Capabilities and can be added, removed or not used from the compute node without requiring any VNF changes

NOTE: GPUs, video transcoding cards, crypto cards are such resources. Acceleration resources are associated with compute nodes.

resource reservation identifier: identifier that establishes the identity of an arrangement to secure usage of resources by a consumer

NOTE: The identifier does not identify the resources that have been reserved.

routing resource: logical network resource that provides routing capabilities between different virtualised network resources of type "network"

EXAMPLE: In the OpenStack® case, this is a neutron Router.

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virtualised resource descriptor: template declaring parameters, requirements, lifecycle and composition of a set of virtualised resources

NOTE: The virtualised resource descriptor is used by the VIM to perform orchestration and lifecycle management of virtualised resources.

EXAMPLE: In the OpenStack® case, this is a Heat Orchestration Template (HOT).

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.2] apply.

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

4.1 Introduction

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

The Or-Vi reference point is used for exchanges between NFV Orchestrator and VIM and supports the following interfaces:

- Software Image Management.
- Virtualised Resources Information Management, composed of:
  - Virtualised Compute Resources Information Management.
  - Virtualised Network Resources Information Management.
  - Virtualised Storage Resources Information Management.
- Virtualised Resources Capacity Management, composed of:
  - Virtualised Compute Resources Capacity Management.
  - Virtualised Network Resources Capacity Management.
  - Virtualised Storage Resources Capacity Management.
- Virtualised Resources Management, composed of:
  - Virtualised Compute Resources Management.
  - Virtualised Network Resources Management.
  - Virtualised Storage Resources Management.
- Virtualised Resources Change Notification, composed of:
  - Virtualised Compute Resources Change Notification.
  - Virtualised Network Resources Change Notification.
  - Virtualised Storage Resources Change Notification.
- Virtualised Resources Reservation Management, composed of:
  - Virtualised Compute Resources Reservation Management.
  - Virtualised Network Resources Reservation Management.
  - Virtualised Storage Resources Reservation Management.
  - Virtualised Resources Reservation Change Notification.
- Virtualised Resource Quota Management, composed of:
  - Virtualised Compute Resources Quota Management.
  - Virtualised Network Resources Quota Management.

  - Virtualised Storage Resources Quota Management.
  - Virtualised Resources Quota Change Notification.
- Virtualised Resources Performance Management.
- Virtualised Resources Fault Management.
- NFP Management.
- Policy Management.

All the interfaces above are produced by the VIM and consumed by the NFV Orchestrator.

No interface is produced by the NFV Orchestrator.

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:

- Management and Orchestration - Vi-Vnfm reference point - Interface and Information Model Specification ETSI GS NFV-IFA 006 [7]:
  - ETSI GS NFV-IFA 006 [7] and the present document are both specifying interfaces provided by the VIM. The two specifications are therefore related.
- Management and Orchestration - Functional requirements specification ETSI GS NFV-IFA 010 [2]:
  - The key functional requirements from ETSI GS NFV-IFA 010 [2] provide the guidance and need to be fulfilled by the interfaces associated to the Or-Vi reference point.

4.3 Conventions

The following notations, defined in ISO/IEC 9646-7 [1], 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;
- N/A not applicable - in the given context, it is impossible to use the capability;
- 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.

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 part of 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-Vi reference point.

5.2 Or-Vi Reference point requirements

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

Table 5.2-1: Or-Vi Reference point requirements

Number	Functional requirement description
Or-Vi.001	The Or-Vi reference point shall support the Software Image Management interface provided by the VIM.
Or-Vi.002	The Or-Vi reference point shall support the Virtualised Compute Resources Management interface provided by the VIM.
Or-Vi.003	The Or-Vi reference point shall support the Virtualised Network Resources Management interface provided by the VIM.
Or-Vi.004	The Or-Vi reference point shall support the Virtualised Storage Resources Management interface provided by the VIM.
Or-Vi.005	The Or-Vi reference point shall support the Virtualised Resources Fault Management interface provided by the VIM.
Or-Vi.006	The Or-Vi reference point shall support the Virtualised Compute Resources Capacity Management interface provided by the VIM.
Or-Vi.007	The Or-Vi reference point shall support the Virtualised Network Resources Capacity Management interface provided by the VIM.
Or-Vi.008	The Or-Vi reference point shall support the Virtualised Storage Resources Capacity Management interface provided by the VIM.
Or-Vi.009	The Or-Vi reference point shall support the Virtualised Resources Performance Management interface provided by the VIM.
Or-Vi.010	The Or-Vi reference point shall support the Network Forwarding Path Management interface provided by the VIM.
Or-Vi.011	The Or-Vi reference point shall support the Virtualised Compute Resources Information Management interface provided by the VIM.
Or-Vi.012	The Or-Vi reference point shall support the Virtualised Network Resources Information Management interface provided by the VIM.
Or-Vi.013	The Or-Vi reference point shall support the Virtualised Storage Resources Information Management interface provided by the VIM.
Or-Vi.014	All operations on interfaces supported by the Or-Vi reference point require authentication and authorization of the consumer.
Or-Vi.015	The Or-Vi reference point shall support the Virtualised Compute Resources Change Notification interface provided by the VIM.
Or-Vi.016	The Or-Vi reference point shall support the Virtualised Network Resources Change Notification interface provided by the VIM.
Or-Vi.017	The Or-Vi reference point shall support the Virtualised Storage Resources Change Notification interface provided by the VIM.
Or-Vi.018	The Or-Vi reference point shall support the Virtualised Compute Resources Reservation Management interface provided by the VIM.
Or-Vi.019	The Or-Vi reference point shall support the Virtualised Network Resources Reservation Management interface provided by the VIM.
Or-Vi.020	The Or-Vi reference point shall support the Virtualised Storage Resources Reservation Management interface provided by the VIM.
Or-Vi.021	The Or-Vi reference point shall support the Virtualised Resources Reservation Change Notification Interface provided by the VIM.
Or-Vi.022	The Or-Vi reference point shall support the Virtualised Compute Resources Quota Management interface provided by the VIM.
Or-Vi.023	The Or-Vi reference point shall support the Virtualised Network Resources Quota Management interface provided by the VIM
Or-Vi.024	The Or-Vi reference point shall support the Virtualised Storage Resources Quota Management interface provided by the VIM.
Or-Vi.025	The Or-Vi reference point shall support the Virtualised Resources Quota Change Notification interface provided by the VIM.
Or-Vi.026	The Or-Vi reference point shall support the Compute Host Reservation Management interface provided by the VIM.
Or-Vi.027	The Or-Vi reference point shall support the Compute Host Reservation Change Notification interface provided by the VIM.
Or-Vi.028	The Or-Vi reference point shall support the Compute Host Capacity Management interface provided by the VIM.
Or-Vi.029	The Or-Vi reference point shall support the Policy Management interface provided by the VIM.

Number	Functional requirement description
Or-Vi.030	The Or-Vi reference point shall support the Data Flow Mirroring Management interface provided by the VIM.

5.3 Interface requirements

5.3.1 Software Image Management interface requirements

Table 5.3.1-1 specifies requirements applicable to the Software Image Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.1-1: Software Image Management interface requirements

Numbering	Functional requirements description
Or-Vi.Sim.001	The Software Image Management interface produced by the VIM on the Or-Vi reference point shall support adding software images in the VIM.
Or-Vi.Sim.002	The Software Image Management interface produced by the VIM on the Or-Vi reference point shall support deleting software images in the VIM.
Or-Vi.Sim.003	The Software Image Management interface produced by the VIM on the Or-Vi reference point should support updating software images in the VIM.
Or-Vi.Sim.004	The Software Image Management interface produced by the VIM on the Or-Vi reference point shall support querying information of software images from the VIM.
NOTE: The Software Image Management Interface addresses software images at virtualisation container level, e.g. VM images.	

5.3.2 Virtualised Resources Information Management interface requirements

Unless differently specified, the requirements in this clause are applicable to Virtualised Compute, Network and Storage Resources Information Management interfaces and apply respectively to consumable virtualised compute, network and storage resources.

Table 5.3.2-1 specifies requirements applicable to the Virtualised Resources Information Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.2-1: Virtualised Resources Information Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrim.001	The Virtualised Resources Information Management interface produced by the VIM on the Or-Vi reference point shall support querying information regarding consumable virtualised resources that can be provided by the VIM.
Or-Vi.Vrim.002	The Virtualised Resources Information Management interface produced by the VIM on the Or-Vi reference point shall support notifications to the consumer of changes to information regarding consumable virtualised resources that can be provided by the VIM.

5.3.3 Virtualised Resources Capacity Management interface requirements

Unless differently specified, the requirements in this clause are applicable to Virtualised Compute, Network and Storage Resources Capacity Management interfaces.

Table 5.3.3-1 specifies requirements applicable to the Virtualised Resources Capacity Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.3-1: Virtualised Resources Capacity Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrcm.001	The Virtualised Resources Capacity Management interface produced by the VIM on the Or-Vi reference point shall support querying the capacity managed by the producer, in terms of: • the amount of available resources (of a certain type and characteristics) (see note 1); and • the amount of allocated resources (of a certain type and characteristics); and • the amount of reserved resources (of a certain type and characteristics); and • the total amount of resources (of a certain type and characteristics) based on input filter criteria.
Or-Vi.Vrcm.002	The Virtualised Resources Capacity Management interface produced by the VIM on the Or-Vi reference point shall support notifications to the consumer of changes in the available, allocated, reserved and total capacity managed by the producer, based on input filter criteria.
Or-Vi.Vrcm.003	The Virtualised Resources Capacity Management interface produced by the VIM on the Or-Vi reference point shall support the query of information about Resource Zones within the NFVI used by the VIM (see note 2).
Or-Vi.Vrcm.004	The Virtualised Resources Capacity Management interface produced by the VIM on the Or-Vi reference point shall support querying information about NFVI-PoPs the VIM administers, such as the geographical location and network connectivity endpoints.
NOTE 1: Available resources exclude allocated resources and reserved resources. NOTE 2: Resource Zones within the NFVI are managed by the PIM function in NFV-MANO, which makes these resource zones available to the VIM for its virtualised resources. The VIM has the visibility for only the NFVI resource zones and the NFVI resources within those resource zones that it uses.	

5.3.4 Network Forwarding Path Management interface requirements

Table 5.3.4-1 specifies requirements applicable to the Network Forwarding Path Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.4-1: Network Forwarding Path Management interface requirements

Numbering	Functional requirements description
Or-Vi.Nfpm.001	The Network Forwarding Path Management interface produced by VIM on the Or-Vi reference point shall support creating Network Forwarding Paths.
Or-Vi.Nfpm.002	The Network Forwarding Path Management interface produced by VIM on the Or-Vi reference point shall support deleting Network Forwarding Paths.
Or-Vi.Nfpm.003	The Network Forwarding Path Management interface produced by VIM on the Or-Vi reference point shall support changing the state of Network Forwarding Paths. The state change can affect the constituent Connection Points and Virtual Links.
Or-Vi.Nfpm.004	The Network Forwarding Path Management interface produced by VIM on the Or-Vi reference point shall support querying information about a Network Forwarding Path.
Or-Vi.Nfpm.005	The Network Forwarding Path Management interface produced by VIM on the Or-Vi reference point shall support creating or updating the classification and selection rules applied to a specific Network Forwarding Path instance.

5.3.5 Virtualised Resources Management interface requirements

Unless differently specified, the requirements in this clause are applicable to Virtualised Compute, Network and Storage Resources Management interfaces and apply respectively to virtualised compute, network and storage resources.

Table 5.3.5-1 specifies requirements applicable to the Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point.

It shall be possible to use virtualised resource descriptors to convey the exchange of information associated to interface operations fulfilled by the requirements in Table 5.3.5-1.

Table 5.3.5-1: Virtualised Resources Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrm.001	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support requesting the allocation of virtualised resources.
Or-Vi.Vrm.002	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support querying information about instantiated virtualised resources.
Or-Vi.Vrm.003	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support updating instantiated virtualised resources (see example).
Or-Vi.Vrm.004	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support terminating instantiated virtualised resources.
Or-Vi.Vrm.005	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support operating instantiated virtualised resources (see note 1).
Or-Vi.Vrm.006	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support scaling instantiated virtualised resources (see note 1).
Or-Vi.Vrm.007	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support migrating instantiated virtualised resources (see note 1).
Or-Vi.Vrm.008	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support attaching instantiated virtualised storage resources to instantiated virtualised compute resources.
Or-Vi.Vrm.009	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support detaching instantiated virtualised storage resources from instantiated virtualised compute resources.
Or-Vi.Vrm.010	The Virtualised Resources Management interface produced by the VIM on the Or-Vi reference point shall support managing the power state of managed virtualised resources. See note 2.
EXAMPLE: Updating the configuration and/or parameterization of an instantiated virtualised resource, changing the power state of an instantiated virtualised resource.	
NOTE 1: This requirement does not apply to the Virtualised Network Resources Management interface. NOTE 2: The present document version supports only managing the power state of virtualised compute resources, hence the requirement only applies to the Virtualised Compute Resource Management interface.	

5.3.6 Virtualised Resources Reservation Management interface requirements

Unless differently specified, the requirements in this clause are applicable to Virtualised Compute, Network and Storage Resources Reservation Management interfaces and apply respectively to virtualised compute, network and storage resource reservations.

Table 5.3.6-1 specifies requirements applicable to the Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.6-1: Virtualised Resources Reservation Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrrm.001	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support creating resource reservations.
Or-Vi.Vrrm.002	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support querying information about resource reservations.
Or-Vi.Vrrm.003	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support updating (e.g. increase or decrease the amount of reserved resources) resource reservations.
Or-Vi.Vrrm.004	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support terminating resource reservations.
Or-Vi.Vrrm.005	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support specifying during the creation or update of the reservation the start and end time (or duration) for allocation and usage of resources that are part of the resource reservation.
Or-Vi.Vrrm.006	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support specifying during the creation or update of a reservation the resource zones where the resources need to be reserved.
Or-Vi.Vrrm.007	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support the resource reservation at different resource granularities.
Or-Vi.Vrrm.008	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support the resource reservation at virtualisation container (e.g. virtual machine) granularity level.

Numbering	Functional requirements description
Or-Vi.Vrrm.009	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support the resource reservation at resource pool granularity level.
Or-Vi.Vrrm.010	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support identifying the consumer (e.g. tenant) of the reserved resources during the creation and update of the respective resource reservation.

5.3.7 Virtualised Resource Reservation Change Notification interface requirements

Table 5.3.7-1 specifies requirements applicable to the Virtualised Resource Reservation Change Notification interface produced by the VIM on the Or-Vi reference point.

Table 5.3.7-1: Virtualised Resource Reservation Change Notification interface requirements

Numbering	Functional requirements description
Or-Vi.Vrrcn.001	The Virtualised Resources Reservation Change Notification interface produced by the VIM on the Or-Vi reference point shall support notification of changes related to virtualised resource reservation.

5.3.8 Virtualised Resources Change Notification interface requirements

Unless differently specified, the requirements in this clause are applicable to Virtualised Compute, Network and Storage Resources Change Notification interfaces and apply respectively to virtualised compute, network and storage resources.

Table 5.3.8-1 specifies requirements applicable to the Virtualised Resources Change Notification interface produced by the VIM on the Or-Vi reference point.

Table 5.3.8-1: Virtualised Resources Change Notification interface requirements

Numbering	Functional requirements description
Or-Vi.Vrcn.001	The Virtualised Resource Change Notification interface produced by the VIM on the Or-Vi reference point shall support providing state change notifications about virtualised resources, e.g. that will be impacted due to maintenance of NFVI components, evacuation of physical hosts, addition and termination of resources, or migration to support energy efficiency.

5.3.9 Virtualised Resources Performance Management interface requirements

Table 5.3.9-1 specifies requirements applicable to the Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.9-1: Virtualised Resources Performance Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrpm.001	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall enable the NFVO to control the collection and reporting of performance information for virtualised resources.
Or-Vi.Vrpm.002	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support the capability to notify the availability of performance information.
Or-Vi.Vrpm.003	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall expose the type of virtualised resources (e.g. compute, storage, network), for which the VIM collects the performance information in the NFVI domain.
Or-Vi.Vrpm.004	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall expose the type of performance information that the VIM can collect for the monitored virtualised resource(s).

Numbering	Functional requirements description
Or-Vi.Vrpm.005	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall enable the NFVO create a PM job specifying the type of resource(s) and performance information that the NFVO requires.
Or-Vi.Vrpm.006	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall enable NFVO to create a PM job specifying the granularity for collection and reporting of performance information from specified virtualised resource(s).
Or-Vi.Vrpm.007	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall enable the NFVO to delete a PM job.
Or-Vi.Vrpm.008	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall enable the NFVO to receive notifications of data availability for a PM job.
Or-Vi.Vrpm.009	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support PM jobs for periodic collection of performance information (bounded or unbounded).
Or-Vi.Vrpm.010	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support the grouping of measurements (see note).
Or-Vi.Vrpm.011	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support the setting of threshold conditions on the performance information collected by the VIM for specified virtualised resource(s).
Or-Vi.Vrpm.012	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support the deletion of threshold conditions on the performance information collected by the VIM for specified virtualised resource(s).
Or-Vi.Vrpm.013	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support the capability to notify about a threshold defined for a specified metric of a virtualised resource being crossed.
Or-Vi.Vrpm.014	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall enable the NFVO to receive notifications related to threshold crossing.
Or-Vi.Vrpm.015	The Virtualised Resources Performance Management interface produced by the VIM on the Or-Vi reference point shall support querying the list of active PM jobs and defined threshold conditions by the consumer entity that created them.
NOTE: The group does not imply any modification/aggregation of performance measurements data and may be viewed as an alias for a pre-defined list of measurements. The group can be created by e.g. device type, by port type, by virtual machine, etc.	

5.3.10 Virtualised Resources Fault Management interface requirements

Table 5.3.10-1 specifies requirements applicable to the Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.10-1: Virtualised Resources Fault Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrfm.001	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall enable the NFVO to collect virtualised resource fault information.
Or-Vi.Vrfm.002	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall support providing alarm notifications related to faults on virtualised resources to the NFVO.
Or-Vi.Vrfm.003	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall support providing notification when there is a change in alarm information on virtualised resources.
Or-Vi.Vrfm.004	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall support the sending of notification to the NFVO when an alarm has been created.
Or-Vi.Vrfm.005	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall support the sending of notification to the NFVO when an alarm has been cleared.
Or-Vi.Vrfm.006	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall allow unambiguous identification of the alarm sent to the NFVO.
Or-Vi.Vrfm.007	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall allow unambiguous identification of the virtualised resources causing the alarm.
Or-Vi.Vrfm.008	The Virtualised Resources Fault Management interface produced by the VIM on the Or-Vi reference point shall allow unambiguous identification of the alarm cause.

5.3.11 Virtualised Resources Quota Management interface requirements

Unless differently specified, the requirements in this clause are applicable to Virtualised Compute, Network and Storage Resources Quota Management interfaces and apply respectively to virtualised compute, network and storage resource.

Table 5.3.11-1 specifies requirements applicable to the Virtualised Resources Quota Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.11-1: Virtualised Resources Quota Management interface requirements

Numbering	Functional requirements description
Or-Vi.Vrqm.001	The Virtualised Resources Quota Management interface produced by the VIM on the Or-Vi reference point shall support creating resource quota. See note.
Or-Vi.Vrqm.002	The Virtualised Resources Quota Management interface produced by the VIM on the Or-Vi reference point shall support querying information about resource quota.
Or-Vi.Vrqm.003	The Virtualised Resources Quota Management interface produced by the VIM on the Or-Vi reference point shall support updating (e.g. increase or decrease the amount of resources in the quota) resource quota.
Or-Vi.Vrqm.004	The Virtualised Resources Quota Management interface produced by the VIM on the Or-Vi reference point shall support terminating resource quota.
Or-Vi.Vrqm.005	The Virtualised Resources Quota Management interface produced by the VIM on the Or-Vi reference point shall support identifying the consumer (e.g. tenant) of the virtualised resources during the creation and update of the respective resource quota.
NOTE: As an option to create Quotas a VIM can associate default quotas to every "infrastructure resource group" and allow the modification of these default Quotas.	

5.3.12 Compute Host Reservation Management interface requirements

Table 5.3.12-1 specifies requirements applicable to the Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.12-1: Compute Host Reservation Management interface requirements

Numbering	Functional requirements description
Or-Vi.Chrm.001	The Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point shall support creating compute host reservations.
Or-Vi.Chrm.002	The Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point shall support querying information about compute host reservations.
Or-Vi.Chrm.003	The Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point shall support updating compute host reservations (e.g. increase the minimum amount of compute hosts to be reserved).
Or-Vi.Chrm.004	The Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point shall support terminating compute host reservations.
Or-Vi.Chrm.005	The Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point shall support specifying during the creation or update of the reservation the start and end time (or duration) for allocation and usage of virtualised compute resources on reserved compute hosts.
Or-Vi.Chrm.006	The Compute Host Reservation Management interface produced by the VIM on the Or-Vi reference point shall support specifying during the creation or update of the reservation the set of properties that define the capabilities associated to the compute hosts (e.g. hypervisor capabilities) to be reserved.
Or-Vi.Chrm.007	The Virtualised Resources Reservation Management interface produced by the VIM on the Or-Vi reference point shall support identifying the consumer (e.g. tenant) of the reserved resources during the creation and update of the respective compute host reservation.

5.3.13 Compute Host Reservation Change Notification interface requirements

Table 5.3.13-1 specifies requirements applicable to the Compute Host Reservation Change Notification interface produced by the VIM on the Or-Vi reference point.

Table 5.3.13-1: Compute Host Reservation Change Notification interface requirements

Numbering	Functional requirements description
Or-Vi.Chrcn.001	The Compute Host Reservation Change Notification interface produced by the VIM on the Or-Vi reference point shall support notification of changes related to compute host reservation.

5.3.14 Compute Host Capacity Management interface requirements

Table 5.3.14-1 specifies requirements applicable to the Compute Host Capacity Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.14-1: Compute Host Capacity Management interface requirements

Numbering	Functional requirements description
Or-Vi.Chcm.001	The Compute Host Capacity Management interface produced by the VIM on the Or-Vi reference point shall support querying based on input filter criteria the capacity managed by the producer, in terms of: • the amount of available resources (see note); and • the amount of used resources; and • the amount of reserved resources; and • the total amount of resources.
Or-Vi.Chcm.002	The Compute Host Capacity Management interface produced by the VIM on the Or-Vi reference point shall support notifications to the consumer of changes in the available, allocated, reserved and total capacity managed by the producer, based on input filter criteria.
NOTE: Available resources exclude used resources and reserved resources.	

5.3.15 Policy Management interface requirements

Table 5.3.15-1 specifies requirements applicable to the policy management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.15-1: Policy management interface requirements

Numbering	Requirements description
Or-Vi.Plcm.001	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support transferring NFV-MANO policies. See notes 1 and 2.
Or-Vi.Plcm.002	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support deleting NFV-MANO policies. See note 1.
Or-Vi.Plcm.003	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support querying NFV-MANO policies. See note 1.
Or-Vi.Plcm.004	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support activating NFV-MANO policies. See note 1.
Or-Vi.Plcm.005	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support deactivating NFV-MANO policies. See note 1.
Or-Vi.Plcm.006	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support providing to the NFVO notifications about changes of a policy that are related to operations of transferring policy, deleting policy, activating policy and deactivating policy.
Or-Vi.Plcm.007	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support providing to the NFVO notifications about any detected policy conflicts.
Or-Vi.Plcm.008	The Policy Management interface produced by the VIM on the Or-Vi reference point shall support subscribing to policy management related notifications.
NOTE 1: For this reference point, NFV-MANO policies include policies applied in virtualised resource management (resource allocation, reservation, quota management and capacity management). NOTE 2: The case of transferring NFV-MANO policy applies when: - a new policy is imported from the NFVO, which results in the creation of a new policy locally; or - the changes for an existing policy are imported from the NFVO, which results in the update of a policy locally.	

5.3.16 Data Flow Mirroring Management interface requirements

Table 5.3.16-1 specifies requirements applicable to the Data Flow Mirroring Management interface produced by the VIM on the Or-Vi reference point.

Table 5.3.16-1: Data Flow Mirroring Management interface requirements

Numbering	Functional requirements description
Or-Vi.Dfmm.001	The Data Flow Mirroring Management interface produced by the VIM on the Or-Vi reference point shall support creating Data Flow Mirroring Job.
Or-Vi. Dfmm.002	The Data Flow Mirroring Management interface produced by the VIM on the Or-Vi reference point shall support deleting Data Flow Mirroring Job.
Or-Vi. Dfmm.003	The Data Flow Mirroring Management interface produced by the VIM on the Or-Vi reference point shall support updating Data Flow Mirroring Job.
Or-Vi. Dfmm.004	The Data Flow Mirroring Management interface produced by the VIM on the Or-Vi reference point shall support querying information about Data Flow Mirroring Job.

6 NFVO exposed interfaces facing the VIM

There are no interfaces exposed by the NFVO associated to the Or-Vi reference point.

7 VIM exposed Interfaces

7.1 Introduction

This clause defines the interfaces exposed by the VIM towards the NFVO over the Or-Vi reference point.

NOTE 1: The fact that operation parameters and information element attributes are presented in tabular form does not preclude stage 3 designs in which these operation parameters and information element attributes are encoded in different parts of request and response messages. For example, in a RESTful interface, parts of them may be encoded in the URL, in the message header, in the message body or any combination thereof.

NOTE 2: The present document version does not specify the required operations for the management of resource groups for infrastructure tenants (e.g. creation of a resource group, etc.). The management of resource groups is necessary to support operations where a "resourceGroupId" is carried in input and/or output parameters of the operations. Refer to interface operations:

- add image operation (clause 7.2.2);
- allocate virtualised compute, network and storage resource operations (clauses 7.3.1.2, 7.4.1.2 and 7.5.1.2);
- create compute, network and storage resource reservation operations (clauses 7.8.1.2, 7.8.2.2 and 7.8.3.2); and
- virtualised Resource Quota interface operations (clauses 7.9.1.2, 7.9.1.3, 7.9.1.4, 7.9.1.5, 7.9.2.2, 7.9.2.3, 7.9.2.4, 7.9.2.5, 7.9.3.2, 7.9.3.3, 7.9.3.4 and 7.9.3.5).

7.2 Software Image Management Interface

7.2.1 Description

This interface allows an authorized consumer functional block to manage the software images in a VIM.

NOTE 1: This interface addresses software images at Virtualisation Container level, e.g. VM images.

NOTE 2: While not shown explicitly, interfaces may be consumed by authenticated and authorized other parties.

NOTE 3: The interface exposure assumes (but does not mandate that) software images are stored in repositories managed by the VIM(s) in order to minimize delays incurred on transferring such software images after initiation of the VNF lifecycle.

NOTE 4: All the operations applicable on multiple images are assumed to be best effort.

7.2.2 Add Image operation

7.2.2.1 Description

This operation allows adding a new software image to the image repository managed by the VIM.

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

Table 7.2.2.1-1: Add Image operation

Message	Requirement	Direction
AddImageRequest	Mandatory	NFVO → VIM
AddImageResponse	Mandatory	VIM → NFVO

7.2.2.2 Input parameters

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

Table 7.2.2.2-1: Add Image operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
name	M	1	String	Name of the software image.
provider	M	1	String	Provider of the software image.
version	M	1	Not specified	Version of the software image.
userMetadata	M	0..N	KeyValuePair	User-defined metadata.
softwareImage	M	1	Not specified	Binary software image file.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
visibility	M	1	Enum	Controls the visibility of the image. VALUES: • PRIVATE • PUBLIC In case of "PRIVATE" value, the image is available only for the tenant assigned to the provided resourceGroupId and the administrator tenants of the VIM while in case of "PUBLIC" value, all tenants of the VIM can use the image.

7.2.2.3 Output parameters

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

Table 7.2.2.3-1: Add Image operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageMetadata	M	1	SoftwareImageInformation	Metadata about the software image that has been added. See clause 8.2.2.

7.2.2.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not the image was successfully added to the image repository.

7.2.3 Query Images operation

7.2.3.1 Description

This operation allows querying the information of the software images in the image repository managed by the VIM.

For example, this would allow retrieving information of a selection of images previously provisioned, based on filtering criteria using the image metadata or to obtain URIs of images based on metadata criteria in order to apply an update or delete operation on them.

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

Table 7.2.3.1-1: Query Images operation

Message	Requirement	Direction
QueryImagesRequest	Mandatory	NFVO → VIM
QueryImagesResponse	Mandatory	VIM → NFVO

7.2.3.2 Input parameters

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

Table 7.2.3.2-1: Query Images operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
imageQueryFilter	M	1	Filter	Filter used to select the software image instances on which this operation is to act.

7.2.3.3 Output parameters

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

Table 7.2.3.3-1: Query Images operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageInformation	M	0..N	SoftwareImageInformation	Information of all software images matching the query. See clause 8.2.2.

7.2.3.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not it was possible to process the query.

7.2.4 Query Image operation

7.2.4.1 Description

This operation allows querying information about a specific software image in the image repository managed by the VIM.

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

Table 7.2.4.1-1: Query Image operation

Message	Requirement	Direction
QueryImageRequest	Mandatory	NFVO → VIM
QueryImageResponse	Mandatory	VIM → NFVO

7.2.4.2 Input Parameters

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

Table 7.2.4.2-1: Query Image operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageId	M	1	Identifier	Identifier of the software image to be queried.

7.2.4.3 Output Parameters

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

Table 7.2.4.3-1: Query Image operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageInformation	M	0..1	SoftwareImageInformation	Information of the software image matching the query. See clause 8.2.2.

7.2.4.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not it was possible to process the query.

7.2.5 Update Image operation

7.2.5.1 Description

This operation enables the update of a software image in the VIM.

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

Table 7.2.5.1-1: Update Image operation

Message	Requirement	Direction
UpdateImageRequest	Mandatory	NFVO → VIM
UpdateImageResponse	Mandatory	VIM → NFVO

7.2.5.2 Input parameters

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

Table 7.2.5.2-1: Update Image operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageId	M	1	Identifier	Identifier of the software image to be updated.
userMetadata	M	0..N	KeyValuePair	User-defined metadata for the software image.

7.2.5.3 Output parameters

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

Table 7.2.5.3-1: Update Image operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageMetadata	M	1	SoftwareImageInformation	Updated metadata of the software image. See clause 8.2.2.

7.2.5.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not the software image was successfully updated.

7.2.6 Delete Image operation

7.2.6.1 Description

This operation enables the deletion of a software image from the VIM.

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

Table 7.2.6.1-1: Delete Image operation

Message	Requirement	Direction
DeleteImageRequest	Mandatory	NFVO → VIM
DeleteImageResponse	Mandatory	VIM → NFVO

7.2.6.2 Input parameters

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

Table 7.2.6.2-1: Delete Image operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageId	M	1	Identifier	Identifier of the software image to be deleted.

7.2.6.3 Output parameters

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

Table 7.2.6.3-1: Delete Image operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedId	O	0..1	Identifier	Identifier of the software image successfully deleted.

7.2.6.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not the selected software image was successfully deleted. A software image is successfully deleted when the image is no longer visible in the VIM interfaces, physical resources of the image can be cleaned up after the operation returned.

7.3 Virtualised Compute Interfaces

7.3.1 Virtualised Compute Resources Management Interface

7.3.1.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised compute resources available to the consumer functional block. The interface includes operations for allocating, querying, updating and terminating virtualised compute resources as well as operations for scaling, migrating and operating the administrative status of a virtualised compute resource.

7.3.1.2 Allocate Virtualised Compute Resource operation

7.3.1.2.1 Description

This operation allows requesting the allocation of virtualised compute resources as indicated by the consumer functional block.

Table 7.3.1.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.2.1-1: Allocate Virtualised Compute Resource operation

Message	Requirement	Direction
AllocateComputeRequest	Mandatory	NFVO → VIM
AllocateComputeResponse	Mandatory	VIM → NFVO

7.3.1.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.2.2-1.

Table 7.3.1.2.2-1: Allocate Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeName	M	0..1	String	Name provided by the consumer for the virtualised compute resource to be allocated. It can be used for identifying resources from consumer side.
reservationId	M	0..1	Identifier	Identifier of the resource reservation applicable to this virtualised resource management operation. Cardinality can be 0 if no resource reservation was used.
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinity Constraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to be allocated. All the listed constraints shall be fulfilled for a successful operation.
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour that is providing information about the particular memory, CPU and disk resources for virtualised compute resource to be allocated. The Compute Flavour is created with Create Compute Flavour operation (see clause 7.3.5.2). For the content of Compute Flavour see clause 8.4.2.2.
vcImageId	M	0..1	Identifier	Identifier of the virtualisation container software image (e.g. a virtual machine image). Cardinality can be 0 if an "empty" virtualisation container is allocated.
interfaceData	M	0..N	VirtualInterfaceData	Data of network interfaces which are specific to a Virtual Compute Resource instance. See clause 8.4.3.7.

Parameter	Qualifier	Cardinality	Content	Description
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
locationConstraints	M	0..1	Not specified	If present, it defines location constraints for the resource(s) is (are) requested to be allocated, e.g. in what particular resource zone.
userData	M	0..1	UserData	Contains user data to customize the virtualised compute resource at boot-time. See note.
NOTE: The user data may consist of static data obtained from an attribute in the VNFD and/or data provided by the NFVO or the EM to the VNFM in the operation that triggers the invocation of the Allocate Virtualised Compute Resource operation, e.g. the Instantiate VNF operation. The user data is transparent to the VIM. It is passed to the allocated virtualised compute resource where it is up to the guest software to avail of it in order to e.g. configure credentials, address information, etc.				

7.3.1.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.2.3-1.

Table 7.3.1.2.3-1: Allocate Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeData	M	1	VirtualCompute	Contains information of the newly instantiated virtualised compute resource. See clause 8.4.3.2.

7.3.1.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the virtualised compute resource and allocated this resource according to the input requirements and constraints. In addition, the VIM shall return to the NFVO information on the newly instantiated virtualised compute resource plus any additional information about the allocate request operation. The VIM may also return intermediate status reports during the allocation process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.1.3 Query Virtualised Compute Resource operation

7.3.1.3.1 Description

This operation allows querying information about instantiated virtualised compute resources.

Table 7.3.1.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.3.1-1: Query Virtualised Compute Resource operation

Message	Requirement	Direction
QueryComputeRequest	Mandatory	NFVO → VIM
QueryComputeResponse	Mandatory	VIM → NFVO

7.3.1.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.3.2-1.

Table 7.3.1.3.2-1: Query Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryComputeFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more resources to be queried by providing their identifiers.

7.3.1.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.3.3-1.

Table 7.3.1.3.3-1: Query Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualCompute	Contains information about the virtual compute resource(s) matching the filter. The cardinality can be 0 if no matching compute resources exist. See clause 8.4.3.2.

7.3.1.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised compute resources. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the compute resources that the NFVO has access to and that are matching the filter shall be returned.

7.3.1.4 Update Virtualised Compute Resource operation

7.3.1.4.1 Description

This operation allows updating the configuration and/or parameters of an instantiated virtualised compute resource. This can include, for instance, updating metadata adding extra virtual network interfaces to a compute resource, attaching a virtual network interface to a specific network port, or changing the power state of the virtualised compute resource.

Table 7.3.1.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.4.1-1: Update Virtualised Compute Resource operation

Message	Requirement	Direction
UpdateComputeRequest	Mandatory	NFVO → VIM
UpdateComputeResponse	Mandatory	VIM → NFVO

7.3.1.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.4.2-1.

Table 7.3.1.4.2-1: Update Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to be updated.
networkInterfaceNew	M	0..N	VirtualNetworkInterfaceData	New virtual network interface(s) to be added to the compute resource. See note 1. See clause 8.4.2.6.

Parameter	Qualifier	Cardinality	Content	Description
networkInterfaceUpdate	M	0..N	VirtualNetworkInterface	Virtual network interface(s) to be updated on the compute resource. This can include, for instance, attaching/detaching a virtual network interface to/from its port, or re-attaching to another network port. See note 1. See clause 8.4.3.6.
powerStateUpdate	M	0..1	Not specified	Target power state of the virtualised compute resource. This can include changing the power state of virtual CPUs of the compute resource. See notes 1 and 2.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs, used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE 1: Cardinality can be "0", as it is recommended that only one type of update is handled per operation request, either adding new virtual network interfaces (see "networkInterfaceNew" input), updating existing ones (see "networkInterfaceUpdate" input), or changing the power state of the virtualised compute resource is made in a single operation request. NOTE 2: The operation "Operate Virtualised Compute Resource" (see clause 7.3.1.6) enables operating the virtualised compute resource in terms of starting, stopping and suspending, which are also related to power state management.				

7.3.1.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.4.3-1.

Table 7.3.1.4.3-1: Update Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource that has been updated. This parameter has the same value as the input parameter.
computeData	M	1	VirtualCompute	Contains information of the updated attributes of the instantiated virtualised compute resource. See clause 8.4.3.2.

7.3.1.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource. In addition, the VIM shall return to the NFVO information on the updated virtualised compute resource plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.1.5 Terminate Virtualised Compute Resource operation

7.3.1.5.1 Description

This operation allows de-allocating and terminating one or more instantiated virtualised compute resource(s). When the operation is done on multiple resources, it is assumed to be best-effort, i.e. it can succeed for a subset of the resources, and fail for the remaining ones.

Table 7.3.1.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.5.1-1: Terminate Virtualised Compute Resource operation

Message	Requirement	Direction
TerminateComputeRequest	Mandatory	NFVO → VIM
TerminateComputeResponse	Mandatory	VIM → NFVO

7.3.1.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.5.2-1.

Table 7.3.1.5.2-1: Terminate Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1..N	Identifier	Identifier(s) of the virtualised compute resource(s) to be terminated.

7.3.1.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.5.3-1.

Table 7.3.1.5.3-1: Terminate Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1..N	Identifier	Identifier(s) of the virtualised compute resource(s) successfully terminated.

7.3.1.5.4 Operation results

After successful operation, the VIM has terminated the virtualised compute resources and removed the internal management objects for those resources. In addition, the VIM shall return to the NFVO information on the terminated virtualised compute resource plus any additional information about the terminate request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.1.6 Operate Virtualised Compute Resource operation

7.3.1.6.1 Description

This operation allows executing specific operation command on instantiated virtualised compute resources.

Table 7.3.1.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.6.1-1: Operate Virtualised Compute Resource operation

Message	Requirement	Direction
OperateComputeRequest	Mandatory	NFVO → VIM
OperateComputeResponse	Mandatory	VIM → NFVO

7.3.1.6.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.6.2-1.

Table 7.3.1.6.2-1: Operate Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to operate.
computeOperation	M	1	String	Type of operation to be performed on the virtualised compute resource. Possible values are: "start", "stop", "pause", "suspend", "reboot", "quiesce", "unquiesce", "create snapshot", "revert to snapshot" and "delete snapshot".
computeOperationInputData	M	0..N	KeyValuePair	Additional parameters associated to the operation to be performed. For example, if the operation is "delete snapshot", information identifying the snapshot to be deleted is provided.

7.3.1.6.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.6.3-1.

Table 7.3.1.6.3-1: Operate Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeData	M	1	VirtualCompute	Containing information on the new status of the operated virtualised compute resource. See clause 8.4.3.2.
computeOperationOutputData	M	0..N	KeyValuePair	Set of output values depending on the type of operation. For instance, when a snapshot operation is requested, this field provides information about the identifier of the snapshot and its location.

7.3.1.6.4 Operation results

After successful operation, the VIM has executed the requested operation command on the virtualised compute resource. In addition, the VIM shall return to the NFVO information on the new status of the operated virtualised compute resources, operation specific data plus any additional information about the operate request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.1.7 Scale Virtualised Compute Resource operation

7.3.1.7.1 Description

This operation allows scaling a virtualised compute resource by adding or removing capacity in terms of virtual CPUs and virtual memory.

Table 7.3.1.7.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.7.1-1: Scale Virtualised Compute Resource operation

Message	Requirement	Direction
ScaleComputeRequest	Mandatory	NFVO → VIM
ScaleComputeResponse	Mandatory	VIM → NFVO

7.3.1.7.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.7.2-1.

Table 7.3.1.7.2-1: Scale Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to be scaled.
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour that is providing information about the particular memory, CPU and disk resources for virtualised compute resource to be allocated. The Compute Flavour should be created with Create Compute Flavour operation (see clause 7.3.5.2). For the content of Compute Flavour see clause 8.4.2.2.

7.3.1.7.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.7.3-1.

Table 7.3.1.7.3-1: Scale Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeData	M	1	VirtualCompute	Contains information of the scaled virtualised compute resource. See clause 8.4.3.2.

7.3.1.7.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource and has scaled this resource. In addition, the VIM shall return to the NFVO information on the scaled virtualised compute resource plus any additional information about the scale request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.1.8 Migrate Virtualised Compute Resource operation

7.3.1.8.1 Description

This operation allows moving a virtualised compute resource between locations. For instance, the operation performs the migration of a computing resource from one physical machine (host) to another physical machine.

Table 7.3.1.8.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.8.1-1: Migrate Virtualised Compute Resource operation

Message	Requirement	Direction
MigrateComputeRequest	Mandatory	NFVO → VIM
MigrateComputeResponse	Mandatory	VIM → NFVO

7.3.1.8.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.8.2-1.

Table 7.3.1.8.2-1: Migrate Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to be migrated.
migrationConstraint	M	0..1	Not specified	When present, the migration constraint parameter gives indications on where to migrate the resource, e.g. to a specific resource zone.

Parameter	Qualifier	Cardinality	Content	Description
affinityOrAntiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to be migrated. All the listed constraints shall be fulfilled for a successful operation. This information is only necessary if the VIM needs to maintain affinity during the migration operation based on a list of resources.
migrationType	M	1	Enum	Defines the type of migration. VALUES: • LIVE_MIGRATION • OFFLINE_MIGRATION

7.3.1.8.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.8.3-1.

Table 7.3.1.8.3-1: Migrate Virtualised Compute Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeData	M	1	VirtualCompute	Contains information of the new host of the migrated virtualised compute resource. See clause 8.4.3.2.

7.3.1.8.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource and has migrated this resource. In addition, the VIM shall return to the NFVO information on the migrated virtualised compute resource plus any additional information about the migrate request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.1.9 Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group operation

7.3.1.9.1 Description

This operation allows an authorized consumer functional block to request the creation of a resource affinity or anti-affinity constraints group. An anti-affinity group contains resources that are not placed in proximity, e.g. that do not share the same physical NFVI node. An affinity group contains resources that are placed in proximity, e.g. that do share the same physical NFVI node.

This operation shall be supported by the VIM. It shall be supported by the NFVO, if the NFVO supports named resource groups for affinity/anti-affinity (see clause 8.4.8.2).

Table 7.3.1.9.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.9.1-1: Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group operation

Message	Requirement	Direction
CreateComputeResourceAffinityOrAntiAffinityConstraintsGroupRequest	Mandatory	NFVO → VIM
CreateComputeResourceAffinityOrAntiAffinityConstraintsGroupResponse	Mandatory	VIM → NFVO

7.3.1.9.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.9.2-1.

Table 7.3.1.9.2-1: Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
groupName	M	1	String	Name of the group, given by the consumer.
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group. VALUES: • AFFINITY • ANTI_AFFINITY
scope	M	0..1	Enum	Qualifies the scope of the constraint. VALUES: • NFVI_NODE • Etc. Defaults to "NFVI_NODE" if absent.

7.3.1.9.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.9.3-1.

Table 7.3.1.9.3-1: Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
groupId	M	1	Identifier	Identifier of the group

7.3.1.9.4 Operation results

On success, the requested resource affinity or anti-affinity constraints group has been created. On failure, appropriate error information is returned.

7.3.1.10 Attach Virtualised Storage Resource operation

7.3.1.10.1 Description

This operation allows attaching a virtualised storage resource (e.g. volume) to a compute resource.

Table 7.3.1.10.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.10.1-1: Attach Virtualised Storage Resource operation

Message	Requirement	Direction
AttachVirtualisedStorageResourceRequest	Mandatory	NFVO → VIM
AttachVirtualisedStorageResourceResponse	Mandatory	VIM → NFVO

7.3.1.10.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.10.2-1.

Table 7.3.1.10.2-1: Attach Virtualised Storage Resource input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the instantiated virtualised compute resource.
storageId	M	1	Identifier	Identifier of the instantiated virtualised storage resource to be attached.
mountpoint	M	0..1	String	If present, it defines where the virtualised storage resource is to be attached to the compute resource.

7.3.1.10.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.10.3-1.

Table 7.3.1.10.3-1: Attach Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
computeData	M	1	VirtualCompute	Contains information of the virtualised storage resource attached to the compute resource. See clause 8.4.3.2.

7.3.1.10.4 Operation results

In case of success, the virtualised storage resource is attached to the compute resource. In case of failure, the VIM shall return to the NFVO appropriate error information.

7.3.1.11 Detach Virtualised Storage Resource operation

7.3.1.11.1 Description

This operation allows detaching a virtualised storage resource (e.g. volume) from a compute resource.

Table 7.3.1.11.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.1.11.1-1: Detach Virtualised Storage Resource operation

Message	Requirement	Direction
DetachVirtualisedStorageResourceRequest	Mandatory	NFVO → VIM
DetachVirtualisedStorageResourceResponse	Mandatory	VIM → NFVO

7.3.1.11.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.11.2-1.

Table 7.3.1.11.2-1: Detach Virtualised Storage Resource input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the instantiated virtualised compute resource.
storageId	M	1	Identifier	Identifier of the instantiated virtualised storage resource to be detached.

7.3.1.11.3 Output parameters

No output parameter.

7.3.1.11.4 Operation results

In case of success, the virtualised storage resource is detached from the compute resource. In case of failure, the VIM shall return to the NFVO appropriate error information.

7.3.2 Virtualised Compute Resources Change Notification Interface

7.3.2.1 Introduction

This interface allows an authorized consumer functional block to request subscription to virtualised compute resources change notifications and to provide such notification to the subscribed consumer. As such, it provides the notification part of the Virtualised Compute Resource Management interface.

7.3.2.2 Subscribe operation

7.3.2.2.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications related to virtualised compute resource changes sent by the VIM. Specification of filtering mechanism is part of the protocol design.

Table 7.3.2.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.2.2.1-1: Subscribe operation

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

7.3.2.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.2.2.2-1.

Table 7.3.2.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting the virtualised resource(s) or virtual resource group(s) and the related change notifications to subscribe to. This filter can contain information about specific types of changes to subscribe to, or attributes of the resource.

7.3.2.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.2.2.3-1.

Table 7.3.2.2.3-1: Subscribe operation output parameters

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

7.3.2.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to compute resource changes sent by the VIM. 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 NFVO.

7.3.2.3 Notify operation

7.3.2.3.1 Description

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

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

Table 7.3.2.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.2.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation:

- VirtualisedResourceChangeNotification. See clause 8.4.9.

7.3.3 Virtualised Compute Resources Information Management Interface

7.3.3.1 Description

This interface allows an authorized consumer functional block to request operations related to the information about consumable virtualised compute resources. The consumable virtualised compute resources include (not limited to) virtualised compute (virtualised CPU, virtualised memory), virtualised storage, virtualised NIC, etc. which are managed by a VIM.

The information elements related to consumable virtualised compute resources describe the types and characteristics of the virtualised resources that a consumer functional block can request for allocation as part of the Virtualised Compute Resource Management interface. The interface and related parameters also support the retrieval of information necessary for describing the types and characteristics of the virtualised resources that are exposed over the Virtualised Compute Resource Capacity interface.

The following operations are defined for this interface:

1) Subscribe resources information changes operation.
2) Notify resources information changes operation.
3) Query resources information operation.

7.3.3.2 Subscribe operation

7.3.3.2.1 Description

This operation enables the NFVOs to subscribe for the notifications related to information changes about consumable virtualised compute resources. This also enables the NFVO to specify the scope of the subscription in terms of the specific virtual compute resources to be reported by the VIM using a filter as the input.

Table 7.3.3.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.3.2.1-1: Subscribe operation

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

7.3.3.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.3.2.2-1.

Table 7.3.3.2.2-1: Subscribe operation input parameters

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

7.3.3.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.3.2.3-1.

Table 7.3.3.2.3-1: Subscribe operation output parameters

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

7.3.3.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to information changes about consumable virtualised compute resources sent by the VIM. 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 NFVO.

7.3.3.3 Notify operation

7.3.3.3.1 Description

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

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

Table 7.3.3.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.3.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- InformationChangeNotification. See clause 8.3.2.

7.3.3.4 Query Virtualised Compute Resource Information operation

7.3.3.4.1 Description

This operation supports retrieval of information for the various types of virtualised compute resources managed by the VIM.

Table 7.3.3.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.3.4.1-1: Query Virtualised Compute Resource Information operation

Message	Requirement	Direction
QueryVirtualComputeResourceInfoRequest	Mandatory	NFVO → VIM
QueryVirtualComputeResourceInfoResponse	Mandatory	VIM → NFVO

7.3.3.4.2 Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.3.4.2-1.

Table 7.3.3.4.2-1: Query Virtualised Compute Resource Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
informationQueryFilter	M	1	Filter	Filter defining the information of consumable virtualised resources on which the query applies.

7.3.3.4.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.3.4.3-1.

Table 7.3.3.4.3-1: Query Virtualised Compute Resource Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
virtualisedResourceInformation	M	0..N	VirtualComputeResourceInformation	Virtualised compute resource information in the VIM that satisfies the query condition. See clause 8.3.3.2.

7.3.3.4.4 Operation results

After successful operation, the VIM has run the query for the various types of virtualised compute resources. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about for the various types of virtualised compute resources that are matching the filter shall be returned.

7.3.4 Virtualised Compute Resources Capacity Management Interface

7.3.4.1 Introduction

This interface allows an authorized consumer functional block to request operations related to capacity and usage reporting. The interface allows retrieval of information about:

- The available, allocated, reserved and total capacity of the compute resources managed by a VIM instance, globally or per resource zone.
- Utilization of the capacity, both on VIM global level but also per resource zone.
- The geographical location and network connectivity endpoints (e.g. network gateway) to the NFVI-PoP(s) administered by the VIM.

NOTE 1: This provides information to determine the network endpoints to reach VNFs instantiated making use of virtualised compute resources managed by the VIM. This information may be used by the NFVO for building and keeping NFVI-PoP topology information.

NOTE 2: For per resource zone capacity information, the VIM provides only the information about the virtualised resources it manages within that resource zone. Other resources within a particular resource zone (e.g. physical resources, CIS cluster resources) that are not used by the VIM are not factored in the capacity information per resource zone.

The interface enables the capture of information for resources usage and input to capacity planning, capacity changes, and consequently for Network Service planning, etc.

The interface also enables the query of information about compute-related Resource Zones within the NFVI-PoP(s) used by the VIM-managed virtualised compute resources.

7.3.4.2 Query Compute Capacity operation

7.3.4.2.1 Description

This operation supports retrieval of capacity information for the various types of consumable virtualised compute resources available in the Virtualised Compute Resources Information Management Interface.

Table 7.3.4.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.4.2.1-1: Query Compute Capacity operation

Message	Requirement	Direction
QueryComputeCapacityRequest	Mandatory	NFVO → VIM
QueryComputeCapacityResponse	Mandatory	VIM → NFVO

7.3.4.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.4.2.2-1.

Table 7.3.4.2.2-1: Query Compute Capacity operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier	When specified, this parameter identifies the resource zone for which the capacity is requested. When not specified, the total capacity managed by the VIM instance is to be returned.
computeResourceTypeId	M	0..1	Identifier	Identifier of the resource type for which the issuer wants to know the available, total, reserved and/or allocated capacity (see note 1).
resourceCriteria	M	0..1	Not specified	Input capacity computation parameter for selecting the virtual memory, virtual CPU and acceleration capabilities for which the issuer wants to know the available, total, reserved and/or allocated capacity. Selecting parameters/attributes that shall be used are defined in the VirtualComputeResourceInformation, VirtualCpuResourceInformation, and VirtualMemoryResourceInformation information elements (see note 2). This information element and the computeResourceTypeId are mutually exclusive (see note 1).
attributeSelector	M	0..1	String	Input parameter for selecting which capacity information (i.e. available, total, reserved and/or allocated capacity) is queried. When not present, all four values are requested.
timePeriod	M	0..1	TimePeriodInformation	Time interval for which capacity is queried. When omitted, an interval starting "now" is used. The time interval can be specified since resource reservations can be made for a specified time interval. See clause 8.7.2.

NOTE 1: If the issuer wishes to query for capacity information related to a resource type discovered by the Virtualised Compute Resources Information Management interface (i.e. by the Query Virtualised Compute Resource Information operation, see clause 7.3.3.4), it may use the computeResourceTypeId obtained via that interface. If the issuer wants to specify the characteristics of the resource type for which capacity information is needed, it shall use the resourceCriteria IE. This can be the case e.g. when there is no resource type obtained via the Virtualised Compute Resources Information management interface exactly matching the wanted characteristics or when the issuer wishes to obtain capacity information in a granularity not matching the resource types.

NOTE 2: Not all VirtualComputeResourceInformation, VirtualCpuResourceInformation, and VirtualMemoryResourceInformation IEs or not all attributes of these IEs might be relevant for a capacity query.

7.3.4.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.4.2.3-1.

Table 7.3.4.2.3-1: Query Compute Capacity operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityResponse	M	1	CapacityInformation	Capacity during the requested time period. The scope is according to parameter zoneId of the request during the time interval. See clause 8.7.3.

7.3.4.2.4 Operation results

After successful operation, the VIM has queried the capacity information for the various types of consumable virtualised compute resources. The result of the query shall indicate with a standard success/error result if the query has been processed correctly.

7.3.4.3 Subscribe operation

7.3.4.3.1 Description

This operation supports subscribing to compute capacity change notifications.

Table 7.3.4.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.4.3.1-1: Subscribe operation

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

7.3.4.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.4.3.2-1.

Table 7.3.4.3.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier	When specified, this parameter identifies the resource zone for which the capacity change notifications are requested. When not specified, the total capacity managed by the VIM instance is to be notified.
computeResourceTypeId	M	0..1	Identifier	Identifier of the resource type for which the issuer wants to know the available, total, reserved and/or allocated capacity (see note 1).

Parameter	Qualifier	Cardinality	Content	Description
resourceCriteria	M	0..1	Not specified	Input capacity computation parameter for selecting the virtual memory, virtual CPU and acceleration capabilities for which the issuer wants to know the available, total, reserved and/or allocated capacity. Selecting parameters/attributes that shall be used are defined in the VirtualComputeResourceInformation, VirtualCpuResourceInformation, and VirtualMemoryResourceInformation information elements (see note 2). This information element and the computeResourceTypeId are mutually exclusive (see note 1).
threshold	M	0..N	ResourceCapacityThreshold	When specified, this parameter indicates a capacity value which, once crossed, will trigger a notification. When not specified, notifications are issued at every change (see note 3). See clause 8.7.5.
attributeSelector	M	0..1	String	Input parameter for selecting which capacity information (i.e. available, total, reserved and/or allocated capacity) the subscription refers to. When not present, all four values are requested.

NOTE 1: If the issuer wishes to subscribe for capacity information related to a resource type discovered by the Virtualised Compute Resources Information management interface (i.e. by the Query Virtualised Compute Resource Information operation, see clause 7.3.3.4), it may use the computeResourceTypeId obtained via that interface. If the issuer wants to specify the characteristics of the resource type for which capacity information is needed, it shall use the resourceCriteria IE. This can be the case e.g. when there is no resource type obtained via the Virtualised Compute Resources Information Management interface exactly matching the wanted characteristics or when the issuer wishes to obtain capacity information in a granularity not matching the resource types.
NOTE 2: Not all VirtualComputeResourceInformation, VirtualCpuResourceInformation, and VirtualMemoryResourceInformation IEs or not all attributes of these IEs might be relevant for a capacity subscription.
NOTE 3: The VIM may still implement a minimum-delta threshold in order to avoid an excessive notification flow.

7.3.4.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.4.3.3-1.

Table 7.3.4.3.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityChangeSubscriptionId	M	1	Identifier	Subscription Id

7.3.4.3.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to compute capacity changes sent by the VIM. 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 NFVO.

7.3.4.4 Notify operation

7.3.4.4.1 Description

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

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

Table 7.3.4.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.4.4.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- CapacityChangeNotification. See clause 8.7.4.

7.3.4.5 Query Compute Resource Zone operation

7.3.4.5.1 Description

This operation enables the NFVO to query information about a Resource Zone, e.g. listing the properties of the Resource Zone, and other metadata.

Table 7.3.4.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.4.5.1-1: Query Compute Resource Zone operation

Message	Requirement	Direction
QueryComputeResourceZoneRequest	Mandatory	NFVO → VIM
QueryComputeResourceZoneResponse	Mandatory	VIM → NFVO

7.3.4.5.2 Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.4.5.2-1.

Table 7.3.4.5.2-1: Query Compute Resource Zone operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting information to query. For instance, based on identifier of the Resource Zone, identifier of the NFVI-PoP, properties of the Resource Zone or other meta-data.

7.3.4.5.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.4.5.3-1.

Table 7.3.4.5.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneInfo	M	0..N	ResourceZone	Filtered information that has been retrieved about the Resource Zone (see clause 8.10.2). The cardinality can be 0 if no matching information exists.

7.3.4.5.4 Operation Results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether the operation has been processed satisfactorily or it has failed.

7.3.4.6 Query NFVI-PoP Compute Information operation

7.3.4.6.1 Description

This operation enables the NFVOs to query general information to the VIM concerning the geographical location and network connectivity endpoints to the NFVI-PoP(s) administered by the VIM, and to determine network endpoints to reach VNFs instantiated making use of virtualised compute resources in the NFVI as specified by the exchanged information elements.

Table 7.3.4.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.4.6.1-1: Query NFVI-PoP Compute Information operation

Message	Requirement	Direction
NfviPopComputeInformationRequest	Mandatory	NFVO → VIM
NfviPopComputeInformationResponse	Mandatory	VIM → NFVO

7.3.4.6.2 Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.4.6.2-1.

Table 7.3.4.6.2-1: Query NFVI-PoP Compute Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting information to query.

7.3.4.6.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.4.6.3-1.

Table 7.3.4.6.3-1: Query NFVI-PoP Compute Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
nfviInfo	M	0..N	NfviPop	Filtered information that has been retrieved (see clause 8.10.3). The cardinality can be 0 if no matching information exists.

7.3.4.6.4 Operation Results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether the operation has been processed satisfactorily or it has failed.

7.3.5 Virtualised Compute Flavour Management Interface

7.3.5.1 Introduction

This interface allows an authorized consumer functional block to request operations related to flavours. The interface includes operations for allocating, querying, updating and terminating flavours.

7.3.5.2 Create Compute Flavour operation

7.3.5.2.1 Description

This operation allows requesting the creation of a flavour as indicated by the consumer functional block.

Table 7.3.5.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.5.2.1-1: Create Compute Flavour operation

Message	Requirement	Direction
CreateComputeFlavourRequest	Mandatory	NFVO → VIM
CreateComputeFlavourResponse	Mandatory	VIM → NFVO

7.3.5.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.5.2.2-1.

Table 7.3.5.2.2-1: Create Compute Flavour operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
Flavour	M	1	VirtualComputeFlavour	Provides information about the particular memory, CPU and disk resources for virtualised compute resource to be allocated. See clause 8.4.2.2.

7.3.5.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.5.2.3-1.

Table 7.3.5.2.3-1: Create Compute Flavour operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
flavourId	M	1	Identifier	Identifier of the created Compute Flavour.

7.3.5.2.4 Operation results

After successful operation, the VIM has created the Compute Flavour. In addition, the VIM shall return to the NFVO information on the newly created Compute Flavour.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.3.5.3 Query Compute Flavour operation

7.3.5.3.1 Description

This operation allows querying information about created Compute Flavours.

Table 7.3.5.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.5.3.1-1: Query Compute Flavour operation

Message	Requirement	Direction
QueryComputeFlavourRequest	Mandatory	NFVO → VIM
QueryComputeFlavourResponse	Mandatory	VIM → NFVO

7.3.5.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.5.3.2-1.

Table 7.3.5.3.2-1: Query Compute Flavour operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryComputeFlavourFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more Compute Flavours to be queried by providing their identifiers.

7.3.5.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.5.3.3-1.

Table 7.3.5.3.3-1: Query Compute Flavour operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
flavours	M	0..N	VirtualComputeFlavour	List of Compute Flavours matching the query. For the definition of Compute Flavour see clause 8.4.2.2.

7.3.5.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the Compute Flavours. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the Compute Flavours that the NFVO has access to and that are matching the filter shall be returned.

7.3.5.4 Delete Compute Flavour operation

7.3.5.4.1 Description

This operation allows deleting a Compute Flavour.

Table 7.3.5.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.3.5.4.1-1: Delete Compute Flavour operation

Message	Requirement	Direction
DeleteComputeFlavourRequest	Mandatory	NFVO → VIM
DeleteComputeFlavourResponse	Mandatory	VIM → NFVO

7.3.5.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.5.4.2-1.

Table 7.3.5.4.2-1: Delete Compute Flavour operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour to be deleted.

7.3.5.4.3 Output parameters

No output parameters.

7.3.5.4.4 Operation results

After successful operation, the VIM has deleted the Compute Flavour, so no new Virtualised Compute Resource can be allocated based on it. The already allocated Virtualised Compute Resources are not affected.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.4 Virtualised Network Interfaces

7.4.1 Virtualised Network Resources Management Interface

7.4.1.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised network resources available to the consumer functional block. The interface includes operations for allocating, querying, updating and terminating virtualised network resources.

7.4.1.2 Allocate Virtualised Network Resource operation

7.4.1.2.1 Description

This operation allows an authorized consumer functional block to request the allocation of virtualised network resources as indicated by the consumer functional block.

Table 7.4.1.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.1.2.1-1: Allocate Virtualised Network Resource operation

Message	Requirement	Direction
AllocateNetworkRequest	Mandatory	NFVO → VIM
AllocateNetworkResponse	Mandatory	VIM → NFVO

7.4.1.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.1.2.2-1.

Table 7.4.1.2.2-1: Allocate Virtualised Network Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
networkResourceName	M	0..1	String	Name provided by the consumer for the virtualised network resource to be allocated. It can be used for identifying resources from consumer side.
reservationId	M	0..1	Identifier	Identifier of the resource reservation applicable to this virtualised resource management operation.
networkResourceType	M	0..1	Enum	Type of virtualised network resource. VALUES: • NETWORK • SUBNET • NETWORK_PORT • TRUNK • ROUTING_RESOURCE

Parameter	Qualifier	Cardinality	Content	Description
typeNetworkData	M	0..1	VirtualNetworkData	Provides information about the particular virtual network resource to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.2.
typeNetworkPortData	M	0..1	VirtualNetworkPortData	Provides information about the particular network port to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.5.
typeSubnetData	M	0..1	NetworkSubnetData	Provides information about the particular sub-network resource to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.4.
typeRoutingResourceData	M	0..1	RoutingResourceData	Provides information about the particular routing resource to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.9.
typeTrunkData	M	0..1	VirtualTrunkData	Provides information about the particular trunk to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.6.
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinityConstraint	List of element with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised network resource to be allocated. All the listed constraints shall be fulfilled for a successful operation.
locationConstraints	M	0..1	Not specified	If present, it defines location constraints for the resource(s) to be allocated, e.g. in what particular resource zone.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.

7.4.1.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.1.2.3-1.

Table 7.4.1.2.3-1: Allocate Virtualised Network Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
networkData	M	0..1	VirtualNetwork	If network types are created satisfactorily, it contains the data relative to the instantiated virtualised network resource. Cardinality can be "0" if the request did not include creation of such type of resource. See clause 8.4.5.2.

Parameter	Qualifier	Cardinality	Content	Description
subnetData	M	0..1	NetworkSubnet	If subnet types are created satisfactorily, it contains the data relative to the allocated subnet. Cardinality can be "0" if the request did not include creation of such type of resource. See clause 8.4.5.3.
networkPortData	M	0..1	VirtualNetworkPort	If network port types are created satisfactorily, it contains the data relative to the allocated network port. Cardinality can be "0" if the request did not include creation of such type of resource. See clause 8.4.5.4.
trunkData	M	0..1	VirtualTrunk	If trunk types are created satisfactorily, it contains the data relative to the allocated trunk. Cardinality can be "0" if the request did not include creation of such type of resource. See clause 8.4.5.5.
routingResourceData	M	0..1	RoutingResource	If routing resource types are created satisfactorily, it contains the data relative to the allocated routing resource. Cardinality can be "0" if the request did not include creation of such type of resource. See clause 8.4.5.6.

7.4.1.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the virtualised network resource and allocated this resource. In addition, the VIM shall return to the NFVO information on the newly instantiated virtualised network resource plus any additional information about the allocate request operation. The VIM may also return intermediate status reports during the allocation process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.4.1.3 Query Virtualised Network Resource operation

7.4.1.3.1 Description

This operation allows querying information about instantiated virtualised network resources.

Table 7.4.1.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.1.3.1-1: Query Virtualised Network Resource operation

Message	Requirement	Direction
QueryNetworkRequest	Mandatory	NFVO → VIM
QueryNetworkResponse	Mandatory	VIM → NFVO

7.4.1.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.1.3.2-1.

Table 7.4.1.3.2-1: Query Virtualised Network Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryNetworkFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more resources to be queried by providing their identifiers.

7.4.1.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.1.3.3-1.

Table 7.4.1.3.3-1: Query Virtualised Network Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualNetwork	Contains information about the virtual network resource(s) matching the filter. Cardinality can be 0 if no matching network resources exist. See clause 8.4.5.2.
queryTrunkResult	M	0..N	VirtualTrunk	Contains information about the virtual trunk(s) matching the filter. Cardinality can be "0" if no matching virtual trunk resources exist. See clause 8.4.5.5.

7.4.1.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised network resources. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the network resources that the NFVO has access to and that are matching the filter shall be returned.

7.4.1.4 Update Virtualised Network Resource operation

7.4.1.4.1 Description

This operation allows updating the information of an instantiated virtualised network resource.

Table 7.4.1.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.1.4.1-1: Update Virtualised Network Resource operation

Message	Requirement	Direction
UpdateNetworkRequest	Mandatory	NFVO → VIM
UpdateNetworkResponse	Mandatory	VIM → NFVO

7.4.1.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.1.4.2-1.

Table 7.4.1.4.2-1: Update Virtualised Network Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
networkResourceId	M	1	Identifier	Identifier of the virtualised network resource to be updated.
updateNetworkData	M	0..1	VirtualNetworkData	If update is on a network resource, the element contains the fields that can be updated. See clause 8.4.4.2.
updateSubnetData	M	0..1	NetworkSubnetData	If update is on a subnet resource, the element contains the fields that can be updated. See clause 8.4.4.4.
updateNetworkPort	M	0..1	VirtualNetworkPortData	If update is on a network port, the element contains the fields that can be updated. See clause 8.4.4.5.
updateRoutingResourceData	M	0..1	RoutingResourceData	If update is on a routing resource, the element contains the fields that can be updated. See clause 8.4.4.9.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
updateTrunkData	M	0..1	UpdateTrunkData	If update is on a trunk resource, the element contains the fields that can be updated. See clause 8.4.4.8.

7.4.1.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.1.4.3-1.

Table 7.4.1.4.3-1: Query Virtualised Network Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
networkResourceId	M	1	Identifier	Identifier of the virtualised network resource that has been updated. This parameter has the same value as the input parameter.
networkData	M	0..1	VirtualNetwork	If network types are updated satisfactorily, it contains the data relative to the updated network. Cardinality can be "0" if the request did not include update of such type of resource. See clause 8.4.5.2.
subnetData	M	0..1	NetworkSubnet	If subnet types are updated satisfactorily, it contains the data relative to the updated subnet. Cardinality can be "0" if the request did not include update of such type of resource. See clause 8.4.5.3.
networkPortData	M	0..1	VirtualNetworkPort	If network port types are updated satisfactorily, it contains the data relative to the updated network port. Cardinality can be "0" if the request did not include update of such type of resource. See clause 8.4.5.4.
trunkData	M	0..1	VirtualTrunk	If a trunk resource is updated satisfactorily, it contains the data relative to the updated trunk. Cardinality can be "0" if the request did not include update of such type of resource. See clause 8.4.5.5.

Parameter	Qualifier	Cardinality	Content	Description
routingResourceDat a	M	0..1	RoutingResource	If routing resource types are updated satisfactorily, it contains the data relative to the updated routing resource. Cardinality can be "0" if the request did not include update of such type of resource. See clause 8.4.5.6.

7.4.1.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised network resource. In addition, the VIM shall return to the NFVO information on the updated virtualised network resource plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.4.1.5 Terminate Virtualised Network Resource operation

7.4.1.5.1 Description

This operation allows de-allocating and terminating one or more instantiated virtualised network resource(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids and fail for the remaining ones.

Table 7.4.1.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.1.5.1-1: Terminate Virtualised Network Resource operation

Message	Requirement	Direction
TerminateNetworkRequest	Mandatory	NFVO → VIM
TerminateNetworkResponse	Mandatory	VIM → NFVO

7.4.1.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.1.5.2-1.

Table 7.4.1.5.2-1: Terminate Virtualised Network Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
networkResourceId	M	1..N	Identifier	Identifier of the virtualised network resource(s) to be terminated.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple virtualised network resources in one request, or as a series of requests that terminates one virtualised network resource at a time.				

7.4.1.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.1.5.3-1.

Table 7.4.1.5.3-1: Terminate Virtualised Network Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
networkResourceId	M	1..N	Identifier	Identifier of the virtualised network resource(s) successfully terminated. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple virtualised network resources in one request, or as a series of requests that terminates one virtualised network resource at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.4.1.5.4 Operation results

After successful operation, the VIM has terminated the virtualised network resources and removed the internal management objects for those resources. In addition, the VIM shall return to the NFVO information whether the virtualised network resources are successfully terminated.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.4.1.6 Create Virtualised Network Resource Affinity Or AntiAffinity Constraints Group operation

7.4.1.6.1 Description

This operation allows an authorized consumer functional block to request the creation of a resource affinity or anti-affinity constraints group. An anti-affinity group contains resources that are not placed in proximity, e.g. that do not share the same physical networking device. An affinity group contains resources that are placed in proximity, e.g. that do share the same physical networking device.

This operation shall be supported by the VIM. It shall be supported by the NFVO, if the NFVO supports named resource groups for affinity/anti-affinity (see clause 8.4.8.2).

Table 7.4.1.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.1.6.1-1: Create Virtualised Network Resource Affinity Or AntiAffinity Constraints Group operation

Message	Requirement	Direction
CreateNetworkResourceAffinityOrAntiAffinityConstraintsGroupRequest	Mandatory	NFVO → VIM
CreateNetworkResourceAffinityOrAntiAffinityConstraintsGroupResponse	Mandatory	VIM → NFVO

7.4.1.6.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.1.6.2-1.

Table 7.4.1.6.2-1: Create Virtualised Network Resource Affinity Or AntiAffinity Constraints Group operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
groupName	M	1	String	Name of the group, given by the consumer.
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group. VALUES: • AFFINITY • ANTI_AFFINITY
scope	M	0..1	Enum	Qualifies the scope of the constraint. VALUES: • NFVI_NODE • NIC • Etc. Defaults to "NFVI_NODE" if absent.

7.4.1.6.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.1.6.3-1.

Table 7.4.1.6.3-1: Create Virtualised Network Resource Affinity Or AntiAffinity Constraints Group operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
groupId	M	1	Identifier	Identifier of the group

7.4.1.6.4 Operation results

On success, the requested resource affinity or anti-affinity constraints group has been created. On failure, appropriate error information is returned.

7.4.2 Virtualised Network Resources Change Notification Interface

7.4.2.1 Introduction

This interface allows an authorized consumer functional block to request subscription to virtualised network resources change notifications, and to provide such notification to the subscribed consumer. As such, it provides the notification part of the Virtualised Network Resource Management interface.

7.4.2.2 Subscribe operation

7.4.2.2.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications related to network resource changes sent by the VIM. Specification of filtering mechanism is part of the protocol design.

Table 7.4.2.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.2.2.1-1: Subscribe operation

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

7.4.2.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.2.2.2-1.

Table 7.4.2.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting the virtualised resource(s) or virtual resource group(s) and the related change notifications to subscribe to. This filter can contain information about specific types of changes to subscribe to, or attributes of the resource.

7.4.2.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.2.2.3-1.

Table 7.4.2.2.3-1: Subscribe operation output parameters

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

7.4.2.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to network resource changes sent by the VIM. 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 NFVO.

7.4.2.3 Notify operation

7.4.2.3.1 Description

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

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

Table 7.4.2.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.2.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation:

- VirtualisedResourceChangeNotification. See clause 8.4.9.

7.4.3 Virtualised Network Resources Information Management Interface

7.4.3.1 Description

This interface allows an authorized consumer functional block to request operations related to the information about consumable virtualised network resources. The consumable virtualised network resources include (not limited to) virtualised NIC, floating IP addresses, etc., which are managed by a VIM.

The information elements related to consumable virtualised network resources describe the types and characteristics of the virtualised resources that a consumer functional block can request for allocation as part of the Virtualised Network Resource Management interface. The interface and related parameters also support the retrieval of information necessary for describing the types and characteristics of the virtualised resources that are exposed over the Virtualised Network Resource Capacity interface.

The following operations are defined for this interface:

- Subscribe resources information changes operation.
- Notify resources information changes operation.
- Query resources information operation.

7.4.3.2 Subscribe operation

7.4.3.2.1 Description

This operation enables the NFVOs to subscribe for the notifications related to information changes about consumable virtualised network resources. This also enables the NFVO to specify the scope of the subscription in terms of the specific virtual network resources to be reported by the VIM using a filter as the input.

Table 7.4.3.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.3.2.1-1: Subscribe operation

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

7.4.3.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.3.2.2-1.

Table 7.4.3.2.2-1: Subscribe operation input parameters

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

7.4.3.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.3.2.3-1.

Table 7.4.3.2.3-1: Subscribe operation output parameters

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

7.4.3.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to information changes about consumable virtualised network resources sent by the VIM. 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 NFVO.

7.4.3.3 Notify operation

7.4.3.3.1 Description

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

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

Table 7.4.3.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.3.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- InformationChangeNotification. See clause 8.3.2.

7.4.3.4 Query Virtualised Network Resource Information operation

7.4.3.4.1 Description

This operation supports retrieval of information for the various types of virtualised network resources managed by the VIM.

Table 7.4.3.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.3.4.1-1: Query Virtualised Network Resource Information operation

Message	Requirement	Direction
QueryVirtualNetworkResourceInfoRequest	Mandatory	NFVO → VIM
QueryVirtualNetworkResourceInfoResponse	Mandatory	VIM → NFVO

7.4.3.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.3.4.2-1.

Table 7.4.3.4.2-1: Query Virtualised Network Resource Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
informationQueryFilter	M	1	Filter	Filter defining the information of consumable virtualised resources on which the query applies.

7.4.3.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.3.4.3-1.

Table 7.4.3.4.3-1: Query Virtualised Network Resource Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
virtualisedResourceInformation	M	0..N	VirtualNetworkResource Information	Virtualised network resource information in the VIM that satisfies the query condition. See clause 8.3.5.

7.4.3.4.4 Operation results

After successful operation, the VIM has run the query for information about the various types of virtualised network resources it managed. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the various types of virtualised network resources managed by the VIM and that are matching the filter shall be returned.

7.4.4 Virtualised Network Resources Capacity Management Interface

7.4.4.1 Introduction

This interface allows an authorized consumer functional block to request operations related to network capacity and usage reporting. The interface allows retrieval of information about:

- The available, allocated, reserved and total capacity of the network resources managed by a VIM instance, globally or per resource zone.
- Utilization of the capacity, both on VIM global level but also per resource zone.
- The geographical location and network connectivity endpoints (e.g. network gateway) to the NFVI-PoP(s) administer by the VIM.

NOTE 1: This provides information to determine the network endpoints to reach VNFs instantiated making use of virtualised network resources managed by the VIM. This information may be used by the NFVO for building and keeping NFVI-PoP topology information.

NOTE 2: For per resource zone capacity information, the VIM provides only the information about the virtualised resources it manages within that resource zone. Other resources within a particular resource zone (e.g. physical resources, CIS cluster resources) that are not used by the VIM are not factored in the capacity information per resource zone.

The interface enables the capture of information for resources usage and input to capacity planning, capacity changes, and consequently for Network Service planning, etc.

7.4.4.2 Query Network Capacity operation

7.4.4.2.1 Description

This operation supports retrieval of capacity information for the various types of consumable virtualised network resources available in the Virtualised Network Resources Information Management Interface.

Table 7.4.4.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.4.2.1-1: Query Network Capacity operation

Message	Requirement	Direction
QueryNetworkCapacityRequest	Mandatory	NFVO → VIM
QueryNetworkCapacityResponse	Mandatory	VIM → NFVO

7.4.4.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.4.2.2-1.

Table 7.4.4.2.2-1: Query Network Capacity operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier	When specified, this parameter identifies the resource zone for which the capacity is requested. When not specified, the total capacity managed by the VIM instance is to be returned.
networkResourceTypeId	M	0..1	Identifier	Identifier of the resource type for which the issuer wants to know the available, total, reserved and/or allocated capacity (see note 1).
resourceCriteria	M	0..1	Not specified	Input capacity computation parameter for selecting the characteristics of the virtual network for which the issuer wants to know the available, total, reserved and/or allocated capacity. Selecting parameters/attributes that shall be used are defined in the VirtualNetworkResourceInformation information element (see note 2). This information element and the networkResourceTypeID are mutually exclusive (see note 1).
attributeSelector	M	0..1	String	Input parameter for selecting which capacity information (i.e. available, total, reserved and/or allocated capacity) is queried. When not present, all four values are requested.
timePeriod	M	0..1	TimePeriod Information	Time interval for which capacity is queried. When omitted, an interval starting "now" is used. The time interval can be specified since resource reservations can be made for a specified time interval. See clause 8.7.2.

Parameter	Qualifier	Cardinality	Content	Description
NOTE 1: If the issuer wishes to query for capacity information related to a resource type discovered by the Virtualised Network Resources Information Management interface (i.e. by the Query Virtualised Network Resource Information operation, see clause 7.4.3.4), it may use the networkResourceTypeId obtained via that interface. If the issuer wants to specify the characteristics of the resource type for which capacity information is needed, it shall use the resourceCriteria IE. This can be the case e.g. when there is no resource type obtained via the Virtualised Network Resources Information Management interface exactly matching the wanted characteristics or when the issuer wishes to obtain capacity information in a granularity not matching the resource types. NOTE 2: Not all attributes in the VirtualNetworkResourceInformation IE might be relevant for a capacity query.				

7.4.4.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.4.2.3-1.

Table 7.4.4.2.3-1: Query Network Capacity operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityResponse	M	1	CapacityInformation	Capacity during the requested time period. The scope is according to parameter zoneId of the request during the time interval. See clause 8.7.3.

7.4.4.2.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not it was possible to process the query.

7.4.4.3 Subscribe operation

7.4.4.3.1 Description

This operation supports subscribing to the network capacity change notifications.

Table 7.4.4.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.4.3.1-1: Subscribe operation

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

7.4.4.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.4.3.2-1.

Table 7.4.4.3.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier	When specified, this parameter identifies the resource zone for which the capacity change notifications are requested. When not specified, the total capacity managed by the VIM instance is to be notified.
networkResourceTypeId	M	0..1	Identifier	Identifier of the resource type for which the issuer wants to know the available, total, reserved and/or allocated capacity (see note 1).

Parameter	Qualifier	Cardinality	Content	Description
resourceCriteria	M	0..1	Not specified	Input capacity computation parameter for selecting the characteristics of the virtual network for which the issuer wants to know the available, total, reserved and/or allocated capacity. Selecting parameters/attributes that shall be used are defined in the VirtualNetworkResourceInformation information element (see note 2). This information element and the networkResourceTypeID are mutually exclusive (see note 1).
threshold	M	0..N	ResourceCapacityThreshold	When specified, this parameter indicates a capacity value which, once crossed, will trigger a notification. When not specified, notifications are issued at every change (see note 3). See clause 8.7.5.
attributeSelector	M	0..1	String	Input parameter for selecting which capacity (i.e. available, total, reserved and/or allocated capacity) the subscription refers to. When not present, all four values are requested.

NOTE 1: If the issuer wishes to subscribe for capacity information related to a resource type discovered by the Virtualised Network Resources Information management interface (i.e. by the Query Virtualised Network Resource Information operation, see clause 7.4.3.4), it may use the networkResourceTypeId obtained via that interface. If the issuer wants to specify the characteristics of the resource type for which capacity information is needed, it shall use the resourceCriteria IE. This can be the case e.g. when there is no resource type obtained via the Virtualised Network Resources Information Management interface exactly matching the wanted characteristics or when the issuer wishes to obtain capacity information in a granularity not matching the resource types.
NOTE 2: Not all attributes in the VirtualNetworkResourceInformation IE might be relevant for a capacity subscription.
NOTE 3: The VIM may still implement a minimum-delta threshold in order to avoid an excessive notification flow.

7.4.4.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.4.3.3-1.

Table 7.4.4.3.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityChangeSubscriptionId	M	1	Identifier	Subscription Id

7.4.4.3.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to network capacity changes sent by the VIM. 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 NFVO.

7.4.4.4 Notify operation

7.4.4.4.1 Description

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

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

Table 7.4.4.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.4.4.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- CapacityChangeNotification. See clause 8.7.4.

7.4.4.5 Query NFVI-PoP Network Information operation

7.4.4.5.1 Description

This operation enables the NFVOs to query general information to the VIM concerning the geographical location and network connectivity endpoints (e.g. network gateway) to the NFVI-PoP(s) administered by the VIM, and to determine network endpoints to reach VNFs instantiated making use of virtualised network resources in the NFVI as specified by the exchanged parameters.

Table 7.4.4.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.4.5.1-1: Query NFVI-PoP Network Information operation

Message	Requirement	Direction
NfviPopNetworkInformationRequest	Mandatory	NFVO → VIM
NfviPopNetworkInformationResponse	Mandatory	VIM → NFVO

7.4.4.5.2 Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.4.5.2-1.

Table 7.4.4.5.2-1: Query NFVI-PoP Network Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting information to query.

7.4.4.5.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.4.5.3-1.

Table 7.4.4.5.3-1: Query NFVI-PoP Network Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
nfviInfo	M	0..N	NfviPop	Filtered information that has been retrieved (see clause 8.10.3). The cardinality can be 0 if no matching information exists.

7.4.4.5.4 Operation Results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether the operation has been processed satisfactorily or it has failed.

7.4.5 Network Forwarding Path Management Interface

7.4.5.1 Description

This clause describes the NFP Management interface supported on Or-Vi reference point. This interface is produced by the VIM and consumed by the NFVO. The interface enables, for instance, sending an NFP representation to the VIM so that the VIM can set-up necessary network connections and paths in the related NFVI.

An NFP is an ordered list of Connection Points with the associated classifying policy to be applied.

NOTE: Interactions between load balancing and NFP management requires further study.

7.4.5.2 Create NFP operation

7.4.5.2.1 Description

This operation is used to set-up an NFP in the NFVI.

Based on the NFP related information included in the VNFFGD, the NFVO creates and sends a "CreateNFPRequest" to the VIM. The VIM will send a "CreateNFPResponse" as a response to the request.

Table 7.4.5.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.5.2.1-1: Create NFP operation

Message	Requirement	Direction
CreateNFPRequest	Mandatory	NFVO → VIM
CreateNFPResponse	Mandatory	NFVO ← VIM

7.4.5.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.5.2.2-1.

Table 7.4.5.2.2-1: Create NFP operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
virtualNetworkPortGroup	M	1..N	VirtualNetworkPort Group	A virtual network port group. See note 3.
totalVnp	O	0..1	Integer	Total number of virtual network port groups in this NFP.
nfpRule	M	1	Rule	NFP classification and selection rule.
NOTE 1: Void. NOTE 2: Void. NOTE 3: When multiple parameters are included, the position of the parameter in the information element value specifies the position of the virtual network port group in the path.				

7.4.5.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.5.2.3-1.

Table 7.4.5.2.3-1: Create NFP operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
nfpId	M	1..N	Identifier	Unique identification of the NFP(s) that has been created. This identification can be used to identify a particular NFP as and when required.

7.4.5.2.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not it was possible to create the NFP.

7.4.5.3 Query NFP operation

7.4.5.3.1 Description

This operation is used to query a single or multiple NFPs.

The NFVO creates and sends a "QueryNFPRequest"; the request identifies the NFP(s) to be queried. The VIM will send a "QueryNFPResponse" as a response to the request.

Table 7.4.5.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.5.3.1-1: Query NFP operation

Message	Requirement	Direction
QueryNFPRequest	Mandatory	NFVO → VIM
QueryNFPResponse	Mandatory	NFVO ← VIM

7.4.5.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.5.3.2-1.

Table 7.4.5.3.2-1: Query NFP operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryFilter	M	1	Filter	Query filter based on e.g. name, identifier, or status information expressing the type of information to be retrieved. It can also be used to specify one or more NFP resources to be queried by providing their identifiers.

7.4.5.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.5.3.3-1.

Table 7.4.5.3.3-1: Query NFP operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
nfpResult	M	0..N	Nfp	Provides the result of the query. The cardinality can be 0 if no matching information exists. See clause 8.9.

7.4.5.3.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not it was possible to process the query.

7.4.5.4 Delete NFP operation

7.4.5.4.1 Description

This operation is used to remove an existing NFP in the NFVI.

The NFVO creates and sends a "DeleteNFPRequest" to the VIM. The request identifies the NFP to be deleted. The VIM sends a "DeleteNFPResponse" as response to the request.

NOTE: The deletion of an NFP does not imply the deletion of underlying connectivity.

Table 7.4.5.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.5.4.1-1: Delete NFP operation

Message	Requirement	Direction
DeleteNFPRequest	Mandatory	NFVO → VIM
DeleteNFPResponse	Mandatory	NFVO ← VIM

7.4.5.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.5.4.2-1.

Table 7.4.5.4.2-1: Delete NFP operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
nfpId	M	1..N	Identifier	Unique identification of the NFP(s) 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 terminate multiple NFPs in one request, or as a series of requests that terminates one NFP at a time.				

7.4.5.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.5.4.3-1.

Table 7.4.5.4.3-1: Delete NFP operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedNfpId	M	0..N	Identifier	Identifiers of the deleted NFP(s). See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple NFPs in one request, or as a series of requests that terminates one NFP at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.4.5.4.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not all the selected NFP were successfully deleted.

7.4.5.5 Change NFP State operation

7.4.5.5.1 Description

This operation is used to request changing the state (enable or disable) of an NFP.

Table 7.4.5.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.5.5.1-1: Change NFP State operation

Message	Requirement	Direction
ChangeNfpStateRequest	Mandatory	NFVO → VIM
ChangeNfpStateResponse	Mandatory	NFVO ← VIM

7.4.5.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.5.5.2-1.

Table 7.4.5.5.2-1: Change NFP State operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
nfpId	M	1..N	Identifier	Identification of the NFP(s) whose states are to be changed.
desiredState	M	1	Enum	The state into which the NFP(s) are requested to be changed. VALUES: • ENABLED • DISABLED

7.4.5.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.5.5.3-1.

Table 7.4.5.5.3-1: Change NFP State operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
changedNfpId	M	1..N	Identifier	Identifiers of the NFP(s) that have successfully been changed.

7.4.5.5.4 Operation Results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not the operation was successful.

7.4.5.6 Update NFP operation

7.4.5.6.1 Description

This operation is used to update or create the classification and selection rule for an existing NFP instance in the NFVI.

The NFVO creates and sends a "UpdateNFPRequest" to the VIM. The VIM will send an "UpdateNFPResponse" as a response to the request.

Table 7.4.5.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.4.5.6.1-1: Update NFP operation

Message	Requirement	Direction
UpdateNFPRequest	Mandatory	NFVO → VIM
UpdateNFPResponse	Mandatory	NFVO ← VIM

7.4.5.6.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.4.5.6.2-1.

Table 7.4.5.6.2-1: Update NFP operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
nfpId	M	1	Identifier	Identifier of the NFP to be modified.
nfpRule	M	1	Rule	NFP classification and selection rule.

7.4.5.6.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.4.5.6.3-1.

Table 7.4.5.6.3-1: Update NFP operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
nfpInfo	M	1	Nfp	Provides the updated NFP information of the NFP instance. See clause 8.9.

7.4.5.6.4 Operation results

As a result of this operation, the update of classification and selection rules has replaced the existing rules, if any already in place, by the newly provided rules. The producer (the VIM) shall indicate to the consumer (the NFVO) whether or not the NFP instance has been updated successfully.

7.5 Virtualised Storage Interfaces

7.5.1 Virtualised Storage Resources Management Interface

7.5.1.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised storage resources available to the consumer functional block. The interface includes operations for allocating, querying, updating and terminating virtualised storage resources as well as operations for scaling, migrating and operating the administrative status of a virtualised resource.

7.5.1.2 Allocate Virtualised Storage Resource operation

7.5.1.2.1 Description

This operation allows requesting the allocation of virtualised storage resources as indicated by the consumer functional block.

Table 7.5.1.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.2.1-1: Allocate Virtualised Storage Resource operation

Message	Requirement	Direction
AllocateStorageRequest	Mandatory	NFVO → VIM
AllocateStorageResponse	Mandatory	VIM → NFVO

7.5.1.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.2.2-1.

Table 7.5.1.2.2-1: Allocate Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageName	M	0..1	String	Name provided by the consumer for the virtualised storage resource to be allocated. It can be used for identifying resources from consumer side.
reservationId	M	0..1	Identifier	Identifier of the resource reservation applicable to this virtualised resource management operation.

Parameter	Qualifier	Cardinality	Content	Description
affinityOrAntiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised storage resource to be allocated. All the listed constraints shall be fulfilled for a successful operation.
storageData	M	1	VirtualStorageFlavour	Provides information about the type and size of the storage. See clause 8.4.6.2.
locationConstraints	M	0..1		If present, it defines location constraints for the resource(s) to be allocated, e.g. in what particular resource zone.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.

7.5.1.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.2.3-1.

Table 7.5.1.2.3-1: Allocate Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
storageResource	M	1	VirtualStorage	Contains information of the newly instantiated virtualised storage resource. See clause 8.4.7.2.

7.5.1.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the virtualised storage resource and allocated this resource. In addition, the VIM shall return to the NFVO information on the newly instantiated virtualised storage resource plus any additional information about the allocate request operation. The VIM may also return intermediate status reports during the allocation process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.5.1.3 Query Virtualised Storage Resource operation

7.5.1.3.1 Description

This operation allows querying information about instantiated virtualised storage resources.

Table 7.5.1.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.3.1-1: Query Virtualised Storage Resource operation

Message	Requirement	Direction
QueryStorageRequest	Mandatory	NFVO → VIM
QueryStorageResponse	Mandatory	VIM → NFVO

7.5.1.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.3.2-1.

Table 7.5.1.3.2-1: Query Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageQueryFllter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more resources to be queried by providing their identifiers.

7.5.1.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.3.3-1.

Table 7.5.1.3.3-1: Query Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualStorage	Contains information about the virtual storage resource(s) matching the filter. The cardinality can be 0 if no matching storage resources exist. See clause 8.4.7.2.

7.5.1.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised storage resources. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the storage resources that the NFVO has access to and that are matching the filter shall be returned.

7.5.1.4 Update Virtualised Storage Resource operation

7.5.1.4.1 Description

This operation allows updating the configuration and/or parameters of an instantiated virtualised storage resource, including updating its metadata.

Table 7.5.1.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.4.1-1: Update Virtualised Storage Resource operation

Message	Requirement	Direction
UpdateStorageRequest	Mandatory	NFVO → VIM
UpdateStorageResponse	Mandatory	VIM → NFVO

7.5.1.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.4.2-1.

Table 7.5.1.4.2-1: Update Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource to be updated.
updateStorageData	M	0..1	VirtualStorageFlavour	Contains the fields that can be updated of a storage resource. See clause 8.4.6.2.
metaData	O	0..N	KeyValuePair	List of meta-data key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

7.5.1.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.4.3-1.

Table 7.5.1.4.3-1: Update Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource that has been updated. This parameter has the same value as the input parameter.
storageData	M	1	VirtualStorage	Contains the data relative to the updated storage. See clause 8.4.7.2.

7.5.1.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource. In addition, the VIM shall return to the NFVO information on the updated virtualised storage resource plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.5.1.5 Terminate Virtualised Storage Resource operation

7.5.1.5.1 Description

This operation allows de-allocating and terminating one or more instantiated virtualised storage resource(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.5.1.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.5.1-1: Terminate Virtualised Storage Resource operation

Message	Requirement	Direction
TerminateStorageRequest	Mandatory	NFVO → VIM
TerminateStorageResponse	Mandatory	VIM → NFVO

7.5.1.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.5.2-1.

Table 7.5.1.5.2-1: Terminate Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1..N	Identifier	Identifier of the virtualised storage resource(s) to be terminated.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple virtualised storage resources in one request, or as a series of requests that terminates one virtualised storage resource at a time.				

7.5.1.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.5.3-1.

Table 7.5.1.5.3-1: Update Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1..N	Identifier	Identifier of the virtualised storage resource(s) successfully terminated. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple virtualised storage resources in one request, or as a series of requests that terminates one virtualised storage resource at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.5.1.5.4 Operation results

After successful operation, the VIM has terminated the virtualised storage resources and removed the internal management objects for those resources. In addition, the VIM shall return to the NFVO information whether the virtualised storage resources are successfully terminated.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.5.1.6 Operate Virtualised Storage Resource operation

7.5.1.6.1 Description

This operation allows executing specific operation command on instantiated virtualised storage resources.

Table 7.5.1.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.6.1-1: Operate Virtualised Storage Resource operation

Message	Requirement	Direction
OperateStorageRequest	Mandatory	NFVO → VIM
OperateStorageResponse	Mandatory	VIM → NFVO

7.5.1.6.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.6.2-1.

Table 7.5.1.6.2-1: Operate Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource to be operated.
storageOperation	M	1	String	Type of operation to perform on the virtualised storage resource. Possible values include: "create snapshot", "revert to snapshot", and "delete snapshot".
storageOperationInputData	M	0..N	KeyValue Pair	Additional parameters associated to the operation to perform. For example, if the operation is "delete snapshot", information identifying the snapshot to be deleted.

7.5.1.6.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.6.3-1.

Table 7.5.1.6.3-1: Operate Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
storageData	M	1	VirtualStorage	Contains information on the new status of the operated virtualised storage resource. See clause 8.4.7.2.
storageOperationOutputData	M	0..N	KeyValue Pair	Set of output values depending on the type of operation. For instance, when a snapshot operation is requested, this field provides information about the identifier of the snapshot.

7.5.1.6.4 Operation results

After successful operation, the VIM has executed the requested operation command on the virtualised storage resource. In addition, the VIM shall return to the NFVO information on the new status of the operated virtualised storage resources, operation specific data plus any additional information about the operate request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.5.1.7 Scale Virtualised Storage Resource operation

7.5.1.7.1 Description

This operation allows resizing an instantiated virtualised storage resource.

Table 7.5.1.7.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.7.1-1: Scale Virtualised Storage Resource operation

Message	Requirement	Direction
ScaleStorageRequest	Mandatory	NFVO → VIM
ScaleStorageResponse	Mandatory	VIM → NFVO

7.5.1.7.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.7.2-1.

Table 7.5.1.7.2-1: Scale Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource to be scaled.
newSize	M	1	Number	Resized amount of allocated storage virtualised resource.

7.5.1.7.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.7.3-1.

Table 7.5.1.7.3-1: Scale Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
storageData	M	1	VirtualStorage	Contains information of the scaled virtualised storage resource. See clause 8.4.7.2.

7.5.1.7.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource and has scaled this resource. In addition, the VIM shall return to the NFVO information on the scaled virtualised storage resource plus any additional information about the scale request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.5.1.8 Migrate Virtualised Storage Resource operation

7.5.1.8.1 Description

This operation allows migrating instantiated virtualised storage resources from one storage location to another. For instance, the operation performs the migration of a volume resource from one physical machine (host) to another physical machine.

Table 7.5.1.8.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.8.1-1: Migrate Virtualised Storage Resource operation

Message	Requirement	Direction
MigrateStorageRequest	Mandatory	NFVO → VIM
MigrateStorageResponse	Mandatory	VIM → NFVO

7.5.1.8.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.8.2-1.

Table 7.5.1.8.2-1: Migrate Virtualised Storage Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource to be migrated.
affinityOrAntiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to be migrated. All the listed constraints shall be fulfilled for a successful operation. This information is only necessary if the VIM needs to maintain affinity during the migration operation based on a list of resources.
migrationConstraint	M	0..1	Not specified	When present, the migration constraint parameter gives indications on where to migrate the virtualised storage resource, e.g. to a specific resource zone or to a specific host.

7.5.1.8.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.8.3-1.

Table 7.5.1.8.3-1: Migrate Virtualised Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
storageData	M	1	VirtualStorage	Contains information of the migrated virtualised storage resource. See clause 8.4.7.2.

7.5.1.8.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource and has migrated this resource. In addition, the VIM shall return to the NFVO information on the migrated virtualised storage resource plus any additional information about the migrate request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.5.1.9 Create Virtualised Storage Resource Affinity Or AntiAffinity Constraints Group operation

7.5.1.9.1 Description

This operation allows an authorized consumer functional block to request the creation of a resource affinity or anti-affinity constraints group. An anti-affinity group contains resources that are not placed in proximity, e.g. that do not share the same physical storage node. An affinity group contains resources that are placed in proximity, e.g. that do share the same physical storage node.

This operation shall be supported by the VIM. It shall be supported by the NFVO, if the NFVO supports named resource groups for affinity/anti-affinity (see clause 8.4.8.2).

Table 7.5.1.9.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.1.9.1-1: Create Virtualised Storage Resource Affinity Or AntiAffinity Constraints Group operation

Message	Requirement	Direction
CreateStorageResourceAffinityOrAntiAffinityConstraintsGroupRequest	Mandatory	NFVO → VIM
CreateStorageResourceAffinityOrAntiAffinityConstraintsGroupResponse	Mandatory	VIM → NFVO

7.5.1.9.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.1.9.2-1.

Table 7.5.1.9.2-1: Create Virtualised Storage Resource Affinity Or AntiAffinity Constraints Group operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
groupName	M	1	String	Name of the group, given by the consumer.
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group. VALUES: • AFFINITY • ANTI_AFFINITY
scope	M	0..1	Enum	Qualifies the scope of the affinity constraint. VALUES: • NFVI_NODE • Etc. Defaults to "NFVI_NODE" if absent.

7.5.1.9.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.1.9.3-1.

Table 7.5.1.9.3-1: Create Virtualised Storage Resource Affinity Or AntiAffinity Constraints Group operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
groupId	M	1	Identifier	Identifier of the group

7.5.1.9.4 Operation results

On success, the requested resource affinity or anti-affinity constraints group has been created. On failure, appropriate error information is returned.

7.5.2 Virtualised Storage Resources Change Notification Interface

7.5.2.1 Introduction

This interface allows an authorized consumer functional block to request subscription to virtualised storage resources change notifications, and to provide such notification to the subscribed consumer. As such, it provides the notification part of the Virtualised Storage Resource Management interface.

7.5.2.2 Subscribe operation

7.5.2.2.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications related to storage resource changes sent by the VIM. Specification of filtering mechanism is part of the protocol design.

Table 7.5.2.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.2.2.1-1: Subscribe operation

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

7.5.2.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.2.2.2-1.

Table 7.5.2.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting the virtualised resource(s) or virtual resource group(s) and the related change notifications to subscribe to. This filter can contain information about specific types of changes to subscribe to, or attributes of the resource.

7.5.2.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.2.2.3-1.

Table 7.5.2.2.3-1: Subscribe operation output parameters

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

7.5.2.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to storage resource changes sent by the VIM. 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 NFVO.

7.5.2.3 Notify operation

7.5.2.3.1 Description

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

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

Table 7.5.2.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.2.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation:

- VirtualisedResourceChangeNotification. See clause 8.4.9.

7.5.3 Virtualised Storage Resources Information Management Interface

7.5.3.1 Description

This interface allows an authorized consumer functional block to request operations related to the information about consumable virtualised storage resources which are managed by a VIM.

The information elements related to consumable virtualised storage resources describe the types and characteristics of the virtualised resources that a consumer functional block can request for allocation as part of the Virtualised Storage Resource Management interface. The interface and related parameters also support the retrieval of information necessary for describing the types and characteristics of the virtualised resources that are exposed over the Virtualised Storage Resource Capacity interface.

The following operations are defined for this interface:

- Subscribe resources information changes operation.
- Notify resources information changes operation.
- Query resources information operation.

7.5.3.2 Subscribe operation

7.5.3.2.1 Description

This operation enables the NFVOs to subscribe for the notifications related to information changes about consumable virtualised storage resources. This also enables the NFVO to specify the scope of the subscription in terms of the specific virtual storage resources to be reported by the VIM using a filter as the input.

Table 7.5.3.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.3.2.1-1: Subscribe operation

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

7.5.3.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.3.2.2-1.

Table 7.5.3.2.2-1: Subscribe operation input parameters

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

7.5.3.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.3.2.3-1.

Table 7.5.3.2.3-1: Subscribe operation output parameters

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

7.5.3.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to information changes about consumable virtualised storage resources sent by the VIM. 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 NFVO.

7.5.3.3 Notify operation

7.5.3.3.1 Description

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

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

Table 7.5.3.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.3.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- InformationChangeNotification. See clause 8.3.2.

7.5.3.4 Query Virtualised Storage Resource Information operation

7.5.3.4.1 Description

This operation supports retrieval of information for the various types of virtualised storage resources managed by the VIM.

Table 7.5.3.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.3.4.1-1: Query Virtualised Storage Resource Information operation

Message	Requirement	Direction
QueryVirtualStorageResourceInfoRequest	Mandatory	NFVO → VIM
QueryVirtualStorageResourceInfoResponse	Mandatory	VIM → NFVO

7.5.3.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.3.4.2-1.

Table 7.5.3.4.2-1: Query Virtualised Storage Resource Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
informationQueryFilter	M	1	Filter	Filter defining the information of consumable virtualised resources on which the query applies.

7.5.3.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.3.4.3-1.

Table 7.5.3.4.3-1: Query Virtualised Storage Resource Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
virtualisedResourceInformation	M	0..N	VirtualStorageResourceInformation	Virtualised storage resources information in the VIM that satisfies the query condition. See clause 8.3.4.

7.5.3.4.4 Operation results

After successful operation, the VIM has run the query for the various types of virtualised storage resources. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about for the various types of virtualised storage resources that are matching the filter shall be returned.

7.5.4 Virtualised Storage Resources Capacity Management Interface

7.5.4.1 Introduction

This interface allows an authorized consumer functional block to request operations related to storage capacity and usage reporting. The interface allows retrieval of information about:

- The available, allocated, reserved and total capacity of the storage resources managed by a VIM instance, globally or per resource zone.
- Utilization of the capacity, both on VIM global level but also per resource zone.
- The geographical location and network connectivity endpoints to the NFVI-PoP(s) administered by the VIM.

NOTE 1: This provides information to determine the network endpoints to reach VNFs instantiated making use of virtualised storage resources managed by the VIM. This information may be used by the NFVO for building and keeping NFVI-PoP topology information.

NOTE 2: For per resource zone capacity information, the VIM provides only the information about the virtualised resources it manages within that resource zone. Other resources within a particular resource zone (e.g. physical resources, CIS cluster resources) that are not used by the VIM are not factored in the capacity information per resource zone.

The interface enables the capture of information for resources usage and input to capacity planning, capacity changes, and consequently for Network Service planning, etc.

The interface also enables the query of information about storage-related Resource Zones within the NFVI-PoP(s) used by the VIM-managed virtualised storage resources.

7.5.4.2 Query Storage Capacity operation

7.5.4.2.1 Description

This operation supports retrieval of capacity information for the various types of consumable virtualised storage resources available in the Virtualised Storage Resources Information Management Interface.

Table 7.5.4.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.4.2.1-1: Query Storage Capacity operation

Message	Requirement	Direction
QueryStorageCapacityRequest	Mandatory	NFVO → VIM
QueryStorageCapacityResponse	Mandatory	VIM → NFVO

7.5.4.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.4.2.2-1.

Table 7.5.4.2.2-1: Query Storage Capacity operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier	When specified, this parameter identifies the resource zone for which the capacity is requested. When not specified, the total capacity managed by the VIM instance is to be returned.

Parameter	Qualifier	Cardinality	Content	Description
storageResourceTypeId	M	0..1	Identifier	Identifier of the resource type for which the issuer wants to know the available, total, reserved and/or allocated capacity (see note 1).
resourceCriteria	M	0..1	Not specified	Input capacity computation parameter for selecting the characteristics of the virtual storage for which the issuer wants to know the available, total, reserved and/or allocated capacity. Selecting parameters/attributes that shall be used are defined in the VirtualStorageResourceInformation information element (see note 2). This information element and the storageResourceTypeID are mutually exclusive (see note 1).
attributeSelector	M	0..1	String	Input parameter for selecting which capacity information (i.e. available, total, reserved and/or allocated capacity) is queried. When not present, all four values are requested.
timePeriod	M	0..1	TimePeriodInformation	Time interval for which capacity is queried. When omitted, an interval starting "now" is used. The time interval can be specified since resource reservations can be made for a specified time interval. See clause 8.7.2.
NOTE 1: If the issuer wishes to query for capacity information related to a resource type discovered by the Virtualised Storage Resources Information Management interface (i.e. by the Query Virtualised Storage Resource Information operation, see clause 7.5.3.4), it may use the storageResourceTypeId obtained via that interface. If the issuer wants to specify the characteristics of the resource type for which capacity information is needed, it shall use the resourceCriteria IE. This can be the case e.g. when there is no resource type obtained via the Virtualised Storage Resources Information management interface exactly matching the wanted characteristics or when the issuer wishes to obtain capacity information in a granularity not matching the resource types. NOTE 2: Not all attributes in the VirtualStorageResourceInformation IE might be relevant for a capacity query.				

7.5.4.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.4.2.3-1.

Table 7.5.4.2.3-1: Query Storage Capacity operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityResponse	M	1	CapacityInformation	Capacity during the requested time period. The scope is according to parameter zoneId of the request during the time interval. See clause 8.7.3.

7.5.4.2.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not it was possible to process the query.

7.5.4.3 Subscribe operation

7.5.4.3.1 Description

This operation supports subscribing to the storage capacity change notifications.

Table 7.5.4.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.4.3.1-1: Subscribe operation

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

7.5.4.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.4.3.2-1.

Table 7.5.4.3.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier	When specified, this parameter identifies the resource zone for which the capacity change notifications are requested. When not specified, the total capacity managed by the VIM instance is to be notified.
storageResourceTypeId	M	0..1	Identifier	Identifier of the resource type for which the issuer wants to know the available, total, reserved and/or allocated capacity (see note 1).
resourceCriteria	M	0..1	Not specified	Input capacity computation parameter for selecting the characteristics of the virtual storage for which the issuer wants to know the available, total, reserved and/or allocated capacity. Selecting parameters/attributes that shall be used are defined in the VirtualStorageResourceInformation information element (see note 2). This information element and the storageResourceTypeID are mutually exclusive (see note 1).
threshold	M	0..N	ResourceCapacityThreshold	When specified, this parameter indicates a capacity value which, once crossed, will trigger a notification. When not specified, notifications are issued at every change (see note 3). See clause 8.7.5.
attributeSelector	M	0..1	String	Input parameter for selecting which capacity information (i.e. available, total, reserved and/or allocated capacity) the subscription refers to. When not present, all four values are requested.

NOTE 1: If the issuer wishes to subscribe for capacity information related to a resource type discovered by the Virtualised Storage Resources Information management interface (i.e. by the Query Virtualised Storage Resource Information operation, see clause 7.5.3.4), it may use the storageResourceTypeId obtained via that interface. If the issuer wants to specify the characteristics of the resource type for which capacity information is needed, it shall use the resourceCriteria IE. This can be the case e.g. when there is no resource type obtained via the Virtualised Storage Resources Information Management interface exactly matching the wanted characteristics or when the issuer wishes to obtain capacity information in a granularity not matching the resource types.

NOTE 2: Not all attributes in the VirtualStorageResourceInformation IE might be relevant for a capacity subscription.

NOTE 3: The VIM may still implement a minimum-delta threshold in order to avoid an excessive notification flow.

7.5.4.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.4.3.3-1.

Table 7.5.4.3.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityChangeSubscriptionId	M	1	Identifier	Subscription Id

7.5.4.3.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to storage capacity changes sent by the VIM. 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 NFVO.

7.5.4.4 Notify operation

7.5.4.4.1 Description

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

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

Table 7.5.4.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.4.4.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- CapacityChangeNotification. See clause 8.7.4.

7.5.4.5 Query NFVI-PoP Storage Information operation

7.5.4.5.1 Description

This operation enables the NFVOs to query general information to the VIM concerning the geographical location and network connectivity endpoints to the NFVI-PoP(s) administered by the VIM, and to determine network endpoints to reach VNFs instantiated making use of virtualised storage resources in the NFVI as specified by the exchanged parameters.

Table 7.5.4.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.4.5.1-1: Query NFVI-PoP Storage Information operation

Message	Requirement	Direction
NfviPopStorageInformationRequest	Mandatory	NFVO → VIM
NfviPopStorageInformationResponse	Mandatory	VIM → NFVO

7.5.4.5.2 Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.4.5.2-1.

Table 7.5.4.5.2-1: Query NFVI-PoP Storage Information operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting information to query.

7.5.4.5.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.4.5.3-1.

Table 7.5.4.5.3-1: Query NFVI-PoP Storage Information operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
nfviInfo	M	0..N	NfviPop	Filtered information that has been retrieved (see clause 8.10.3). The cardinality can be 0 if no matching information exists.

7.5.4.5.4 Operation Results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether the operation has been processed satisfactorily or it has failed.

7.5.4.6 Query Storage Resource Zone operation

7.5.4.6.1 Description

This operation enables the NFVO to query information about a Resource Zone, e.g. listing the properties of the Resource Zone and other metadata.

Table 7.5.4.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.5.4.6.1-1: Query Storage Resource Zone operation

Message	Requirement	Direction
QueryStorageResourceZoneRequest	Mandatory	NFVO → VIM
QueryStorageResourceZoneRequest	Mandatory	VIM → NFVO

7.5.4.6.2 Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.5.4.6.2-1.

Table 7.5.4.6.2-1: Query Storage Resource Zone operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting information to query. For instance, based on identifier of the Resource Zone, identifier of NFVI-PoP, properties of the Resource Zone or other meta-data.

7.5.4.6.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.5.4.6.3-1.

Table 7.5.4.6.3-1: Query Storage Resource Zone operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
zoneInfo	M	0..N	ResourceZone	Filtered information that has been retrieved about the Resource Zone (see clause 8.10.2). The cardinality can be 0 if no matching information exists.

7.5.4.6.4 Operation Results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether the operation has been processed satisfactorily or it has failed.

7.6 Virtualised Resource Fault Management Interface

7.6.1 Description

This interface shall allow providing alarms from the VIM resulting from the faults related to the virtualised resources visible to the consumer functional block, including virtualised container crashes, virtual network ports errors, virtual container's to storage disconnection, etc. The interface also provides information about faults related to the pools of resources, for instance, reserved resources unavailable, resource exhaustion, etc. It has to be noted that only those types of resources that have been catalogued and offered through right abstractions to consumer functional blocks are in scope.

The fault management interface shall support the following operations:

- Subscribe operation (Subscription by the NFVO with the VIM for the notification related to the alarms resulting from the Faults).
- Notify operation (Notifications of alarms or alarm state change from VIM to NFVO).
- Get alarm list operation (Accessing active alarms from the VIM).

7.6.2 Subscribe operation

7.6.2.1 Description

This operation enables the NFVO to subscribe for notifications related to the alarms and their state changes resulting from the virtualised resources faults with the VIM. This also enables the NFVO to specify the scope of the subscription in terms of the specific alarms for the virtualised resources to be reported by the VIM using a filter as the input.

Table 7.6.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.6.2.1-1: Subscribe operation

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

7.6.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.6.2.2-1.

Table 7.6.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting virtualised resources and related alarms. This can contain the resource information, severity and cause of the alarm.

7.6.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.6.2.3-1.

Table 7.6.2.3-1: Subscribe operation output parameters

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

7.6.2.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) in the SubscribeResponse message whether the subscription was successful or not.

7.6.3 Notify operation

7.6.3.1 Description

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

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

Table 7.6.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.6.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- AlarmNotification. See clause 8.6.2.
- AlarmClearedNotification. See clause 8.6.3.

7.6.4 Get Alarm List operation

7.6.4.1 Description

This operation enables the NFVOs to query for active alarms from the VIM.

Table 7.6.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.6.4.1-1: Get Alarm List operation

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

7.6.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.6.4.2-1.

Table 7.6.4.2-1: 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 resource identifiers, severity and cause.

7.6.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.6.4.3-1.

Table 7.6.4.3-1: Get Alarm List operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
alarm	M	0..N	Alarm	Information about an alarm including AlarmId, affected Resource 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). See clause 8.6.4.

7.6.4.4 Operation results

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

7.7 Virtualised Resources Performance Management Interface

7.7.1 Description

This interface allows providing performance management information (measurement results collection and notifications) related to virtualised resources including (but not limited to) resource consumption level, e.g. vCPU power consumption, VM memory usage oversubscription, VM disk latency, etc. It has to be noted that only types of resources that have been catalogued and offered through abstractions to consumer functional blocks are in scope.

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 8.5.7). The details of the performance measurements are provided using the PerformanceReport information element (see clause 8.5.4). Delivery mechanism for the performance reports is not specified in the present document.

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

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

7.7.2 Create PM Job operation

7.7.2.1 Description

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

The NFVO needs to be subscribed to receive PerformanceInformationAvailable notifications in order to know when new collected performance information is available.

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

Table 7.7.2.1-1: Create PM Job operation

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

7.7.2.2 Input parameters

The input parameters carried by the createPmJobRequest message are listed in Table 7.7.2.2-1.

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

Table 7.7.2.2-1: Create PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceSelector	M	1	ObjectSelection	Defines the resources for which performance information is requested to be collected. See clause 8.5.2.
performanceMetric	M	0..N	String	Defines the type of performance metric(s) for the specified resources. At least one of the two (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 (performance metric or group) shall be present.
collectionPeriod	M	1	Not specified	Specifies the periodicity at which the VIM will collect performance information (see note).
reportingPeriod	M	1	Not specified	Specifies the periodicity at which the VIM will report to the NFVO about performance information (see note).
reportingBoundary	O	0..1	Not specified	Specifies 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 VIM 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 part of the protocol design, 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.				

7.7.2.3 Output parameters

The output parameters carried by the CreatePmJobResponse message are listed in Table 7.7.2.3-1.

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

Table 7.7.2.3-1: Create PM Job operation output parameters

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

7.7.2.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not the PM job was successfully created. The VIM may not support the collectionPeriod and can reject the CreatePmJobRequest.

7.7.3 Query PM Job operation

7.7.3.1 Description

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

This operation is not returning performance reports.

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

Table 7.7.3.1-1: Query PM Job operation

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

7.7.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.7.3.2-1.

Table 7.7.3.2-1: Query PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryFilter	M	1	Filter	Filter defining the PM Jobs on which the query applies. It can also be used to specify one or more PM Jobs to be queried, by providing their identifiers.

7.7.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.7.3.3-1.

Table 7.7.3.3-1: Query PM Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobDetails	M	0..N	PmJob	Details of PM jobs matching the input filter. The cardinality can be 0 if no matching PM Jobs exist. See clause 8.5.3.

7.7.3.4 Operation results

After successful operation, the VIM has run the query for PM job details. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the PM jobs that are matching the filter shall be returned.

7.7.4 Delete PM Jobs operation

7.7.4.1 Description

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

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

Table 7.7.4.1-1: Delete PM Job operation

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

7.7.4.2 Input parameters

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

Table 7.7.4.2-1: Delete PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobIds	M	1..N	Identifier	Identifiers of the PM job 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 terminate multiple PM jobs in one request, or as a series of requests that terminates one PM job at a time.				

7.7.4.3 Output parameters

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

Table 7.7.4.3-1: Delete PM Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedPmJobId	M	1..N	Identifier	Identifiers of the PM jobs successfully deleted. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple PM jobs in one request, or as a series of requests that terminates one PM job at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.7.4.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not all the selected PM jobs were successfully deleted.

7.7.5 Subscribe operation

7.7.5.1 Description

This operation enables the NFVOs to subscribe for the notifications related to performance information with the VIM. This also enables the NFVO to specify the scope of the subscription in terms of the specific virtual resources to be reported by the VIM using a filter as the input.

NOTE 1: Specification of filtering mechanism is part of the protocol design.

NOTE 2: It is part of the protocol design whether subscribing is represented as a separate "Subscribe" operation or whether subscription-related information is managed as part of managing PM jobs and Thresholds.

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

Table 7.7.5.1-1: Subscribe operation

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

7.7.5.2 Input Parameters

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

Table 7.7.5.2-1: Subscribe operation input parameters

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

7.7.5.3 Output Parameters

The parameters returned by the operation shall follow the indications provided in Table 7.7.5.3-1.

Table 7.7.5.3-1: Subscribe operation output parameters

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

7.7.5.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to performance information sent by the VIM. 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 NFVO.

7.7.6 Notify operation

7.7.6.1 Description

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

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

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

Table 7.7.6.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- PerformanceInformationAvailableNotification. See clause 8.5.8.
- ThresholdCrossedNotification. See clause 8.5.9.

7.7.7 Create Threshold operation

7.7.7.1 Description

This operation will allow the NFVO to create a threshold to specify threshold levels on specified performance metric and resource(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 7.7.7.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.7.7.1-1: Create Threshold operation

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

7.7.7.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.7.7.2-1.

Table 7.7.7.2-1: Create Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceSelector	M	1..N	ObjectSelection	Defines the resources for which the threshold is to be defined. See clause 8.5.2.
performanceMetric	M	1	String	Defines the performance metric on which the threshold is to be defined.
thresholdType	M	1	Enum	Defines the type of threshold. The list of possible values is part of the protocol design and might include: single/multi valued threshold, static/dynamic threshold, template based threshold, etc. VALUES: • SIMPLE: Single-valued static threshold • Etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, details on the notification to be generated.

7.7.7.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.7.7.3-1.

Table 7.7.7.3-1: Create Threshold operation output parameters

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

7.7.7.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not the threshold was successfully created.

7.7.8 Query Threshold operation

7.7.8.1 Description

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

Table 7.7.8.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.7.8.1-1: Query Threshold operation

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

7.7.8.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.7.8.2-1.

Table 7.7.8.2-1: Query Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryFilter	M	1	Filter	Filter defining the thresholds on which the query applies. It can also be used to specify one or more thresholds to be queried by providing their identifiers.

7.7.8.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.7.8.3-1.

Table 7.7.8.3-1: Query Threshold operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdDetails	M	0..N	Threshold	List of threshold details matching the input filter. The cardinality can be 0 if no matching threshold details exist. See clause 8.5.4.

7.7.8.4 Operation results

After successful operation, the VIM has run the query for threshold details. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the threshold details that are matching the filter shall be returned.

7.7.9 Delete Thresholds operation

7.7.9.1 Description

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

Table 7.7.9.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.7.9.1-1: Delete Threshold operation

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

7.7.9.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.7.9.2-1.

Table 7.7.9.2-1: Delete Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdId	M	1..N	Identifier	Identifiers of 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 terminate multiple thresholds in one request, or as a series of requests that terminates one threshold at a time.				

7.7.9.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.7.9.3-1.

Table 7.7.9.3-1: Delete Threshold operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedThresholdId	M	1..N	Identifier	Identifiers of the thresholds that have been deleted successfully. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple thresholds in one request, or as a series of requests that terminates one threshold at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.7.9.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (NFVO) whether or not all the selected thresholds were successfully deleted.

7.8 Virtualised Resource Reservation Interfaces

7.8.1 Virtualised Compute Resources Reservation Management Interface

7.8.1.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised compute resources reservations available to the consumer functional block. The interface includes operations for creating, querying, updating and terminating reservations on virtualised compute resources.

7.8.1.2 Create Compute Resource Reservation operation

7.8.1.2.1 Description

This operation allows requesting the reservation of virtualised compute resources as indicated by the consumer functional block.

Table 7.8.1.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.1.2.1-1: Create Compute Resource Reservation operation

Message	Requirement	Direction
CreateComputeResourceReservationRequest	Mandatory	NFVO → VIM
CreateComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.8.1.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.1.2.2-1.

Table 7.8.1.2.2-1: Create Compute Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
computePoolReservation	M	0..1	ComputePoolReservation	Amount of compute resources to be reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000} (see note). See clause 8.8.3.2.
virtualisationContainerReservation	M	0..N	VirtualisationContainerReservation	Virtualisation containers to be reserved (e.g. following a specific compute "flavour") (see note). See clause 8.8.5.2.

Parameter	Qualifier	Cardinality	Content	Description
affinityConstraint	M	0..N	AffinityOrAntiAffinity Constraint	Affinity information of the virtualised compute resources to reserve. For the resource reservation at resource pool granularity level, it defines the affinity information of the virtual compute pool resources to reserve. For the resource reservation at virtual container granularity level, it defines the affinity information of the virtualisation container(s) to reserve. See clause 8.4.8.2.
antiAffinityConstraint	M	0..N	AffinityOrAntiAffinity Constraint	Anti-affinity information of the virtualised compute resources to reserve. For the resource reservation at resource pool granularity level, it defines the anti-affinity information of the virtual compute pool resources to reserve. For the resource reservation at virtual container granularity level, it defines the anti-affinity information of the virtualisation container(s) to reserve. See clause 8.4.8.2.
startTime	M	0..1	DateTime	Specifies when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.
locationConstraints	M	0..1	Not specified	If present, it specifies location constraints for the resource(s) that is (are) requested to be reserved, e.g. in what particular resource zone.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
existingVirtualComputeResourcesTermination	M	0..N	Identifier (Reference to VirtualCompute)	Reference to existing virtual compute resources that are planned to be terminated by the consumer, and whose capacities information can be considered for computing the requested resource reservation.
NOTE: Either a computePoolReservation or a virtualisationContainerReservation shall be present in a single operation request, but not both at the same time.				

7.8.1.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.1.2.3-1.

Table 7.8.1.2.3-1: Create Compute Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedVirtualCompute	Contains information about the reserved resource. See clause 8.8.2.

7.8.1.2.4 Operation results

For the creation of the virtualised resource reservation, the VIM shall consider the new virtualised resources requested to be reserved, together with their characteristics, schedule and constraints, as well as the indicated, if present, existing virtualised resources that are planned to be terminated.

After successful operation, the VIM has created the internal management objects for the compute resource reservation and updated the information about the virtualised resource capacity according to the newly reserved resources. In addition, the VIM shall return to the NFVO information on the newly created reservation plus any additional information about the create reservation request operation. The VIM may also return intermediate status reports during the reservation process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.1.3 Query Compute Resource Reservation operation

7.8.1.3.1 Description

This operation allows querying information about reserved compute resources that the consumer has access to.

Table 7.8.1.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.1.3.1-1: Query Compute Resource Reservation operation

Message	Requirement	Direction
QueryComputeResourceReservationRequest	Mandatory	NFVO → VIM
QueryComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.8.1.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.1.3.2-1.

Table 7.8.1.3.2-1: Query Compute Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryReservationFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information expressing the type of information to be retrieved. It can also be used to specify one or more reservations to be queried by providing their identifiers.

7.8.1.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.1.3.3-1.

Table 7.8.1.3.3-1: Query Compute Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedVirtualCompute	Contains information about the reserved resource. Cardinality is 0 if the query did not return any result. See clause 8.8.2.

7.8.1.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised compute resource reservations. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the compute resource reservations that the NFVO has access to and that are matching the filter shall be returned.

7.8.1.4 Update Compute Resource Reservation operation

7.8.1.4.1 Description

This operation allows updating compute resource reservations (e.g. increase or decrease the amount of reserved resources).

Table 7.8.1.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.1.4.1-1: Update Compute Resource Reservation operation

Message	Requirement	Direction
UpdateComputeResourceReservationRequest	Mandatory	NFVO → VIM
UpdateComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.8.1.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.1.4.2-1.

Table 7.8.1.4.2-1: Update Compute Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the existing resource reservation to be updated.
computePoolReservation	M	0..1	ComputePoolReservation	New amount of compute resources to be reserved. See clause 8.8.3.2.
virtualisationContainerReservation	M	0..N	VirtualisationContainerReservation	New virtualisation containers to be reserved (e.g. following a specific compute "flavour"). See clause 8.8.5.2.
startTime	M	0..1	DateTime	Specifies when the consumption of the resource starts. If not present, the original setting will not be changed. If present and the value is 0, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.
existingVirtualComputeResourcesTermination	M	0..N	Identifier (Reference to VirtualCompute)	Reference to existing virtual compute resources that are planned to be terminated by the consumer, and whose capacities information can be considered for computing the requested resource reservation update.

7.8.1.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.1.4.3-1.

Table 7.8.1.4.3-1: Update Compute Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedVirtualCompute	Contains information about the updated reserved resource. See clause 8.8.2.

7.8.1.4.4 Operation results

For the update of the virtualised resource reservation, the VIM shall consider the new virtualised resources requested to be reserved, together with their characteristics, schedule and constraints, as well as the indicated, if present, existing virtualised resources that are planned to be terminated.

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource reservation and updated the information about the virtualised resource capacity according to the updated reserved capacity. In addition, the VIM shall return to the NFVO information on the updated reservation plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.1.5 Terminate Compute Resource Reservation operation

7.8.1.5.1 Description

This operation allows terminating one or more issued compute resource reservation(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.8.1.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.1.5.1-1: Terminate Compute Resource Reservation operation

Message	Requirement	Direction
TerminateComputeResourceReservationRequest	Mandatory	NFVO → VIM
TerminateComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.8.1.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.1.5.2-1.

Table 7.8.1.5.2-1: Terminate Compute Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the resource reservation(s) to be terminated.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple compute resource reservations in one request, or as a series of requests that terminates one compute resource reservation at a time.				

7.8.1.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.1.5.3-1.

Table 7.8.1.5.3-1: Terminate Compute Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the resource reservation(s) successfully terminated. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple compute resource reservations in one request, or as a series of requests that terminates one compute resource reservation at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.8.1.5.4 Operation results

After successful operation, the VIM has terminated the virtualised compute resource reservations and removed the internal management objects for those reservations and updated the information about the virtualised resource capacity according to the terminated reservations. In addition, the VIM shall return to the NFVO information whether the reservations are successfully terminated.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.2 Virtualised Network Resources Reservation Management Interface

7.8.2.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised network resources reservations available to the consumer functional block. The interface includes operations for creating, querying, updating and terminating reservations on virtualised network resources.

7.8.2.2 Create Network Resource Reservation operation

7.8.2.2.1 Description

This operation allows requesting the reservation of virtualised network resources as indicated by the consumer functional block.

Table 7.8.2.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.2.2.1-1: Create Network Resource Reservation operation

Message	Requirement	Direction
CreateNetworkResourceReservationRequest	Mandatory	NFVO → VIM
CreateNetworkResourceReservationResponse	Mandatory	VIM → NFVO

7.8.2.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.2.2.2-1.

Table 7.8.2.2.2-1: Create Network Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
networkReservation	M	1	VirtualNetworkReservation	Type and configuration of virtualised network resources that need to be reserved, e.g. {"numPublicIPs": 20}. See clause 8.8.4.3.
startTime	M	0..1	DateTime	Specifies when the consumption of the resources starts. If not present, resources are reserved for immediate use.

Parameter	Qualifier	Cardinality	Content	Description
endTime	M	0..1	DateTime	Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.
affinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Affinity information of the virtual network resources to reserve. See clause 8.4.8.2.
antiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Anti-affinity information of the virtual network resources to reserve. See clause 8.4.8.2.
locationConstraints	M	0..1	Not specified	If present, it specifies location constraints for the resource(s) that is (are) requested to be reserved, e.g. in what particular resource zone.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
existingVirtualNetwork ResourcesTermination	M	0..N	Identifier (Reference to VirtualNetwork)	Reference to existing virtual network resources that are planned to be terminated by the consumer, and whose capacities information can be considered for computing the requested resource reservation.

7.8.2.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.2.2.3-1.

Table 7.8.2.2.3-1: Create Network Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedVirtualNetwork	Contains information about the reserved resource. See clause 8.8.4.2.

7.8.2.2.4 Operation results

For the creation of the virtualised resource reservation, the VIM shall consider the new virtualised resources requested to be reserved, together with their characteristics, schedule and constraints, as well as the indicated, if present, existing virtualised resources that are planned to be terminated.

After successful operation, the VIM has created the internal management objects for the network resource reservation and updated the information about the virtualised resource capacity according to the newly reserved resources. In addition, the VIM shall return to the NFVO information on the newly created reservation plus any additional information about the create reservation request operation. The VIM may also return intermediate status reports during the reservation process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.2.3 Query Network Resource Reservation operation

7.8.2.3.1 Description

This operation allows querying information about reserved network resources that the consumer has access to.

Table 7.8.2.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.2.3.1-1: Query Network Resource Reservation operation

Message	Requirement	Direction
QueryNetworkResourceReservationRequest	Mandatory	NFVO → VIM
QueryNetworkResourceReservationResponse	Mandatory	VIM → NFVO

7.8.2.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.2.3.2-1.

Table 7.8.2.3.2-1: Query Network Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryReservationFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more reservations to be queried by providing their identifiers.

7.8.2.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.2.3.3-1.

Table 7.8.2.3.3-1: Query Network Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedVirtualNetwork	Contains information about the reserved resource(s) matching the filter. The cardinality can be 0 if no matching reservation exists. See clause 8.8.4.2.

7.8.2.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised network resource reservations. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the network resource reservations that the NFVO has access to and that are matching the filter shall be returned.

7.8.2.4 Update Network Resource Reservation operation

7.8.2.4.1 Description

This operation allows updating network resource reservations (e.g. increase or decrease the amount of reserved resources).

Table 7.8.2.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.2.4.1-1: Update Network Resource Reservation operation

Message	Requirement	Direction
UpdateNetworkResourceReservationRequest	Mandatory	NFVO → VIM
UpdateNetworkResourceReservationResponse	Mandatory	VIM → NFVO

7.8.2.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.2.4.2-1.

Table 7.8.2.4.2-1: Update Network Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the existing resource reservation to be updated.
networkReservation	M	0..1	VirtualNetworkReservation	New amount of network resources to be reserved. See clause 8.8.4.3.
startTime	M	0..1	DateTime	Specifies when the consumption of the resource starts. If not present, the original setting will not be changed. If present and the value is 0, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.
existingVirtualNetworkResourcesTermination	M	0..N	Identifier (Reference to VirtualNetwork)	Reference to existing virtual network resources that are planned to be terminated by the consumer, and whose capacities information can be considered for computing the requested resource reservation update.

7.8.2.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.2.4.3-1.

Table 7.8.2.4.3-1: Update Network Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedVirtualNetwork	Contains information about the updated reserved resource. See clause 8.8.4.2.

7.8.2.4.4 Operation results

For the update of the virtualised resource reservation, the VIM shall consider the new virtualised resources requested to be reserved, together with their characteristics, schedule and constraints, as well as the indicated, if present, existing virtualised resources that are planned to be terminated.

After successful operation, the VIM has updated the internal management objects for the virtualised network resource reservation and updated the information about the virtualised resource capacity according to the updated reserved capacity. In addition, the VIM shall return to the NFVO information on the updated reservation plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.2.5 Terminate Network Resource Reservation operation

7.8.2.5.1 Description

This operation allows terminating one or more issued network resource reservation(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.8.2.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.2.5.1-1: Terminate Network Resource Reservation operation

Message	Requirement	Direction
TerminateNetworkResourceReservationRequest	Mandatory	NFVO → VIM
TerminateNetworkResourceReservationResponse	Mandatory	VIM → NFVO

7.8.2.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.2.5.2-1.

Table 7.8.2.5.2-1: Terminate Network Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the resource reservation(s) to be terminated.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple network resource reservations in one request, or as a series of requests that terminates one network resource reservation at a time.				

7.8.2.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.2.5.3-1.

Table 7.8.2.5.3-1: Terminate Network Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the resource reservation(s) successfully terminated. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple network resource reservations in one request, or as a series of requests that terminates one network resource reservation at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.8.2.5.4 Operation results

After successful operation, the VIM has terminated the virtualised network resource reservations and removed the internal management objects for those reservations and updated the information about the virtualised resource capacity according to the terminated reservations. In addition, the VIM shall return to the NFVO information whether the termination of the reservations was successful.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.3 Virtualised Storage Resources Reservation Management Interface

7.8.3.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised storage resources reservations available to the consumer functional block. The interface includes operations for creating, querying, updating and terminating reservations on virtualised storage resources.

7.8.3.2 Create Storage Resource Reservation operation

7.8.3.2.1 Description

This operation allows requesting the reservation of virtualised storage resources as indicated by the consumer functional block.

Table 7.8.3.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.3.2.1-1: Create Storage Resource Reservation operation

Message	Requirement	Direction
CreateStorageResourceReservationRequest	Mandatory	NFVO → VIM
CreateStorageResourceReservationResponse	Mandatory	VIM → NFVO

7.8.3.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.3.2.2-1.

Table 7.8.3.2.2-1: Create Storage Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
storagePoolReservation	M	1	StoragePoolReservation	Type and configuration of virtualised storage that need to be reserved. E.g. amount of storage resources that need to be reserved, e.g. {"gigabytes": 1 000, "snapshots": 10, "volumes": 10}. See clause 8.8.6.3.
startTime	M	0..1	DateTime	Specifies when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.
affinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Affinity information of the virtual storage resources to reserve. See clause 8.4.8.2.
antiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Anti-affinity information of the virtual storage resources to reserve. See clause 8.4.8.2.
locationConstraints	M	0..1	Not specified	If present, it specifies location constraints for the resource(s) that is (are) requested to be reserved, e.g. in what particular Resource Zone.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
existingVirtualStorageResourcesTermination	M	0..N	Identifier (Reference to VirtualStorage)	Reference to existing virtual storage resources that are planned to be terminated by the consumer, and whose capacities information can be considered for computing the requested resource reservation.

7.8.3.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.3.2.3-1.

Table 7.8.3.2.3-1: Create Storage Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedVirtualStorage	Contains information about the reserved resource. See clause 8.8.6.2.

7.8.3.2.4 Operation results

For the creation of the virtualised resource reservation, the VIM shall consider the new virtualised resources requested to be reserved, together with their characteristics, schedule and constraints, as well as the indicated, if present, existing virtualised resources that are planned to be terminated.

After successful operation, the VIM has created the internal management objects for the storage resource reservation and updated the information about the virtualised resource capacity according to the newly reserved resources. In addition, the VIM shall return to the NFVO information on the newly created reservation plus any additional information about the create reservation request operation. The VIM may also return intermediate status reports during the reservation process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.3.3 Query Storage Resource Reservation operation

7.8.3.3.1 Description

This operation allows querying information about reserved resources that the consumer has access to.

Table 7.8.3.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.3.3.1-1: Query Storage Resource Reservation operation

Message	Requirement	Direction
QueryStorageResourceReservationRequest	Mandatory	NFVO → VIM
QueryStorageResourceReservationResponse	Mandatory	VIM → NFVO

7.8.3.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.3.3.2-1.

Table 7.8.3.3.2-1: Query Storage Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryReservationFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more reservations to be queried by providing their identifiers.

7.8.3.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.3.3.3-1.

Table 7.8.3.3.3-1: Query Storage Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedVirtualStorage	Contains information about the reserved resource(s) matching the filter. The cardinality can be 0 if no matching reservation exist. See clause 8.8.6.2.

7.8.3.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised storage resource reservations. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the storage resource reservations that the NFVO has access to and that are matching the filter shall be returned.

7.8.3.4 Update Storage Resource Reservation operation

7.8.3.4.1 Description

This operation allows updating resource reservations (e.g. increase or decrease the amount of reserved resources).

Table 7.8.3.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.3.4.1-1: Update Storage Resource Reservation operation

Message	Requirement	Direction
UpdateStorageResourceReservationRequest	Mandatory	NFVO → VIM
UpdateStorageResourceReservationResponse	Mandatory	VIM → NFVO

7.8.3.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.3.4.2-1.

Table 7.8.3.4.2-1: Update Storage Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the existing resource reservation to be updated.
storagePoolReservation	M	0..1	StoragePoolReservation	New amount of storage resources to be reserved. See clause 8.8.6.3.
startTime	M	0..1	DateTime	Specifies when the consumption of the resource starts. If not present, the original setting will not be changed. If present and the value is 0, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.
existingVirtualStorageResourcesTermination	M	0..N	Identifier (Reference to VirtualStorage)	Reference to existing virtual storage resources that are planned to be terminated by the consumer, and whose capacities information can be considered for computing the requested resource reservation update.

7.8.3.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.3.4.3-1.

Table 7.8.3.4.3-1: Update Storage Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedVirtualStorage	Contains information about the updated reserved resource. See clause 8.8.6.2.

7.8.3.4.4 Operation results

For the update of the virtualised resource reservation, the VIM shall consider the new virtualised resources requested to be reserved, together with their characteristics, schedule and constraints, as well as the indicated, if present, existing virtualised resources that are planned to be terminated.

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource reservation and updated the information about the virtualised resource capacity according to the updated reserved capacity. In addition, the VIM shall return to the NFVO information on the updated reservation plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.3.5 Terminate Storage Resource Reservation operation

7.8.3.5.1 Description

This operation allows terminating one or more issued storage resource reservation(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.8.3.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.3.5.1-1: Terminate Storage Resource Reservation operation

Message	Requirement	Direction
TerminateStorageResourceReservationRequest	Mandatory	NFVO → VIM
TerminateStorageResourceReservationResponse	Mandatory	VIM → NFVO

7.8.3.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.3.5.2-1.

Table 7.8.3.5.2-1: Terminate Storage Resource Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the resource reservation(s) to be terminated.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple storage resource reservations in one request, or as a series of requests that terminates one storage resource reservation at a time.				

7.8.3.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.3.5.3-1.

Table 7.8.3.5.3-1: Update Storage Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the resource reservation(s) successfully terminated. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple storage resource reservations in one request, or as a series of requests that terminates one storage resource reservation at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.8.3.5.4 Operation results

After successful operation, the VIM has terminated the virtualised storage resource reservations and removed the internal management objects for those reservations and updated the information about the virtualised resource capacity according to the terminated reservations. In addition, the VIM shall return to the NFVO information whether the termination of the reservations was successful.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.8.4 Virtualised Resources Reservation Change Notification Interface

7.8.4.1 Introduction

This interface allows an authorized consumer functional block to request subscription to changes on reservation of virtualised resources, and to provide such notification to the subscribed consumer. As such, it provides the notification part of the Virtualised Resources Reservation Management interfaces.

7.8.4.2 Subscribe operation

7.8.4.2.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications related to reservation on virtualised resources sent by the VIM. Specification of filtering mechanism is part of the protocol design.

Table 7.8.4.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.4.2.1-1: Subscribe operation

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

7.8.4.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.8.4.2.2-1.

Table 7.8.4.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting the virtualised resource(s) and the related change notifications to subscribe to. This filter can contain information about specific attributes of the resource or of the reservation.

7.8.4.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.8.4.2.3-1.

Table 7.8.4.2.3-1: Subscribe operation output parameters

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

7.8.4.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to changes on reservation of virtualised storage resources sent by the VIM. 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 NFVO.

7.8.4.3 Notify operation

7.8.4.3.1 Description

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

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

Table 7.8.4.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.8.4.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation:

- VirtualisedResourceReservationChangeNotification. See clause 8.8.7.

7.9 Virtualised Resource Quota Interfaces

7.9.1 Virtualised Compute Resources Quota Management Interface

7.9.1.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised compute resources quotas available to the consumer functional block. The interface includes operations for creating, querying, updating and terminating quotas on virtualised compute resources.

7.9.1.2 Create Compute Resource Quota operation

7.9.1.2.1 Description

This operation allows requesting the quota of virtualised compute resources as indicated by the consumer functional block.

Table 7.9.1.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.1.2.1-1: Create Compute Resource Quota operation

Message	Requirement	Direction
CreateComputeResourceQuotaRequest	Mandatory	NFVO → VIM
CreateComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.1.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.1.2.2-1.

Table 7.9.1.2.2-1: Create Compute Resource Quota operation input parameters

Parameter	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.
virtualComputeQuota	M	1	VirtualComputeQuotaData	Amount of compute resources to be restricted by the quota, e.g. number of instances. See clause 8.11.2.2.

7.9.1.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.1.2.3-1.

Table 7.9.1.2.3-1: Create Compute Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
quotaData	M	1	VirtualComputeQuota	Contains information about the quota resource. See clause 8.11.2.3.

7.9.1.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the compute resource quota. In addition, the VIM shall return to the NFVO information on the newly created quota plus any additional information about the create quota request operation. The VIM may also return intermediate status reports during the quota process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.1.3 Query Compute Resource Quota operation

7.9.1.3.1 Description

This operation allows querying quota information about compute resources that the consumer has access to.

Table 7.9.1.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.1.3.1-1: Create Compute Resource Quota operation

Message	Requirement	Direction
QueryComputeResourceQuotaRequest	Mandatory	NFVO → VIM
QueryComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.1.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.1.3.2-1.

Table 7.9.1.3.2-1: Query Compute Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryQuotaFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information expressing the type of information to be retrieved. It can also be used to specify one or more quotas to be queried by providing their identifiers.

7.9.1.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.1.3.3-1.

Table 7.9.1.3.3-1: Query Compute Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualComputeQuota	Contains information about the quota resource. The cardinality can be 0 if no matching quota exists. See clause 8.11.2.3.

7.9.1.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised compute resource quotas. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the compute resource quotas that the NFVO has access to and that are matching the filter shall be returned.

7.9.1.4 Update Compute Resource Quota operation

7.9.1.4.1 Description

This operation allows updating compute resource quotas (e.g. increase or decrease the amount of quota resources).

Table 7.9.1.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.1.4.1-1: Update Compute Resource Quota operation

Message	Requirement	Direction
UpdateComputeResourceQuotaRequest	Mandatory	NFVO → VIM
UpdateComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.1.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.1.4.2-1.

Table 7.9.1.4.2-1: Update Compute Resource Quota operation input parameters

Parameter	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.
virtualComputeQuota	M	1	VirtualComputeQuotaData	New amount of compute resources to be restricted by the quota. See clause 8.11.2.2.

7.9.1.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.1.4.3-1.

Table 7.9.1.4.3-1: Update Compute Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
quotaData	M	1	VirtualComputeQuota	Contains information about the updated quota resource. See clause 8.11.2.3.

7.9.1.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource quota. In addition, the VIM shall return to the NFVO information on the updated quota plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.1.5 Terminate Compute Resource Quota operation

7.9.1.5.1 Description

This operation allows terminating one or more issued compute resource quota(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.9.1.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.1.5.1-1: Terminate Compute Resource Quota operation

Message	Requirement	Direction
TerminateComputeResourceQuotaRequest	Mandatory	NFVO → VIM
TerminateComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.1.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.1.5.2-1.

Table 7.9.1.5.2-1: Terminate Compute Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1..N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple compute resource quotas in one request, or as a series of requests that terminates one compute resource quota at a time.				

7.9.1.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.1.5.3-1.

Table 7.9.1.5.3-1: Update Compute Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1..N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple compute resource quotas in one request, or as a series of requests that terminates one compute resource quota at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.9.1.5.4 Operation results

After successful operation, the VIM has terminated the virtualised compute resource quotas and removed the internal management objects for those quotas In addition, the VIM shall return to the NFVO information whether the termination of the quotas was successful.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.2 Virtualised Network Resources Quota Management Interface

7.9.2.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised network resources quotas available to the consumer functional block. The interface includes operations for creating, querying, updating and terminating quotas on virtualised network resources.

7.9.2.2 Create Network Resource Quota operation

7.9.2.2.1 Description

This operation allows requesting the quota of virtualised network resources as indicated by the consumer functional block.

Table 7.9.2.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.2.2.1-1: Create Network Resource Quota operation

Message	Requirement	Direction
CreateNetworkResourceQuotaRequest	Mandatory	NFVO → VIM
CreateNetworkResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.2.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.2.2.2-1.

Table 7.9.2.2.2-1: Create Network Resource Quota operation input parameters

Parameter	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.
virtualNetworkQuota	M	1	VirtualNetworkQuotaData	Type and configuration of virtualised network resources to be restricted by the quota, e.g. {"numPublicIps": 20}. See clause 8.11.3.2.

7.9.2.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.2.2.3-1.

Table 7.9.2.2.3-1: Create Network Resource Quota operation output parameter

Parameter	Qualifier	Cardinality	Content	Description
quotaData	M	1	VirtualNetworkQuota	Contains information about the quota resource. See clause 8.11.3.3.

7.9.2.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the network resource quota. In addition, the VIM shall return to the NFVO information on the newly created quota plus any additional information about the create quota request operation. The VIM may also return intermediate status reports during the quota process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.2.3 Query Network Resource Quota operation

7.9.2.3.1 Description

This operation allows querying information about quota network resources that the consumer has access to.

Table 7.9.2.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.2.3.1-1: Query Network Resource Quota operation

Message	Requirement	Direction
QueryNetworkResourceQuotaRequest	Mandatory	NFVO → VIM
QueryNetworkResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.2.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.2.3.2-1.

Table 7.9.2.3.2-1: Query Network Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryQuotaFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more quotas to be queried by providing their identifiers.

7.9.2.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.2.3.3-1.

Table 7.9.2.3.3-1: Query Network Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualNetworkQuota	Contains information about the quota resource(s) matching the filter. The cardinality can be 0 if no matching quota exists. See clause 8.11.3.3.

7.9.2.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised network resource quotas. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the network resource quotas that the NFVO has access to and that are matching the filter shall be returned.

7.9.2.4 Update Network Resource Quota operation

7.9.2.4.1 Description

This operation allows updating network resource quotas (e.g. increase or decrease the amount of quota resources).

Table 7.9.2.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.2.4.1-1: Update Network Resource Quota operation

Message	Requirement	Direction
UpdateNetworkResourceQuotaRequest	Mandatory	NFVO → VIM
UpdateNetworkResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.2.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.2.4.2-1.

Table 7.9.2.4.2-1: Update Network Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
virtualNetworkQuota	M	1	VirtualNetworkQuotaData	New amount of network resources to be restricted by the quota. See clause 8.11.3.2.

7.9.2.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.2.4.3-1.

Table 7.9.2.4.3-1: Update Network Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
quotaData	M	1	VirtualNetworkQuota	Contains information about the updated quota resource. See clause 8.11.3.3.

7.9.2.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised network resource quota. In addition, the VIM shall return to the NFVO information on the updated quota plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.2.5 Terminate Network Resource Quota operation

7.9.2.5.1 Description

This operation allows terminating one or more issued network resource quota(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.9.2.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.2.5.1-1: Terminate Network Resource Quota operation

Message	Requirement	Direction
TerminateNetworkResourceQuotaRequest	Mandatory	NFVO → VIM
TerminateNetworkResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.2.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.2.5.2-1.

Table 7.9.2.5.2-1: Terminate Network Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1..N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple network resource quotas in one request, or as a series of requests that terminates one network resource quota at a time.				

7.9.2.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.2.5.3-1.

Table 7.9.2.5.3-1: Terminate Compute Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1..N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple network resource quotas in one request, or as a series of requests that terminates one network resource quota at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.9.2.5.4 Operation results

After successful operation, the VIM has terminated the virtualised network resource quotas and removed the internal management objects for those quotas. In addition, the VIM shall return to the NFVO information whether the termination of the quotas was successful.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.3 Virtualised Storage Resources Quota Management Interface

7.9.3.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised storage resources quotas available to the consumer functional block. The interface includes operations for creating, querying, updating and terminating quotas on virtualised storage resources.

7.9.3.2 Create Storage Resource Quota operation

7.9.3.2.1 Description

This operation allows requesting the quota of virtualised storage resources as indicated by the consumer functional block.

Table 7.9.3.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.3.2.1-1: Create Storage Resource Quota operation

Message	Requirement	Direction
CreateStorageResourceQuotaRequest	Mandatory	NFVO → VIM
CreateStorageResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.3.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.3.2.2-1.

Table 7.9.3.2.2-1: Create Storage Resource Quota operation input parameters

Parameter	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.
virtualStorageQuota	M	1	VirtualStorageQuotaData	Type and configuration of virtualised storage to be restricted by the quota. E.g. amount of storage resources that need to be restricted by the quota, e.g. {"storageSize": 1 000, "numSnapshots": 10, "numVolumes": 10}. See clause 8.11.4.2.

7.9.3.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.3.2.3-1.

Table 7.9.3.2.3-1: Create Storage Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
quotaData	M	1	VirtualStorageQuota	Contains information about the quota resource. See clause 8.11.4.3.

7.9.3.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the storage resource quota. In addition, the VIM shall return to the NFVO information on the newly created quota plus any additional information about the create quota request operation. The VIM may also return intermediate status reports during the quota process.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.3.3 Query Storage Resource Quota operation

7.9.3.3.1 Description

This operation allows querying information about quota resources that the consumer has access to.

Table 7.9.3.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.3.3.1-1: Query Storage Resource Quota operation

Message	Requirement	Direction
QueryStorageResourceQuotaRequest	Mandatory	NFVO → VIM
QueryStorageResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.3.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.3.3.2-1.

Table 7.9.3.3.2-1: Query Storage Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryQuotaFilter	M	1	Filter	Query filter based on e.g. name, identifier, meta-data information or status information, expressing the type of information to be retrieved. It can also be used to specify one or more quotas to be queried by providing their identifiers.

7.9.3.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.3.3.3-1.

Table 7.9.3.3.3-1: Query Storage Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualStorageQuota	Contains information about the quota resource(s) matching the filter. The cardinality can be 0 if no matching quota exists. See clause 8.11.4.3.

7.9.3.3.4 Operation results

After successful operation, the VIM has queried the internal management objects for the virtualised storage resource quotas. The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the storage resource quotas that the NFVO has access to and that are matching the filter shall be returned.

7.9.3.4 Update Storage Resource Quota operation

7.9.3.4.1 Description

This operation allows updating resource quotas (e.g. increase or decrease the amount of quota resources).

Table 7.9.3.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.3.4.1-1: Update Storage Resource Quota operation

Message	Requirement	Direction
UpdateStorageResourceQuotaRequest	Mandatory	NFVO → VIM
UpdateStorageResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.3.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.3.4.2-1.

Table 7.9.3.4.2-1: Update Storage Resource Quota operation input parameters

Parameter	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.
virtualStorageQuota	M	1	VirtualStorageQuotaData	New amount of storage resources to be restricted by the quota. See clause 8.11.4.2.

7.9.3.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.3.4.3-1.

Table 7.9.3.4.3-1: Update Storage Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
quotaData	M	0..1	VirtualStorageQuota	Contains information about the updated quota resource. See clause 8.11.4.3.

7.9.3.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource quota. In addition, the VIM shall return to the NFVO information on the updated quota plus any additional information about the update request operation.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.3.5 Terminate Storage Resource Quota operation

7.9.3.5.1 Description

This operation allows terminating one or more issued storage resource quota(s). When the operation is done on multiple ids, it is assumed to be best-effort, i.e. it can succeed for a subset of the ids, and fail for the remaining ones.

Table 7.9.3.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.3.5.1-1: Terminate Storage Resource Quota operation

Message	Requirement	Direction
TerminateStorageResourceQuotaRequest	Mandatory	NFVO → VIM
TerminateStorageResourceQuotaResponse	Mandatory	VIM → NFVO

7.9.3.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.3.5.2-1.

Table 7.9.3.5.2-1: Terminate Storage Resource Quota operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1..N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple storage resource quotas in one request, or as a series of requests that terminates one storage resource quota at a time.				

7.9.3.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.3.5.3-1.

Table 7.9.3.5.3-1: Terminate Storage Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceGroupId	M	1..N	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain. See note 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple storage resource quotas in one request, or as a series of requests that terminates one storage resource quota at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.9.3.5.4 Operation results

After successful operation, the VIM has terminated the virtualised storage resource quotas and removed the internal management objects for those quotas. In addition, the VIM shall return to the NFVO information whether the termination of the quotas was successful.

If the operation was not successful, the VIM shall return to the NFVO appropriate error information.

7.9.4 Virtualised Resources Quota Change Notification Interface

7.9.4.1 Introduction

This interface allows an authorized consumer functional block to request subscription to changes on quota of virtualised resources, and to provide such notification to the subscribed consumer. As such, it provides the notification part of the Virtualised Resources Quota Management interfaces.

7.9.4.2 Subscribe operation

7.9.4.2.1 Description

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

Table 7.9.4.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.4.2.1-1: Subscribe operation

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

7.9.4.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.9.4.2.2-1.

Table 7.9.4.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting the virtualised resource(s) and the related change notifications to subscribe to. This filter can contain information about specific attributes of the resource or of the quota.

7.9.4.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.9.4.2.3-1.

Table 7.9.4.2.3-1: Subscribe operation output parameters

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

7.9.4.2.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to changes on quota of virtualised storage resources sent by the VIM. 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 NFVO.

7.9.4.3 Notify operation

7.9.4.3.1 Description

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

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

Table 7.9.4.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.9.4.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation:

- VirtualisedResourceQuotaChangeNotification. See clause 8.11.5.

7.10 Compute Host Reservation Management Interface

7.10.1 Description

This interface allows an authorized consumer functional block to perform operations on compute host reservations available to the consumer functional block.

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

- Create Compute Host Reservation operation
- Query Compute Host Reservation operation
- Update Compute Host Reservation operation
- Terminate Compute Host Reservation operation

7.10.2 Create Compute Host Reservation operation

7.10.2.1 Description

This operation allows requesting the reservation of compute hosts as indicated by the consumer functional block.

Table 7.10.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.10.2.1-1: Create Compute Host Reservation operation

Message	Requirement	Direction
CreateComputeHostReservationRequest	Mandatory	NFVO → VIM
CreateComputeHostReservationResponse	Mandatory	VIM → NFVO

7.10.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.10.2.2-1.

Table 7.10.2.2-1: Create Compute Host Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
minAmount	M	1	Integer	Minimum amount of compute hosts to be reserved. See note.
maxAmount	M	1	Integer	Maximum amount of compute hosts to be reserved. See note.
startTime	M	0..1	DateTime	Specifies the start time for consumption of the reserved compute hosts by a given tenant. When omitted, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Specifies the end time for consumption of the reserved compute hosts by a given tenant. When omitted, a configurable default date-time is used.
computeHostProperties	M	0..N	Not specified	Set of properties that specify the capabilities associated to the compute hosts (e.g. hypervisor capabilities) to be reserved.
locationConstraints	M	0..1	Not specified	If present, it specifies location constraints for the resource(s) to be reserved, e.g. in what particular resource zone.

Parameter	Qualifier	Cardinality	Content	Description
NOTE: The VIM tries to reserve maxAmount of compute hosts. If the amount of available compute hosts for the requested time window (i.e. between startTime and endTime) is between minAmount and maxAmount, the VIM reserves all of the available compute hosts. In case the VIM cannot reserve minAmount of compute hosts during the requested time window, the request cannot be fulfilled and the operation fails and appropriate error information is returned.				

7.10.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.10.2.3-1.

Table 7.10.2.3-1: Create Compute Host Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedComputeHosts	Contains information about the reserved compute hosts. See clause 8.13.2.

7.10.2.4 Operation results

In case of success, the VIM shall return to the NFVO information on the newly created reservation plus any additional information about the create compute host reservation request operation.

In case of failure, the VIM shall return to the NFVO appropriate error information.

7.10.3 Query Compute Host Reservation operation

7.10.3.1 Description

This operation allows querying information about reserved compute hosts.

Table 7.10.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.10.3.1-1: Query Compute Host Reservation operation

Message	Requirement	Direction
QueryComputeHostReservationRequest	Mandatory	NFVO → VIM
QueryComputeHostReservationResponse	Mandatory	VIM → NFVO

7.10.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.10.3.2-1.

Table 7.10.3.2-1: Query Compute Host Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryReservationFilter	M	1	Filter	Input filter that can be used e.g. to specify a reservation to be queried by providing its identifier.

7.10.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.10.3.3-1.

Table 7.10.3.3-1: Query Compute Host Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedComputeHosts	Contains information about the reserved compute hosts. Cardinality is 0 if the query did not return any result. See clause 8.13.2.

7.10.3.4 Operation results

The result of the query shall indicate with a standard success/error result if the query has been processed correctly. For a particular query, information about the compute host reservations that the NFVO has access to and that are matching the filter shall be returned.

7.10.4 Update Compute Host Reservation operation

7.10.4.1 Description

This operation allows updating compute host reservations (e.g. increase the minimum amount of reserved compute hosts).

Table 7.10.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.10.4.1-1: Update Compute Host Reservation operation

Message	Requirement	Direction
UpdateComputeHostReservationRequest	Mandatory	NFVO → VIM
UpdateComputeHostReservationResponse	Mandatory	VIM → NFVO

7.10.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.10.4.2-1.

Table 7.10.4.2-1: Update Compute Host Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the existing compute host reservation to be updated.
minAmount	M	0..1	Integer	New minimum amount of compute hosts to be reserved. See note 1.
maxAmount	M	0..1	Integer	New maximum amount of compute hosts to be reserved. See note 1.
startTime	M	0..1	DateTime	New start time for consumption of the reserved compute hosts by a given tenant. See note 1.
endTime	M	0..1	DateTime	New end time for consumption of the reserved compute hosts by a given tenant. See note 1.
computeHostProperties	M	0..N	Not specified	Set of properties that define the capabilities associated to the compute hosts (e.g. hypervisor capabilities) to be updated. See notes 1 and 2.
locationConstraints	M	0..1	Not specified	Location constraints for the resource(s) to be reserved, e.g. in what particular resource zone. See notes 1 and 2.
NOTE 1: When omitted, i.e. Cardinality = 0, the value is not updated. NOTE 2: It is not possible to update the computeHostProperties and locationConstraints after startTime.				

7.10.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.10.4.3-1.

Table 7.10.4.3-1: Update Compute Host Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationData	M	1	ReservedComputeHosts	Contains information about the updated reserved compute hosts. See clause 8.13.2.

7.10.4.4 Operation results

In case of success, the VIM shall return to the NFVO information on the updated reservation plus any additional information about the update compute host reservation request operation.

In case of failure, e.g. the VIM cannot reserve at least minAmount of compute hosts during the requested time windows, the existing compute host reservation is not updated and the VIM shall return to the NFVO appropriate error information.

7.10.5 Terminate Compute Host Reservation operation

7.10.5.1 Description

This operation allows the termination of one or more compute host reservations.

Table 7.10.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.10.5.1-1: Terminate Compute Host Reservation operation

Message	Requirement	Direction
TerminateComputeHostReservationRequest	Mandatory	NFVO → VIM
TerminateComputeHostReservationResponse	Mandatory	VIM → NFVO

7.10.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.10.5.2-1.

Table 7.10.5.2-1: Terminate Compute Host Reservation operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	1..N	Identifier	Identifier of the compute host reservation(s) to be terminated.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple compute host reservations in one request, or as a series of requests that terminates one compute host reservation at a time.				

7.10.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.10.5.3-1.

Table 7.10.5.3-1: Terminate Compute Host Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
reservationId	M	0..N	Identifier	Identifier of the compute host reservation(s) successfully terminated.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple compute host reservations in one request, or as a series of requests that terminates one compute host reservation at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.10.5.4 Operation results

In case of success, the VIM shall return to the NFVO information on the terminated reservation plus any additional information about the terminate compute host reservation request operation.

In case of failure, the VIM shall return to the NFVO appropriate error information.

7.11 NFVI Capacity Management Interfaces

7.11.1 Compute Host Capacity Management Interface

7.11.1.1 Introduction

This interface allows an authorized consumer functional block to request operations related to capacity and usage reporting. The interface allows retrieval of information about:

- The available, used, reserved and total capacity of the physical compute resources used by a VIM instance, globally or per resource zone.
- Utilization of the capacity, both on VIM global level but also per resource zone.

NOTE 1: The VIM interacts with the PIM function for getting information about the physical compute resources that are being used by its virtualised resources.

NOTE 2: For per resource zone capacity information, the VIM provides only the information about the physical compute resources that are being used by its virtualised resources within that resource zone.

The interface enables the capture of information for resources usage and input to capacity planning, capacity changes, and consequently for Network Service planning, etc.

7.11.1.2 Query Compute Host Capacity operation

7.11.1.2.1 Description

This operation supports retrieval of compute host capacity information. Specification of filtering mechanism and the type of the output parameter is part of the protocol design.

Table 7.11.1.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.11.1.2.1-1: Query Compute Host Capacity operation

Message	Requirement	Direction
QueryComputeHostCapacityRequest	Mandatory	NFVO → VIM
QueryComputeHostCapacityResponse	Mandatory	VIM → NFVO

7.11.1.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.11.1.2.2-1.

Table 7.11.1.2.2-1: Query Compute Host Capacity operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting information to query. For instance, based on the resource zone, the time interval for which capacity is queried, and which capacity information (i.e. available, total, reserved and/or used capacity) is queried.

7.11.1.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.11.1.2.3-1.

Table 7.11.1.2.3-1: Query Compute Capacity operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
capacityResponse	M	0..1	Not specified	The capacity matching the query. Cardinality is 0 if no data is matching the inputFilter.

7.11.1.2.4 Operation results

After successful operation, the VIM has queried the compute host capacity information. The result of the query shall indicate with a standard success/error result if the query has been processed correctly.

7.11.1.3 Subscribe operation

7.11.1.3.1 Description

This operation supports subscribing to compute host capacity change notifications.

Table 7.11.1.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.11.1.3.1-1: Subscribe operation

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

7.11.1.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.11.1.3.2-1.

Table 7.11.1.3.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
inputFilter	M	1	Filter	Input filter for selecting notifications. The filter shall support: • Resource zone for which the capacity change notifications are requested. When not specified the total capacity managed by the VIM instance will be notified. • Threshold: When specified this parameter indicates a capacity value which, once crossed, will trigger a notification. When not specified, notifications are issued at every change (see note). • Input parameter for selecting which capacity information (i.e. available, total, reserved and/or used capacity) the subscription refers to. When not present, all four values are requested.
NOTE: The VIM may still implement a minimum-delta threshold in order to avoid an excessive notification flow.				

7.11.1.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.11.1.3.3-1.

Table 7.11.1.3.3-1: Subscribe operation output parameters

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

7.11.1.3.4 Operation results

After successful subscription, the NFVO is registered to receive notifications related to compute host capacity changes sent by the VIM. 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 NFVO.

7.11.1.4 Notify operation

7.11.1.4.1 Description

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

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

Table 7.11.1.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.11.1.4.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- CapacityChangeNotification. See clause 8.7.4.

7.12 Policy Management interface

7.12.1 Description

This interface allows the NFVO to invoke policy management operations towards the VIM.

The following policy management operations are defined for this interface:

- Transfer Policy
- Delete Policy
- Query Policy
- Activate Policy
- Deactivate Policy

This interface allows the NFVO to manage subscriptions to notifications sent by the VIM which inform about changes of a policy and about any detected policy conflicts. It allows the VIM to provide such notifications to the subscriber (e.g. NFVO).

7.12.2 Transfer Policy operation

7.12.2.1 Description

This operation enables the NFVO to transfer an NFV-MANO policy to the VIM. Table 7.12.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.2.1-1: Transfer Policy operation

Message	Requirement	Direction
TransferPolicyRequest	Mandatory	NFVO → VIM
TransferPolicyResponse	Mandatory	VIM → NFVO

7.12.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.2.2-1.

Table 7.12.2.2-1: Transfer Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
designer	M	1	String	Human readable name of designer of the policy.
name	M	1	String	Human readable name of the policy.
version	M	1	Version	Version of the policy. Its value shall be the same as the one within the policy being transferred, i.e. the "policyVersion" attribute in the "Policy" information element specified in ETSI GS NFV-IFA 048 [8].
policy	M	1	Policy	Specifies the policy. See notes 1 and 2. "Policy" is specified in clause 5.2 of ETSI GS NFV-IFA 048 [8].
NOTE 1: An identifier for uniquely identifying the policy shall be included in the policy. NOTE 2: The NFVO may use this operation to update an existing policy with a new version. Different policy versions share the same internal identifier of the policy but having different PolicyInfo instances. The design of different policy versions and their business logic is out of the scope of the present document.				

7.12.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.2.3-1.

Table 7.12.2.3-1: Transfer Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1	Identifier	Identifier of the policy information created by the VIM.

7.12.2.4 Operation results

In case of success, the NFV-MANO policy is transferred to the VIM and corresponding policy information is created by the VIM. In case of failure, appropriate error information is returned.

7.12.3 Delete Policy operation

7.12.3.1 Description

This operation enables the NFVO to delete one or multiple NFV-MANO policy(ies) from the VIM. Table 7.12.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.3.1-1: Delete Policy operation

Message	Requirement	Direction
DeletePolicyRequest	Mandatory	NFVO → VIM
DeletePolicyResponse	Mandatory	VIM→ NFVO

7.12.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.3.2-1.

Table 7.12.3.2-1: Delete Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1..N	Identifier (Reference to PolicyInfo)	References the policy information 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 policies in one request, or as a series of requests that delete one policy at a time.				

7.12.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.3.3-1.

Table 7.12.3.3-1: Delete Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedPolicyInfoId	M	0..N	Identifier (Reference to PolicyInfo)	References the deleted NFV-MANO policy information.

7.12.3.4 Operation results

In case of success, the NFV-MANO policy(ies) are deleted from the VIM, and a success indicator is returned to the NFVO. In case of failure, appropriate error information is returned.

7.12.4 Query Policy operation

7.12.4.1 Description

This operation enables the NFVO to query the information from the VIM on one or multiple NFV-MANO policy(ies). Table 7.12.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.4.1-1: Query Policy operation

Message	Requirement	Direction
QueryPolicyRequest	Mandatory	NFVO → VIM
QueryPolicyResponse	Mandatory	VIM → NFVO

7.12.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.4.2-1.

Table 7.12.4.2-1: Query Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the NFV-MANO policy information on which the query applies, based on attributes of NFV-MANO policy information. It can also be used to specify one or more NFV-MANO policy(ies) information to be queried by providing their identifiers.
attributeSelector	M	0..N	String	Provides a list of attribute names of NFV-MANO policy information. If present, only these attributes are returned for the policy information matching the filter. If absent, the complete policy information is returned.

7.12.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.4.3-1.

Table 7.12.4.3-1: Query Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryNsPolicyInfoResult	M	0..N	PolicyInfo	NFV-MANO policy information matching the input filter. If attributeSelector is present, only the attributes listed in attributeSelector are returned for the selected policy information. See note.
NOTE: The lower cardinality is 0 since there may be no matches to the provided filter.				

7.12.4.4 Operation results

After success operation, the VIM has queried the internal NFV-MANO policy information. The result of the operation indicates whether it has been successful or not with a standard success/error result. For a particular query, policy information that is matching the filter shall be returned.

7.12.5 Activate Policy operation

7.12.5.1 Description

This operation enables the NFVO to activate one or multiple NFV-MANO policy(ies) in the VIM. Table 7.12.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.5.1-1: Activate Policy operation

Message	Requirement	Direction
ActivatePolicyRequest	Mandatory	NFVO → VIM
ActivatePolicyResponse	Mandatory	VIM → NFVO

7.12.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.5.2-1.

Table 7.12.5.2-1: Activate Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1..N	Identifier (Reference to PolicyInfo)	References the policy information to be activated. 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 activate multiple policies in one request, or as a series of requests that activate one policy at a time.				

7.12.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.5.3-1.

Table 7.12.5.3-1: Activate Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
activatedPolicyInfoId	M	0..N	Identifier (Reference to PolicyInfo)	References the activated NFV-MANO policy(ies).

7.12.5.4 Operation results

In case of success, the NFV-MANO policy(ies) are activated in the VIM, and a success indicator is returned to the NFVO. In case of failure, appropriate error information is returned.

7.12.6 Deactivate Policy operation

7.12.6.1 Description

This operation enables the NFVO to deactivate one or multiple NFV-MANO policy(ies) in the VIM. Table 7.12.6.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.6.1-1: Deactivate Policy operation

Message	Requirement	Direction
DeactivatePolicyRequest	Mandatory	NFVO → VIM
DeactivatePolicyResponse	Mandatory	VIM → NFVO

7.12.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.6.2-1.

Table 7.12.6.2-1: Deactivate Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1..N	Identifier (Reference to PolicyInfo)	References the policy information to be deactivated. 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 deactivate multiple policies in one request, or as a series of requests that deactivate one policy at a time.				

7.12.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.6.3-1.

Table 7.12.6.3-1: Deactivate Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deactivatedPolicyInfoId	M	0..N	Identifier (Reference to PolicyInfo)	References the deactivated NFV-MANO policy(ies).

7.12.6.4 Operation results

In case of success, the NFV-MANO policy(ies) are deactivated in the VIM, and a success indicator is returned to the NFVO. In case of failure, appropriate error information is returned.

7.12.7 Subscribe operation

7.12.7.1 Description

This operation enables the NFVO to subscribe with a filter for the notifications sent by the VIM which are related to changes of a policy and any detected policy conflicts. Changes of a policy are related to operations of transferring policy, deleting policy, activating policy and deactivating policy.

Table 7.12.7.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.7.1-1: Subscribe operation

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

7.12.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.7.2-1.

Table 7.12.7.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting the notifications. This filter can contain information about specific types of notifications to subscribe to, or attributes of the PolicyInfo. Details are part of the protocol design.

7.12.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.7.3-1.

Table 7.12.7.3-1: Subscribe operation output parameters

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

7.12.7.4 Operation results

After successful subscription, the consumer (NFVO) is registered to receive notifications about events related to changes of a policy and any detected policy conflicts.

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.

7.12.8 Notify operation

7.12.8.1 Description

This operation notifies a subscriber about events related to notifications about changes of a policy and any detected policy conflicts.

This operation distributes notifications to subscribers. It is a one-way operation issued by the producer (VIM) 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 7.12.8.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.8.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

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

- PolicyChangeNotification. See clause 8.14.3.
- PolicyConflictNotification. See clause 8.14.4.

7.12.9 Terminate Subscription operation

7.12.9.1 Description

This operation enables the NFVO to terminate a particular subscription.

Table 7.12.9.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.9.1-1: Terminate Subscription operation

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

7.12.9.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.9.2-1.

Table 7.12.9.2-1: Terminate Subscription operation input parameters

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

7.12.9.3 Output parameters

None.

7.12.9.4 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.

7.12.10 Query Subscription Info operation

7.12.10.1 Description

This operation enables the NFVO to query information about subscriptions.

Table 7.12.10.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.12.10.1-1: Query Subscription Info operation

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

7.12.10.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in Table 7.12.10.2-1.

Table 7.12.10.2-1: 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 part of the protocol design.

7.12.10.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in Table 7.12.10.3-1.

Table 7.12.10.3-1: 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 part of the protocol design.

7.12.10.4 Operation results

After successful operation, the VIM 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 changes of a policy and any detected policy conflicts that the NFVO has access to and that are matching the filter shall be returned.

7.13 Data Flow Mirroring Management Interface

7.13.1 Introduction

This interface allows an authorized consumer to request operations related to management of data flow mirroring. The Data Flow Mirroring Management interface supports the following operations:

- Create Data Flow Mirroring Job
- Delete Data Flow Mirroring Job
- Query Data Flow Mirroring Job
- Update Data Flow Mirroring Job

The Data Flow Mirroring Job is described by defining the destination where the mirrored flow is to be delivered and by identifying the traffic, that is requested to be mirrored.

7.13.2 Create Data Flow Mirroring Job operation

7.13.2.1 Description

This operation supports creating a Data Flow Mirroring Job.

Table 7.13.2.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.13.2.1-1: Create Data Flow Mirroring Job operation

Message	Requirement	Direction
CreateDataFlowMirroringJobRequest	Mandatory	NFVO → VIM
CreateDataFlowMirroringJobResponse	Mandatory	VIM → NFVO

7.13.2.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.13.2.2-1.

Table 7.13.2.2-1: Create Data Flow Mirroring Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
mirroringJobName	M	1	String	Name of Data Flow Mirroring Job.
description	M	1	String	Information description of Data Flow Mirroring Job.
collectorDetails	M	1	Not specified	Information about where the mirrored flow is to be delivered. See note 1.
dataFlowDetails	M	1..N	Not specified	Information about the data flows that need to be mirrored. See note 2.
NOTE 1: Information could include ports where to mirror the data flow. NOTE 2: Information could include characteristics of the data flows such as VLANs, or IP addresses, direction of the data flow, etc.				

7.13.2.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.13.2.3-1.

Table 7.13.2.3-1: Create Data Flow Mirroring Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
mirroringJob	M	1	MirroringJob	Information about the Data Flow Mirroring Job that has been created.

7.13.2.4 Operation results

After successful operation, the VIM has created the Data Flow Mirroring Job. The result of the creation shall indicate with a standard success/error result if the creation request has been processed correctly.

7.13.3 Delete Data Flow Mirroring Job operation

7.13.3.1 Description

This operation supports deletion of Data Flow Mirroring Job.

Table 7.13.3.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table7.13.3.1-1: Delete Data Flow Mirroring Job operation

Message	Requirement	Direction
DeleteDataFlowMirroringJobRequest	Mandatory	NFVO → VIM
DeleteDataFlowMirroringJobResponse	Mandatory	VIM → NFVO

7.13.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.13.3.2-1.

Table 7.13.3.2-1: Delete Data Flow Mirroring Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
mirroringJobId	M	1..N	Identifier (Reference to MirroringJob)	Identifier of the data flow mirroring job(s) to be deleted. 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 terminate multiple data flow mirroring jobs in one request, or as a series of requests that terminates one data flow mirroring job at a time.				

7.13.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.13.3.3-1.

Table 7.13.3-1: Delete Data Flow Mirroring Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedMirroringJobId	M	1..N	Identifier (Reference to MirroringJob)	Identifier of the data flow mirroring job(s) successfully deleted. See notes 1 and 2.
NOTE 1: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to terminate multiple data flow mirroring jobs in one request, or as a series of requests that terminates one data flow mirroring job at a time. NOTE 2: If the operation is performed on a single entity, this output parameter need not be returned.				

7.13.3.4 Operation results

After successful operation, the VIM has deleted Data Flow Mirroring Job. The result of the deletion shall indicate with a standard success/error result if the deletion request has been processed correctly.

7.13.4 Query Data Flow Mirroring Job operation

7.13.4.1 Description

This operation supports querying information about Data Flow Mirroring Job.

Table 7.13.4.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.13.4.1-1: Query Data Flow Mirroring Job operation

Message	Requirement	Direction
QueryDataFlowMirroringJobRequest	Mandatory	NFVO → VIM
QueryDataFlowMirroringJobResponse	Mandatory	VIM → NFVO

7.13.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.13.4.2-1.

Table 7.13.4.2-1: Query Data Flow Mirroring Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
queryFilter	M	1	Filter	Filter defining the Data Flow Mirroring Jobs on which the query applies. It can also be used to specify one or more Data Flow Mirroring Jobs to be queried, by providing their identifiers. See note.
attributeSelector	M	0..N	String	Provides a list of attribute names of MirroringJob. If present, only these attributes are returned for the data flow mirroring jobs matching the filter. If absent, the complete data flow mirroring job information is returned.
NOTE: If data flow mirroring job identifier is specified, the related information of specific data flow mirroring job will be queried. If not, the information of all data flow mirroring jobs will be queried.				

7.13.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.13.4.3-1.

Table 7.13.4.3-1: Query Data Flow Mirroring Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	MirroringJob	Information details of data flow mirroring jobs matching the input filter. If attributeSelector is present, only the attributes listed in attributeSelector are returned for the selected data flow mirroring job information. The cardinality can be 0 if no matching Data Flow Mirroring Jobs exist.

7.13.4.4 Operation results

After successful operation, the VIM has queried Data Flow Mirroring Job. The result of the query shall indicate with a standard success/error result if the query request has been processed correctly.

7.13.5 Update Data Flow Mirroring Job operation

7.13.5.1 Description

This operation supports updating Data Flow Mirroring Job.

Table 7.13.5.1-1 lists the information flow exchanged between the NFVO and the VIM.

Table 7.13.5.1-1: Update Data Flow Mirroring Job operation

Message	Requirement	Direction
UpdateDataFlowMirroringJobRequest	Mandatory	NFVO → VIM
UpdateDataFlowMirroringJobResponse	Mandatory	VIM → NFVO

7.13.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.13.5.2-1.

Table 7.13.5.2-1: Update Data Flow Mirroring Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
mirroringJobId	M	1	Identifier(Reference to MirroringJob)	Identifier of the Data Flow Mirroring Job to update.
mirroringJobName	M	0..1	String	Name of Data Flow Mirroring Job. See note.
description	M	0..1	String	Information description of Data Flow Mirroring Job. See note.
collectorDetails	M	0..1	Not specified	New information about the destination where the mirrored flow is to be delivered. See note.
NOTE: Updating Data Flow Mirroring Job can involve one or more following cases: 1) updating the name of data flow mirroring job, related to "mirroringJobName"; 2) updating information description of data flow mirroring job, related to "description"; 3) updating the definition about where the mirrored data flow needs to be delivered, related to "collectorDetails".				

7.13.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.13.5.3-1.

Table 7.13.5.3-1: Update Data Flow Mirroring Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
mirroringJob	M	1	MirroringJob	Information about the Data Flow Mirroring Job

7.13.5.4 Operation results

After successful operation, the VIM has updated Data Flow Mirroring Job. The result of the query shall indicate with a standard success/error result if the query request has been processed correctly.

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.

8.2 Information elements related to software images

8.2.1 Introduction

This clause specifies information elements related to software images.

8.2.2 SoftwareImageInformation information element

8.2.2.1 Description

This information element represents Software Image Information.

8.2.2.2 Attributes

The SoftwareImageInformation information element shall follow the indications provided in Table 8.2.2.2-1.

Table 8.2.2.2-1: Attributes of the SoftwareImageInformation information element

Attribute	Qualifier	Cardinality	Content	Description
softwareImageId	M	1	Identifier	Identifier of this software image.
name	M	1	Not specified	Name of this software image.
provider	M	1	Not specified	Provider of this software image.
version	M	1	Not specified	Version of this software image.
checksum	M	1	Not specified	Checksum of the software image file.
containerFormat	M	1	Not specified	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	Disk format of a software image is the format of the underlying disk image.
createdAt	M	1	Not specified	Time this software image was created.
updatedAt	M	1	Not specified	Time this software image was last updated.
minDisk	M	1	Not specified	Minimal disk size for this software image.
minRam	M	1	Not specified	Minimal RAM size for this software image.
size	M	1	Not specified	Size of this software image.
status	M	1	Not specified	Status of this software image.
userMetadata	O	0..N	KeyValuePair	User-defined metadata.

8.3 Information elements and notifications related to Consumable Virtualised Resources Information

8.3.1 Introduction

The clauses below define information elements and notifications related to Consumable Virtualised Resources Information.

8.3.2 InformationChangeNotification

8.3.2.1 Description

This notification informs the receiver that information related to consumable virtualised resources has changed.

8.3.2.2 Trigger conditions

- Addition of consumable virtualised resources.
- Removal of consumable virtualised resources.
- Update of consumable virtualised resources.

8.3.2.3 Attributes

The InformationChangeNotification notification shall follow the indications provided in Table 8.3.2.3-1.

Table 8.3.2.3-1: Attributes of the InformationChangeNotification notification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the consumable virtualised resource type.
resourceTypeId	M	1	Identifier (Reference to VirtualComputeResourceInformation, VirtualStorageResourceInformation, or VirtualNetworkResourceInformation)	References the consumable virtualised resource type.

Attribute	Qualifier	Cardinality	Content	Description
vimId	M	1	Identifier	Identifier of the VIM reporting the change.
changeType	M	1	Enum	Categorizes the type of change. VALUES: • ADDITION • REMOVAL • UPDATE
changedResourceData	M	0..1	Not specified	Details of the changes of consumable virtualised resource information. Its content can differ based on the values of the resourceTypeId and changeType.

8.3.3 Information elements related to Virtual Compute Resource Information

8.3.3.1 Introduction

The information elements below define the characteristics of consumable virtualised compute resources.

8.3.3.2 VirtualComputeResourceInformation information element

8.3.3.2.1 Description

This clause describes the attributes for the VirtualComputeResourceInformation information element.

8.3.3.2.2 Attributes

The VirtualComputeResourceInformation information element shall follow the indications provided in Table 8.3.3.2.2-1.

Table 8.3.3.2.2-1: Attributes of the VirtualComputeResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
computeResourceTypeId	M	1	Identifier	Identifier of the consumable virtualised compute resource type.
virtualMemory	M	0..1	VirtualMemoryResourceInformation	Defines the virtual memory characteristics of the consumable virtualised compute resource. See note.
virtualCpu	M	0..1	VirtualCpuResourceInformation	Defines the virtual CPU(s) characteristics of the consumable virtualised compute resource. See note.
accelerationCapability	M	0..N	Not specified	Acceleration capabilities (e.g. crypto, GPU) for the consumable virtualised compute resources from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided (see also note).
NOTE: Cardinality can be "0" if the attribute refers to a characteristic that is not being reported on a specific query or notification, e.g. through an InformationChangeNotification.				

8.3.3.3 VirtualCpuResourceInformation information element

8.3.3.3.1 Description

The VirtualCpuResourceInformation defines the virtual CPU(s) characteristics of consumable virtualised compute resource.

8.3.3.3.2 Attributes

The VirtualCpuResourceInformation information element shall follow the indications provided in Table 8.3.3.3.2-1.

Table 8.3.3.3.2-1: Attributes of the VirtualCpuResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
cpuArchitecture	M	1	String	CPU architecture type. Examples are x86, ARM.
numVirtualCpu	M	0..1	Number	Number of virtual CPUs. Cardinality "1" covers the case where a specific configuration for the consumable resource is advertised.
cpuClock	M	1	Number	Minimum CPU clock rate (e.g. in MHz) available for the virtualised CPU resources.
virtualCpuOversubscriptionPolicy	M	0..1	Not specified	CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 if no concrete policy is defined.
virtualCpuPinningSupported	M	1	Boolean	Defines whether CPU pinning capability is available on the consumable virtualised compute resource.

8.3.3.4 VirtualMemoryResourceInformation information element

8.3.3.4.1 Description

The VirtualMemoryResourceInformation defines the virtual memory characteristics of consumable virtualised compute resource.

8.3.3.4.2 Attributes

The VirtualMemoryResourceInformation information element shall follow the indications provided in Table 8.3.3.4.2-1.

Table 8.3.3.4.2-1: Attributes of the VirtualMemoryResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	0..1	Number	Amount of virtual memory (e.g. in MB). Cardinality "1" covers the case where a specific configuration for the consumable resource is advertised.
virtualMemOversubscriptionPolicy	M	0..1	Not specified	Memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 if no concrete policy is defined.
numaSupported	M	1	Boolean	Specifies if the memory allocation can be cognisant of the relevant process/core allocation.

8.3.4 VirtualStorageResourceInformation information element

8.3.4.1 Description

This information element defines the characteristics of consumable virtual storage resources.

8.3.4.2 Attributes

The VirtualStorageResourceInformation information element shall follow the indications provided in Table 8.3.4.2-1.

Table 8.3.4.2-1: Attributes of the VirtualStorageResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
storageResourceTypeId	M	1	Identifier	Identifier of the consumable virtualised storage resource type.
typeOfStorage	M	1	String	Type of virtualised storage resource (e.g. volume, object).
sizeOfStorage	M	0..1	Number	Size of virtualised storage resource (e.g. size of volume, in GB). Cardinality "1" covers the case where a specific configuration for the consumable resource is advertised.
rdmaSupported	O	0..1	Boolean	Indicates if the storage supports RDMA.

8.3.5 VirtualNetworkResourceInformation information element

8.3.5.1 Description

This information element defines the characteristics of consumable virtual network resources.

8.3.5.2 Attributes

The VirtualNetworkResourceInformation information element shall follow the indications provided in Table 8.3.5.2-1.

Table 8.3.5.2-1: Attributes of the VirtualNetworkResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
networkResourceTypeId	M	1	Identifier	Identifier of the network resource type.
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).
networkType	M	0..1	String	The type of network that maps to the virtualised network. Examples are: "local", "vlan", "vxlan", "gre", etc.
networkQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes that the network shall support. See clause 8.4.4.3.

8.4 Information elements and notifications related to Virtualised Resources

8.4.1 Introduction

The Virtualised Resources information elements contain the details of the content carried by the various input and output information elements that are exchanged between the VIM and NFVO as part of the relevant interfaces defined for the virtualised compute, network and storage resources.

The clauses below define information elements and notifications related to Virtualised Resources.

8.4.2 Information elements related to Virtual Compute Flavour

8.4.2.1 Introduction

The clauses below define information elements related to Virtual Compute Flavour.

8.4.2.2 VirtualComputeFlavour information element

8.4.2.2.1 Description

The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces. The NetworkInterfaceType information element encapsulates information of a virtual network interface for a compute resource.

8.4.2.2.2 Attributes

The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

The VirtualComputeFlavour information element shall follow the indications provided in Table 8.4.2.2.2-1.

Table 8.4.2.2.2-1: Attributes of the VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
flavourId	M	1	Identifier	Identifier given to the compute flavour.
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is requested.
virtualMemory	M	1	VirtualMemoryData	Virtual memory of the virtualised compute. See clause 8.4.2.5.
virtualCpu	M	1	VirtualCpuData	Virtual CPU(s) of the virtualised compute. See clause 8.4.2.3.
storageAttributes	M	0..N	VirtualStorageData	Contains information about the size of virtualised storage resources (e.g. size of volume, in GB), the type of storage (e.g. volume, object) and support for RDMA. See clause 8.4.6.3.
virtualNetworkInterface	M	0..N	VirtualNetworkInterfaceData	Virtual network interfaces of the virtualised compute. See clause 8.4.2.6.

8.4.2.3 VirtualCpuData information element

8.4.2.3.1 Description

Information describing a virtual CPU.

8.4.2.3.2 Attributes

The VirtualCpuData 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 VirtualCpuData information element

Attribute	Qualifier	Cardinality	Content	Description
cpuArchitecture	M	0..1	String	CPU architecture type. Examples are x86, ARM. The cardinality can be 0 during the allocation request, if no particular CPU architecture type is requested.
numVirtualCpu	M	1	Integer	Number of virtual CPUs.
cpuClock	M	0..1	Number	Minimum CPU clock rate (e.g. in MHz) available for the virtualised CPU resources. The cardinality can be 0 during the allocation request, if no particular value is requested.
virtualCpuOversubscription Policy	M	0..1	Not specified	CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 during the allocation request, if no particular value is requested.
virtualCpuPinning	M	0..1	VirtualCpuPinningData	Virtual CPU pinning configuration for the virtualised compute resource. See clause 8.4.3.4.
powerStateReqs	M	0..1	Not specified	Virtual CPU power (state) requirements for the virtualised compute resource.

8.4.2.4 VirtualCpuPinningData information element

8.4.2.4.1 Description

Information describing CPU pinning policy and rules for virtual CPU to physical CPU mapping of the virtualised compute resource.

8.4.2.4.2 Attributes

The VirtualCpuPinningData information element shall follow the indications provided in Table 8.4.2.4.2-1.

Table 8.4.2.4.2-1: Attributes of the VirtualCpuPinningData information element

Attribute	Qualifier	Cardinality	Content	Description
virtualCpuPinning Policy	M	1	Enum	Indicates the policy for CPU pinning. VALUES: • STATIC • DYNAMIC In case of "STATIC", the virtual CPU cores are requested to be allocated to logical CPU cores according to the rules defined in virtualCpuPinningRules. In case of "DYNAMIC", the allocation of virtual CPU cores to logical CPU cores is decided by the VIM (e.g. SMT (Simultaneous Multi-Threading) requirements).
virtualCpuPinning Rules	M	0..N	Not specified	List of rules that should be considered during the allocation of the virtual CPUs to logical CPUs in case of "static" virtualCpuPinningPolicy.

8.4.2.5 VirtualMemoryData information element

8.4.2.5.1 Description

Information describing virtual memory.

8.4.2.5.2 Attributes

The VirtualMemoryData information element shall follow the indications provided in Table 8.4.2.5.2-1.

Table 8.4.2.5.2-1: Attributes of the VirtualMemoryData information element

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	1	Number	Amount of virtual Memory (e.g. in MB).
virtualMemOversubscriptionPolicy	M	0..1	Not specified	Memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 during the allocation request, if no particular value is requested.
numaEnabled	M	0..1	Boolean	Specifies the memory allocation to be cognisant of the relevant process/core allocation. The cardinality can be 0 during the allocation request, if no particular value is requested.

8.4.2.6 VirtualNetworkInterfaceData information element

8.4.2.6.1 Description

A virtual network interface is a communication endpoint under a compute resource.

8.4.2.6.2 Attributes

The VirtualNetworkInterfaceData information element shall follow the indications provided in Table 8.4.2.6.2-1.

Table 8.4.2.6.2-1: Attributes of the VirtualNetworkInterfaceData information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier	In the case when the virtual network interface is attached to the network, it identifies such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
networkPortId	M	0..1	Identifier	If the virtual network interface is attached to a specific network port, it identifies such a network port. The cardinality can be 0 in the case that a network interface is created without any specific network port attachment.
typeVirtualNic	M	1	Not specified	Type of network interface. The type allows for defining how such interface is to be realized, e.g. normal virtual NIC, with direct PCI passthrough, SR-IOV, etc.
typeConfiguration	M	0..N	Not specified	Extra configuration that the virtual network interface supports based on the type of virtual network interface.
bandwidth	M	0..1	Number	Bandwidth of the virtual network interface (in Mbps).
accelerationCapability	M	0..N	Not specified	Specifies if the virtual network interface requires certain acceleration capabilities (e.g. RDMA, packet dispatch, TCP Chimney). The cardinality can be 0, if no particular acceleration capability is requested.

Attribute	Qualifier	Cardinality	Content	Description
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.3 Information elements related to Virtual Compute

8.4.3.1 Introduction

The information elements in this group encapsulate data of an instantiated virtualised compute resource.

8.4.3.2 VirtualCompute information element

8.4.3.2.1 Description

This clause describes the attributes for the VirtualCompute information element.

8.4.3.2.2 Attributes

The VirtualCompute information element shall follow the indications provided in Table 8.4.3.2.2-1.

Table 8.4.3.2.2-1: Attributes of the VirtualCompute information elements

Attribute	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource.
computeName	M	0..1	String	Name of the virtualised compute resource.
flavourId	M	1	Identifier	Identifier of the given compute flavour used to instantiate this virtual compute.
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided.
virtualCpu	M	1	VirtualCpu	Virtual CPU(s) of the virtualised compute. See clause 8.4.3.3.
virtualMemory	M	1	VirtualMemory	Virtual memory of the compute. See clause 8.4.3.5.
virtualNetworkInterface	M	0..N	VirtualNetworkInterface	Provides information of the instantiated virtual network interfaces of the compute resource. See clause 8.4.3.6.
virtualDisks	M	1..N	VirtualStorage	Provides information of the virtualised storage resources (volumes, ephemeral that are attached to the compute resource. See clause 8.4.7.2.
vcImageId	M	0..1	Identifier	Identifier of the virtualisation container software image (e.g. virtual machine image). Cardinality can be 0 if an "empty" virtualisation container is allocated.
zoneId	M	0..1	Identifier	If present, it identifies the resource zone where the virtual compute resources have been allocated.
hostId	M	1	Identifier	Identifier of the host the virtualised compute resource is allocated on.

Attribute	Qualifier	Cardinality	Content	Description
operationalState	M	1	Enum	Operational state of the compute resource. See note. VALUES: • ENABLED • DISABLED
runningState	M	1	Enum	Running state of the compute resource. See note. VALUES: • STARTED • STOPPED • PAUSED • SUSPENDED • REBOOTING
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE: Values of the operationalState attribute are rather administrative states, while the runningState attribute provides operational state information.				

8.4.3.3 VirtualCpu information element

8.4.3.3.1 Description

The virtual CPU(s) of the virtualised compute.

8.4.3.3.2 Attributes

The VirtualCpu 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 VirtualCpu information element

Attribute	Qualifier	Cardinality	Content	Description
cpuArchitecture	M	1	String	CPU architecture type. Examples are x86, ARM.
numVirtualCpu	M	1	Integer	Number of virtual CPUs.
cpuClock	M	1	Number	Minimum CPU clock rate (e.g. in MHz) available for the virtualised CPU resources.
virtualCpuOversubscription Policy	M	0..1	Not specified	CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 if no policy has been defined during the allocation request.
virtualCpuPinning	M	0..1	VirtualCpuPinning	Virtual CPU pinning configuration for the virtualised compute resource. See clause 8.4.3.4.
powerState	M	0..1	Not specified	Virtual CPU power state information of the virtualised compute resource.

8.4.3.4 VirtualCpuPinning information element

8.4.3.4.1 Description

This clause describes the attributes for the VirtualCpuPinning information element.

8.4.3.4.2 Attributes

The VirtualCpuPinning information element shall follow the indications provided in Table 8.4.3.4.2-1.

Table 8.4.3.4.2-1: Attributes of the VirtualCpuPinning information element

Attribute	Qualifier	Cardinality	Content	Description
cpuPinningPolicy	M	1	Enum	Indicates the policy for CPU pinning. VALUES: • STATIC • DYNAMIC In case of "STATIC", the virtual CPU cores have been allocated to physical CPU cores according to the rules defined in cpuPinningRules. In case of "DYNAMIC", the allocation of virtual CPU cores to physical CPU cores is decided by the VIM.
cpuPinningRules	M	0..N	Not specified	A list of rules that should be considered during the allocation of the virtual CPUs to physical CPUs in case of "static" cpuPinningPolicy.
cpuMap	M	1	Not specified	Describes the association of virtual CPU cores to physical CPU cores.

8.4.3.5 VirtualMemory information element

8.4.3.5.1 Description

This clause describes the attributes for the VirtualMemory information element.

8.4.3.5.2 Attributes

The VirtualMemory information element shall follow the indications provided in Table 8.4.3.5.2-1.

Table 8.4.3.5.2-1: Attributes of the VirtualMemory information element

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	1	Number	Amount of virtual Memory (e.g. in MB).
virtualMemOversubscriptionPolicy	M	0..1	Not specified	Memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 if no policy has been defined during the allocation request.
numaEnabled	M	1	Boolean	Specifies the memory allocation to be cognisant of the relevant process/core allocation.

8.4.3.6 VirtualNetworkInterface information element

8.4.3.6.1 Description

A virtual network interface resource is a communication endpoint under an instantiated compute resource.

8.4.3.6.2 Attributes

The VirtualNetworkInterface information element shall follow the indications provided in Table 8.4.3.6.2-1.

Table 8.4.3.6.2-1: Attributes of the VirtualNetworkInterface information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the virtual network interface.
ownerId	M	1	Identifier	Identifier of the owner of the network interface (e.g. a virtualised compute resource).

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	In the case when the virtual network interface is attached to the network, it references such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
networkPortId	M	0..1	Identifier (Reference to VirtualNetworkPort)	If the virtual network interface is attached to a specific network port, it references such a network port. The cardinality can be 0 in the case that a network interface is created without any specific network port attachment.
ipAddress	M	0..N	IpAddress	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network, or when an IP address can be automatically configured, e.g. by DHCP.
typeVirtualNic	M	1	Not specified	Type of network interface. The type allows for defining how such interface is to be realized, e.g. normal virtual NIC, with direct PCI passthrough, etc.
typeConfiguration	M	0..N	Not specified	Extra configuration that the virtual network interface supports based on the type of virtual network interface, including support for SR-IOV with configuration of Virtual Functions (VF).
macAddress	M	1	MacAddress	MAC address of the virtual network interface.
bandwidth	M	1	Number	Bandwidth of the virtual network interface (in Mbps).
accelerationCapability	M	0..N	Not specified	Describes the acceleration capabilities utilized by the virtual network interface. The cardinality can be 0, if no acceleration capability is utilized.
operationalState	M	1	Enum	Operational state of the virtual network interface. VALUES: • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.3.7 VirtualInterfaceData information element

8.4.3.7.1 Description

A virtual interface represents the data of a virtual network interface specific to a Virtual Compute Resource instance.

8.4.3.7.2 Attributes

The VirtualInterfaceData information element shall follow the indications provided in Table 8.4.3.7.2-1.

Table 8.4.3.7.2-1: Attributes of the VirtualInterfaceData information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	In the case when the virtual network interface is attached to the network, it references such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
ipAddress	M	0..N	IpAddress	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network, or when an IP address can be automatically configured, e.g. by DHCP.
macAddress	M	0..1	MacAddress	MAC address desired for the virtual network interface. The cardinality can be 0 to allow for network interface without specific MAC address configuration.

8.4.4 Information elements related to Virtual Network Data

8.4.4.1 Introduction

The information elements in this group encapsulate information to allocate or update virtualised network resources.

8.4.4.2 VirtualNetworkData information element

8.4.4.2.1 Description

This clause describes the attributes for the VirtualNetworkData information element.

8.4.4.2.2 Attributes

The VirtualNetworkData information element shall follow the indications provided in Table 8.4.4.2.2-1.

Table 8.4.4.2.2-1: Attributes of the VirtualNetworkData information element

Attribute	Qualifier	Cardinality	Content	Description
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).
networkType	M	0..1	String	Type of network that maps to the virtualised network. This list is extensible. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn", etc. Cardinality can be "0" to cover the case where this attribute is not required to create the virtualised network.
providerNetwork	M	0..1	String	Name of the infrastructure provider network used to realize the virtual network. Cardinality can be "0" to cover the case where virtual network is not based on infrastructure provider network.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
networkQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes that the network shall support. See clause 8.4.4.3. Cardinality can be "0" for network without any specified QoS requirements.

Attribute	Qualifier	Cardinality	Content	Description
isShared	M	0..1	Boolean	Specifies whether the virtualised network is shared among consumers.
sharingCriteria	M	0..1	Not specified	Only present for shared networks. Indicate the sharing criteria for this network. This criteria might be a list of authorized consumers.
layer3Attributes	M	0..N	NetworkSubnetData	Attribute allows setting up a network providing defined layer 3 connectivity. See clause 8.4.4.4 for further information on the attributes required for layer 3 connectivity.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
connectedNetworks	M	0..N	Identifier (Reference to VirtualNetwork)	Specifies the virtual network resources to which the newly created virtual network is intended to be explicitly interconnected.

8.4.4.3 NetworkQoS information element

8.4.4.3.1 Description

This clause describes the attributes for the NetworkQoS information element. This type gives QoS options to be supported on the virtualised network, e.g. latency, jitter, etc.

8.4.4.3.2 Attributes

The NetworkQoS 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 NetworkQoS information element

Attribute	Qualifier	Cardinality	Content	Description
qosName	M	1	String	Name given to the QoS parameter.
qosValue	M	1	Value	Value of the QoS parameter.

8.4.4.4 NetworkSubnetData information element

8.4.4.4.1 Description

The NetworkSubnetData information element encapsulates information to allocate or update virtualised sub-networks.

8.4.4.4.2 Attributes

The NetworkSubnetData information element shall follow the indications provided in Table 8.4.4.4.2-1.

Table 8.4.4.4.2-1: Attributes of the NetworkSubnetData information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier	Identifier of the virtualised network that the virtualised sub-network is attached to. The cardinality can be 0 to cover the case where this type is used to describe the L3 attributes of a network rather than a subnetwork or when NetworkSubnetData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note.
ipVersion	M	0..1	Enum	IP version of the network/subnetwork.

Attribute	Qualifier	Cardinality	Content	Description
				VALUES: • IPV4 • IPV6 Cardinality can be 0 when NetworkSubnetData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note.
gatewayIp	M	0..1	IpAddress	Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.
cidr	M	0..1	Not specified	CIDR of the network/subnetwork, i.e. network address and subnet mask. Cardinality can be 0 when NetworkSubnetData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note.
isDhcpEnabled	M	0..1	Boolean	True when DHCP is to be enabled for this network/subnetwork, or false otherwise.
addressPool	M	0..N	Not specified	Address pools for the network/subnetwork. The cardinality can be 0 when VIM is allowed to allocate all addresses in the CIDR except for the address of the network/subnetwork gateway.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE: In these cases, changing the parameter is such a fundamental change that a new virtualised network resource should be created instead of updating an existing network resource.				

8.4.4.5 VirtualNetworkPortData information element

8.4.4.5.1 Description

The VirtualNetworkPortData information element encapsulates information to allocate or update virtual network ports for network resources. A network port resource is a communication endpoint instantiated under a network resource.

8.4.4.5.2 Attributes

The VirtualNetworkPortData information element shall follow the indications provided in Table 8.4.4.5.2-1.

Table 8.4.4.5.2-1: Attributes of the VirtualNetworkPortData information element

Attribute	Qualifier	Cardinality	Content	Description
portType	M	0..1	String	Type of network port. Examples of types are normal ports, trunk ports or subports. Cardinality can be "0" if the consumer does not need to provide specific port type to create a "normal port" (i.e. by default, a "normal port" will be created). See note 1.
networkId	M	0..1	Identifier	Identifier of the network that the port belongs to. When creating a port, such port needs to be part of a network. Cardinality can be "0" when VirtualNetworkPortData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note 2.

Attribute	Qualifier	Cardinality	Content	Description
bandwidth	M	0..1	Number	Bandwidth of the virtual network port (in Mbps). Cardinality can be "0" for virtual network ports without any specified bandwidth requirements.
portQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes applicable to the port. See clause 8.4.4.3. Cardinality can be "0" for the virtual network ports if no specific QoS requirements are requested.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE 1: After instantiation, the normal port can be referenced as a parent port or sub port in a trunk port resource (see clause 8.4.4.6 VirtualTrunkData information element). NOTE 2: In this case, changing the parameter is such a fundamental change that a new virtualised network resource should be created instead of updating an existing network resource.				

8.4.4.6 VirtualTrunkData information element

8.4.4.6.1 Description

The VirtualTrunkData information element encapsulates information to allocate virtual trunk. A virtual trunk is a logical network resource which can be used to multiplex packets coming from and going to multiple networks using one trunk port. Trunk is modelled as a collection of network ports, one parent port and a sequence of subports.

8.4.4.6.2 Attributes

The VirtualTrunkData information element shall follow the indications provided in Table 8.4.4.6.2-1.

Table 8.4.4.6.2-1: Attributes of the VirtualTrunkData information element

Attribute	Qualifier	Cardinality	Content	Description
parentPortId	M	1	Identifier (Reference to VirtualNetwork Port)	References the network port that used as parent port of the trunk to be created.
subportList	M	0..N	TrunkSubport	Provides information on subports associate to the trunk to be created. Cardinality can be "0" to allow for trunk without subport at creation time.

8.4.4.7 TrunkSubport information element format

8.4.4.7.1 Description

This clause describes the attributes for the TrunkSubport information element.

8.4.4.7.2 Attributes

The TrunkSubport information element shall follow the indications provided in Table 8.4.4.7.2-1.

Table 8.4.4.7.2-1: Attributes of the TrunkSubport information element

Attribute	Qualifier	Cardinality	Content	Description
subportId	M	1	Identifier (Reference to VirtualNetwork Port)	References the network port that used as subport of the trunk.
segmentationType	M	0..1	Enum	The encapsulation type for the traffics coming in and out of the trunk subport. See note. VALUES: • VLAN: the subport uses VLAN as encapsulation type • VXLAN: the subport uses VXLAN as encapsulation type • NVGRE: the subport uses NVGRE as encapsulation type • INHERIT: the subport gets its segmentation type from the network it is connected to Cardinality 0 means default value VLAN is used.
segmentationId	M	1	Integer	The segmentation identifier of the subport, which is used to differentiate the traffics on different networks coming in and out of the trunk port. See note 1.
isAutomaticDiscovery	M	0..1	Boolean	It indicates if additional parameters are exchanged through the use of a routing protocol. See note 2.
NOTE 1: The segmentationType and segmentationId specified on the subport is intentionally decoupled from the networkType and segmentationId of the network that the subport attached to. For example, it is possible to configure the Network with (networkType = vxlan, segmentationId = 5 000) and create subport with (segmentationType = vlan, segmentationId = 100).The traffic flow can be remapped as necessary. NOTE 2: In the case of VXLAN as encapsulation type, when using the TrunkSubport information element to describe a Network Virtualisation Edge (NVE), this may exchange additional information with other NVEs through the use of routing protocols such as iBGP. The isAutomaticDiscovery attribute shall not be present if segmentationType field is not set to VXLAN.				

8.4.4.8 UpdateTrunkData information element

8.4.4.8.1 Description

This clause describes the attributes for the UpdateTrunkData information element.

8.4.4.8.2 Attributes

The UpdateTrunkData information element shall follow the indications provided in Table 8.4.4.8.2-1.

Table 8.4.4.8.2-1: Attributes of the UpdateTrunkData information element

Attribute	Qualifier	Cardinality	Content	Description
portId	M	0..N	Identifier (Reference to VirtualNetwork Port)	Provides information on subport(s) to be deleted from a trunk resource. See note.
subportList	M	0..N	TrunkSubport	Provides information on subport(s) to be added to a trunk resource. See note.
NOTE: Only one type of the two attributes (portId or subportList) shall be present.				

8.4.4.9 RoutingResourceData information element

8.4.4.9.1 Description

This clause describes the attributes for the RoutingResourceData information element.

8.4.4.9.2 Attributes

The RoutingResourceData information element shall follow the indications provided in Table 8.4.4.9.2-1.

Table 8.4.4.9.2-1: Attributes of the RoutingResourceData information element

Attribute	Qualifier	Cardinality	Content	Description
Name	M	1	String	Name of the routing resource.
distributed	M	0..1	Boolean	If present, it specifies whether the routing resource is requested to be distributed.
operationalState	M	1	Enum	Operational state of the routing resource. VALUES: • ENABLED • DISABLED
ha	M	0..1	Boolean	If present, it specifies whether the routing resource is requested to have high availability.
zoneId	M	0..1	Identifier	If present, it identifies the Resource Zone where the routing resource is requested to be allocated.
subnet	M	0..N	Identifier	Identifier of the subnet(s) that the routing resource is associated with.
routingSet	M	0..N	RoutingSetData	Specifies the information used to set the routing resource.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.4.10 RoutingSetData information element

8.4.4.10.1 Description

This clause describes the attributes for the RoutingSetData information element.

8.4.4.10.2 Attributes

The RoutingSetData information element shall follow the indications provided in Table 8.4.4.10.2-1.

Table 8.4.4.10.2-1: Attributes of the RoutingSetData information element

Attribute	Qualifier	Cardinality	Content	Description
destination	M	1	IpAddress	The destination address of one route.
nexthop	M	1	IpAddress	The nexthop IP address of one route.
ipVersion	M	1	Enum	Specifies IP version of the destination and nexthop addresses. VALUES: • IPV4 • IPV6

8.4.5 Information elements related to Virtual Network

8.4.5.1 Introduction

The information elements in this group encapsulate information of an instantiated virtualised network resource. In the NFVI, a virtual network transports information among the network interfaces of VM instances and physical network interfaces, providing the necessary connectivity.

8.4.5.2 VirtualNetwork information element

8.4.5.2.1 Description

This clause describes the attributes for the VirtualNetwork information element.

8.4.5.2.2 Attributes

The VirtualNetwork information element shall follow the indications provided in Table 8.4.5.2.2-1.

Table 8.4.5.2.2-1: Attributes of the VirtualNetwork information element

Attribute	Qualifier	Cardinality	Content	Description
networkResourceId	M	1	Identifier	Identifier of the virtualised network resource.
networkResourceName	M	0..1	String	Name of the virtualised network resource.
subnetId	M	0..N	Identifier (Reference to NetworkSubnet)	References the network subnet. Only present if the network provides layer 3 connectivity. See clause 8.4.5.3.
networkPort	M	0..N	VirtualNetworkPort	Provides information of an instantiated virtual network port
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).
networkType	M	1	String	Type of network that maps to the virtualised network. This list is extensible. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn", etc.
providerNetwork	M	0..1	String	Name of the infrastructure provider network used to realize the virtual network. Cardinality can be "0" to cover the case where virtual network is not based on infrastructure provider network.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
networkQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes that the network supports. See clause 8.4.4.3. Cardinality can be "0" for virtual network without any QoS requirements.
isShared	M	1	Boolean	Defines whether the virtualised network is shared among consumers.
sharingCriteria	M	0..1	Not specified	Indicates the sharing criteria for this network. The criteria might be a list of authorized consumers. Only present for shared networks.
zoneId	M	0..1	Identifier	If present, it identifies the resource zone where the virtual network resources have been allocated.
operationalState	M	1	Enum	Operational state of the virtualised network. VALUES: • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

Attribute	Qualifier	Cardinality	Content	Description
connectedNetworks	M	0..N	Identifier (Reference to VirtualNetwork)	Specifies the virtual network resources to which the newly created virtual network is intended to be explicitly interconnected.

8.4.5.3 NetworkSubnet information element

8.4.5.3.1 Description

The NetworkSubnet information element encapsulates information of an instantiated virtualised sub-network.

8.4.5.3.2 Attributes

The NetworkSubnet information element shall follow the indications provided in Table 8.4.5.3.2-1.

Table 8.4.5.3.2-1: Attributes of the NetworkSubnet information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the virtualised sub-network.
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	References the virtualised network that the virtualised sub-network is attached to. The cardinality can be 0 to cover the case where this type is used to describe the L3 attributes of a network rather than a subnetwork.
ipVersion	M	1	Enum	IP version of the network/subnetwork. VALUES: • IPV4 • IPV6
gatewayIp	M	1	IpAddress	IP address of the network/subnetwork gateway.
cidr	M	1	Not specified	CIDR of the network/subnetwork, i.e. network address and subnet mask.
isDhcpEnabled	M	1	Boolean	True when DHCP is enabled for this network/subnetwork, or false otherwise.
addressPool	M	0..N	Not specified	Address pools for the network/subnetwork. The cardinality can be 0 when VIM is allowed to allocate all addresses in the CIDR except for the address of the network/subnetwork gateway.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.5.4 VirtualNetworkPort information element

8.4.5.4.1 Description

The VirtualNetworkPort information element encapsulates information of an instantiated virtual network port.
A network port resource is a communication endpoint instantiated under a network resource.

8.4.5.4.2 Attributes

The VirtualNetworkPort information element shall follow the indications provided in Table 8.4.5.4.2-1.

Table 8.4.5.4.2-1: Attributes of the VirtualNetworkPort information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the virtual network port.

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	1	Identifier (Reference to VirtualNetwork)	References the network that the port belongs to. When creating a port, such port needs to be part of a network.
attachedResourceId	M	0..1	Identifier (Reference to VirtualNetworkInterface)	References the attached resource to the network port (e.g. a virtualised compute resource, or identifier of the virtual network interface). Cardinality can be "0" if there is no specific resource connected to the network port.
portType	M	0..1	String	Type of network port. Examples of types are normal ports, trunk ports or subports. Cardinality can be "0" if the network port is a "normal port". See note.
Bandwidth	M	0..1	Number	Bandwidth of the virtual network port (in Mbps). Cardinality can be "0" for virtual network ports without any specific allocated bandwidth.
portQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes applicable to the port. See clause 8.4.4.3. Cardinality can be "0" for virtual network ports without any specific QoS requirements.
operationalState	M	1	Enum	Operational state of the virtual network port. VALUES: • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE: After instantiation, the normal port can be referenced as a parent port or sub port in a trunk port resource (see clause 8.4.4.6 VirtualTrunkData information element).				

8.4.5.5 VirtualTrunk information element

8.4.5.5.1 Description

The VirtualTrunk information element encapsulates information of an instantiated virtual trunk. A virtual trunk is a logical network resource which can be used to multiplex packets coming from and going to multiple networks using one network port. Trunk is modelled as a collection of network ports, one parent port and a sequence of subports.

8.4.5.5.2 Attributes

The VirtualTrunk information element shall follow the indications provided in Table 8.4.5.5.2-1.

Table 8.4.5.5.2-1: Attributes of the VirtualTrunk information element

Attribute	Qualifier	Cardinality	Content	Description
trunkResourceId	M	1	Identifier	Identifier of the virtual trunk.
parentPortId	M	1	Identifier (Reference to VirtualNetworkPort)	References the network port that used as parent port of the trunk.
subportList	M	0..N	TrunkSubport	Provides information on subport of the trunk.
operationalState	M	1	Enum	Operational state of the virtualised network. VALUES: • ENABLED • DISABLED

8.4.5.6 RoutingResource information element

8.4.5.6.1 Description

The RoutingResource information element encapsulates information of an instantiated routing resource.
A routing resource is a logical network resource that provides routing capabilities between different virtualised network resources of type "network".

8.4.5.6.2 Attributes

The RoutingResource information element shall follow the indications provided in Table 8.4.5.6.2-1.

Table 8.4.5.6.2-1: Attributes of the RoutingResource information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the routing resource.
name	M	1	String	Name of the routing resource.
subnet	M	0..N	Identifier (Reference to NetworkSubnet)	References the network subnet(s). See clause 8.4.5.3.
operationalState	M	1	Enum	Operational state of the compute resource. VALUES: • ENABLED • DISABLED
ha	M	0..1	Boolean	Specifies whether the routing resource has high availability. It shall be present when support for high availability is enabled.
zoneId	M	0..1	Identifier	If present, it identifies the Resource Zone where the routing resource has been allocated.
distributed	M	0..1	Boolean	Specifies whether the routing resource is distributed. It shall be present when support for distributed routing resource is enabled.
routingSet	M	0..N	RoutingSetData	Specifies the information used to set the routing resource.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.6 Information elements related to Virtual Storage Flavour

8.4.6.1 Introduction

The information elements in this group encapsulate information to allocate or update virtualised storage resources.

8.4.6.2 VirtualStorageFlavour information element

8.4.6.2.1 Description

This clause describes the attributes for the VirtualStorageFlavour information element. The VirtualStorageFlavour information element encapsulates information for storage flavours. A storage flavour includes information about the size of the storage, and the type of storage.

8.4.6.2.2 Attributes

The VirtualStorageFlavour information element shall follow the indications provided in Table 8.4.6.2.2-1.

Table 8.4.6.2.2-1: Attributes of the VirtualStorageFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
flavourId	M	0..1	Identifier	Identifier of the storage flavour. Cardinality can be "0" if no specific virtual storage flavour is referred.
storageAttributes	M	1	VirtualStorageData	Contains information about the size of virtualised storage resource (e.g. size of volume, in GB), the type of storage (e.g. volume, object), and support for RDMA. See clause 8.4.6.3.

8.4.6.3 VirtualStorageData information element

8.4.6.3.1 Description

This clause describes the attributes for the VirtualStorageData information element.

8.4.6.3.2 Attributes

The VirtualStorageData information element shall follow the indications provided in Table 8.4.6.3.2-1.

Table 8.4.6.3.2-1: Attributes of the VirtualStorageData information element

Attribute	Qualifier	Cardinality	Content	Description
typeOfStorage	M	1	String	Type of virtualised storage resource (e.g. volume, object).
sizeOfStorage	M	1	Number	Size of virtualised storage resource (e.g. size of volume, in GB).
rdmaEnabled	O	0..1	Boolean	Indicates if the storage supports RDMA.

8.4.7 Information elements related to Virtual Storage

8.4.7.1 Introduction

The information elements in this group encapsulate information of an instantiated virtualised storage resource.

8.4.7.2 VirtualStorage information element

8.4.7.2.1 Description

The VirtualStorage information element encapsulates information of an instantiated virtualised storage resource.

8.4.7.2.2 Attributes

The VirtualStorage information element shall follow the indications provided in Table 8.4.7.2.2-1.

Table 8.4.7.2.2-1: Attributes of the VirtualStorage information element

Attribute	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource.
storageName	M	0..1	String	Name of the virtualised storage resource.
flavourId	M	0..1	Identifier	Identifier of the storage flavour used to instantiate this virtual storage. Cardinality can be "0" if no specific virtual storage flavour is referred.
typeOfStorage	M	1	String	Type of virtualised storage resource (e.g. volume, object).
sizeOfStorage	M	1	Number	Size of virtualised storage resource (e.g. size of volume, in GB).

Attribute	Qualifier	Cardinality	Content	Description
rdmaEnabled	O	1	Boolean	Indicates if the storage supports RDMA.
ownerId	M	0..1	Identifier	Identifier of the virtualised resource that owns and uses such a virtualised storage resource. The value can be NULL if the virtualised storage is not attached yet to any other resource (e.g. a virtual machine).
zoneId	M	0..1	Identifier	If present, it identifies the resource zone where the virtual storage resources have been allocated.
hostId	M	0..1	Identifier	Identifier of the host where the virtualised storage resource is allocated. A cardinality of 0 refers to distributed storage solutions.
operationalState	M	1	Enum	Operational state of the resource. VALUES: • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.8 Information elements related to Affinity or AntiAffinity

8.4.8.1 Introduction

This clause defines information elements needed to express affinity and anti-affinity of a given virtualised resource (i.e. a virtualised compute, storage or network resource).

Two ways of specifying affinity or anti-affinity can be distinguished: Explicit resource lists and named resource groups. In case of an explicit resource list, the consumer manages the list of resources the actual resource is requested to be affine or anti-affine with, and builds the list as more resources are created. In case of a named resource group, the consumer needs to create the group first by invoking the appropriate operation to create a Compute/Storage/Network resource affinity or anti-affinity constraints group defined in clauses 7.3.1.9, 7.4.1.6 and 7.5.1.9. Subsequently, as part of resource creation, the consumer passes the name(s) or identifier(s) of the group(s) to the producer which manages and builds the group of resources.

The VIM shall support both explicit resource lists and named resource groups for affinity/anti-affinity. The NFVO shall support at least one of these options.

8.4.8.2 AffinityOrAntiAffinityConstraint information element

8.4.8.2.1 Description

This clause describes the attributes for the AffinityOrAntiAffinityConstraint information element.

8.4.8.2.2 Attributes

The AffinityOrAntiAffinityConstraint information element shall follow the indications provided in Table 8.4.8.2.2-1.

Table 8.4.8.2.2-1: Attributes of the AffinityOrAntiAffinityConstraint information element

Attribute	Qualifier	Cardinality	Content	Description
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity constraint. VALUES: • AFFINITY • ANTI_AFFINITY

Attribute	Qualifier	Cardinality	Content	Description
scope	M	0..1	Enum	Qualifies the scope of the constraint. In case of compute resource, the values are as follows. VALUES: • NFVI_POP • NFVI_NODE • Etc. In case of ports, the values are as follows. VALUES: • VIRTUAL_SWITCH_OR_ ROUTER • PHYSICAL_NIC • PHYSICAL_NETWORK • NFVI_NODE • Etc. In case of networks, the values are as follows. VALUES: • PHYSICAL_NIC • PHYSICAL_NETWORK • NFVI_NODE • Etc. In case of subnets, it should be ignored. Defaults to "NFVI_NODE" if absent.
affinityOrAntiAffinityResourceList	M	0..1	AffinityOrAntiAffinityResourceList	Consumer-managed list of identifiers of virtualised resources with which the actual resource is requested to be affine or anti-affine. Either affinityOrAntiAffinityResourceList or affinityOrAntiAffinityResourceGroupId but not both shall be present.
affinityOrAntiAffinityResourceGroupId	M	0..1	Identifier	Identifier of the producer-managed group of virtualised resources with which the actual resource is requested to be affine or anti-affine. Either affinityOrAntiAffinityResourceList or affinityOrAntiAffinityResourceGroupId but not both shall be present (see note).
CONDITION: If explicit resource lists for affinity/anti-affinity (see clause 8.4.8.3) are supported, the affinityOrAntiAffinityResourceList information element shall be supported. If named resource groups for affinity/anti-affinity (see clause 8.4.8.2) are supported, the affinityOrAntiAffinityResourceGroupId information element shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (aka VIM tenant).				
NOTE: It is a prerequisite for the consumer to create the group using the appropriate operation Create Compute/Storage/Network Resource Affinity Or AntiAffinity Constraints Group defined in clauses 7.3.1.9, 7.4.1.6 and 7.5.1.9.				

8.4.8.3 AffinityOrAntiAffinityResourceList information element

8.4.8.3.1 Description

The AffinityOrAntiAffinityResourceList information element defines an explicit list of resources to express affinity or anti-affinity between these resources and a current resource. The scope of the affinity or anti-affinity can also be defined.

8.4.8.3.2 Attributes

The AffinityOrAntiAffinityResourceList information element shall follow the indications provided in Table 8.4.8.3.2-1.

Table 8.4.8.3.2-1: Attributes of the AffinityOrAntiAffinityResourceList information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1..N	Identifier	List of identifiers of virtualised resources.

8.4.9 VirtualisedResourceChangeNotification

8.4.9.1 Description

This notification informs the receiver of changes in the virtualised resources that are allocated or their groups. The support of the notification is mandatory.

8.4.9.2 Trigger conditions

This notification is produced when the virtualised resource will be impacted due to changes in underlying resources produced by maintenance and operation of the NFVI, including:

- Maintenance of NFVI components, e.g. physical maintenance/repair, hypervisor software updates, etc.
- Evacuation of physical hosts.
- Addition and removal of physical resources.
- Operation and management of NFVI resources, e.g. to support energy efficiency or resource usage optimization.

NOTE 1: The above operations could trigger further actions, e.g. migration of virtualised resources.

The VIM shall evaluate the NFVI operation and maintenance constraints (expressed as policies) (as specified in Annex B of ETSI GS NFV-IFA 006 [7]) available to the VIM (including system configured constraints and constraints from the VNFD) applicable to the virtualised resources and their groups to determine when notifications need to be produced and what content they need to provide for NFVI operation and maintenance.

The VIM shall provide the capability to provide notifications identifying the group of virtualised resources. If an NFVI operation and maintenance session is going to impact more than one member of a group, this notification about identifying the group of virtualised resources shall be provided to all subscribers before any member of the group is impacted.

NOTE 2: It is up to the protocol design stage to determine whether this notification can be modelled as a "bulk" operation that allows to send multiple notifications in one request, or as a series of operations that notify an (upcoming) impact at a time.

An end of changes to the group shall be notified when all impacts to the group members have been completed.

8.4.9.3 Attributes

The VirtualisedResourceChangeNotification shall follow the indications provided in Table 8.4.9.3-1.

Table 8.4.9.3-1: Attributes of the VirtualisedResourceChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the virtualised resource.
virtualisedResourceId	M	1	Identifier	Identifier of the instantiated virtualised resource for which the change notification is issued. This identifier value shall be the same as the one returned when the allocation of this virtualised resource was acknowledged.

Attribute	Qualifier	Cardinality	Content	Description
virtualisedResourceGroupId	M	0..1	Identifier	Identifier of the affinity or anti-affinity group of the virtualised resource for which the change notification is issued. This identifier value shall be the same as the one returned when the affinity or anti-affinity group was created.
endOfChange	M	0..1	Boolean	If the value is True it indicates the end of the changes of virtualised resources for which the notification of type of change is issued.
changeTime	M	1	DateTime	Specifies the anticipated time of change of the virtualised resource for which the change notification is issued or the ending time of changes of virtualised resources if the value of the endOfChange is "true".
vimId	M	1	Identifier	Identifier of the VIM reporting the change.
changeType	M	1	String	Categorizes the type of change. Possible values can be related to maintenance and operation of the NFVI, including e.g. normal, maintenance, evacuation, optimization, etc.
changedResourceData	M	0..1	Not specified	Details of the changes of the resource Its content can differ based on the different values of the attribute changeType.

8.4.10 UserData information element

8.4.10.1 Description

This clause describes the attributes for the UserData information element.

8.4.10.2 Attributes

The UserData information element shall follow the indications provided in Table 8.4.10.2-1.

Table 8.4.10.2-1: Attributes of the UserData information element

Attribute	Qualifier	Cardinality	Content	Description
content	M	1	String	Contains the user data to customize a virtualised compute resource at boot-time.
method	M	0..1	Enum	Method used as transportation media to convey the content of the UserData to the virtualised compute resource. VALUES: • CONFIG_DRIVE

8.5 Information elements and notifications related to Virtualised Resources Performance Management

8.5.1 Introduction

The clauses below define information elements and notifications related to virtualised resources performance management.

8.5.2 ObjectSelection information element

8.5.2.1 Description

This information element allows to specify resources on which performance information will be provided.

The object types for this information element will be the measured object types defined in ETSI GS NFV-IFA 027 [5] for virtualised resources.

The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface.

8.5.2.2 Attributes

The ObjectSelection information element shall follow the indications provided in Table 8.5.2.2-1.

Table 8.5.2.2-1: Attributes of the ObjectSelection information element

Attribute	Qualifier	Cardinality	Content	Description
objectType	M	0..N	String	Provide measured the object type. The object types for this information element will be the measured object types defined in ETSI GS NFV-IFA 027 [5] for virtualised resources. One of the two alternatives (objectType + objectFilter or objectInstanceId) shall be present.
objectFilter	M	0..1	Filter	Filter applied on the object types to specify on which object instances the performance information is requested to be collected. One of the two alternatives (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 virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface. One of the two alternatives (objectType + objectFilter or objectInstanceId) shall be present.

8.5.3 PmJob information element

8.5.3.1 Description

This information element provides the details of the PM Job.

The object instances for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

8.5.3.2 Attributes

The PmJob information element shall follow the indications provided in Table 8.5.3.2-1.

Table 8.5.3.2-1: Attributes of the PmJob information element

Attribute	Qualifier	Cardinality	Content	Description
pmJobId	M	1	Identifier	Identifier of the PM
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 virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface. See clause 8.5.2.

Attribute	Qualifier	Cardinality	Content	Description
performanceMetric	M	0..N	String	Defines the type of performance metric(s) for the specified object instances. Valid values are specified as "Measurement Name" values in clause 7.1 of ETSI GS NFV-IFA 027 [5]. At least one of the two (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. Valid values are specified as "Measurement Group" values in clause 7.1 of ETSI GS NFV-IFA 027 [5]. At least one of the two (performance metric or group) shall be present.
collectionPeriod	M	1	Not specified	Specifies the periodicity at which the producer will collect performance information (see note).
reportingPeriod	M	1	Not specified	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 part of the protocol design, 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.				

8.5.4 Threshold information element

8.5.4.1 Description

This information element provides the details of a threshold.

The object instances for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

8.5.4.2 Attributes

The Threshold information element shall follow the indications provided in Table 8.5.4.2-1.

Table 8.5.4.2-1: Attributes of the Threshold information element

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier	Identifier of the threshold.
objectSelector	M	1	ObjectSelection	Defines the object instances associated with the threshold. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface. See clause 8.5.1.
performanceMetric	M	1	String	Defines the performance metric associated with the threshold. Valid values are specified as "Measurement Name" values in clause 7.1 of ETSI GS NFV-IFA 027 [5].

Attribute	Qualifier	Cardinality	Content	Description
thresholdType	M	1	Enum	Type of threshold. The list of possible values is part of the protocol design and might include: single/multi valued threshold, static/dynamic threshold, template based threshold. VALUES: • SIMPLE: Single-valued static threshold • Etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, details on the notification to be generated.

8.5.5 PerformanceReport information element

8.5.5.1 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 virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

8.5.5.2 Attributes

The PerformanceReport information element shall follow the indications provided in Table 8.5.5.2-1.

Table 8.5.5.2-1: Attributes of the PerformanceReport information element

Attribute	Qualifier	Cardinality	Content	Description
performanceReport	M	1..N	PerformanceReportEntry	List of performance information entries. See clause 8.5.6.

8.5.6 PerformanceReportEntry information element

8.5.6.1 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 types for this information element will be the types defined in the Virtual Resources Information Interface.

The object instances for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

8.5.6.2 Attributes

The PerformanceReport Entry information element shall follow the indications provided in Table 8.5.6.2-1.

Table 8.5.6.2-1: 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 measured object types defined in ETSI GS NFV-IFA 027 [5] for virtualised resources. See clause 8.5.2.

Attribute	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1	Identifier	Object instance for which the performance metric is reported. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface.
performanceMetric	M	1	String	Name of the metric collected. This attribute's value contains the related "Measurement Name" value as defined in clause 7.1 of ETSI GS NFV-IFA 027 [5].
performanceValue	M	1..N	PerformanceValueEntry	List of performance values with associated timestamp and measurement context (see ETSI GS NFV-IFA 027 [5]). See clause 8.5.7.

8.5.7 PerformanceValueEntry information element

8.5.7.1 Description

This information element defines a single performance value with its associated time stamp and measurement context (see ETSI GS NFV-IFA 027 [5]).

8.5.7.2 Attributes

The PerformanceValueEntry information element shall follow the indications provided in Table 8.5.7.2-1.

Table 8.5.7.2-1: 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. The type of this attribute corresponds to the related "Measurement Unit" as defined in clause 7.1 of ETSI GS NFV-IFA 027 [5].
measurementContext	M	0..1	Not specified	Measurement context of the metric collected. The specific measurement context for each kind of performance metrics is defined in ETSI GS NFV-IFA 027 [5].

8.5.8 PerformanceInformationAvailableNotification

8.5.8.1 Description

This notification informs the receiver that performance information is available. Delivery mechanism for the performance reports is not specified in the present document.

The object instances for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

8.5.8.2 Trigger conditions

New performance information is available.

8.5.8.3 Attributes

The PerformanceInformationAvailableNotification shall follow the indications provided in Table 8.5.8.3-1.

Table 8.5.8.3-1: Attributes of the PerformanceInformationAvailableNotification

Attribute	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1..N	Identifier	Object instances for which performance information is available. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface. See clause 8.3.

8.5.9 ThresholdCrossedNotification

8.5.9.1 Description

This notification informs the receiver that a threshold value has been crossed.

The object instances for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

8.5.9.2 Trigger conditions

- A Threshold has been crossed. Depending on threshold type, there might be s single or multiple crossing values.

8.5.9.3 Attributes

The ThresholdCrossedNotification shall follow the indications provided in Table 8.5.9.3-1.

Table 8.5.9.3-1: 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	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 virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [5]. These resources shall be known by the Virtualised Resource Management interface. See clause 8.3.
performanceMetric	M	1	String	Performance metric associated with the threshold.
performanceValue	M	1	Value	Value of the metric that resulted in threshold crossing.
measurementContext	M	0..1	Not specified	Measurement context of the metric collected. The specific measurement context for each kind of performance metrics is defined in ETSI GS NFV-IFA 027 [5].

8.6 Information elements and notifications related to Virtualised Resources Fault Management

8.6.1 Introduction

This clause defines notifications and information elements related to virtualised resources fault management.

8.6.2 AlarmNotification

8.6.2.1 Description

This notification informs the receiver of alarms resulting from the faults related to the virtualised resources managed by the VIM. The notification is mandatory.

8.6.2.2 Trigger conditions

- An alarm has been created.
- An alarm has been updated, e.g. if the severity of the alarm has changed.

8.6.2.3 Attributes

The AlarmNotification shall follow the indications provided in Table 8.6.2.3-1.

Table 8.6.2.3-1: Attributes of the AlarmNotification

Attribute	Qualifier	Cardinality	Content	Description
alarm	M	1	Alarm	Information about an alarm including AlarmId, affected virtualised resource identifier, and FaultDetails. See clause 8.7.1.
NOTE: In case the alarm cause cannot be determined, the notification should identify the alarm as cause as being undetermined.				

8.6.3 AlarmClearedNotification

8.6.3.1 Description

This notification informs the receiver of the clearing of an alarm related to the virtualised resources managed by the VIM. The alarm's perceived severity has been set to "cleared" since the corresponding fault has been solved. The notification is mandatory.

8.6.3.2 Trigger conditions

An alarm has been cleared.

8.6.3.3 Attributes

The AlarmClearedNotification shall follow the indications provided in Table 8.6.3.3-1.

Table 8.6.3.3-1: Attributes of the AlarmClearedNotification

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier (Reference to Alarm)	Alarm identifier.
alarmClearedTime	M	1	DateTime	Timestamp indicating when the alarm was cleared.

8.6.4 Alarm information element

8.6.4.1 Description

The Alarm information element encapsulates information about an alarm.

The Managed Objects for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

The allowed values for the faultType attribute depend on the type of the related managed object as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9]. The values of isRootCause and correlatedAlarmID are set by the VIM, based on its functional implementation of alarm correlation (see VIM functional requirement on alarm correlation VIM.Irfm.001 in ETSI GS NFV-IFA 010 [2]).

8.6.4.2 Attributes

The Alarm information element shall follow the indications provided in Table 8.6.4.2-1.

Table 8.6.4.2-1: Attributes of the Alarm information element

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier	Alarm identifier.
managedObjectId	M	1	Identifier	Identifier of the affected managed Object. The Managed Objects for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface. (see clause 7.8). A virtualised resource can have fault monitored sub-object types and identification information is carried as defined in the respective Alarm definition as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9], e.g. using the "faultDetails" attribute.
alarmRaisedTime	M	1	DateTime	Timestamp indicating when the alarm was first 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.
state	M	1	Enum	State of the alarm. VALUES: • FIRED • UPDATED • CLEARED
perceivedSeverity	M	1	Enum	Perceived severity of the managed object failure. • CRITICAL • MAJOR • MINOR • WARNING • INDETERMINATE • CLEARED Valid values applicable to specific Alarms are specified as "Perceived severity" values of the Alarm applicable to Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].
eventTime	M	1	DateTime	Timestamp indicating when the fault was observed.

Attribute	Qualifier	Cardinality	Content	Description
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 [3]. VALUES: • COMMUNICATION_ALARMS • PROCESSING_ALARM • ENVIRONMENT_ALARM • QOS_ALARM • EQUIPMENT_ALARM Valid values applicable to specific Alarms are specified as "Event type" values of the Alarm applicable to Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].
faultType	M	0..1	String	Information related to the type of the fault. The allowed values for the faultType attribute depend on the type of the related managed object. Valid values applicable to specific Alarms are specified as "Alarm definition identifier" values of the Alarm applicable to Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].
probableCause	M	1	String	Information about the probable cause of the fault. Valid values applicable to specific Alarms are specified as "Probable cause" values of the Alarm applicable to Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].
isRootCause	M	1	Boolean	Parameter indicating if this fault is the root for other correlated alarms. If TRUE, then the alarms listed in the parameter correlatedAlarmId are caused by this fault.
correlatedAlarmId	M	0..N	Identifier (Reference to Alarm)	List of other alarms correlated to this fault.
faultDetails	M	0..N	Not specified	Provides additional information about the fault. Valid values applicable to specific Alarms are specified as "Fault details" values of the Alarm applicable to Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].

8.7 Information elements and notifications related to Virtualised Resources Capacity Management

8.7.1 Introduction

The clauses below define information elements and notifications related to virtualised resources capacity management.

8.7.2 TimePeriodInformation information element

8.7.2.1 Description

This information element specifies a time period for which capacity is queried.

8.7.2.2 Attributes

The TimePeriodInformation information element shall follow the indications provided in Table 8.7.2.2-1.

Table 8.7.2.2-1: Attributes of the TimePeriodInformation information element

Attribute	Qualifier	Cardinality	Content	Description
startTime	M	1	DateTime	Indication when the capacity query period starts.
endTime	M	1	DateTime	Indication when the capacity query period ends.

8.7.3 CapacityInformation information element

8.7.3.1 Description

Multiple instances of this information element (at least one for each resource type) are used to specify the available (i.e. consumable), reserved, allocated and the total capacity managed by the VIM or in a resource zone managed by the VIM.

8.7.3.2 Attributes

The CapacityInformation information element shall follow the indications provided in Table 8.7.3.2-1.

Table 8.7.3.2-1: Attributes of the CapacityInformation information element

Attribute	Qualifier	Cardinality	Content	Description
availableCapacity	M	0..1	Not specified	Free capacity available for allocation and reservation. It can be specified in terms of current capacity; or • minimum and maximum capacity; • average capacity; or • other statistical measurement in the specified time interval. The set of measurements is part of the protocol design.
reservedCapacity	M	0..1	Not specified	Reserved capacity. It can be specified in terms of current capacity; or • minimum and maximum capacity; • average capacity; or • other statistical measurement in the specified time interval. The set of measurements is part of the protocol design.
totalCapacity	M	0..1	Not specified	The total capacity is usually specified as a fixed capacity without variations in time (see note 1). The set of measurements is part of the protocol design.
allocatedCapacity	M	0..1	Not specified	The allocated capacity is usually specified as the current allocated capacity (see note 2).
NOTE 1: VIM does not keep schedules for equipment build-out. NOTE 2: The allocated capacity is given without time variation since the VIM does not have a schedule of future allocations and de-allocations.				

8.7.4 CapacityChangeNotification

8.7.4.1 Description

This notification informs the receiver of changes in the capacity of NFVI resources managed by the VIM. The notification is mandatory.

8.7.4.2 Trigger conditions

This notification is published when the available, allocated/used, reserved or total capacity of NFVI resources managed by the VIM is changed due to:

- Allocation/termination/updating of NFVI resources affecting the available and/or allocated/used capacity.
- Creation/termination/updating of reservations affecting the available and/or reserved capacity.
- Addition/removal/upgrading of physical infrastructure affecting the available and total capacity.
- Faults and repair of physical infrastructure affecting the c available and total capacity.

8.7.4.3 Attributes

The CapacityChangeNotification shall follow the indications provided in Table 8.7.4.3-1.

Table 8.7.4.3-1: Attributes of the CapacityChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Identifies a change in the capacity.
zoneId	M	0..1	Identifier	Identifies the resource zone for which the capacity has changed. When omitted the total capacity managed by the VIM is reported.
resourceDescriptor	M	1	Not specified	Resource type for which the capacity is changed.
capacityInformation	M	1	CapacityInformation	Available, total, reserved and/or allocated/used capacity of the Resource Zone, or the available, total, reserved and/or allocated/used capacity of the VIM in case the Resource Zone is omitted.

8.7.5 ResourceCapacityThreshold information element

8.7.5.1 Description

This information element defines thresholds for sending capacity change notifications.

8.7.5.2 Attributes

The ResourceCapacityThreshold information element shall follow the indications provided in Table 8.7.5.2-1.

Table 8.7.5.2-1: Attributes of the ResourceCapacityThreshold information element

Attribute	Qualifier	Cardinality	Content	Description
thresholdType	M	1	Enum	Specifies the type of threshold. The list of possible values is part of the protocol design and might include: absolute value, percentage of total capacity, delta related to current value, single/multi valued threshold, static/dynamic threshold, etc. VALUES: • SIMPLE: Single-valued static threshold • Etc.
threshold	M	1	Not specified	Details of the threshold: value to be crossed and direction in which it is crossed and capacity information to which it applies (available, total, reserved, allocated).

8.8 Information elements and notifications related to Reservation

8.8.1 Introduction

The Virtualised Resource Reservation information elements contain information related to reservations of virtualisation resources used for input and output in the Compute, Network and Storage Virtualised Resource Reservation Management interfaces.

The clauses below define information elements and notifications related to reservation.

8.8.2 ReservedVirtualCompute information element

8.8.2.1 Description

The compute resource reservation information element encapsulates information about a reservation for virtualised compute resources. It includes information about virtual compute resource pool and virtualisation container reservations.

8.8.2.2 Attributes

The ReservedVirtualCompute information element shall follow the indications provided in Table 8.8.2.2-1.

Table 8.8.2.2-1: Attributes of the ReservedVirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the resource reservation.
computePoolReserved	M	0..1	ReservedComputePool	Information about compute resources that have been reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}. See clause 8.8.3.3.
virtualisationContainerReserved	M	0..N	ReservedVirtualisationContainer	Information about the virtualisation container(s) that have been reserved. See clause 8.8.5.3.
reservationStatus	M	1	Enum	Status of the compute resource reservation, e.g. to indicate if a reservation is being used. VALUES: • RESERVATION_BEING_USED • RESERVATION_NOT_USED
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication when the reservation ends (when it is expected that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

8.8.3 Information elements related to Compute Pool Reservation

8.8.3.1 Introduction

The compute reservation information elements encapsulate information about virtual compute resource pool reservations. The information elements contain details about number of CPU cores, number of virtualisation container instances, size of virtual memory, as well as different attributes of the virtual compute resource pool.

8.8.3.2 ComputePoolReservation information element

8.8.3.2.1 Description

This clause describes the attributes for the ComputePoolReservation information element.

8.8.3.2.2 Attributes

The ComputePoolReservation information element shall follow the indications provided in Table 8.8.3.2.2-1.

Table 8.8.3.2.2-1: Attributes of the ComputePoolReservation information element

Attribute	Qualifier	Cardinality	Content	Description
numCpuCores	M	1	Integer	Number of CPU cores to be reserved.
numVcInstances	M	1	Integer	Number of virtualised container instances to be reserved.
virtualMemSize	M	1	Number	Size of virtual memory to be reserved.
computeAttributes	M	1	VirtualComputeAttributes ReservationData	Information specifying additional attributes of the compute resource to be reserved. See clause 8.8.3.4.

8.8.3.3 ReservedComputePool information element

8.8.3.3.1 Description

This clause describes the attributes for the ReservedComputePool information element.

8.8.3.3.2 Attributes

The ReservedComputePool information element shall follow the indications provided in Table 8.8.3.3.2-1.

Table 8.8.3.3.2-1: Attributes of the ReservedComputePool information element

Attribute	Qualifier	Cardinality	Content	Description
numCpuCores	M	1	Integer	Number of CPU cores that have been reserved.
numVcInstances	M	1	Integer	Number of virtual container instances that have been reserved.
virtualMemSize	M	1	Number	Size of virtual memory that has been reserved.
computeAttributes	M	1	ReservedVirtualCompute Attributes	Information specifying additional attributes of the virtual compute resource that have been reserved. See clause 8.8.3.5.
zoneId	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtual compute resources have been reserved. If not present, the reserved compute resources are not bound to a specific resource zone.

8.8.3.4 VirtualComputeAttributesReservationData information element

8.8.3.4.1 Description

This clause describes the attributes for the VirtualComputeAttributesReservationData information element.

8.8.3.4.2 Attributes

The VirtualComputeAttributesReservationData information element shall follow the indications provided in Table 8.8.3.4.2-1.

Table 8.8.3.4.2-1: Attributes of the VirtualComputeAttributesReservationData information element

Attribute	Qualifier	Cardinality	Content	Description
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is requested.
cpuArchitecture	M	0..1	Not specified	CPU architecture type. Examples are "x86", "ARM". The cardinality can be 0, if no particular CPU architecture type is requested.
virtualCpuOversubscriptionPolicy	M	0..1	Not specified	CPU core oversubscription policy in terms of virtual CPU cores to physical CPU cores/threads on the platform. The cardinality can be 0, if no particular value is requested.

8.8.3.5 ReservedVirtualComputeAttributes information element

8.8.3.5.1 Description

This clause describes the attributes for the ReservedVirtualComputeAttributes information element.

8.8.3.5.2 Attributes

The ReservedVirtualComputeAttributes information element shall follow the indications provided in Table 8.8.3.5.2-1.

Table 8.8.3.5.2-1: Attributes of the ReservedVirtualComputeAttributes information element

Attribute	Qualifier	Cardinality	Content	Description
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided.
cpuArchitecture	M	0..1	Not specified	CPU architecture type. Examples are "x86", "ARM". The cardinality can be 0, if no particular CPU architecture type is provided.
virtualCpuOversubscriptionPolicy	M	0..1	Not specified	CPU core oversubscription policy in terms of virtual CPU cores to physical CPU cores/threads on the platform. The cardinality can be 0, if no particular value is provided.

8.8.4 Information elements related to Network Reservation

8.8.4.1 Introduction

The network reservation information elements encapsulate information about network resource reservations. A network reservation includes information about number and list of public IP addresses, network type, and bandwidth requirements. It can also include specific network ports for reservation. The network resource reservation includes information about a created reservation for a network resource.

8.8.4.2 ReservedVirtualNetwork information element

8.8.4.2.1 Description

This clause describes the attributes for the ReservedVirtualNetwork information element.

8.8.4.2.2 Attributes

The ReservedVirtualNetwork information element shall follow the indications provided in Table 8.8.4.2.2-1.

Table 8.8.4.2.2-1: Attributes of the ReservedVirtualNetwork information element

Attribute	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the resource reservation.
publicIpAddresses	M	0..1	ReservedPublicIpAddresses	Information specifying the list of public IP addresses that have been reserved. See clause 8.8.4.9.
networkAttributes	M	1	ReservedVirtualNetworkAttributes	Information specifying additional attributes of the network resource that has been reserved. See clause 8.8.4.6.
networkPorts	M	0..N	ReservedVirtualNetworkPort	List of specific network ports that have been reserved. See clause 8.8.4.7.
reservationStatus	M	1	Enum	Status of the network resource reservation, e.g. to indicate if a reservation is being used. VALUES: • RESERVATION_BEING_USED • RESERVATION_NOT_USED
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication when the reservation ends (when it is expected that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.
zoneId	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtual network resources have been reserved. If not present, the reserved network resources are not bound to a specific resource zone.

8.8.4.3 VirtualNetworkReservation information element

8.8.4.3.1 Description

This clause describes the attributes for the VirtualNetworkReservation information element.

8.8.4.3.2 Attributes

The VirtualNetworkReservation information element shall follow the indications provided in Table 8.8.4.3.2-1.

Table 8.8.4.3.2-1: Attributes of the VirtualNetworkReservation information element

Attribute	Qualifier	Cardinality	Content	Description
publicIpAddresses	M	0..1	PublicIpAddressesReservationData	Information specifying the number and list of public IP addresses to be reserved. See clause 8.8.4.8.
networkAttributes	M	1	VirtualNetworkAttributesReservationData	Information specifying additional attributes of the network resource to be reserved. See clause 8.8.4.4.
networkPorts	M	0..N	VirtualNetworkPortReservationData	List of specific network ports to be reserved. See clause 8.8.4.5.

8.8.4.4 VirtualNetworkAttributesReservationData information element

8.8.4.4.1 Description

This clause describes the attributes for the VirtualNetworkAttributesReservationData information element.

8.8.4.4.2 Attributes

The VirtualNetworkAttributesReservationData information element shall follow the indications provided in Table 8.8.4.4.2-1.

Table 8.8.4.4.2-1: Attributes of the VirtualNetworkAttributesReservationData information element

Attribute	Qualifier	Cardinality	Content	Description
bandwidth	M	1	Number	Minimum network bitrate (in Mbps).
networkType	M	0..1	String	Type of network that maps to the virtualised network to be reserved. Examples are: "local", "vlan", "vxlan", "gre", etc.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network to be reserved, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
isShared	M	0..1	Boolean	Specifies whether the virtualised network to be reserved is shared among consumers.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.8.4.5 VirtualNetworkPortReservationData information element

8.8.4.5.1 Description

This clause describes the attributes for the VirtualNetworkPortReservationData information element.

A network port is a communication endpoint under a network.

8.8.4.5.2 Attributes

The VirtualNetworkPortReservationData information element shall follow the indications provided in Table 8.8.4.5.2-1.

Table 8.8.4.5.2-1: Attributes of the VirtualNetworkPortReservationData information element

Attribute	Qualifier	Cardinality	Content	Description
portId	M	1	Identifier	Identifier of the network port to reserve.
portType	M	1	Not specified	Type of network port. Examples of types are access ports, or trunk ports (layer 1) that become transport for multiple layer 2 or layer 3 networks.
bandwidth	M	0..1	Number	Bitrate of the virtual network port (in Mbps).
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.8.4.6 ReservedVirtualNetworkAttributes information element

8.8.4.6.1 Description

This clause describes the attributes for the ReservedVirtualNetworkAttributes information element.

8.8.4.6.2 Attributes

The ReservedVirtualNetworkAttributes information element shall follow the indications provided in Table 8.8.4.6.2-1.

Table 8.8.4.6.2-1: Attributes of the ReservedVirtualNetworkAttributes information element

Attribute	Qualifier	Cardinality	Content	Description
bandwidth	M	1	Number	Minimum network bitrate (in Mbps).
networkType	M	1	String	Type of network that maps to the virtualised network that has been reserved. Examples are: "local", "vlan", "vxlan", "gre", etc.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network that has been reserved, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
isShared	M	1	Boolean	Specifies whether the virtualised network that has been reserved is shared among consumers.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.8.4.7 ReservedVirtualNetworkPort information element

8.8.4.7.1 Description

This clause describes the attributes for the ReservedVirtualNetworkPort information element.

A network port is a communication endpoint under a network.

8.8.4.7.2 Attributes

The ReservedVirtualNetworkPort information element shall follow the indications provided in Table 8.8.4.7.2-1.

Table 8.8.4.7.2-1: Attributes of the ReservedVirtualNetworkPort information element

Attribute	Qualifier	Cardinality	Content	Description
portId	M	1	Identifier	Identifier of the network port that has been reserved.
portType	M	1	Not specified	Type of network port. Examples of types are access ports, or trunk ports (layer 1) that become transport for multiple layer 2 or layer 3 networks.
bandwidth	M	0..1	Number	Bitrate of the virtual network port (in Mbps).
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.8.4.8 PublicIpAddressesReservationData information element

8.8.4.8.1 Description

This clause describes the attributes for the PublicIpAddressesReservationData information element.

8.8.4.8.2 Attributes

The PublicIpAddressesReservationData information element shall follow the indications provided in Table 8.8.4.8.2-1.

Table 8.8.4.8.2-1: Attributes of the PublicIpAddressesReservationData information element

Attribute	Qualifier	Cardinality	Content	Description
numPublicIps	M	0..1	Integer	Number of public IP addresses to be reserved.
networkId	M	0..1	Identifier	Unique identifier of the network from which public IP addresses can be reserved.
publicIps	M	0..N	IpAddress	List of public IP addresses to be reserved.
NOTE 1: It is assumed that the virtual network identified by networkId with subnetwork has been created and that the public IP addresses are outside of the allocation pool(s) of this network/subnetwork. NOTE 2: At least one of the attributes shall be present.				

8.8.4.9 ReservedPublicIpAddresses information element

8.8.4.9.1 Description

This clause describes the attributes for the ReservedPublicIpAddresses information element.

8.8.4.9.2 Attributes

The ReservedPublicIpAddresses information element shall follow the indications provided in Table 8.8.4.9.2-1.

Table 8.8.4.9.2-1: Attributes of the ReservedPublicIpAddresses information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	1	Identifier	Unique identifier of the network from which public IP addresses have been reserved.
publicIps	M	1..N	IpAddress	List of public IP addresses that have been reserved.

8.8.5 Information elements related to Virtualisation Container Reservation

8.8.5.1 Introduction

The VirtualisationContainerReservation information element encapsulates information about virtualisation container reservations, including (among others), virtual memory, CPUs, storage and virtual network interfaces, as well as a zone ID.

8.8.5.2 VirtualisationContainerReservation information element

8.8.5.2.1 Description

This clause describes the attributes for the VirtualisationContainerReservation information element.

8.8.5.2.2 Attributes

The VirtualisationContainerReservation information element shall follow the indications provided in Table 8.8.5.2.2-1.

Table 8.8.5.2.2-1: Attributes of the VirtualisationContainerReservation information element

Attribute	Qualifier	Cardinality	Content	Description
containerId	M	1	Identifier	Identifier of the virtualisation container to be reserved.
containerFlavour	M	1	VirtualComputeFlavour	Encapsulates information of the virtualisation container to be reserved. See clause 8.4.2.2.

8.8.5.3 ReservedVirtualisationContainer information element

8.8.5.3.1 Description

This clause describes the attributes for the ReservedVirtualisationContainer information element.

8.8.5.3.2 Attributes

The ReservedVirtualisationContainer information element shall follow the indications provided in Table 8.8.5.3.2-1.

Table 8.8.5.3.2-1: Attributes of the ReservedVirtualisationContainer information element

Attribute	Qualifier	Cardinality	Content	Description
containerId	M	1	Identifier	Identifier of the virtualisation container that has been reserved.
flavourId	M	1	Identifier	Identifier of the given compute flavour used to reserve the virtualisation container.
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided.
virtualMemory	M	1	VirtualMemory	Virtual memory of the reserved virtualisation container.
virtualCpu	M	1	VirtualCpu	Virtual CPU(s) of the reserved virtualisation container.
virtualDisks	M	1..N	VirtualStorage	Provides information of the virtualised storage resources attached to the reserved virtualisation container.
virtualNetworkInterface	M	0..N	VirtualNetworkInterface	Provides information of the virtual network interfaces of the reserved virtualisation container.

Attribute	Qualifier	Cardinality	Content	Description
zoneId	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtualisation container has been reserved. Cardinality can be 0 to cover the case where reserved network resources are not bound to a specific resource zone.

8.8.6 Information elements related to Storage Reservation

8.8.6.1 Introduction

The storage reservation information elements encapsulate information about storage resource pool reservations.
A storage reservation includes information about the size of storage, number of snapshots, and number of volumes.
The storage resource reservation includes information about a created reservation for a storage resource.

8.8.6.2 ReservedVirtualStorage information element

8.8.6.2.1 Description

This clause describes the attributes for the ReservedVirtualStorage information element.

8.8.6.2.2 Attributes

The ReservedVirtualStorage information element shall follow the indications provided in Table 8.8.6.2.2-1.

Table 8.8.6.2.2-1: Attributes of the ReservedVirtualStorage information element

Attribute	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the resource reservation.
storagePoolReserved	M	0..1	ReservedStoragePool	Information about storage resources that have been reserved, e.g. {"gigabytes": 1 000, "snapshots": 10, "volumes": 10}. See clause 8.8.6.4.
reservationStatus	M	1	Enum	Status of the storage resource reservation, e.g. to indicate if a reservation is being used. VALUES: • RESERVATION_BEING_USED • RESERVATION_NOT_USED
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication when the reservation ends (when it is expected that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

8.8.6.3 StoragePoolReservation information element

8.8.6.3.1 Description

This clause describes the attributes for the StoragePoolReservation information element.

8.8.6.3.2 Attributes

The StoragePoolReservation information element shall follow the indications provided in Table 8.8.6.3.2-1.

Table 8.8.6.3.2-1: Attributes of the StoragePoolReservation information element

Attribute	Qualifier	Cardinality	Content	Description
storageSize	M	1	Number	Size of virtualised storage resource (e.g. size of volume, in GB) to be reserved.
numSnapshots	M	0..1	Integer	Number of snapshots to be reserved. Cardinality can be 0 if no specific number of snapshots is to be reserved.
numVolumes	M	0..1	Integer	Number of volumes to be reserved. Cardinality can be 0 if no specific number of volumes is to be reserved.

8.8.6.4 ReservedStoragePool information element

8.8.6.4.1 Description

This clause describes the attributes for the ReservedStoragePool information element.

8.8.6.4.2 Attributes

The ReservedStoragePool information element shall follow the indications provided in Table 8.8.6.4.2-1.

Table 8.8.6.4.2-1: Attributes of the ReservedStoragePool information element

Attribute	Qualifier	Cardinality	Content	Description
storageSize	M	1	Number	Size of virtualised storage resource that has been reserved.
numSnapshots	M	1	Integer	Number of snapshots that have been reserved.
numVolumes	M	1	Integer	Number of volumes that have been reserved.
zoneId	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtual storage resources have been reserved. If not present, the reserved storage resources are not bound to a specific resource zone.

8.8.7 VirtualisedResourceReservationChangeNotification

8.8.7.1 Description

This notification indicates a change in a virtualised resource reservation. Support of this notification is mandatory.

8.8.7.2 Trigger conditions

This notification is triggered when:

- A resource reservation has been updated.
- A resource reservation changed due to changes in underlying resources that are part of this reservation.

8.8.7.3 Attributes

The VirtualisedResourceReservationChangeNotification shall follow the indications provided in Table 8.8.7.3-1.

Table 8.8.7.3-1: Attributes of the VirtualisedResourceReservationChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the virtualised resource reservation.
reservationId	M	1	Identifier	Identifies the reservation being changed.
vimId	M	1	Identifier	Identifies the VIM reporting the change.
changeType	M	1	String	Categorizes the type of change. Possible values can be related to an update of the reservation or a change in the resources part of the reservation.
changedReservationData	M	0..1	Not specified	Details of the changes of the reservation.

8.9 Nfp information element

8.9.1 Description

This clause defines the Nfp information element.

8.9.2 Attributes

The Nfp information element shall follow the indications provided in Table 8.9.2-1.

Table 8.9.2-1: Attributes of the Nfp information element

Attribute	Qualifier	Cardinality	Content	Description
nfpId	M	1	Identifier	Identifier of the NFP.
virtualNetworkPortGroup	M	1..N	VirtualNetworkPortGroup	Virtual network port group. See note 3.
totalVnp	O	0..1	Integer	Total number of virtual network ports in this NFP queried for.
nfpRule	M	1	Rule	NFP classification and selection rule(s).
nfpState	M	1	Enum	Indicates whether the NFP is enabled or disabled. VALUES: • ENABLED • DISABLED
NOTE 1: Void. NOTE 2: Void. NOTE 3: When multiple attributes are included, the position of the attribute in the information element value specifies the position of the virtual network port group in the path.				

8.10 Information elements related to NFVI-PoP

8.10.1 Introduction

This clause defines information elements related to NFVI-PoP.

8.10.2 ResourceZone information element

8.10.2.1 Description

The ResourceZone information element contains information about the Resource Zone.

8.10.2.2 Attributes

The ResourceZone information element shall follow the indications provided in Table 8.10.2.2-1.

Table 8.10.2.2-1: Attributes of the ResourceZone information element

Attribute	Qualifier	Cardinality	Content	Description
zoneId	M	1	Identifier	Identifier of the Resource Zone (see note).
zoneName	M	1	String	Name of the Resource Zone.
zoneState	M	1	String	Information about the current state of the Resource Zone, e.g. if the Resource Zone is available.
nfviPopId	M	1	Identifier (Reference to NfviPop)	Identifier of the NFVI-PoP the Resource Zone belongs to.
zoneProperty	M	1..N	Not specified	Set of properties that define the capabilities associated to the Resource Zone. Examples of capabilities may include: support of certain compute resource types (e.g. low performance, acceleration capabilities, etc. (see clause 8.3.2)), association to certain NFVI-PoP physical segregation (e.g. different power or network sub-systems, availability of redundancy power sub-systems), etc.
metadata	O	0..N	KeyValuePair	Other metadata associated to the Resource Zone.
NOTE: This identifier is unique within an NFVI-PoP and is assigned by the PIM during resource zone creation. The VIM uses the same identifier for a resource zone that is assigned by the PIM.				

8.10.3 NfviPop information element

8.10.3.1 Description

The NfviPop information element contains basic data to identify an NFVI-PoP in a VIM. It provides geographic location information of the NFVI resources that the VIM manages, as well as other attributes which help consumer functional blocks build topological information relative to NFVI-PoP connectivity to other NFVI-PoP or N-PoP.

8.10.3.2 Attributes

The NfviPop information element shall follow the indications provided in Table 8.10.3.2-1.

Table 8.10.3.2-1: Attributes of the NfviPop information element

Attribute	Qualifier	Cardinality	Content	Description
nfviPopId	M	1	Identifier	Identifier of the NFVI-PoP.
vimId	M	1	Identifier	Identifier of the VIM.
geographicalLocationInfo	M	1	Location	Provides information about the geographic location (e.g. geographic coordinates or address of the building, etc.) of the NFVI resources that the VIM manages.
networkConnectivityEndpoint	M	1..N	ConnectivityService Endpoint	Information about network connectivity endpoints to the NFVI-PoP that the VIM manages which helps build topology information relative to NFVI-PoP connectivity to other NFVI-PoP or N-PoP. These endpoints enable the entities instantiated in the NFVI-PoP to be reachable by networks outside of the NFVI-PoP.

8.10.4 ConnectivityServiceEndpoint information element

8.10.4.1 Description

The ConnectivityServiceEndpoint information element contains User Network Interface data between NFVI-PoP and external network (e.g. WAN).

8.10.4.2 Attributes

The ConnectivityServiceEndpoint information element shall follow the indications provided in Table 8.10.4.2-1.

Table 8.10.4.2-1: Attributes of the ConnectivityServiceEndpoint information element

Attribute	Qualifier	Cardinality	Content	Description
connectivityServiceEndpointId	M	1	Identifier	Identifier of an endpoint to the NFVI-PoP.
associatedResourceId	M	1	Identifier	Identifier of the resource providing the endpoint (e.g. a physical or virtual network gateway).
connectivityServiceEndpoint	M	1	Not specified	Contains data about protocol names, logical or physical network port, etc.

8.11 Information elements and notifications related to Quota

8.11.1 Introduction

The quota information elements contain information related to quota of virtualised resources used for input and output in the Virtualised Compute, Network and Storage Resource Quota Management interfaces.

The clauses below define information elements and notifications related to quota.

8.11.2 Information elements related to Compute Quota

8.11.2.1 Introduction

The compute quota information elements encapsulate information about virtual compute resource quotas. The information elements contain details about number of instance cores, number of virtualisation container instances, size of virtual memory.

The clauses below define information elements related to compute quota.

8.11.2.2 VirtualComputeQuotaData information element

8.11.2.2.1 Description

This clause describes the attributes for the VirtualComputeQuotaData information element.

8.11.2.2.2 Attributes

The VirtualComputeQuotaData information element shall follow the indications provided in Table 8.11.2.2.2-1.

Table 8.11.2.2.2-1: Attributes of the VirtualComputeQuotaData information element

Attribute	Qualifier	Cardinality	Content	Description
numVCPUs	M	0..1	Integer	Number of CPU cores to be restricted by the quota. The cardinality can be 0 if no specific number of CPU cores is to be restricted by the quota or the quota for CPU cores is not to be update (see note).
numVcInstances	M	0..1	Integer	Number of virtualisation container instances to be restricted by the quota. The cardinality can be 0 if no specific number of virtualisation container instances is to be restricted by the quota or the quota for virtualisation container instances is not to be update (see note).

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	0..1	Number	Size of virtual memory to be restricted by the quota. The cardinality can be 0 if no specific size of virtual memory is to be restricted by the quota or the quota for virtual memory is not to be update (see note).
NOTE: At least one of the three attributes shall be present.				

8.11.2.3 VirtualComputeQuota information element

8.11.2.3.1 Description

This clause describes the attributes for the VirtualComputeQuota information element.

8.11.2.3.2 Attributes

The VirtualComputeQuota information element shall follow the indications provided in Table 8.11.2.3.2-1.

Table 8.11.2.3.2-1: Attributes of the VirtualComputeQuota information element

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.
numVCPUs	M	0..1	Integer	Number of CPU cores that have been restricted by the quota. The cardinality can be 0 if no specific number of CPU cores has been requested to be restricted by the quota.
numVcInstances	M	0..1	Integer	Number of virtualisation container instances that have been restricted by the quota. The cardinality can be 0 if no specific number of CPU cores has been requested to be restricted by the quota.
virtualMemSize	M	0..1	Number	Size of virtual memory that has been restricted by the quota. The cardinality can be 0 if no specific number of CPU cores has been requested to be restricted by the quota.

8.11.3 Information elements related to Network Quota

8.11.3.1 Introduction

The network quota information elements encapsulate information about network resource quotas. A network quota includes information about number of public IP addresses. It can also include specific network ports and number of subnets for quota.

The clauses below define information elements related to network quota.

8.11.3.2 VirtualNetworkQuotaData information element

8.11.3.2.1 Description

This clause describes the attributes for the VirtualNetworkQuotaData information element.

8.11.3.2.2 Attributes

The VirtualNetworkQuotaData information element shall follow the indications provided in Table 8.11.3.2.2-1.

Table 8.11.3.2.2-1: Attributes of the VirtualNetworkQuotaData information element

Attribute	Qualifier	Cardinality	Content	Description
numPublicIps	M	0..1	Integer	Number of public IP addresses to be restricted by the quota. The cardinality can be 0 if no specific number of public IP addresses is to be restricted by the quota or the quota for public IP addresses is not to be update (see note).
numPorts	M	0..1	Integer	Number of ports to be restricted by the quota. The cardinality can be 0 if no specific number of ports is to be restricted by the quota or the quota for ports is not to be update (see note).
numSubnets	M	0..1	Integer	Number of subnets to be restricted by the quota. The cardinality can be 0 if no specific number of subnets is to be restricted by the quota or the quota for subnets is not to be update (see note).
NOTE: At least one of the three attributes shall be present.				

8.11.3.3 VirtualNetworkQuota information element

8.11.3.3.1 Description

This clause describes the attributes for the VirtualNetworkQuota information element.

8.11.3.3.2 Attributes

The VirtualNetworkQuota information element shall follow the indications provided in Table 8.11.3.3.2-1.

Table 8.11.3.3.2-1: Attributes of the VirtualNetworkQuota information element

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.
numPublicIps	M	0..1	Integer	Number of public IP addresses that have been restricted by the quota. The cardinality can be 0 if no specific number of public IP addresses has been requested to be restricted by the quota.
numPorts	M	0..1	Integer	Number of ports that have been restricted by the quota. The cardinality can be 0 if no specific number of ports has been requested to be restricted by the quota.
numSubnets	M	0..1	Integer	Number of subnets that have been restricted by the quota. The cardinality can be 0 if no specific number of subnets has been requested to be restricted by the quota.

8.11.4 Information elements related to Storage Quota

8.11.4.1 Introduction

The storage quota information elements encapsulate information about storage resource quotas. A storage quota includes information about the size of storage, number of snapshots, and number of volumes.

The clauses below define information elements related to storage quota.

8.11.4.2 VirtualStorageQuotaData information element

8.11.4.2.1 Description

This clause describes the attributes for the VirtualStorageQuotaData information element.

8.11.4.2.2 Attributes

The VirtualStorageQuotaData information element shall follow the indications provided in Table 8.11.4.2.2-1.

Table 8.11.4.2.2-1: Attributes of the VirtualStorageQuotaData information element

Attribute	Qualifier	Cardinality	Content	Description
storageSize	M	0..1	Number	Size of virtualised storage resource (e.g. size of volume, in GB) to be restricted by the quota. Cardinality can be 0 if no specific size of virtualised storage resource is to be restricted by the quota or the quota for the size of virtualised storage resource is not to be update (see note).
numSnapshots	M	0..1	Integer	Number of snapshots to be restricted by the quota. Cardinality can be 0 if no specific number of snapshots is to be restricted by the quota or the quota for the snapshots is not to be update (see note).
numVolumes	M	0..1	Integer	Number of volumes to be restricted by the quota. Cardinality can be 0 if no specific number of volumes is to be restricted by the quota or the quota for the volumes is not to be update (see note).
NOTE: At least one of the three attributes shall be present.				

8.11.4.3 VirtualStorageQuota information element

8.11.4.3.1 Description

This clause describes the attributes for the VirtualStorageQuota information element.

8.11.4.3.2 Attributes

The VirtualStorageQuota information element shall follow the indications provided in Table 8.11.4.3.2-1.

Table 8.11.4.3.2-1: Attributes of the VirtualStorageQuota information element

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.
storageSize	M	0..1	Number	Size of virtualised storage resource that has been restricted by the quota. Cardinality can be 0 if no specific size of virtualised storage resource has been requested to be restricted by the quota.
numSnapshots	M	0..1	Integer	Number of snapshots that have been restricted by the quota. The cardinality can be 0 if no specific number of snapshots has been requested to be restricted by the quota.
numVolumes	M	0..1	Integer	Number of volumes that have been restricted by the quota. The cardinality can be 0 if no specific number of volumes has been requested to be restricted by the quota.

8.11.5 VirtualisedResourceQuotaChangeNotification

8.11.5.1 Description

This notification indicates a Quota change in a virtualised resource. Support of this notification is mandatory.

8.11.5.2 Trigger conditions

This notification is triggered when:

- A resource Quota is being updated.

8.11.5.3 Attributes

The VirtualisedResourceQuotaChangeNotification information element shall follow the indications provided in Table 8.11.5.3-1.

Table 8.11.5.3-1: Attributes of the VirtualisedResourceQuotaChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the virtualised resource Quota.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
vimId	M	1	Identifier	Identifies the VIM reporting the change.
changeType	M	1	String	It categorizes the type of change. Possible values can be related to an update of the Quota.
changedQuotaData	M	0..1	Not specified	Details of the changes of the Quota.

8.12 Additional information elements for Nfp management

8.12.1 VirtualNetworkPortGroup information element

8.12.1.1 Description

This clause defines the VirtualNetworkPortGroup information element. This information element references a set of virtual network port pairs, each corresponding to a pair of egress and ingress CPs and specifies rules for forwarding traffic to the ingress ports of the constituent port pairs.

8.12.1.2 Attributes

The VirtualNetworkPortGroup information element shall follow the indications provided in Table 8.12.1.2-1.

Table 8.12.1.2-1: Attributes of the VirtualNetworkPortGroup information element

Attributes	Qualifier	Cardinality	Content	Description
virtualNetworkPortPair	M	1..N	VirtualNetworkPortPair	Specifies a virtual network port pair. See note.
forwardingBehaviour	M	0..1	Enum	Specifies a rule to apply to forward traffic to the ingress virtual network ports of the group. VALUES: • ALL • LB "ALL" specifies a rule that traffic flows shall be forwarded simultaneously to all network ports; "LB" specifies a rule that traffic flows shall be forwarded to one network port of the group selected based on a load-balancing algorithm.

Attributes	Qualifier	Cardinality	Content	Description
forwardingBehaviourInputParameters	M	0..1	Not specified	Provides input parameters to configure the forwarding behaviour (e.g. identifies a load balancing algorithm and criteria).
NOTE: All virtual network port pairs in a group shall be instantiated from connection point descriptors or service access point descriptors referenced in the corresponding network forwarding path descriptor (see ETSI GS NFV-IFA 014 [4]), as belonging to the same network forwarding path position.				

8.12.2 VirtualNetworkPortPair information element

8.12.2.1 Description

This clause defines the VirtualNetworkPortPair information element. This information element references a pair of ingress and egress virtual network ports.

8.12.2.2 Attributes

The VirtualNetworkPortPair information element shall follow the indications provided in Table 8.12.2.2-1.

Table 8.12.2.2-1: Attributes of the VirtualNetworkPortPair information element

Attributes	Qualifier	Cardinality	Content	Description
ingressVnp	M	1	Identifier (Reference to VirtualNetworkPort)	Identifies a virtual network port. See notes 1, 2 and 3.
egressVnp	M	1	Identifier (Reference to VirtualNetworkPort)	Identifies a virtual network port. See notes 1, 2 and 3.
NOTE 1: This identifier maps to the resourceId attribute of a VirtualNetworkPort information element as defined in clause 8.4.5.4. NOTE 2: The mapping between virtual network ports and connection points specified in a VNFD and an NSD is managed by the VNFM and NFVO. NOTE 3: The two virtual network ports may be identical.				

8.13 Information elements related to Compute Host Reservation

8.13.1 Introduction

This clause defines information elements related to Compute Host Reservation.

8.13.2 ReservedComputeHosts information element

8.13.2.1 Description

This clause describes the attributes for the ReservedComputeHosts information element.

8.13.2.2 Attributes

The ReservedComputeHosts information element shall follow the indications provided in Table 8.13.2.2-1.

Table 8.13.2.2-1: Attributes of the ReservedComputeHosts information element

Attribute	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the compute host reservation.
minAmount	M	1	Integer	Minimum amount of reserved compute hosts.

Attribute	Qualifier	Cardinality	Content	Description
maxAmount	M	1	Integer	Maximum amount of reserved compute hosts.
startTime	M	1	DateTime	Start time for consumption of the reserved compute hosts by a given tenant.
endTime	M	1	DateTime	End time for consumption of the reserved compute hosts by a given tenant.
reservationStatus	M	1	Enum	Status of the resource reservation, e.g. to indicate if a reservation is being used. VALUES: • RESERVATION_BEING_USED • RESERVATION_NOT_USED
computeHostProperties	M	0..N	Not specified	Set of properties that define the capabilities associated to the reserved compute hosts (e.g. hypervisor capabilities).
zoneId	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the compute hosts have been reserved.

8.14 Information elements and notifications related to Policy Management

8.14.1 Introduction

The clauses below define information elements and notifications related to policy management.

8.14.2 Information elements related to Policy Management Operations

8.14.2.1 Introduction

The clauses below define information elements related to policy management operations.

8.14.2.2 PolicyInfo information element

8.14.2.2.1 Description

This information element provides policy related information. It contains the policy itself and additional information related to the policy.

8.14.2.2.2 Attributes

The structure of the PolicyInfo information element shall comply with the provisions for the PolicyInfo information element as defined in ETSI GS NFV-IFA 013 [6], clause 8.8.2.2.2.

8.14.3 PolicyChangeNotification

8.14.3.1 Description

This notification indicates a change of an NFV-MANO policy related to operations of transferring policy, deleting policy, activating policy and deactivating policy.

Support of this notification is mandatory.

8.14.3.2 Trigger Conditions

The notification is produced when:

- A policy has been changed as a result of an operation of TransferPolicy, DeletePolicy, ActivatePolicy or DeactivatePolicy.

8.14.3.3 Attributes

The PolicyChangeNotification shall comply with the provisions in clause 8.8.3.3 of ETSI GS NFV-IFA 013 [6].

8.14.4 PolicyConflictNotification

8.14.4.1 Description

This notification indicates a policy conflict is detected by the VIM. A policy conflict can include any conflicted monitored events, conditions or actions among two or more polices enforced by the VIM.

Support of this notification is mandatory.

8.14.4.2 Trigger Conditions

The notification is produced when:

- A policy conflict is detected by the VIM.

8.14.4.3 Attributes

The PolicyConflictNotification shall comply with the provisions in clause 8.8.4.3 of ETSI GS NFV-IFA 013 [6].

8.15 Information elements related to Mirroring Job

8.15.1 Introduction

This clause specifies information elements related to a data flow mirroring job.

8.15.2 MirroringJob information element

8.15.2.1 Description

This information element represents a data flow mirroring job.

8.15.2.2 Attributes

The MirroringJob information element shall follow the indications provided in Table 8.15.2.2-1.

Table 8.15.2.2-1: Attributes of the MirroringJob information element

Attribute	Qualifier	Cardinality	Content	Description
mirroringJobId	M	1	Identifier	Unique identifier of the Data Flow Mirroring Job.
mirroringJobName	M	1	String	Name of the Data Flow Mirroring Job.
description	M	1	String	Information description of the Data Flow Mirroring Job.
collectorDetails	M	1	Not specified	Information about where the mirrored flow is to be delivered. See note 1.
dataFlowDetails	M	1..N	Not specified	Information about the data flows that need to be mirrored. See note 2.
NOTE 1: Information could include ports where to mirror the data flow. NOTE 2: Information could include characteristics of the data flows such as VLANs, or IP addresses, direction of the data flow, etc.				

Annex A (informative): Change history

Date	Version	Information about changes
June 2017	V2.1.2	Updated with CRs: NFVIFA(16)000347, NFVIFA(17)000092r4, NFVIFA(17)000197r3, NFVIFA(17)000226, NFVIFA(17)000246r3, NFVIFA(17)000309, NFVIFA(17)000311r4, NFVIFA(17)000312r5, NFVIFA(17)000343r4, NFVIFA(17)000411r3, NFVIFA(17)000446r2, NFVIFA(17)000447r2, NFVIFA(17)000448, NFVIFA(17)000464r2, NFVIFA(17)000467r2, NFVIFA(17)000472r2, NFVIFA(17)000485r1, NFVIFA(17)000546r4, NFVIFA(17)000588, NFVIFA(17)000590r1.
December 2017	V2.3.2	Updated with CRs: NFVIFA(17)000611, NFVIFA(17)000593r1, NFVIFA(17)000592, NFVIFA(17)000632r3, NFVIFA(17)000790r2, NFVIFA(17)000772r2, NFVIFA(17)000921, NFVIFA(17)001081r3, NFVIFA(17)001146.
June 2018	V2.4.2	Updated with CRs: NFVIFA(18)000372r5, NFVIFA(18)000463r3, NFVIFA(18)000606r1.
June 2018	V3.0.1	Updated with CRs: NFVIFA(18)000420r1, NFVIFA(18)000432r1, NFVIFA(18)000559, NFVIFA(18)000608r1, NFVIFA(18)000617, NFVIFA(18)000660.
November 2018	V3.1.2	Updated with CRs: NFVIFA(18)000743r3.
February 2019	V3.1.4	Updated with CRs: NFVIFA(18)0001111r2, NFVIFA(18)0001121, NFVIFA(18)000902.
July 2019	V3.2.2	Starting version for 1H2019 specification work. Unmodified with respect to published version v3.2.1.
July 2019	V3.2.3	Updated with CRs: NFVIFA(19)000455 (FEAT03 MegaCR), NFVIFA(19)000535r1, NFVIFA(19)000541r2, NFVIFA(19)000580, NFVIFA(19)000583.
October 2019	V3.3.2	Starting version for the second half of 2019 specification work. Unmodified with respect to published version v3.3.1. Update of the rapporteur.
December 2019	V3.3.3	Updated with CRs: NFVIFA(19)000764, NFVIFA(19)000828, NFVIFA(19)000878, NFVIFA(19)000886, NFVIFA(19)000897.
March 2020	V3.3.4	Updated with CRs: NFVIFA(19)000991r3, NFVIFA(20)000097r1, NFVIFA(20)000101r2, NFVIFA(20)000102r1, NFVIFA(20)000106, NFVIFA(20)000125r2, NFVIFA(20)000127, NFVIFA(20)000143r1.
April 2020	V3.3.5	Updated with CRs: NFVIFA(20)000179r3, NFVIFA(20)000180r2, NFVIFA(20)000188, NFVIFA(20)000297.
May 2020	V3.3.6	Updated with CR: NFVIFA(20)000346r2.
June 2020	V4.0.1	Release 4 initial draft version created from published version 3.4.1.
October 2020	V4.0.2	Updated with CRs: NFVIFA(20)000493, NFVIFA(20)000497, NFVIFA(20)000498.
December 2020	V4.0.3	Updated with CRs: NFVIFA(20)000768, NFVIFA(20)000914, NFVIFA(20)000932, NFVIFA(20)000728r1(Enh02.01 MegaCR), NFVIFA(20)00810 (Enh02.03 MegaCR).
March 2021	V4.0.4	Undo the merge of NFVIFA(20)00810 (Enh02.03 MegaCR) for ed421 publication version.
July 2021	V4.2.2	Initial draft version on ed431 maintenance created from published version 4.2.1.
October 2021	V4.2.3	Updated with CRs: NFVIFA(20)00810r1 (Enh02.03 MegaCR).
July 2022	V4.3.2	Initial draft version on ed441 maintenance created from published version 4.3.1.
September 2022	V4.3.3	Updated with CRs: NFVIFA(22)000088, NFVIFA(22)000094, NFVIFA(22)000096, NFVIFA(22)000088, NFVIFA(22)000400r1, NFVIFA(22)000631r1.
December 2022	V4.3.4	Updated with CR: NFVIFA(22)000759.
January 2023	V4.3.5	Updated with CR: NFVIFA(23)000027r1.
April 2023	V4.4.2	Initial draft version on ed451 maintenance created from published version 4.4.1.
November 2023	V5.0.1	Release 5 initial draft version created from published version 4.5.1.
March 2024	V5.0.2	Updated with CRs: NFVIFA(23)000836, NFVIFA(24)000031, NFVIFA(24)000050r1 FEAT19b IFA005ed511 MegaCR NFVIFA(24)000187 FEAT29 IFA005ed511 MegaCR
March 2024	V5.0.3	Re-implement clause 8.4.4.7.2 to align with the approved CR in: NFVIFA(24)000050r2 FEAT19b IFA005 augmenting attributes for TrunkSubport IE
April 2024	V5.0.4	Updated with CRs in WG final review for ed511: NFVIFA(24)000249r1
June 2024	V5.1.2	Initial ed521 draft version created from published version 5.1.1.
September 2024	V5.1.3	Updated with CRs: NFVIFA(24)000521 FEAT19a IFA005 Adding container networking recommendations NFVIFA(24)000549r1 FEAT29 IFA005ed521 MegaCR

Date	Version	Information about changes
October 2024	V5.1.4	Updated with CR: NFVIFA(24)000582r2_IFA005ed521_Review_contribution-clarification_about_resource zones

History

Document history		
V5.1.1	June 2024	Publication
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