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Network Functions Virtualisation (NFV) Release 2; 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 002 [i.1] 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.

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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); 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); Management and Orchestration; Network Service Templates Specification".

2.2 Informative references

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

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

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

[i.1] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".

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

[i.3] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV); Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

3 Definitions and abbreviations

3.1 Definitions

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

allocate resource: operation that creates an instance of a virtualised resource, involving the assignment of NFVI resources

NOTE 1: Virtualised resources can include virtualised compute resources, virtualised network resources or virtualised storage resources.

NOTE 2: Throughout the present document the term "instantiated virtualised resource" is used to describe an instance of a virtualised resource.

consumable virtualised resource: See ETSI GS NFV-IFA 010 [2].

infrastructure resource group: See ETSI GS NFV-IFA 010 [2].

multi-tenancy: See ETSI GS NFV-IFA 010 [2].

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.

tenant: See ETSI GS NFV-IFA 010 [2].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 002 [i.1] and the following apply:

NOTE: An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in ETSI GS NFV 002 [i.1].

NFP Network Forwarding Path

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.

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 [i.3]:
  - ETSI GS NFV-IFA 006 [i.3] 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.

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.

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); 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 managed by the VIM.
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: Available resources exclude allocated resources and reserved resources.	

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.

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).
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).
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).
EXAMPLE: Updating the configuration and/or parameterization of an instantiated virtualised resource.	
NOTE: This requirement does not apply to the Virtualised Network Resources 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.
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).
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.

Numbering	Functional requirements description
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.
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.	

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	The name of the software image.
provider	M	1	String	The provider of the software image.
version	M	1		The version of the software image.
userMetadata	M	0..N	KeyValuePair	User-defined metadata.
softwareImage	M	1		The 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. 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	The filter is 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	The 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
id	M	1	Identifier	The 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	The 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
id	M	1	Identifier	The 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	The updated metadata the 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
id	M	1	Identifier	The 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	The 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 allocate. 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.
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour that provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate. 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.
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinityConstraint	A list of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to allocate. All the listed constraints shall be fulfilled for a successful operation.
interfaceData	M	0..N	VirtualInterfaceData	The data of network interfaces which are specific to a Virtual Compute Resource instance. See clause 8.4.3.7.
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.

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		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	Element containing 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	Element containing 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. 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	Element containing 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, or attaching a virtual network interface to a specific network port.

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 update.
networkInterfaceNew	M	0..N	VirtualNetworkInterfaceData	The new virtual network interface(s) to add to the compute resource. See note. See clause 8.4.2.6.
networkInterfaceUpdate	M	0..N	VirtualNetworkInterface	The virtual network interface(s) to update 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. See clause 8.4.3.6.
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: Cardinality can be "0", as it is recommended that only one type of update either to add new virtual network interfaces (see "networkInterfaceNew" input) or update existing ones (see "networkInterfaceUpdate" input) is made in a single operation request.				

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	The identifier of the virtualised compute resource that has been updated. This parameter has the same value as the input parameter.
computeData	M	1	VirtualCompute	Element containing 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 perform on the virtualised compute resource. Possible values are: "start", "stop", "pause", "suspend", "reboot", "create snapshot", and "delete snapshot".
computeOperationInputData	M	0..N	KeyValuePair	Additional parameters associated to the operation to perform. For example, if the operation is "delete snapshot", information about what snapshot identifier to delete 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	Element 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 scale.
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour, what provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate. 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	Element containing 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 migrate.
affinityOrAntiAffinityConstraint	CM	0..N	AffinityOrAntiAffinityConstraint	A list of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to migrate. 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		When present, the migration constraint parameter gives indications on where to migrate the resource, e.g. to a specific resource zone.
migrationType	M	1	Enum	It defines the type of migration. Possible values are: LIVE_MIGRATION, and 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	Element containing 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	Identifier	Name of the group, given by the consumer
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group
scope	M	0..1	Enum	If applicable Qualifies the scope of the constraint, e.g. NFVI Node 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
groupIdentifier	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.

7.3.2 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 left for Stage 3 specification.

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) 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: Notify 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: Notify 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: Notify 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: 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.

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 Resource Zones within the NFVI-PoP(s) managed by the VIM.

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 will 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		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	The 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	The 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 is requested. When not specified the total capacity managed by the VIM instance will 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		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	CapacityThreshold	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	The filtered information that has been retrieved about the Resource Zone (see clause 8.10.2). The cardinality can be 0 if no matching information exist.

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	The filtered information that has been retrieved (see clause 8.10.3). The cardinality can be 0 if no matching information exist.

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	The flavour provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate. 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	A 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 allocate. 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. Possible values are: "network", "subnet" or network-port.
typeNetworkData	M	0..1	VirtualNetworkData	The network data provides information about the particular virtual network resource to create. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.2.

Parameter	Qualifier	Cardinality	Content	Description
typeNetworkPortData	M	0..1	VirtualNetworkPortData	The network port data provides information about the particular network port to create. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.5.
typeSubnetData	M	0..1	NetworkSubnetData	The subnet data provides information about the particular sub-network resource to create. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.4.
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinityConstraint	A list of element with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised network resource to allocate. All the listed constraints shall be fulfilled for a successful operation.
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		If present, it defines location constraints for the resource(s) to be allocated, e.g. in what particular resource zone.

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.
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.

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	Element containing information about the virtual network resource(s) matching the filter. The cardinality can be 0 if no matching network resources exist. See clause 8.4.5.2.

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 update.
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.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

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	The 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.

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	Identifier	Name of the group, given by the consumer
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group
scope	M	0..1	Enum	If applicable. Qualifies the scope of the constraint, e.g. NFVI Node, NIC. 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
groupIdentifier	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 left for Stage 3 specification.

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) 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	VirtualNetworkResourceInformation	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: 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.

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 will 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		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	TimePeriodInformation	The 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 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	The 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 is requested. When not specified the total capacity managed by the VIM instance will 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).
resourceCriteria	M	0..1		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	CapacityThreshold	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.

Parameter	Qualifier	Cardinality	Content	Description
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	The filtered information that has been retrieved (see clause 8.10.3). The cardinality can be 0 if no matching information exist.

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	VirtualNetworkPortGroup	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	The 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	Provide the result for the query. Depending on the query, the occurrences of this element will range from zero to many. 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	A 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 NFPs. 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 NFPs whose states are to be changed.
desiredState	M	1	Enum:{ENABLED, DISABLED}	The state into which the NFP(s) are requested to be changed. Permitted values are ENABLED and 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 NFPs 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	Provide 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		Name provided by the consumer for the virtualised storage resource to allocate. 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.
storageData	M	1	VirtualStorageFlavour	The storage data provides information about the type and size of the storage. See clause 8.4.6.2.
affinityOrAntiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	A list of e4lements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised storage resource to allocate. All the listed constraints shall be fulfilled for a successful operation.
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		If present, it defines location constraints for the resource(s) to be allocated, e.g. in what particular resource zone.

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	Element containing 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	Element containing 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 update.
updateStorageData	M	0..1	VirtualStorageFlavour	The element 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	The identifier of the virtualised storage resource that has been updated. This parameter has the same value as the input parameter.
storageData	M	1	VirtualStorage	It 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 operate.
storageOperation	M	1	String	Type of operation to perform on the virtualised storage resource. Possible values include: "create 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 about what snapshot identifier to delete is provided.

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	Element containing 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 scale.
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	Element containing 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 migrate.
affinityOrAntiAffinityConstraint	CM	0..N	AffinityOrAntiAffinityConstraint	A list of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to migrate. 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		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	Element containing 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	Identifier	Name of the group, given by the consumer.
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group.
scope	M	0..1	Enum	If applicable. Qualifies the scope of the affinity constraint, e.g. NFVI Node. 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
groupIdentifier	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 left for Stage 3 specification.

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) 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: 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.

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 storage Resource Zones within the NFVI-PoP(s) managed by the VIM.

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 will be returned.
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		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	The 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	The 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 is requested. When not specified the total capacity managed by the VIM instance will 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		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	CapacityThreshold	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.

Parameter	Qualifier	Cardinality	Content	Description
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	The filtered information that has been retrieved (see clause 8.10.3). The cardinality can be 0 if no matching information exist.

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	The filtered information that has been retrieved about the Resource Zone (see clause 8.10.2). The cardinality can be 0 if no matching information exist.

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 issue a Subscribe request for 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	CM	0..N	String	This 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	CM	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	Enum	Specifies the periodicity at which the VIM will collect performance information (see note).
reportingPeriod	M	1	Enum	Specifies the periodicity at which the VIM will report to the NFVO about performance information (see note).
reportingBoundary	O	0..1		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 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 left for further specification, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

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.

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: Create 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: Query 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.

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: Delete PM Job 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 will be defined. See clause 8.5.2.
performanceMetric	M	1	String	Defines the performance metric on which the threshold will be defined.
thresholdType	M	1	Enum	Defines the type of threshold. The list of possible values is left for later stage and might include: single/ multi valued threshold, static/dynamic threshold, template based threshold, etc.
thresholdDetails	M	1		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 that need 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 that need to be reserved (e.g. following a specific compute "flavour") (see note). See clause 8.8.5.2.
affinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Element with 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	AffinityOrAntiAffinityConstraint	Element with 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	Indication when the consumption of the resources starts. If the value is 0, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication 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	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.
locationConstraints	M	0..1		If present, it defines location constraints for the resource(s) 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.
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	Element containing information about the reserved resource. See clause 8.8.2.

7.8.1.2.4 Operation results

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	Element containing 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	Indication 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	Indication 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	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

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	Element containing information about the updated reserved resource. See clause 8.8.2.

7.8.1.4.4 Operation results

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 terminate.
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. {"PublicIPs": 20} See clause 8.8.4.3.
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If the value is 0, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication 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	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.
affinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Element with affinity information of the virtual network resources to reserve. See clause 8.4.8.2.
antiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Element with anti-affinity information of the virtual network resources to reserve. See clause 8.4.8.2.

Parameter	Qualifier	Cardinality	Content	Description
locationConstraints	M	0..1		If present, it defines location constraints for the resource(s) 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.

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	Element containing information about the reserved resource. See clause 8.8.4.2.

7.8.2.2.4 Operation results

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	Element containing 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	Indication 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	Indication 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	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

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	Element containing information about the updated reserved resource. See clause 8.8.4.2.

7.8.2.4.4 Operation results

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 terminate.
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	Indication when the consumption of the resources starts. If the value is 0, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication 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	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.
affinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Element with affinity information of the virtual storage resources to reserve. See clause 8.4.8.2.
antiAffinityConstraint	M	0..N	AffinityOrAntiAffinityConstraint	Element with anti-affinity information of the virtual storage resources to reserve. See clause 8.4.8.2.
locationConstraints	M	0..1		If present, it defines location constraints for the resource(s) 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.

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	Element containing information about the reserved resource. See clause 8.8.6.2.

7.8.3.2.4 Operation results

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	Element containing 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	Indication 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	Indication 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	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

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	Element containing information about the updated reserved resource. See clause 8.8.6.2.

7.8.3.4.4 Operation results

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 terminate.
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 left for Stage 3 specification.

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 8.9.

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 that need 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	Element containing 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	Element containing 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	Element containing 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 that need 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	Element containing 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	Element containing 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	Element containing 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 that need 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	Element containing 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	Element containing 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	Element containing 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 left for Stage 3 specification.

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.

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
id	M	1	Identifier	The identifier of this software image.
name	M	1		The name of this software image.
provider	M	1		The provider of this software image.
version	M	1		The version of this software image.
checksum	M	1		The checksum of the software image file.
containerFormat	M	1		The container format indicates whether the software image is in a file format that also contains metadata about the actual software.
diskFormat	M	1		The disk format of a software image is the format of the underlying disk image.
createdAt	M	1		The created time of this software image.
updatedAt	M	1		The updated time of this software image.
minDisk	M	1		The minimal Disk for this software image.
minRam	M	1		The minimal RAM for this software image.
size	M	1		The size of this software image.
status	M	1		The 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)	Identifier of the consumable virtualised resource type.
vimId	M	1	Identifier	Identifier of the VIM reporting the change.
changeType	M	1	Enum:{ADDITION, REMOVAL, UPDATE}	It categorizes the type of change. Permitted values are: ADDITION, REMOVAL, and UPDATE.
changedResourceData	M	0..1		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	It defines the virtual memory characteristics of the consumable virtualised compute resource (see note).
virtualCPU	M	0..1	VirtualCpuResourceInformation	It defines the virtual CPU(s) characteristics of the consumable virtualised compute resource (see note).

Attribute	Qualifier	Cardinality	Content	Description
accelerationCapability	M	0..N	AccelerationCapability	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 a 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		The 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	It 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		The 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	It 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	It 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	Element providing 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		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	The virtual memory of the virtualised compute. See clause 8.4.3.5.
virtualCpu	M	1	VirtualCpuData	The virtual CPU(s) of the virtualised compute. See clause 8.4.3.3.
storageAttributes	M	0..N	VirtualStorageData	Element containing information about the size of virtualised storage resources (e.g. size of volume, in GB), the type of storage (e.g. volume, object).
virtualNetworkInterface	M	0..N	VirtualNetworkInterfaceData	The 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		The 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	The virtual CPU pinning configuration for the virtualised compute resource. See clause 8.4.3.4.

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:{static, dynamic} (CpuPinningPolicy)	The policy can take values of "static" or "dynamic". In case of "static" the virtual CPU cores are requested to be allocated to logicall CPU cores according to the rules defined in virualCpuPinningRules. In case of "dynamic" the allocation of virtual CPU cores to logicall CPU cores is decided by the VIM (e.g.: SMT (Simultaneous Multi-Threading) requirements).
virtualCpuPinning Rules	M	0..N		A 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		The 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	It 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		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		Extra configuration that the virtual network interface supports based on the type of virtual network interface.
bandwidth	M	0..1	Number	The bandwidth of the virtual network interface (in Mbps).
accelerationCapability	M	0..N		It specifies if the virtual network interface requires certain acceleration capabilities (e.g. RDMA, packet dispatch, TCP Chimney).
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		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	The virtual CPU(s) of the virtualised compute. See clause 8.4.3.3.
virtualMemory	M	1	VirtualMemory	The virtual memory of the compute. See clause 8.4.3.5.
virtualNetworkInterface	M	0..N	VirtualNetworkInterface	Element with information of the instantiated virtual network interfaces of the compute resource. See clause 8.4.3.6.
virtualDisks	M	1..N	VirtualStorage	Element with 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.
operationalState	M	1	Enum: {enabled, disabled} (OperationalState)	Operational state of the compute 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.

8.4.3.3 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.
virtualCpuOversubscriptionPolicy	M	0..1		The 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	The virtual CPU pinning configuration for the virtualised compute resource. See clause 8.4.3.4.

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: {static, dynamic} (CpuPinningPolicy)	The policy can take values of "static" or "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		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		Shows 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		The 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	It 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).
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	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 (Reference to VirtualNetworkPort)	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.
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.

Attribute	Qualifier	Cardinality	Content	Description
typeVirtualNic	M	1		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		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	The MAC address of the virtual network interface.
bandwidth	M	1	Number	The bandwidth of the virtual network interface (in Mbps).
accelerationCapability	M	0..N		Shows the acceleration capabilities utilized by the virtual network interface. The cardinality can be 0, if no acceleration capability is utilized.
operationalState	M	1	Enum: {enabled, disabled} (OperationalState)	The operational state of the virtual network interface.
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
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	The 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	The type of network that maps to the virtualised network. This list is extensible. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn", etc. The cardinality can be "0" to cover the case where this attribute is not required to create the virtualised network.
segmentType	M	0..1	String	The isolated segment for the virtualised network. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key. The cardinality can be "0" to allow for flat networks without any specific segmentation.
networkQoS	M	0..N	NetworkQoS	Element providing information about Quality of Service attributes that the network shall support. See clause 8.4.4.3. The cardinality can be "0" to allow for networks without any specified QoS requirements.
isShared	M	0..1	Boolean	It defines whether the virtualised network is shared among consumers.
sharingCriteria	M	0..1		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	The 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.

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	The 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: {IPv4, IPv6}	The IP version of the network/subnetwork. 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	The 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 is a communication endpoint under a network.

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	1	String	Type of network port. Examples of types are normal ports, trunk ports or subports.
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.
segmentId	M	0..1	Identifier	The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key. The cardinality can be "0" to allow for flat networks without any specific segmentation.
bandwidth	M	0..1	Number	The bandwidth of the virtual network port (in Mbps). Cardinality can be "0" to allow for virtual network ports without any specified bandwidth requirements.
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 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.				

8.4.5 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.
subnet	M	0..N	Identifier (Reference to NetworkSubnet)	Only present if the network provides layer 3 connectivity. See clause 8.4.5.3.
networkPort	M	0..N	VirtualNetworkPort	Element providing information of an instantiated virtual network port
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).

Attribute	Qualifier	Cardinality	Content	Description
networkType	M	1	String	The type of network that maps to the virtualised network. This list is extensible. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn", etc.
segmentType	M	0..1	String	The isolated segment for the virtualised network. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key. The cardinality can be "0" for flat networks without any specific segmentation.
networkQoS	M	0..N	NetworkQos	Element providing 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	It defines whether the virtualised network is shared among consumers.
sharingCriteria	M	0..1		Only present for shared networks. Indicate the sharing criteria for this network. This criteria might be a list of authorized consumers.
zoneId	M	0..1	Identifier	If present, it identifies the Resource Zone where the virtual network resources have been allocated.
operationalState	M	1	Enum: {enabled, disabled} (OperationalState)	The operational state of the virtualised network.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.5.3 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)	The 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.
ipVersion	M	1	Enum: {IPv4, IPv6}	The IP version of the network/subnetwork.
gatewayIp	M	1	IpAddress	The IP address of the network/subnetwork gateway.
cidr	M	1	Not specified	The 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.
networkId	M	1	Identifier (Reference to VirtualNetwork)	Identifier of 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)	Identifier of the attached resource to the network port (e.g. a virtualised compute resource, or identifier of the virtual network interface). The cardinality can be "0" if there is no specific resource connected to the network port.
portType	M	1	String	Type of network port. Examples of types are access ports (layer 2 or 3), or trunk ports (layer 1) that become transport for multiple layer 2 or layer 3 networks.
segmentId	M	0..1	Identifier	The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key. The cardinality can be "0" for flat networks without any specific segmentation.
bandwidth	M	0..1	Number	The bandwidth of the virtual network port (in Mbps). Cardinality can be "0" for virtual network ports without any specific allocated bandwidth.

Attribute	Qualifier	Cardinality	Content	Description
operationalState	M	1	{enabled, disabled} (OperationalState)	The operational state of the virtual network port.
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	1	Identifier	Identifier of the storage flavour.
storageAttributes	M	1	VirtualStorageData	Element containing 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).

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	1	Identifier	Identifier of the storage flavour used to instantiate this virtual storage.
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	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: {enabled, disabled} (OperationalState)	Operational state of the 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.

8.4.8 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

Identifier	Qualifier	Cardinality	Content	Description
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity constraint.
scope	M	0..1	Enum	Qualifies the scope of the constraint. In case of compute resource: e.g. "NFVI-PoP" or "NFVI Node". In case of ports: e.g. "virtual switch or router" or "physical NIC", or "physical network" or "NFVI Node". In case of networks: e.g. "physical NIC", "physical network" or "NFVI Node". In case of subnets: it should be ignored. Defaults to "NFVI Node" if absent.
affinityAntiAffinityResourceList	CM	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 affinityAntiAffinityResourceList or affinityAntiAffinityResourceGroup but not both shall be present.

Identifier	Qualifier	Cardinality	Content	Description
affinityAntiAffinityResourceGroup	CM	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 affinityAntiAffinityResourceList or affinityAntiAffinityResourceGroup 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 resourceList IE shall be supported. If named resource groups for affinity / anti-affinity (see clause 8.4.8.2) are supported, the resourceGroup IE 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

Identifier	Qualifier	Cardinality	Content	Description
resource	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. 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: The above operations could trigger further actions, e.g. migration of virtualised resources.

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.
vimId	M	1	Identifier	Identifier of the VIM reporting the change.
changeType	M	1	String	It 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		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	String containing 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. Possible 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 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.

8.5.2.2 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	CM	1..N	String	Provide the object type. The object types for this information element will be the types defined in the Virtual Resources Information Interface. See clause 8.3. One of the two alternatives (objectType+ objectFilter or objectInstanceId) shall be present.
objectFilter	CM	1	Filter	The filter will apply on the object types to specify on which object instances the performance information is requested to be collected. One of the two alternatives (objectType+ objectFilter or objectInstanceId) shall be present.
objectInstanceId	CM	1..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. 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. These resources shall be known by the Virtualised Resource Management interface. See clause 8.5.1.
performanceMetric	CM	0..N	String	This defines the type of performance metric(s) for the specified object instances. At least one of the two (performance metric or group) shall be present.

Attribute	Qualifier	Cardinality	Content	Description
performanceMetricGroup	CM	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	Enum	Specifies the periodicity at which the producer will collect performance information (see note).
reportingPeriod	M	1	Enum	Specifies the periodicity at which the producer will report to the consumer about performance information (see note).
reportingBoundary	O	0..1		Identifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE: At the end of each reportingPeriod, the producer will inform the consumer about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reportingPeriod is left for further specification, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

8.5.4 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	Id of threshold.
objectSelector	M	1..N	ObjectSelection	Defines the object instances associated with the threshold. The object instances for this information element will be virtualised resources. 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
thresholdType	M	1	Enum	Type of threshold. The list of possible values is left for later stage and might include: single/ multi valued threshold, static/dynamic threshold, template based threshold.
thresholdDetails	M	1		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
performanceReportEntry	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 types defined in the Virtual Resources Information Interface. See clause 8.3.
objectInstanceId	M	1	Identifier	The object instance for which the performance metric is reported. The object instances for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.
performanceMetric	M	1	String	Name of the metric collected
performanceValue	M	1..N	PerformanceValueEntry	List of performance values with associated timestamp. See clause 8.5.6.

8.5.7 PerformanceValueEntry information element

8.5.7.1 Description

This information element defines a single performance value with its associated time stamp.

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.

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. 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	Threshold which has been crossed
crossingDirection	M	1	Enum	An indication of whether the threshold was crossed in upward or downward direction. Values: UP, DOWN.
objectInstanceId	M	1	Identifier	Object instance for which the threshold has been crossed. The object instances for this information element will be virtualised resources. 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.

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	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. For example, a resource of type "compute" may have faults of type "CPU failure", "memory failure", "network card failure", etc. 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 Description

This clause describes the attributes for the Alarm information element.

8.6.4.3 Attributes

The Alarm information element shall follow the indications provided in Table 8.6.4.3-1.

Table 8.6.4.3-1: 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.
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, e.g. "fired", "updated", "cleared".

Attribute	Qualifier	Cardinality	Content	Description
perceivedSeverity	M	1	Enum	Perceived severity of the managed object failure, legal values, e.g.: • Critical. • Major. • Minor. • Warning. • Indeterminate. • Cleared.
eventTime	M	1	DateTime	Timestamp indicating when the fault was observed.
eventType	M	0..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]: • Communication Alarm • Processing Alarm • Environment Alarm • QoS Alarm • Equipment Alarm
faultType	M	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. For example, a resource of type "compute" may have faults of type "CPU failure", "memory failure", "network card failure", etc.
probableCause	M	1	String	Information about the probable cause of the fault.
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	List of other alarms correlated to this fault.
faultDetails	M	0..N		Provides additional information about the fault, e.g. information about the threshold, monitored attributes, indication of the trend of the monitored parameter, etc.

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.
stopTime	M	1	DateTime	Indication when the capacity query period stops.

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	Depends on the resource type.	The 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 to be defined during Stage 3.
reservedCapacity	M	0..1	Depends on the resource type.	The 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 to be defined during Stage 3.
totalCapacity	M	0..1	Depends on the resource type.	The total capacity is usually specified as a fixed capacity without variations in time (see note 1). The set of measurements is left to Stage 3.
allocatedCapacity	M	0..1	Depends on the resource type.	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 virtual resources managed by the VIM. The notification is mandatory.

8.7.4.2 Trigger conditions

This notification is published when the available, allocated, reserved or total capacity of virtual resources managed by the VIM is changed due to:

- Allocation/termination/updating of virtual resources affecting the available and/or allocated 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	It identifies a change in the capacity.
zoneId	M	0..1	Identifier	The Resource Zone for which the capacity has changed. When omitted the total capacity managed by the VIM is reported.
resourceDescriptor	M	1	The resource type is defined in Virtualised Resources Information Management Interface	The resource type for which the capacity is changed.
capacityInformation	M	1	CapacityInformation	The available, total, reserved and/or allocated capacity of the Resource Zone, or the available, total, reserved and/or allocated capacity of the VIM in case the Resource Zone is omitted.

8.7.5 CapacityThreshold information element

8.7.5.1 Description

This information element defines thresholds for sending capacity change notifications.

8.7.5.2 Attributes

The CapacityThreshold information element shall follow the indications provided in Table 8.7.5.2-1.

Table 8.7.5.2-1: Attributes of the CapacityThreshold information element

Parameter	Qualifier	Cardinality	Content	Description
thresholdType	M	1	Enum	Defines the type of threshold. The list of possible values is left for later stage and might include: absolute value, percentage of total capacity, delta related to current value, single/ multi valued threshold, static/dynamic threshold, etc.
threshold	M	1		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 encapsulate 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.
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If the value is 0, 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	0..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 ComputePoolReservation 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	0..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. Cardinality can be 0 to cover the case where 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		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		CPU architecture type. Examples are "x86", "ARM". The cardinality can be 0, if no particular CPU architecture type is requested.
virtualCpuOversubscriptionPolicy	M	0..1		The 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		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		CPU architecture type. Examples are "x86", "ARM". The cardinality can be 0, if no particular CPU architecture type is provided.
virtualCpuOversubscriptionPolicy	M	0..1		The 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 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.
publicIps	M	0..N	IpAddress	List of public IP addresses that have been reserved.
networkAttributes	M	0..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.
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If the value is 0, 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. Cardinality can be 0 to cover the case where 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
numPublicIps	M	0..1	Integer	Number of public IP addresses to be reserved.
networkAttributes	M	0..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	The type of network that maps to the virtualised network to be reserved. Examples are: "local", "vlan", "vxlan", "gre", etc.
segmentType	M	0..1	String	The isolated segment for the virtualised network to be reserved. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key.
isShared	M	0..1	Boolean	It defines 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		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.

Attribute	Qualifier	Cardinality	Content	Description
segmentId	M	0..1		The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key. The cardinality can be 0 to allow for flat networks without any specific segmentation.
bandwidth	M	0..1	Number	The 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	The type of network that maps to the virtualised network that has been reserved. Examples are: "local", "vlan", "vxlan", "gre", etc.
segmentType	M	1	String	The isolated segment for the virtualised network that has been reserved. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key.
isShared	M	1	Boolean	It defines 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		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.

Attribute	Qualifier	Cardinality	Content	Description
segmentId	M	0..1		The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key. The cardinality can be 0 to allow for flat networks without any specific segmentation.
bandwidth	M	0..1	Number	The 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.

8.8.5 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	The identifier of the virtualisation container to be reserved.
containerFlavour	M	1	VirtualComputeFlavour	The containerFlavour encapsulates information of the virtualisation container to be reserved. See clause 8.4.3.

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	The 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.

Attribute	Qualifier	Cardinality	Content	Description
accelerationCapability	M	0..N		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	The virtual memory of the reserved virtualisation container.
virtualCpu	M	1	VirtualCpu	The virtual CPU(s) of the reserved virtualisation container.
virtualDisks	M	1..N	VirtualStorage	Element with information of the virtualised storage resources attached to the reserved virtualisation container.
virtualNetworkInterface	M	0..N	VirtualNetworkInterface	Element with information of the virtual network interfaces of the reserved virtualisation container.
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.
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If the value is 0, resources are reserved for immediate use.

Attribute	Qualifier	Cardinality	Content	Description
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. Cardinality can be 0 to cover the case where 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	The reservation being changed.
vimId	M	1	Identifier	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 reservation or a change in the resources part of the reservation.
changedReservationData	M	0..1		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

Attributes	Qualifier	Cardinality	Content	Description
nfpId	M	1	Identifier	Identification of the NFP
virtualNetworkPortGroup	M	1..N	VirtualNetworkPortGroup	A 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	An indication of whether the NFP is enabled or 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	The identifier of the Resource Zone.
zoneName	M	1	String	The 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	The identifier of the NFVI-PoP the Resource Zone belongs to.
zoneProperty	M	1..N		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.

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	Identification of the NFVI-PoP.
vimId	M	1	Identifier	Identification of the VIM.
geographicalLocationInfo	M	1	Location	It 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		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.

8.11 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	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		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	Identifies a rule to apply to forward traffic to the ingress virtual network ports of the group. The minimum list of rules to be supported shall include: • ALL = Traffic flows shall be forwarded simultaneously to all network ports. • LB = 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)	The identification of a virtual network port. See notes 1, 2 and 3.
egressVnp	M	1	Identifier (Reference to VirtualNetworkPort)	The identification of 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.				

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Annex B (informative): Bibliography

ETSI GS NFV-IFA 015: "Network Functions Virtualisation (NFV); Management and Orchestration; NFV Information Model Report".

Annex C (informative): Change History

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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
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