



Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification

Disclaimer

The present document has been produced and approved by the Network Functions Virtualisation (NFV) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG.
It does not necessarily represent the views of the entire ETSI membership.

Reference

RGS/NFV-IFA006ed451

Keywordsconfiguration, management, MANO, network, NFV,
virtualisation**ETSI**650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from:

<https://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommitteeSupportStaff.aspx>

If you find a security vulnerability in the present document, please report it through our
Coordinated Vulnerability Disclosure Program:

<https://www.etsi.org/standards/coordinated-vulnerability-disclosure>

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2023.
All rights reserved.

Contents

Intellectual Property Rights	15
Foreword.....	15
Modal verbs terminology.....	15
1 Scope	16
2 References	16
2.1 Normative references	16
2.2 Informative references.....	16
3 Definition of terms, symbols and abbreviations.....	17
3.1 Terms.....	17
3.2 Symbols.....	17
3.3 Abbreviations	17
4 Overview of interfaces and information models associated to the Vi-Vnfm reference point	18
4.1 Introduction	18
4.2 Relation to other NFV group specifications	19
4.3 Conventions.....	19
5 Reference point and interface requirements	19
5.1 Introduction	19
5.2 Vi-Vnfm Reference Point Requirements.....	20
5.3 Interface Requirements.....	20
5.3.1 Software Image Management interface requirements.....	20
5.3.2 Virtualised Resources Information Management interface requirements	21
5.3.3 Virtualised Resources Management interface requirements.....	21
5.3.4 Virtualised Resources Reservation Management interface requirements	22
5.3.5 Virtualised Resources Change Notification interface requirements	22
5.3.6 Virtualised Resources Reservation Change Notification interface requirements	22
5.3.7 Virtualised Resources Quota Management interface requirements	23
5.3.8 Virtualised Resources Performance Management interface requirements.....	23
5.3.9 Virtualised Resources Fault Management interface requirements.....	24
5.3.10 Policy Management interface requirements.....	24
6 VNFM exposed interfaces.....	25
7 VIM exposed interfaces.....	25
7.1 Introduction	25
7.2 Software Image Management Interface.....	25
7.2.1 Description.....	25
7.2.2 Query Images operation.....	26
7.2.2.1 Description	26
7.2.2.2 Input parameters.....	26
7.2.2.3 Output parameters	26
7.2.2.4 Operation results	26
7.2.3 Query Image operation	26
7.2.3.1 Description	26
7.2.3.2 Input parameters.....	27
7.2.3.3 Output parameters	27
7.2.3.4 Operation results	27
7.3 Virtualised Compute Interfaces.....	27
7.3.1 Virtualised Compute Resources Management Interface.....	27
7.3.1.1 Description	27
7.3.1.2 Allocate Virtualised Compute Resource operation	27
7.3.1.2.1 Description	27
7.3.1.2.2 Input parameters	28
7.3.1.2.3 Output parameters	29
7.3.1.2.4 Operation results.....	29

7.3.1.3	Query Virtualised Compute Resource operation.....	29
7.3.1.3.1	Description	29
7.3.1.3.2	Input parameters	29
7.3.1.3.3	Output parameters	29
7.3.1.3.4	Operation results.....	30
7.3.1.4	Update Virtualised Compute Resource operation	30
7.3.1.4.1	Description	30
7.3.1.4.2	Input parameters	30
7.3.1.4.3	Output parameters	31
7.3.1.4.4	Operation results.....	31
7.3.1.5	Terminate Virtualised Compute Resource operation	31
7.3.1.5.1	Description	31
7.3.1.5.2	Input parameters	31
7.3.1.5.3	Output parameters	31
7.3.1.5.4	Operation results.....	32
7.3.1.6	Operate Virtualised Compute Resource operation	32
7.3.1.6.1	Description	32
7.3.1.6.2	Input parameters	32
7.3.1.6.3	Output parameters	33
7.3.1.6.4	Operation results.....	33
7.3.1.7	Scale Virtualised Compute Resource operation	33
7.3.1.7.1	Description	33
7.3.1.7.2	Input parameters	33
7.3.1.7.3	Output parameters	33
7.3.1.7.4	Operation results.....	34
7.3.1.8	Migrate Virtualised Compute Resource operation	34
7.3.1.8.1	Description	34
7.3.1.8.2	Input parameters	34
7.3.1.8.3	Output parameters	35
7.3.1.8.4	Operation results.....	35
7.3.1.9	Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group operation	35
7.3.1.9.1	Description	35
7.3.1.9.2	Input parameters	35
7.3.1.9.3	Output parameters	36
7.3.1.9.4	Operation results.....	36
7.3.1.10	Attach Virtualised Storage Resource operation	36
7.3.1.10.1	Description	36
7.3.1.10.2	Input parameters	36
7.3.1.10.3	Output parameters	36
7.3.1.10.4	Operation results.....	36
7.3.1.11	Detach Virtualised Storage Resource operation.....	37
7.3.1.11.1	Description	37
7.3.1.11.2	Input parameters	37
7.3.1.11.3	Output parameters	37
7.3.1.11.4	Operation results.....	37
7.3.2	Virtualised Compute Resources Change Notification Interface	37
7.3.2.1	Description	37
7.3.2.2	Subscribe operation.....	37
7.3.2.2.1	Description	37
7.3.2.2.2	Input parameters	38
7.3.2.2.3	Output parameters	38
7.3.2.2.4	Operation results.....	38
7.3.2.3	Notify operation	38
7.3.2.3.1	Description	38
7.3.3	Virtualised Compute Resources Information Management Interface.....	38
7.3.3.1	Description	38
7.3.3.2	Subscribe operation.....	39
7.3.3.2.1	Description	39
7.3.3.2.2	Input parameters	39
7.3.3.2.3	Output parameters	39
7.3.3.2.4	Operation results.....	39
7.3.3.3	Notify operation	40

7.3.3.3.1	Description	40
7.3.3.4	Query Virtualised Compute Resource Information operation.....	40
7.3.3.4.1	Description	40
7.3.3.4.2	Input parameters	40
7.3.3.4.3	Output parameters	40
7.3.3.4.4	Operation results.....	41
7.3.4	Virtualised Compute Flavour Management Interface.....	41
7.3.4.1	Introduction.....	41
7.3.4.2	Create Compute Flavour operation	41
7.3.4.2.1	Description	41
7.3.4.2.2	Input parameters	41
7.3.4.2.3	Output parameters	41
7.3.4.2.4	Operation results.....	41
7.3.4.3	Query Compute Flavour operation.....	42
7.3.4.3.1	Description	42
7.3.4.3.2	Input parameters	42
7.3.4.3.3	Output parameters	42
7.3.4.3.4	Operation results.....	42
7.3.4.4	Delete Compute Flavour operation	42
7.3.4.4.1	Description	42
7.3.4.4.2	Input parameters	43
7.3.4.4.3	Output parameters	43
7.3.4.4.4	Operation results.....	43
7.4	Virtualised Network Interfaces.....	43
7.4.1	Virtualised Network Resources Management Interface.....	43
7.4.1.1	Description	43
7.4.1.2	Allocate Virtualised Network Resource operation.....	43
7.4.1.2.1	Description	43
7.4.1.2.2	Input parameters	44
7.4.1.2.3	Output parameters	45
7.4.1.2.4	Operation results.....	45
7.4.1.3	Query Virtualised Network Resource operation	45
7.4.1.3.1	Description	45
7.4.1.3.2	Input parameters	45
7.4.1.3.3	Output parameters	46
7.4.1.3.4	Operation results.....	46
7.4.1.4	Update Virtualised Network Resource operation.....	46
7.4.1.4.1	Description	46
7.4.1.4.2	Input parameters	46
7.4.1.4.3	Output parameters	47
7.4.1.4.4	Operation results.....	47
7.4.1.5	Terminate Virtualised Network Resource operation.....	48
7.4.1.5.1	Description	48
7.4.1.5.2	Input parameters	48
7.4.1.5.3	Output parameters	48
7.4.1.5.4	Operation results.....	48
7.4.1.6	Create Virtualised Network Resource Affinity Or AntiAffinity Constraints Group operation.....	48
7.4.1.6.1	Description	48
7.4.1.6.2	Input parameters	49
7.4.1.6.3	Output parameters	49
7.4.1.6.4	Operation results.....	49
7.4.2	Virtualised Network Resources Change Notification Interface.....	49
7.4.2.1	Description	49
7.4.2.2	Subscribe operation.....	49
7.4.2.2.1	Description	49
7.4.2.2.2	Input parameters	50
7.4.2.2.3	Output parameters	50
7.4.2.2.4	Operation results.....	50
7.4.2.3	Notify operation	50
7.4.2.3.1	Description	50
7.4.3	Virtualised Network Resources Information Management Interface.....	51
7.4.3.1	Description.....	51

7.4.3.2	Subscribe operation.....	51
7.4.3.2.1	Description	51
7.4.3.2.2	Input parameters	51
7.4.3.2.3	Output parameters	51
7.4.3.2.4	Operation results.....	52
7.4.3.3	Notify operation	52
7.4.3.3.1	Description	52
7.4.3.4	Query Virtualised Network Resource Information operation	52
7.4.3.4.1	Description	52
7.4.3.4.2	Input parameters	52
7.4.3.4.3	Output parameters	52
7.4.3.4.4	Operation results.....	53
7.5	Virtualised Storage Interfaces	53
7.5.1	Virtualised Storage Resources Management Interface	53
7.5.1.1	Description	53
7.5.1.2	Allocate Virtualised Storage Resource operation.....	53
7.5.1.2.1	Description	53
7.5.1.2.2	Input parameters	53
7.5.1.2.3	Output parameters	54
7.5.1.2.4	Operation results.....	54
7.5.1.3	Query Virtualised Storage Resource operation	54
7.5.1.3.1	Description	54
7.5.1.3.2	Input parameters	55
7.5.1.3.3	Output parameters	55
7.5.1.3.4	Operation results.....	55
7.5.1.4	Update Virtualised Storage Resource operation.....	55
7.5.1.4.1	Description	55
7.5.1.4.2	Input parameters	56
7.5.1.4.3	Output parameters	56
7.5.1.4.4	Operation results.....	56
7.5.1.5	Terminate Virtualised Storage Resource operation.....	56
7.5.1.5.1	Description	56
7.5.1.5.2	Input parameters	57
7.5.1.5.3	Output parameters	57
7.5.1.5.4	Operation results.....	57
7.5.1.6	Operate Virtualised Storage Resource operation	57
7.5.1.6.1	Description	57
7.5.1.6.2	Input parameters	57
7.5.1.6.3	Output parameters	58
7.5.1.6.4	Operation results.....	58
7.5.1.7	Scale Virtualised Storage Resource operation	58
7.5.1.7.1	Description	58
7.5.1.7.2	Input parameters	58
7.5.1.7.3	Output parameters	58
7.5.1.7.4	Operation results.....	59
7.5.1.8	Migrate Virtualised Storage Resource operation	59
7.5.1.8.1	Description	59
7.5.1.8.2	Input parameters	59
7.5.1.8.3	Output parameters	59
7.5.1.8.4	Operation results.....	60
7.5.1.9	Create Virtualised Storage Resource Affinity Or AntiAffinity Constraints Group operation.....	60
7.5.1.9.1	Description	60
7.5.1.9.2	Input parameters	60
7.5.1.9.3	Output parameters	60
7.5.1.9.4	Operation results.....	61
7.5.2	Virtualised Storage Resources Change Notification Interface.....	61
7.5.2.1	Description	61
7.5.2.2	Subscribe operation.....	61
7.5.2.2.1	Description	61
7.5.2.2.2	Input parameters	61
7.5.2.2.3	Output parameters	61
7.5.2.2.4	Operation results.....	61

7.5.2.3	Notify operation	62
7.5.2.3.1	Description	62
7.5.3	Virtualised Storage Resources Information Management Interface	62
7.5.3.1	Description	62
7.5.3.2	Subscribe operation	62
7.5.3.2.1	Description	62
7.5.3.2.2	Input parameters	62
7.5.3.2.3	Output parameters	63
7.5.3.2.4	Operation results	63
7.5.3.3	Notify operation	63
7.5.3.3.1	Description	63
7.5.3.4	Query Virtualised Storage Resources Information operation	63
7.5.3.4.1	Description	63
7.5.3.4.2	Input parameters	64
7.5.3.4.3	Output parameters	64
7.5.3.4.4	Operation results	64
7.6	Virtualised Resources Fault Management Interface	64
7.6.1	Description	64
7.6.2	Subscribe operation	64
7.6.2.1	Description	64
7.6.2.2	Input parameters	65
7.6.2.3	Output parameters	65
7.6.2.4	Operation results	65
7.6.3	Notify operation	65
7.6.3.1	Description	65
7.6.4	Get Alarm List operation	66
7.6.4.1	Description	66
7.6.4.2	Input parameters	66
7.6.4.3	Output parameters	66
7.6.4.4	Operation results	66
7.7	Virtualised Resources Performance Management Interface	66
7.7.1	Description	66
7.7.2	Create PM Job operation	67
7.7.2.1	Description	67
7.7.2.2	Input parameters	67
7.7.2.3	Output parameters	68
7.7.2.4	Operation results	68
7.7.3	Query PM Job operation	68
7.7.3.1	Description	68
7.7.3.2	Input parameters	68
7.7.3.3	Output parameters	69
7.7.3.4	Operation results	69
7.7.4	Delete PM Jobs operation	69
7.7.4.1	Description	69
7.7.4.2	Input parameters	69
7.7.4.3	Output parameters	69
7.7.4.4	Operation results	69
7.7.5	Subscribe operation	70
7.7.5.1	Description	70
7.7.5.2	Input parameters	70
7.7.5.3	Output parameters	70
7.7.5.4	Operation results	70
7.7.6	Notify operation	70
7.7.6.1	Description	70
7.7.7	Create Threshold operation	71
7.7.7.1	Description	71
7.7.7.2	Input parameters	71
7.7.7.3	Output parameters	71
7.7.7.4	Operation results	72
7.7.8	Query Threshold operation	72
7.7.8.1	Description	72
7.7.8.2	Input parameters	72

7.7.8.3	Output parameters	72
7.7.8.4	Operation results	72
7.7.9	Delete Thresholds operation	73
7.7.9.1	Description	73
7.7.9.2	Input parameters	73
7.7.9.3	Output parameters	73
7.7.9.4	Operation results	73
7.8	Virtualised Resource Reservation Interfaces	73
7.8.1	Virtualised Compute Resources Reservation Management Interface	73
7.8.1.1	Description	73
7.8.1.2	Query Compute Resource Reservation operation	73
7.8.1.2.1	Description	73
7.8.1.2.2	Input parameters	74
7.8.1.2.3	Output parameters	74
7.8.1.2.4	Operation results	74
7.8.2	Virtualised Network Resources Reservation Management Interface	74
7.8.2.1	Description	74
7.8.2.2	Query Network Resource Reservation operation	74
7.8.2.2.1	Description	74
7.8.2.2.2	Input parameters	75
7.8.2.2.3	Output parameters	75
7.8.2.2.4	Operation results	75
7.8.3	Virtualised Storage Resources Reservation Management Interface	75
7.8.3.1	Description	75
7.8.3.2	Query Storage Resource Reservation operation	75
7.8.3.2.1	Description	75
7.8.3.2.2	Input parameters	76
7.8.3.2.3	Output parameters	76
7.8.3.2.4	Operation results	76
7.8.4	Virtualised Resources Reservation Change Notification Interface	76
7.8.4.1	Description	76
7.8.4.2	Subscribe operation	76
7.8.4.2.1	Description	76
7.8.4.2.2	Input parameters	77
7.8.4.2.3	Output parameters	77
7.8.4.2.4	Operation results	77
7.8.4.3	Notify operation	77
7.8.4.3.1	Description	77
7.9	Virtualised Resource Quota Interfaces	78
7.9.1	Virtualised Compute Resources Quota Management Interface	78
7.9.1.1	Description	78
7.9.1.2	Query Compute Resource Quota operation	78
7.9.1.2.1	Description	78
7.9.1.2.2	Input parameters	78
7.9.1.2.3	Output parameters	78
7.9.1.2.4	Operation results	78
7.9.2	Virtualised Network Resources Quota Management Interface	79
7.9.2.1	Description	79
7.9.2.2	Query Network Resource Quota operation	79
7.9.2.2.1	Description	79
7.9.2.2.2	Input parameters	79
7.9.2.2.3	Output parameters	79
7.9.2.2.4	Operation results	79
7.9.3	Virtualised Storage Resources Quota Management Interface	80
7.9.3.1	Description	80
7.9.3.2	Query Storage Resource operation	80
7.9.3.2.1	Description	80
7.9.3.2.2	Input parameters	80
7.9.3.2.3	Output parameters	80
7.9.3.2.4	Operation results	80
7.9.4	Virtualised Resources Quota Change Notification Interface	81
7.9.4.1	Description	81

7.9.4.2	Subscribe operation.....	81
7.9.4.2.1	Description.....	81
7.9.4.2.2	Input parameters.....	81
7.9.4.2.3	Output parameters.....	81
7.9.4.2.4	Operation results.....	81
7.9.4.3	Notify operation.....	81
7.9.4.3.1	Description.....	81
7.10	Policy Management Interface.....	82
7.10.1	Description.....	82
7.10.2	Transfer Policy operation.....	82
7.10.2.1	Description.....	82
7.10.2.2	Input parameters.....	82
7.10.2.3	Output parameters.....	83
7.10.2.4	Operation results.....	83
7.10.3	Delete Policy operation.....	83
7.10.3.1	Description.....	83
7.10.3.2	Input parameters.....	83
7.10.3.3	Output parameters.....	84
7.10.3.4	Operation results.....	84
7.10.4	Query Policy operation.....	84
7.10.4.1	Description.....	84
7.10.4.2	Input parameters.....	84
7.10.4.3	Output parameters.....	84
7.10.4.4	Operation results.....	85
7.10.5	Activate Policy operation.....	85
7.10.5.1	Description.....	85
7.10.5.2	Input parameters.....	85
7.10.5.3	Output parameters.....	85
7.10.5.4	Operation results.....	85
7.10.6	Deactivate Policy operation.....	86
7.10.6.1	Description.....	86
7.10.6.2	Input parameters.....	86
7.10.6.3	Output parameters.....	86
7.10.6.4	Operation results.....	86
7.10.7	Subscribe operation.....	86
7.10.7.1	Description.....	86
7.10.7.2	Input parameters.....	87
7.10.7.3	Output parameters.....	87
7.10.7.4	Operation results.....	87
7.10.8	Notify operation.....	87
7.10.8.1	Description.....	87
7.10.9	Terminate Subscription operation.....	87
7.10.9.1	Description.....	87
7.10.9.2	Input parameters.....	88
7.10.9.3	Output parameters.....	88
7.10.9.4	Operation results.....	88
7.10.10	Query Subscription Info operation.....	88
7.10.10.1	Description.....	88
7.10.10.2	Input parameters.....	88
7.10.10.3	Output parameters.....	88
7.10.10.4	Operation results.....	89
8	Information element exchanged.....	89
8.1	Introduction.....	89
8.2	Information elements related to software images.....	89
8.2.1	Introduction.....	89
8.2.2	SoftwareImageInformation information element.....	89
8.2.2.1	Description.....	89
8.2.2.2	Attributes.....	89
8.3	Information elements and notifications related to Consumable Virtualised Resources Information.....	90
8.3.1	Introduction.....	90
8.3.2	InformationChangeNotification.....	90

8.3.2.1	Description	90
8.3.2.2	Trigger conditions	90
8.3.2.3	Attributes	90
8.3.3	Information elements related to Virtual Compute Resource Information	91
8.3.3.1	Introduction	91
8.3.3.2	VirtualComputeResourceInformation information element	91
8.3.3.2.1	Description	91
8.3.3.2.2	Attributes	91
8.3.3.3	VirtualCpuResourceInformation information element	91
8.3.3.3.1	Description	91
8.3.3.3.2	Attributes	91
8.3.3.4	VirtualMemoryResourceInformation information element	92
8.3.3.4.1	Description	92
8.3.3.4.2	Attributes	92
8.3.4	VirtualStorageResourceInformation information element	92
8.3.4.1	Description	92
8.3.4.2	Attributes	92
8.3.5	VirtualNetworkResourceInformation information element	93
8.3.5.1	Description	93
8.3.5.2	Attributes	93
8.4	Information elements and notifications related to Virtualised Resources	93
8.4.1	Introduction	93
8.4.2	Information elements related to Virtual Compute Flavour	93
8.4.2.1	Introduction	93
8.4.2.2	VirtualComputeFlavour information element	94
8.4.2.2.1	Description	94
8.4.2.2.2	Attributes	94
8.4.2.3	VirtualCpuData information element	94
8.4.2.3.1	Description	94
8.4.2.3.2	Attributes	94
8.4.2.4	VirtualCpuPinningData information element format	95
8.4.2.4.1	Description	95
8.4.2.4.2	Attributes	95
8.4.2.5	VirtualMemoryData information element format	95
8.4.2.5.1	Description	95
8.4.2.5.2	Attributes	96
8.4.2.6	VirtualNetworkInterfaceData information element	96
8.4.2.6.1	Description	96
8.4.2.6.2	Attributes	96
8.4.3	Information elements related to Virtual Compute	97
8.4.3.1	Introduction	97
8.4.3.2	VirtualCompute information element	97
8.4.3.2.1	Description	97
8.4.3.2.2	Attributes	97
8.4.3.3	VirtualCpu information element format	98
8.4.3.3.1	Description	98
8.4.3.3.2	Attributes	98
8.4.3.4	VirtualCpuPinning information element format	98
8.4.3.4.1	Description	98
8.4.3.4.2	Attributes	98
8.4.3.5	VirtualMemory information element format	99
8.4.3.5.1	Description	99
8.4.3.5.2	Attributes	99
8.4.3.6	VirtualNetworkInterface information element	99
8.4.3.6.1	Description	99
8.4.3.6.2	Attributes	99
8.4.3.7	VirtualInterfaceData information element	100
8.4.3.7.1	Description	100
8.4.3.7.2	Attributes	100
8.4.4	Information elements related to Virtual Network Data	100
8.4.4.1	Introduction	100
8.4.4.2	VirtualNetworkData information element format	101

8.4.4.2.1	Description	101
8.4.4.2.2	Attributes	101
8.4.4.3	NetworkQoS information element format	101
8.4.4.3.1	Description	101
8.4.4.3.2	Attributes	101
8.4.4.4	NetworkSubnetData information element	102
8.4.4.4.1	Description	102
8.4.4.4.2	Attributes	102
8.4.4.5	VirtualNetworkPortData information element	102
8.4.4.5.1	Description	102
8.4.4.5.2	Attributes	103
8.4.4.6	VirtualTrunkData information element	103
8.4.4.6.1	Description	103
8.4.4.6.2	Attributes	103
8.4.4.7	TrunkSubport information element format	103
8.4.4.7.1	Description	103
8.4.4.7.2	Attributes	104
8.4.4.8	UpdateTrunkData information element	104
8.4.4.8.1	Description	104
8.4.4.8.2	Attributes	104
8.4.5	Information elements related to Virtual Network	104
8.4.5.1	Introduction	104
8.4.5.2	VirtualNetwork information element	105
8.4.5.2.1	Description	105
8.4.5.2.2	Attributes	105
8.4.5.3	NetworkSubnet information element	106
8.4.5.3.1	Description	106
8.4.5.3.2	Attributes	106
8.4.5.4	VirtualNetworkPort information element	106
8.4.5.4.1	Description	106
8.4.5.4.2	Attributes	106
8.4.5.5	VirtualTrunk information element	107
8.4.6	Information elements related to Virtual Storage Flavour	108
8.4.6.1	Introduction	108
8.4.6.2	VirtualStorageFlavour information element	108
8.4.6.2.1	Description	108
8.4.6.2.2	Attributes	108
8.4.6.3	VirtualStorageData information element	108
8.4.6.3.1	Description	108
8.4.6.3.2	Attributes	108
8.4.7	Information elements related to Virtual Storage	108
8.4.7.1	Introduction	108
8.4.7.2	VirtualStorage information element	109
8.4.7.2.1	Description	109
8.4.7.2.2	Attributes	109
8.4.8	Information elements related to Affinity or AntiAffinity	109
8.4.8.1	Introduction	109
8.4.8.2	AffinityOrAntiAffinityConstraint information element	110
8.4.8.2.1	Description	110
8.4.8.2.2	Attributes	110
8.4.8.3	AffinityOrAntiAffinityResourceList information element	111
8.4.8.3.1	Description	111
8.4.8.3.2	Attributes	111
8.4.9	VirtualisedResourceChangeNotification	111
8.4.9.1	Description	111
8.4.9.2	Trigger conditions	111
8.4.9.3	Attributes	111
8.4.10	UserData information element	112
8.4.10.1	Description	112
8.4.10.2	Attributes	112
8.4.11	CertificateData information element	113
8.4.11.1	Description	113

8.4.11.2	Attributes.....	113
8.5	Information elements and notifications related to Virtualised Resources Performance Management	113
8.5.1	Introduction.....	113
8.5.2	ObjectSelection information element.....	113
8.5.2.1	Description	113
8.5.2.2	Attributes.....	113
8.5.3	PmJob information element	114
8.5.3.1	Description	114
8.5.3.2	Attributes.....	114
8.5.4	Threshold information element.....	115
8.5.4.1	Description	115
8.5.4.2	Attributes.....	115
8.5.5	PerformanceReport information element.....	116
8.5.5.1	Description	116
8.5.5.2	Attributes.....	116
8.5.6	PerformanceReportEntry information element.....	116
8.5.6.1	Description	116
8.5.6.2	Attributes.....	117
8.5.7	PerformanceValueEntry information element	117
8.5.7.1	Description	117
8.5.7.2	Attributes.....	117
8.5.8	PerformanceInformationAvailableNotification	117
8.5.8.1	Description	117
8.5.8.2	Trigger Conditions	118
8.5.8.3	Attributes.....	118
8.5.9	ThresholdCrossedNotification	118
8.5.9.1	Description	118
8.5.9.2	Trigger Condition.....	118
8.5.9.3	Attributes.....	118
8.6	Information elements and notifications related to Virtualised Resources Fault Management	119
8.6.1	Introduction.....	119
8.6.2	AlarmNotification.....	119
8.6.2.1	Description	119
8.6.2.2	Trigger conditions	119
8.6.2.3	Attributes.....	119
8.6.3	AlarmClearedNotification	119
8.6.3.1	Description	119
8.6.3.2	Trigger conditions	119
8.6.3.3	Attributes.....	119
8.6.4	Alarm information element.....	120
8.6.4.1	Description	120
8.6.4.2	Attributes.....	120
8.7	Information elements and notifications related to Reservation	121
8.7.1	Introduction.....	121
8.7.2	ReservedVirtualCompute information element	121
8.7.2.1	Description	121
8.7.2.2	Attributes.....	121
8.7.3	Information elements related to Compute Pool Reservation	122
8.7.3.1	Introduction.....	122
8.7.3.2	ReservedComputePool information element.....	122
8.7.3.2.1	Description	122
8.7.3.2.2	Attributes	122
8.7.3.3	ReservedVirtualComputeAttributes information element.....	123
8.7.3.3.1	Description	123
8.7.3.3.2	Attributes	123
8.7.4	Information elements related to Network reservation.....	123
8.7.4.1	Introduction.....	123
8.7.4.2	ReservedVirtualNetwork information element	123
8.7.4.2.1	Description	123
8.7.4.2.2	Attributes	123
8.7.4.3	ReservedVirtualNetworkAttributes information element	124
8.7.4.3.1	Description	124

8.7.4.3.2	Attributes	124
8.7.4.4	ReservedVirtualNetworkPort information element.....	125
8.7.4.4.1	Description	125
8.7.4.4.2	Attributes	125
8.7.4.5	ReservedPublicIpAddresses information element.....	125
8.7.4.5.1	Description	125
8.7.4.5.2	Attributes	125
8.7.5	Information elements related to Virtualisation Container Reservation.....	125
8.7.5.1	Introduction.....	125
8.7.5.2	ReservedVirtualisationContainer information element.....	125
8.7.5.2.1	Description	125
8.7.5.2.2	Attributes	126
8.7.6	Information elements related to Storage reservation	126
8.7.6.1	Introduction.....	126
8.7.6.2	ReservedVirtualStorage information element.....	126
8.7.6.2.1	Description	126
8.7.6.2.2	Attributes	126
8.7.6.3	ReservedStoragePool information element	127
8.7.6.3.1	Description	127
8.7.6.3.2	Attributes	127
8.7.7	VirtualisedResourceReservationChangeNotification	127
8.7.7.1	Description	127
8.7.7.2	Trigger conditions	127
8.7.7.3	Attributes.....	128
8.8	Information elements and notifications related to Quota.....	128
8.8.1	Introduction.....	128
8.8.2	Information elements related to Compute Quota.....	128
8.8.2.1	Introduction.....	128
8.8.2.2	VirtualComputeQuota information element.....	128
8.8.2.2.1	Description	128
8.8.2.2.2	Attributes	128
8.8.3	Information elements related to Network Quota.....	129
8.8.3.1	Introduction.....	129
8.8.3.2	VirtualNetworkQuota information element	129
8.8.3.2.1	Description	129
8.8.3.2.2	Attributes	129
8.8.4	Information elements related to Storage Quota	129
8.8.4.1	Introduction.....	129
8.8.4.2	VirtualStorageQuota information element	129
8.8.4.2.1	Description	129
8.8.4.2.2	Attributes	129
8.8.5	VirtualisedResourceQuotaChangeNotification.....	130
8.8.5.1	Description	130
8.8.5.2	Trigger conditions	130
8.8.5.3	Attributes.....	130
8.9	Information elements and notifications related to Policy Management	130
8.9.1	Introduction.....	130
8.9.2	Information elements related to Policy Management Operations	131
8.9.2.1	Introduction.....	131
8.9.2.2	PolicyInfo information element	131
8.9.2.2.1	Description	131
8.9.2.2.2	Attributes	131
8.9.3	PolicyChangeNotification.....	131
8.9.3.1	Description	131
8.9.3.2	Trigger Conditions	131
8.9.3.3	Attributes.....	131
8.9.4	PolicyConflictNotification.....	131
8.9.4.1	Description	131
8.9.4.2	Trigger Conditions	131
8.9.4.3	Attributes.....	131

Annex A (informative):	Bibliography.....	132
-------------------------------	--------------------------	------------

Annex B (normative):	NFVI operation and maintenance policies	133
Annex C (informative):	Change history	134
History		136

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<https://ipr.etsi.org/>).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

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

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document specifies the interfaces supported over the Vi-Vnfm reference point of the NFV-MANO architectural framework ETSI GS NFV 006 [i.2] as well as the information elements exchanged over those interfaces.

2 References

2.1 Normative references

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

Referenced documents which are not found to be publicly available in the expected location might be found at <https://docbox.etsi.org/Reference>.

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

The following referenced documents are necessary for the application of the present document.

- [1] [Recommendation ITU-T X.733](#): "Information technology - Open Systems Interconnection - Systems Management: Alarm reporting function".
- [2] [ETSI GS NFV-IFA 027](#): "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Performance Measurements Specification".
- [3] [ETSI GS NFV-IFA 048](#): "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Policy Information Model Specification".

2.2 Informative references

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

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

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

- [i.1] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".
- [i.2] ETSI GS NFV 006: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Architectural Framework Specification".
- [i.3] ISO/IEC 9646-7: "Information technology -- Open Systems Interconnection - Conformance testing methodology and framework -- Part 7: Implementation Conformance Statements".
- [i.4] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".
- [i.5] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".
- [i.6] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

- [i.7] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Functional requirements specification".
- [i.8] Recommendation ITU-T Y.3500: "Information technology - Cloud computing - Overview and vocabulary".
- [i.9] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

NOTE: A term defined in the present document takes precedence over the definition of the same term, if any, in ETSI GR NFV 003 [i.1].

infrastructure resource group: logical resource collection grouping virtual resource instances assigned to a tenant along with Software Images

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: one or more NFV MANO service users sharing access to a set of physical, virtual or service resources

NOTE 1: This definition has been specialized from the term "tenant" as defined in Recommendation ITU-T Y.3500 [i.8].

NOTE 2: The "tenant" concept in NFV should not be confused with the "tenant" (a.k.a "project") concept in OpenStack®. The OpenStack® implementation covers a subset of the overall functionalities required by multi-tenancy in NFV.

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

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

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

3.2 Symbols

Void.

3.3 Abbreviations

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

CMF Certificate Management Function

4 Overview of interfaces and information models associated to the Vi-Vnfm reference point

4.1 Introduction

This clause provides an overview of the interfaces and information element associated with the Vi-Vnfm reference point.

The Vi-Vnfm reference point is used for exchange of information elements between the Virtualised Infrastructure Manager (VIM) and VNF Manager (VNFM), and the following are the interfaces supported by this reference point:

- 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 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 Resources 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.
- Policy Management.

All of the above interfaces are produced by the VIM and consumed by the VNFM. At present no interfaces are produced by the VNFM.

The information elements exchanged by the above interfaces 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:

- Or-Vi Reference Point - Interface and Information Model Specification [i.4]:
 - ETSI GS NFV-IFA 005 [i.4] implements the software image management interface and the interfaces for the management of virtualised resources, their information, performance and failure on the Or-Vi reference point.
- Or-Vnfm Reference Point - Interface and Information Model Specification [i.5]:
 - ETSI GS NFV-IFA 007 [i.5] implements the virtualised resource management interface on the Or-Vnfm reference point.
- Ve-Vnfm Reference Point - Interface and Information Model Specification [i.6]:
 - ETSI GS NFV-IFA 008 [i.6] implements the virtualised resource performance/fault management on the Ve-Vnfm reference point.
- Management and Orchestration; Functional Requirements Specification [i.7]:
 - Interfaces associated with the Vi-Vnfm reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [i.7] for the VIM and VNFM functional blocks.

4.3 Conventions

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

- M mandatory - the capability is required to be supported.
- O optional - the capability may be supported or not.
- N/A not applicable - in the given context, it is impossible to use the capability.
- CM conditional mandatory - the capability is required to be supported and is conditional on the support of some condition. This condition shall be specified in the Description column.
- CO conditional optional - the capability may be supported or not and is conditional on the support of some condition. This condition shall be specified in the Description column.

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

5 Reference point and interface requirements

5.1 Introduction

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

5.2 Vi-Vnfm Reference Point Requirements

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

Table 5.2-1: Vi-Vnfm reference point requirements

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

5.3 Interface Requirements

5.3.1 Software Image Management interface requirements

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

Table 5.3.1-1: Software Image Management interface requirements

Numbering	Functional requirements description
Vi-Vnfm.Sim.001	The Software Image Management interface produced by the VIM on the reference point Vi-Vnfm shall support querying information of software image(s) 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 Vi-Vnfm reference point.

Table 5.3.2-1: Virtualised Resources Information Management interface requirements

Numbering	Functional requirements description
Vi-Vnfm.Vrim.001	The Virtualised Resources Information Management interface produced by the VIM on the Vi-Vnfm reference point shall support querying information regarding consumable virtualised resources that can be provided by the VIM.
Vi-Vnfm.Vrim.002	The Virtualised Resources Information Management interface produced by the VIM on the Vi-Vnfm 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 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 5.3.3-1 specifies requirements applicable to the Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point.

It shall be possible to use virtualised resource descriptors to convey the exchange of information associated to interface operations fulfilled by the requirements in table 5.3.3-1.

Table 5.3.3-1: Virtualised Resources Management interface requirements

Numbering	Functional requirement description
Vi-Vnfm.Vrm.01	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support requesting the allocation of virtualised resources.
Vi-Vnfm.Vrm.02	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support querying information about instantiated virtualised resources.
Vi-Vnfm.Vrm.03	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support updating instantiated virtualised resources (see example).
Vi-Vnfm.Vrm.04	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support terminating instantiated virtualised resources.
Vi-Vnfm.Vrm.05	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support operating instantiated virtualised resources (see note).
Vi-Vnfm.Vrm.06	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support scaling instantiated virtualised resources (see note).
Vi-Vnfm.Vrm.07	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support migrating instantiated virtualised resources (see note).
Vi-Vnfm.Vrm.08	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support attaching instantiated virtualised storage resources to instantiated virtualised compute resources.

Numbering	Functional requirement description
Vi-Vnfm.Vrm.09	The Virtualised Resources Management interface produced by the VIM on the Vi-Vnfm reference point shall support detaching instantiated virtualised storage resources from instantiated virtualised compute resources.
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.	

5.3.4 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 5.3.4-1 specifies requirements applicable to the Virtualised Resources Reservation Management interface produced by the VIM on the Vi-Vnfm reference point.

Table 5.3.4-1: Virtualised Resources Reservation Management interface requirements

Numbering	Functional requirement description
Vi-Vnfm.Vrrm.001	The Virtualised Resources Reservation Management interface produced by the VIM on the Vi-Vnfm reference point shall support querying information about resource reservations that the VNFM has access to.
Vi-Vnfm.Vrrm.002	The Virtualised Resources Reservation Management interface produced by the VIM on the Vi-Vnfm reference point shall support the explicit identification of a reservation.
Vi-Vnfm.Vrrm.003	The Virtualised Resources Reservation Management interface produced by the VIM on the Vi-Vnfm reference point shall support the implicit identification of a reservation.
NOTE: An implicit identification identifies a reservation, for example, by using an associated identifier of the consumer or tenant that uses such reservation.	

5.3.5 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 5.3.5-1 specifies requirements applicable to the Virtualised Resources Change Notification interface produced by the VIM on the Vi-Vnfm reference point.

Table 5.3.5-1: Virtualised Resources Change Notification interface requirements

Numbering	Functional requirement
Vi-Vnfm.Vrcn.01	The Virtualised Resources Change Notification interface produced by the VIM on the Vi-Vnfm 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.

5.3.6 Virtualised Resources Reservation Change Notification interface requirements

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

Table 5.3.6-1: Virtualised Resources Reservation Change Notification interface requirements

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

5.3.7 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 quotas.

Table 5.3.7-1 specifies requirements applicable to the Virtualised Resources Quota Management interface produced by the VIM on the Vi-Vnfm reference point.

Table 5.3.7-1: Virtualised Resources Quota Management interface requirements

Numbering	Functional requirements description
Vi-Vnfm.Vrqm.001	The Virtualised Resources Quota Management interface produced by the VIM on the Vi-Vnfm reference point shall support querying information about resource quotas.
Vi-Vnfm.Vrqm.002	The Virtualised Resources Quota Management interface produced by the VIM on the Vi-Vnfm reference point shall support identifying the consumer (e.g. tenant) of the virtualised resources which the quota is applied to.

5.3.8 Virtualised Resources Performance Management interface requirements

Table 5.3.8-1 specifies requirements applicable to the Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point.

Table 5.3.8-1: Virtualised Resources Reservation Performance Management interface requirements

Numbering	Functional requirements description
Vi-Vnfm.Vrpm.001	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall enable the VNFMs to control the collection and reporting of performance information for virtualised resources.
Vi-Vnfm.Vrpm.002	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall support the capability to notify about the availability of performance information.
Vi-Vnfm.Vrpm.003	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall expose the type of virtualised resource (e.g. compute, storage, network), for which the VIM collects the performance information in the NFVI domain.
Vi-Vnfm.Vrpm.004	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall expose the type of performance information that the VIM can collect for the monitored virtualised resource(s).
Vi-Vnfm.Vrpm.005	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall enable the VNFMs to create a PM job specifying the type of resource(s) and performance information that the VNFMs requires.
Vi-Vnfm.Vrpm.006	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall enable the VNFMs to create a PM job specifying the granularity for collection and reporting of performance information from specified virtualised resource(s).
Vi-Vnfm.Vrpm.007	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall enable the VNFMs to delete a PM job.
Vi-Vnfm.Vrpm.008	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall enable the VNFMs to receive notifications of data availability for a PM job.
Vi-Vnfm.Vrpm.009	The Virtualised Resources Performance Management interface produced by the VIM shall support PM jobs for periodic collection of performance information (bounded or unbounded).
Vi-Vnfm.Vrpm.010	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall support the grouping of measurements (see note).
Vi-Vnfm.Vrpm.011	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall support setting threshold conditions on the performance information collected by the VIM for specified virtualised resource(s).
Vi-Vnfm.Vrpm.012	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall support the deletion of threshold conditions on the performance information collected by the VIM for specified virtualised resource(s).
Vi-Vnfm.Vrpm.013	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall support the capability to notify about a threshold defined for a specified metric for a virtualised resource being crossed.

Numbering	Functional requirements description
Vi-Vnfm.Vrpm.014	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall enable the VNFM to receive notifications related to threshold crossing.
Vi-Vnfm.Vrpm.015	The Virtualised Resources Performance Management interface produced by the VIM on the Vi-Vnfm reference point shall support querying the 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 e.g. by device type, by port type, by virtual machine, etc.

5.3.9 Virtualised Resources Fault Management interface requirements

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

Table 5.3.9-1: Virtualised Resources Reservation Fault Management interface requirements

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

5.3.10 Policy Management interface requirements

Table 5.3.10-1 specifies requirements applicable to the policy management interface produced by the VIM on the Vi-Vnfm reference point.

Table 5.3.10-1: Policy management interface requirements

Numbering	Requirements description
Vi-Vnfm.Plcm.001	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support transferring NFV-MANO policies. See notes 1 and 2.
Vi-Vnfm.Plcm.002	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support deleting NFV-MANO policies. See note 1.
Vi-Vnfm.Plcm.003	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support querying NFV-MANO policies. See note 1.
Vi-Vnfm.Plcm.004	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support activating NFV-MANO policies. See note 1.
Vi-Vnfm.Plcm.005	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support deactivating NFV-MANO policies. See note 1.
Vi-Vnfm.Plcm.006	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support providing to the VNFM notifications about changes of a policy that are related to operations of transferring policy, deleting policy, activating policy and deactivating policy.

Numbering	Requirements description
Vi-Vnfm.Plcm.007	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support providing to the VNFM notifications about any detected policy conflicts.
Vi-Vnfm.Plcm.00x8	The Policy Management interface produced by the VIM on the Vi-Vnfm reference point shall support subscribing to policy management related notifications.
NOTE 1: For this reference point, NFV-MANO policies include policies applied in virtualised resource management (resource allocation).The virtualised resource is used by the VNF(s) which the VNFM manages.	
NOTE 2: The case of transferring NFV-MANO policy applies when: <ul style="list-style-type: none"> - a new policy is imported from the VNFM, which results in the creation of a new policy locally, or - the changes for an existing policy are imported from the VNFM, which results in the update of a policy locally. 	

6 VNFM exposed interfaces

There are no interfaces exposed by the VNFM associated to the Vi-Vnfm reference point.

7 VIM exposed interfaces

7.1 Introduction

This clause defines the interfaces exposed by the VIM towards the VNFM over the Vi-Vnfm 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 parameter of the operations. Refer to interface operations:

- Allocate virtualised compute, network and storage resource operations (clauses 7.3.1.2, 7.4.1.2 and 7.5.1.2).
- Virtualised Resource Quota related information elements (clauses 8.8.2.2, 8.8.3.2 and 8.8.4.2).

7.2 Software Image Management Interface

7.2.1 Description

This interface allows the VNFM to query the VIM for software images.

NOTE 1: This interface addresses software images at virtualisation container level, e.g. VM images.

NOTE 2: 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 VNF lifecycle.

NOTE 3: The Query Images operation applicable on multiple images is assumed to be best effort.

7.2.2 Query Images operation

7.2.2.1 Description

This operation allows querying the information of 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 be able to choose the appropriate kind and version of image for creating new Virtualisation Container instances.

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

Table 7.2.2.1-1: Query Images operation

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

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: Query Images operation input parameters

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

7.2.2.3 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: Query Images operation output parameters

Information element	Qualifier	Cardinality	Content	Description
softwareImageInformation	M	0..N	SoftwareImageInformation	Information of all software images matching the query. See clause 8.2.

7.2.2.4 Operation results

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

7.2.3 Query Image operation

7.2.3.1 Description

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

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

Table 7.2.3.1-1: Query Image operation

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

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 Image operation input parameters

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

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 Image operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
softwareImageInformation	M	0..1	SoftwareImageInformation	Information of the software image matching the query. See clause 8.2.

7.2.3.4 Operation results

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

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 VIM and the VNFM.

Table 7.3.1.2.1-1: Allocate Virtualised Compute Resource operation

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

7.3.1.2.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
computeName	M	0..1	String	Name provided by the consumer for the virtualised compute resource to be allocated. It can be used for identifying resources from consumer side.
reservationId	M	0..1	Identifier	Identifier of the resource reservation applicable to this virtualised resource management operation.
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to be allocated. All the listed constraints shall be fulfilled for a successful operation.
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour, that is providing information about the particular memory, CPU and disk resources for virtualised compute resource to be allocated. The Compute Flavour is created with Create Compute Flavour operation (clause 7.3.4.2). For the content of Compute Flavour see clause 8.4.2.2.
vclmageld	M	0..1	Identifier	Identifier of the virtualisation container software image (e.g. a virtual machine image). Cardinality can be 0 if an "empty" virtualisation container is allocated.
interfaceData	M	0..N	VirtualInterfaceData	Data of network interfaces which are specific to a Virtual Compute Resource instance. See clause 8.4.3.7.
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	0..1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain. Cardinality can be 0 if the consumer credentials are implicitly associated to a specific resource group.
locationConstraints	M	0..1	Not specified	If present, it defines location constraints for the resource(s) is (are) requested to be allocated, e.g. in what particular resource zone.
userData	M	0..1	UserData	Contains user data to customize the virtualised compute resource at boot-time. See note.

Parameter	Qualifier	Cardinality	Content	Description
NOTE:				The user data may consist of static data obtained from an attribute in the VNFD, 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, and/or one or multiple certificate data obtained from CMF when delegation-mode is used. 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, install certificates, etc.

7.3.1.2.3 Output parameters

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

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

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

7.3.1.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the virtualised compute resource and allocated this resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.3.1.3.1-1: Query Virtualised Compute Resource operation

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

7.3.1.3.2 Input parameters

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

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

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

7.3.1.3.3 Output parameters

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

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

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

7.3.1.3.4 Operation results

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

Table 7.3.1.4.1-1: Update Virtualised Compute Resource operation

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

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	New virtual network interface(s) to be added to the compute resource. See note. See clause 8.4.2.6.
networkInterfaceUpdate	M	0..N	VirtualNetworkInterface	Virtual network interface(s) to be updated on the compute resource. This can include, for instance, attaching/detaching a virtual network interface to/from its port, or re-attaching to another network port. See note. 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: Allocate Virtualised Compute Resource operation output parameters

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

7.3.1.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.3.1.5.1-1: Terminate Virtualised Compute Resource operation

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

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 VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.3.1.6.1-1: Operate Virtualised Compute Resource operation

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

7.3.1.6.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to operate.
computeOperation	M	1	String	Type of operation to be performed on the virtualised compute resource. Possible values are: <ul style="list-style-type: none"> • "start" • "stop" • "pause" • "suspend" • "reboot" • "quiesce" • "unquiesce" • "create snapshot" • "revert to snapshot" • "delete snapshot"
computeOperationInputData	M	0..N	KeyValuePair	Additional parameters associated to the operation to be performed. For example, if the operation is "delete snapshot", information identifying the snapshot to be deleted is provided.

7.3.1.6.3 Output parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
computeData	M	1	VirtualCompute	Contains 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 VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.3.1.7.1-1: Scale Virtualised Compute Resource operation

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

7.3.1.7.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to be scaled.
computeFlavourId	M	1	Identifier	Identifier of the Compute Flavour that is providing information about the particular memory, CPU and disk resources for virtualised compute resource to be allocated. The Compute Flavour should be created with Create Compute Flavour operation (clause 7.3.4.2). For the content of Compute Flavour see clause 8.4.2.2.

7.3.1.7.3 Output parameters

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

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

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

7.3.1.7.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource and has scaled this resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.3.1.8.1-1: Migrate Virtualised Compute Resource operation

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

7.3.1.8.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource to be migrated.
migrationConstraint	M	0..1	Not specified	When present, the migration constraint parameter gives indications on where to migrate the resource, e.g. to a specific resource zone.
affinityOrAntiAffinityConstraints	CM	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised compute resource to be migrated. All the listed constraints shall be fulfilled for a successful operation. This information is only necessary if the VIM needs to maintain affinity during the migration operation based on a list of resources.
migrationType	M	1	Enum	Defines the type of migration. VALUES: <ul style="list-style-type: none"> • LIVE_MIGRATION • OFFLINE_MIGRATION

7.3.1.8.3 Output parameters

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

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

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

7.3.1.8.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised compute resource and has migrated this resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VNFM, if the VNFM supports named resource groups for affinity/anti-affinity (see clause 8.4.8.1).

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

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

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

7.3.1.9.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
groupName	M	1	String	Name of the group, given by the consumer.
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group. VALUES: <ul style="list-style-type: none"> • AFFINITY • ANTI_AFFINITY
scope	M	0..1	Enum	Qualifies the scope of the constraint. VALUES: <ul style="list-style-type: none"> • NFVI_NODE • etc. Defaults to "NFVI_NODE" if absent.

7.3.1.9.3 Output parameters

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

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

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

7.3.1.9.4 Operation results

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

7.3.1.10 Attach Virtualised Storage Resource operation

7.3.1.10.1 Description

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

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

Table 7.3.1.10.1-1: Attach Virtualised Storage Resource operation

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

7.3.1.10.2 Input parameters

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

Table 7.3.1.10.2-1: Attach Virtualised Storage Resource input parameters

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

7.3.1.10.3 Output parameters

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

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

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

7.3.1.10.4 Operation results

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

7.3.1.11 Detach Virtualised Storage Resource operation

7.3.1.11.1 Description

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

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

Table 7.3.1.11.1-1: Detach Virtualised Storage Resource operation

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

7.3.1.11.2 Input parameters

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

Table 7.3.1.11.2-1: Detach Virtualised Storage Resource input parameters

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

7.3.1.11.3 Output parameters

No output parameter.

7.3.1.11.4 Operation results

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

7.3.2 Virtualised Compute Resources Change Notification Interface

7.3.2.1 Description

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

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

Table 7.3.2.2.1-1: Subscribe operation

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

7.3.2.2.2 Input parameters

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

Table 7.3.2.2.2-1: Subscribe operation input parameters

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

7.3.2.2.3 Output parameters

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

Table 7.3.2.2.3-1: Subscribe operation output parameters

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

7.3.2.2.4 Operation results

After successful subscription, the VNFM is registered to receive notifications related to compute resource changes on 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 VNFM.

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 (VNFM).

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

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

Table 7.3.2.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 parameters 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 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 VNFM to subscribe for the notifications related to information changes about consumable virtualised compute resources. This also enables the VNFM 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 VIM and the VNFM.

Table 7.3.3.2.1-1: Subscribe operation

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

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 VNFM 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 VNFM.

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 (VNFM).

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

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

Table 7.3.3.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 VIM and the VNFM.

Table 7.3.3.4.1-1: Query Virtualised Compute Resource Information operation

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

7.3.3.4.2 Input parameters

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

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

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

7.3.3.4.3 Output parameters

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

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

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

7.3.3.4.4 Operation results

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

7.3.4 Virtualised Compute Flavour Management Interface

7.3.4.1 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.

7.3.4.2 Create Compute Flavour operation

7.3.4.2.1 Description

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

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

Table 7.3.4.2.1-1: Create Compute Flavour operation

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

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: Create Compute Flavour operation input parameters

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

7.3.4.2.3 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: Create Compute Flavour operation output parameters

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

7.3.4.2.4 Operation results

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

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

7.3.4.3 Query Compute Flavour operation

7.3.4.3.1 Description

This operation allows querying information about created Compute Flavours.

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

Table 7.3.4.3.1-1: Query Compute Flavour operation

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

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: 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.

7.3.4.3.3 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: Query Compute Flavour operation output parameters

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

7.3.4.3.4 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 VNFM has access to and that are matching the filter shall be returned.

7.3.4.4 Delete Compute Flavour operation

7.3.4.4.1 Description

This operation allows deleting a Compute Flavour.

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

Table 7.3.4.4.1-1: Delete Compute Flavour operation

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

7.3.4.4.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in table 7.3.4.4.2-1.

Table 7.3.4.4.2-1: Delete Compute Flavour operation input parameters

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

7.3.4.4.3 Output parameters

No output parameters.

7.3.4.4.4 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 VNFM 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 requesting 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 VIM and the VNFM.

Table 7.4.1.2.1-1: Allocate Virtualised Network Resource operation

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

7.4.1.2.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
networkResourceName	M	0..1	String	Name provided by the consumer for the virtualised network resource to be allocated. It can be used for identifying resources from consumer side.
reservationId	M	0..1	Identifier	Identifier of the resource reservation applicable to this virtualised resource management operation.
networkResourceType	M	0..1	Enum	Type of virtualised network resource. VALUES: <ul style="list-style-type: none"> • NETWORK • SUBNET • NETWORK_PORT • TRUNK
typeNetworkData	M	0..1	VirtualNetworkData	Provides information about the particular virtual network resource to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.2.
typeSubnetData	M	0..1	NetworkSubnetData	Provides information about the particular sub-network resource to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.4.
typeNetworkPortData	M	0..1	VirtualNetworkPortData	Provides information about the particular network port to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.5.
typeTrunkData	M	0..1	VirtualTrunkData	Provides information about the particular trunk to be created. Cardinality can be "0" depending on the value of networkResourceType. See clause 8.4.4.6.
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised network resource to be allocated. All the listed constraints shall be fulfilled for a successful operation.
locationConstraints	M	0..1	Not specified	If present, it defines location constraints for the resource(s) to be allocated, e.g. in what particular resource zone.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
resourceGroupId	M	0..1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain. Cardinality can be 0 if the consumer credentials are implicitly associated to a specific resource group.

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.
trunkData	M	0..1	VirtualTrunk	If trunk types are created satisfactorily, it contains the data relative to the allocated trunk. Cardinality can be "0" if the request did not include creation of such type of resource. See clause 8.4.5.5.

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 VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.4.1.3.1-1: Query Virtualised Network Resource operation

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

7.4.1.3.2 Input parameters

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

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

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

7.4.1.3.3 Output parameters

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

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

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

7.4.1.3.4 Operation results

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

Table 7.4.1.4.1-1: Update Virtualised Network Resource operation

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

7.4.1.4.2 Input parameters

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

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

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

7.4.1.4.3 Output parameters

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

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

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

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 VNFM 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 VNFM 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 an 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 VIM and the VNFM.

Table 7.4.1.5.1-1: Terminate Virtualised Network Resource operation

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

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.

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.

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 VNFM information on the terminated virtualised network resource plus any additional information about the terminate request operation.

If the operation was not successful, the VIM shall return to the VNFM 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 VNFM, if the VNFM supports named resource groups for affinity/anti-affinity (see clause 8.4.8.1).

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

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

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

7.4.1.6.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
groupName	M	1	String	Name of the group, given by the consumer.
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity group. VALUES: <ul style="list-style-type: none"> • AFFINITY • ANTI_AFFINITY
scope	M	0..1	Enum	Qualifies the scope of the constraint. VALUES: <ul style="list-style-type: none"> • NFVI_NODE • NIC • etc. Defaults to "NFVI_NODE" if absent.

7.4.1.6.3 Output parameters

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

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

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

7.4.1.6.4 Operation results

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

7.4.2 Virtualised Network Resources Change Notification Interface

7.4.2.1 Description

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 VNFM to subscribe with a filter for the notifications related to virtualised network resource changes on virtualised resources sent by the VIM. Specification of filtering mechanism is part of the protocol design.

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

Table 7.4.2.2.1-1: Subscribe operation

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

7.4.2.2.2 Input parameters

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

Table 7.4.2.2.2-1: Subscribe operation input parameters

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

7.4.2.2.3 Output parameters

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

Table 7.4.2.2.3-1: Subscribe operation output parameters

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

7.4.2.2.4 Operation results

After successful subscription, the VNFM is registered to receive notifications related to network resource changes on 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 VNFM.

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 (VNFM).

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

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

Table 7.4.2.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 VIM.

The parameters 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 following operations are defined for this interface:

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

7.4.3.2 Subscribe operation

7.4.3.2.1 Description

This operation enables the VNFMs to subscribe for the notifications related to information changes about consumable virtualised network resources. This also enables the VNFM 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 VIM and the VNFM.

Table 7.4.3.2.1-1: Subscribe operation

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

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 VNFM 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 VNFM.

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 (VNFM).

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

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

Table 7.4.3.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 VIM and the VNFM.

Table 7.4.3.4.1-1: Query Virtualised Network Resource Information operation

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

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 resources 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.

7.5 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 storage 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 VIM and the VNFM.

Table 7.5.1.2.1-1: Allocate Virtualised Storage Resource operation

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

7.5.1.2.2 Input parameters

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

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

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

Parameter	Qualifier	Cardinality	Content	Description
affinityOrAntiAffinityConstraints	M	0..N	AffinityOrAntiAffinityConstraint	List of elements with affinity or anti affinity (see clause 8.4.8.2) information of the virtualised storage resource to be allocated. All the listed constraints shall be fulfilled for a successful operation.
storageData	M	1	VirtualStorageFlavour	Provides information about the type and size of the storage. See clause 8.4.6.2.
locationConstraints	M	0..1	Not specified	If present, it defines location constraints for the resource(s) to be allocated, e.g. in what particular resource zone.
metaData	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
resourceGroupId	M	0..1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain. Cardinality can be 0 if the consumer credentials are implicitly associated to a specific resource group.

7.5.1.2.3 Output parameters

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

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

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

7.5.1.2.4 Operation results

After successful operation, the VIM has created the internal management objects for the virtualised storage resource and allocated this resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.5.1.3.1-1: Query Virtualised Storage Resource operation

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

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

7.5.1.3.3 Output parameters

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

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

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

7.5.1.3.4 Operation results

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

Table 7.5.1.4.1-1: Update Virtualised Storage Resource operation

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

7.5.1.4.2 Input parameters

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

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

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

7.5.1.4.3 Output parameters

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

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

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

7.5.1.4.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.5.1.5.1-1: Terminate Virtualised Storage Resource operation

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

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.

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: Terminate 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.

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 VNFM information on the terminated virtualised storage resource plus any additional information about the terminate request operation.

If the operation was not successful, the VIM shall return to the VNFM 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 VIM and the VNFM.

Table 7.5.1.6.1-1: Operate Virtualised Storage Resource operation

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

7.5.1.6.2 Input parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource to be operated.
storageOperation	M	1	String	Type of operation to perform on the virtualised storage resource. Possible values include: "create snapshot", "revert to snapshot", and "delete snapshot".
storageOperationInputData	M	0..N	KeyValue Pair	Additional parameters associated to the operation to perform. For example, if the operation is "delete snapshot", information identifying the snapshot to be deleted 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	Contains information on the new status of the operated virtualised storage resource. See clause 8.4.7.2.
storageOperationOutputData	M	0..N	KeyValue Pair	Set of output values depending on the type of operation. For instance, when a snapshot operation is requested, this field provides information about the identifier of the snapshot.

7.5.1.6.4 Operation results

After successful operation, the VIM has executed the requested operation command on the virtualised storage resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.5.1.7.1-1: Scale Virtualised Storage Resource operation

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

7.5.1.7.2 Input parameters

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

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

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

7.5.1.7.3 Output parameters

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

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

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

7.5.1.7.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource and has scaled this resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VIM and the VNFM.

Table 7.5.1.8.1-1: Migrate Virtualised Storage Resource operation

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

7.5.1.8.2 Input parameters

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

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

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

7.5.1.8.3 Output parameters

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

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

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

7.5.1.8.4 Operation results

After successful operation, the VIM has updated the internal management objects for the virtualised storage resource and has migrated this resource. In addition, the VIM shall return to the VNFM 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 VNFM 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 VNFM, if the VNFM supports named resource groups for affinity/anti-affinity (see clause 8.4.8.1).

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

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

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

7.5.1.9.2 Input parameters

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

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

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

7.5.1.9.3 Output parameters

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

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

Parameter	Qualifier	Cardinality	Content	Description
groupid	M	1	Identifier	Identifier of the group.

7.5.1.9.4 Operation results

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

7.5.2 Virtualised Storage Resources Change Notification Interface

7.5.2.1 Description

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 VNFM to subscribe with a filter for the notifications related to virtualised storage resource changes on virtualised resources sent by the VIM. Specification of filtering mechanism is part of the protocol design.

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

Table 7.5.2.2.1-1: Subscribe operation

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

7.5.2.2.2 Input parameters

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

Table 7.5.2.2.2-1: Subscribe operation input parameters

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

7.5.2.2.3 Output parameters

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

Table 7.5.2.2.3-1: Subscribe operation output parameters

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

7.5.2.2.4 Operation results

After successful subscription, the VNFM is registered to receive notifications related to storage resource changes on 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 VNFM.

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 (VNFM).

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

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

Table 7.5.2.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 parameters 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 following operations are defined for this interface:

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

7.5.3.2 Subscribe operation

7.5.3.2.1 Description

This operation enables the VNFMs to subscribe for the notifications related to information changes about consumable virtualised storage resources. This also enables the VNFM 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 VIM and the VNFM.

Table 7.5.3.2.1-1: Subscribe operation

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

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 VNFM 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 VNFM.

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 (VNFM).

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

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

Table 7.5.3.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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

- InformationChangeNotification. See clause 8.3.2.

7.5.3.4 Query Virtualised Storage Resources 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 VIM and the VNFM.

Table 7.5.3.4.1-1: Query Virtualised Storage Resources Information operation

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

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 Resources 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 Resources 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.

7.6 Virtualised Resources 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 should 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:

- 1) Subscribe operation (Subscription of VNFMs with the VIM for the notifications related to the alarms resulting from the Faults).
- 2) Notify operation (Notifications of alarms or alarm state change from VIM to VNFM).
- 3) Get alarm list operation (Accessing active alarms from the VIM).

7.6.2 Subscribe operation

7.6.2.1 Description

This operation enables the VNFMs to subscribe for the notifications related to the alarms and their state changes resulting from the virtualised resources faults with the VIM. This also enables the VNFM 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 VIM and the VNFM.

Table 7.6.2.1-1: Subscribe operation

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

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 (VNFM) 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 (VNFM).

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

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

Table 7.6.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 VNFM to query the active alarms from the VIM.

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

Table 7.6.4.1-1: Get Alarm List operation

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

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 IDs, 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 resourceId, 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 indicates 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 VNFM.

7.7 Virtualised Resources Performance Management Interface

7.7.1 Description

This interface allows providing performance management (measurement results collection and notifications) related to virtualised resources including (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 right 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 8.5.8). The details of the performance measurements are provided using the PerformanceReport information element (see clause 8.5.5). 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 VNFM:

- 1) Create PM Job operation.
- 2) Delete PM Jobs operation.
- 3) Query PM Job operation.
- 4) Subscribe operation.
- 5) Notify operation.
- 6) Create Threshold operation.
- 7) Delete Thresholds operation.
- 8) Query Threshold operation.

7.7.2 Create PM Job operation

7.7.2.1 Description

This operation will create a PM job, enabling a VNFM 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 VNFM to specify its performance information requirements with the VIM.

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

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

Table 7.7.2.1-1: Create PM Job operation

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

7.7.2.2 Input parameters

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	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	Not specified	Specifies the periodicity at which the VIM will collect performance information. See note.

Parameter	Qualifier	Cardinality	Content	Description
reportingPeriod	M	1	Not specified	Specifies the periodicity at which the VIM will report to the VNFM about performance information. See note.
reportingBoundary	O	0..1	Not specified	Specifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE: At the end of each reportingPeriod, the VIM will inform VNFM about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reportingPeriod is part of the protocol design, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

7.7.2.3 Output parameters

The 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 (VNFM) 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 VNFM 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 VIM and the VNFM.

Table 7.7.3.1-1: Query PM Job operation

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

7.7.3.2 Input parameters

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

Table 7.7.3.2-1: Query PM Job operation input parameters

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

7.7.3.3 Output parameters

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

Table 7.7.3.3-1: Query PM Job operation output parameters

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

7.7.3.4 Operation results

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

7.7.4 Delete PM Jobs operation

7.7.4.1 Description

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

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

Table 7.7.4.1-1: Delete PM Jobs operation

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

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 Jobs operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobId	M	1..N	Identifier	Identifiers of the PM jobs to be deleted.

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 Jobs operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedPmJobId	M	1..N	Identifier	Identifiers of the PM jobs successfully deleted.

7.7.4.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (VNFM) 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 VNFM to subscribe for the notifications related to performance information with the VIM. This also enables the VNFM to specify the scope of the subscription in terms of the specific virtual resources to be reported by the VIM using a filter as the input.

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

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

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

Table 7.7.5.1-1: Subscribe operation

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

7.7.5.2 Input parameters

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

Table 7.7.5.2-1: Subscribe operation input parameters

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

7.7.5.3 Output parameters

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

Table 7.7.5.3-1: Subscribe operation output parameters

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

7.7.5.4 Operation results

After successful subscription, the VNFM 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 VNFM.

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 (VNFM).

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

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

Table 7.7.6.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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 VNFM 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 VIM and the VNFM.

Table 7.7.7.1-1: Create Threshold operation

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

7.7.7.2 Input parameters

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

Table 7.7.7.2-1: Create Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
resourceSelector	M	1..N	ObjectSelection	Defines the resources for which the threshold is to be defined. See clause 8.5.2.
performanceMetric	M	1	String	Defines the performance metric on which the threshold is to be defined.
thresholdType	M	1	Enum	Defines the type of threshold. The list of possible values is part of the protocol design and might include: single/multi valued threshold, static/dynamic threshold, template based threshold. VALUES: <ul style="list-style-type: none"> • SIMPLE: Single-valued static threshold • etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, and direction in which it is crossed, details on the notification to be generated.

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 (VNFM) whether or not the threshold was successfully created.

7.7.8 Query Threshold operation

7.7.8.1 Description

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

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

Table 7.7.8.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	VNFM → VIM
QueryThresholdResponse	Mandatory	VIM → VNFM

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
thresholdDetail	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 VNFM to delete one or more existing threshold(s).

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

Table 7.7.9.1-1: Delete Thresholds operation

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

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 Thresholds operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdId	M	1..N	Identifier	Identifiers of thresholds to be deleted.

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 Thresholds operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedThresholdId	M	1..N	Identifier	Identifiers of the thresholds that have been deleted successfully.

7.7.9.4 Operation results

As a result of this operation, the producer (VIM) shall indicate to the consumer (VNFM) 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 an operation for querying reservations on virtualised compute resources.

7.8.1.2 Query Compute Resource Reservation operation

7.8.1.2.1 Description

This operation allows querying information about reserved compute resources that the consumer has access to.

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

Table 7.8.1.2.1-1: Query Compute Resource Reservation operation

Message	Requirement	Direction
QueryComputeResourceReservationRequest	Mandatory	VNFM → VIM
QueryComputeResourceReservationResponse	Mandatory	VIM → VNFM

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: 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.

7.8.1.2.3 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: Query Compute Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedVirtualCompute	Contains information about the reserved resource(s) matching the filter. The cardinality can be 0 if no matching reservation exists. See clause 8.7.2.

7.8.1.2.4 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 VNFM has access to and that are matching the filter shall be returned.

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 an operation for querying reservations on virtualised network resources.

7.8.2.2 Query Network Resource Reservation operation

7.8.2.2.1 Description

This operation allows querying information about reserved network resources that the consumer has access to.

Table 7.8.2.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.8.2.2.1-1: Query Network Resource Reservation operation

Message	Requirement	Direction
QueryNetworkResourceReservationRequest	Mandatory	VNFM → VIM
QueryNetworkResourceReservationResponse	Mandatory	VIM → VNFM

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: 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.

7.8.2.2.3 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: Query Network Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedVirtualNetwork	Contains information about the reserved resource(s) matching the filter. The cardinality can be 0 if no matching reservation exists. See clause 8.7.4.2.

7.8.2.2.4 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 VNFM has access to and that are matching the filter shall be returned.

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 an operation for querying reservations on virtualised storage resources.

7.8.3.2 Query Storage Resource Reservation operation

7.8.3.2.1 Description

This operation allows querying information about reserved storage resources that the consumer has access to.

Table 7.8.3.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.8.3.2.1-1: Query Storage Resource Reservation operation

Message	Requirement	Direction
QueryStorageResourceReservationRequest	Mandatory	VNFM → VIM
QueryStorageResourceReservationResponse	Mandatory	VIM → VNFM

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: 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.

7.8.3.2.3 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: Query Storage Resource Reservation operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	ReservedVirtualStorage	Contains information about the reserved resource(s) matching the filter. The cardinality can be 0 if no matching reservation exists. See clause 8.7.6.2.

7.8.3.2.4 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 VNFM has access to and that are matching the filter shall be returned.

7.8.4 Virtualised Resources Reservation Change Notification Interface

7.8.4.1 Description

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 VNFM to subscribe with a filter for the notifications related to reservations on virtualised resources sent by the VIM. Specification of filtering mechanism is part of the protocol design.

Table 7.8.4.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.8.4.2.1-1: Subscribe operation

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

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 VNFM is registered to receive notifications related to changes on reservation of virtualised 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 VNFM.

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 (VNFM).

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

Table 7.8.4.3.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.8.4.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

The following notification is sent by this operation:

- VirtualisedResourceReservationChangeNotification. See clause 8.7.7.

7.9 Virtualised Resource Quota Interfaces

7.9.1 Virtualised Compute Resources Quota Management Interface

7.9.1.1 Description

This interface allows an authorized consumer functional block to perform operations on virtualised compute resources quotas available to the consumer functional block. The interface includes operations for querying quotas on virtualised compute resources.

7.9.1.2 Query Compute Resource Quota operation

7.9.1.2.1 Description

This operation allows querying quota information about compute resources that the consumer has access to.

Table 7.9.1.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.9.1.2.1-1: Query Compute Resource Quota operation

Message	Requirement	Direction
QueryComputeResourceQuotaRequest	Mandatory	VNFM → VIM
QueryComputeResourceQuotaResponse	Mandatory	VIM → VNFM

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: 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.

7.9.1.2.3 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: Query Compute Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualComputeQuota	Contains information about the quota resource. The cardinality can be 0 if no matching quota exists. See clause 8.8.2.2.

7.9.1.2.4 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 VNFM has access to and that are matching the filter shall be returned.

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 querying quotas on virtualised network resources.

7.9.2.2 Query Network Resource Quota operation

7.9.2.2.1 Description

This operation allows querying information about quota network resources that the consumer has access to.

Table 7.9.2.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.9.2.2.1-1: Query Network Resource Quota operation

Message	Requirement	Direction
QueryNetworkResourceQuotaRequest	Mandatory	VNFM → VIM
QueryNetworkResourceQuotaResponse	Mandatory	VIM → VNFM

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: 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.

7.9.2.2.3 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: Query Network Resource Quota operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualNetworkQuota	Contains information about the quota resource(s) matching the filter. The cardinality can be 0 if no matching quota exists. See clause 8.8.3.2.

7.9.2.2.4 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 VNFM has access to and that are matching the filter shall be returned.

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 querying quotas on virtualised storage resources.

7.9.3.2 Query Storage Resource operation

7.9.3.2.1 Description

This operation allows querying information about quota resources that the consumer has access to.

Table 7.9.3.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.9.3.2.1-1: Query Storage Resource operation

Message	Requirement	Direction
QueryStorageResourceQuotaRequest	Mandatory	VNFM → VIM
QueryStorageResourceQuotaResponse	Mandatory	VIM → VNFM

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: Query Storage Resource 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.

7.9.3.2.3 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: Query Storage Resource operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	VirtualStorageQuota	Contains information about the quota resource(s) matching the filter. The cardinality can be 0 if no matching quota exists. See clause 8.8.4.2.

7.9.3.2.4 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 VNFM has access to and that are matching the filter shall be returned.

7.9.4 Virtualised Resources Quota Change Notification Interface

7.9.4.1 Description

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 VNFM to subscribe with a filter for the notifications related to quota on virtualised resources sent by the VIM. Specification of filtering mechanism is part of the protocol design.

Table 7.9.4.2.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.9.4.2.1-1: Subscribe operation

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

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 VNFM 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 VNFM.

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 (VNFM).

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

Table 7.9.4.3.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.9.4.3.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

The following notification is sent by this operation:

- VirtualisedResourceQuotaChangeNotification. See clause 8.8.5.

7.10 Policy Management Interface

7.10.1 Description

This interface allows the VNFM to invoke policy management operations towards the VIM.

The following policy management operations are defined for this interface:

- Transfer Policy.
- Delete Policy.
- Query Policy.
- Activate Policy.
- Deactivate Policy.

This interface allows the VNFM to manage subscriptions to notifications sent by the VIM which inform about changes of a policy and about any detected policy conflicts. It allows the VIM to provide such notifications to the subscriber (e.g. VNFM).

7.10.2 Transfer Policy operation

7.10.2.1 Description

This operation enables the VNFM to transfer a NFV-MANO policy to the VIM. Table 7.10.2.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.2.1-1: Transfer Policy operation

Message	Requirement	Direction
TransferPolicyRequest	Mandatory	VNFM → VIM
TransferPolicyResponse	Mandatory	VIM → VNFM

7.10.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.2.2-1.

Table 7.10.2.2-1: Transfer Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
designer	M	1	String	Human readable name of designer of the policy.
name	M	1	String	Human readable name of the policy.
version	M	1	Version	Version of the policy. Its value shall be the same as the one within the policy being transferred, i.e. the "policyVersion" attribute in the "Policy" information element specified in ETSI GS NFV-IFA 048 [3].
policy	M	1	Not specified	Specifies the policy. See notes 1 and 2.
NOTE 1: An identifier for uniquely identifying the policy shall be included in the policy.				
NOTE 2: The VNFM may use this operation to update an existing policy with a new version. Different policy versions share the same internal identifier of the policy but having different PolicyInfo instances. The design of different policy versions and their business logic is out of the scope of the present document.				

7.10.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.2.3-1.

Table 7.10.2.3-1: Transfer Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1	Identifier	Identifier of the policy information created by the VIM.

7.10.2.4 Operation results

In case of success, the NFV-MANO policy is transferred to the VIM and corresponding policy information is created by the VIM. In case of failure, appropriate error information is returned.

7.10.3 Delete Policy operation

7.10.3.1 Description

This operation enables the VNFM to delete one or multiple NFV-MANO policy(ies) from the VIM. Table 7.10.3.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.3.1-1: Delete Policy operation

Message	Requirement	Direction
DeletePolicyRequest	Mandatory	VNFM → VIM
DeletePolicyResponse	Mandatory	VIM → VNFM

7.10.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.3.2-1.

Table 7.10.3.2-1: Delete Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1..N	Identifier (Reference to PolicyInfo)	References the policy information to be deleted.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to delete multiple policies in one request, or as a series of requests that delete one policy at a time.				

7.10.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.3.3-1.

Table 7.10.3.3-1: Delete Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedPolicyInfoId	M	0..N	Identifier (Reference to PolicyInfo)	References the deleted NFV-MANO policy information.

7.10.3.4 Operation results

In case of success, the NFV-MANO policy(ies) are deleted from the VIM, and a success indicator is returned to the VNFM. In case of failure, appropriate error information is returned.

7.10.4 Query Policy operation

7.10.4.1 Description

This operation enables the VNFM to query the information from the VIM on one or multiple NFV-MANO policy(ies). Table 7.10.4.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.4.1-1: Query Policy operation

Message	Requirement	Direction
QueryPolicyRequest	Mandatory	VNFM → VIM
QueryPolicyResponse	Mandatory	VIM → VNFM

7.10.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.4.2-1.

Table 7.10.4.2-1: Query Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the NFV-MANO policy information on which the query applies, based on attributes of NFV-MANO policy information. It can also be used to specify one or more NFV-MANO policy(ies) information to be queried by providing their identifiers.
attributeSelector	M	0..N	String	Provides a list of attribute names of NFV-MANO policy information. If present, only these attributes are returned for the policy information matching the filter. If absent, the complete policy information is returned.

7.10.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.4.3-1.

Table 7.10.4.3-1: Query Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryNsPolicyInfoResult	M	0..N	PolicyInfo	NFV-MANO policy information matching the input filter. If attributeSelector is present, only the attributes listed in attributeSelector are returned for the selected policy information. See note.
NOTE: The lower cardinality is 0 since there may be no matches to the provided filter.				

7.10.4.4 Operation results

After success operation, the VIM has queried the internal NFV-MANO policy information. The result of the operation indicates whether it has been successful or not with a standard success/error result. For a particular query, policy information that is matching the filter shall be returned.

7.10.5 Activate Policy operation

7.10.5.1 Description

This operation enables the VNFM to activate one or multiple NFV-MANO policy(ies) in the VIM. Table 7.10.5.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.5.1-1: Activate Policy operation

Message	Requirement	Direction
ActivatePolicyRequest	Mandatory	VNFM → VIM
ActivatePolicyResponse	Mandatory	VIM → VNFM

7.10.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.5.2-1.

Table 7.10.5.2-1: Activate Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1..N	Identifier (Reference to PolicyInfo)	References the policy information to be activated. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to activate multiple policies in one request, or as a series of requests that activate one policy at a time.				

7.10.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.5.3-1.

Table 7.10.5.3-1: Activate Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
activatedPolicyInfoId	M	0..N	Identifier (Reference to PolicyInfo)	References the activated NFV-MANO policy(ies).

7.10.5.4 Operation results

In case of success, the NFV-MANO policy(ies) are activated in the VIM, and a success indicator is returned to the VNFM. In case of failure, appropriate error information is returned.

7.10.6 Deactivate Policy operation

7.10.6.1 Description

This operation enables the VNFM to deactivate one or multiple NFV-MANO policy(ies) in the VIM. Table 7.10.6.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.6.1-1: Deactivate Policy operation

Message	Requirement	Direction
DeactivatePolicyRequest	Mandatory	VNFM → VIM
DeactivatePolicyResponse	Mandatory	VIM → VNFM

7.10.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.6.2-1.

Table 7.10.6.2-1: Deactivate Policy operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
policyInfoId	M	1..N	Identifier (Reference to PolicyInfo)	References the policy to be deactivated. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to deactivate multiple policies in one request, or as a series of requests that deactivate one policy at a time.				

7.10.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.6.3-1.

Table 7.10.6.3-1: Deactivate Policy operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deactivatedPolicyInfoId	M	0..N	Identifier (Reference to PolicyInfo)	References the deactivated NFV-MANO policy(ies).

7.10.6.4 Operation results

In case of success, the NFV-MANO policy(ies) are deactivated in the VIM, and a success indicator is returned to the VNFM. In case of failure, appropriate error information is returned.

7.10.7 Subscribe operation

7.10.7.1 Description

This operation enables the VNFM to subscribe with a filter for the notifications sent by the VIM which are related to changes of a policy and any detected policy conflicts. Changes of a policy are related to operations of transferring policy, deleting policy, activating policy and deactivating policy.

Table 7.10.7.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.7.1-1: Subscribe operation

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

7.10.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.7.2-1.

Table 7.10.7.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting the notifications. This filter can contain information about specific types of notifications to subscribe to, or attributes of the PolicyInfo. Details are part of the protocol design.

7.10.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.7.3-1.

Table 7.10.7.3-1: Subscribe operation output parameters

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

7.10.7.4 Operation results

After successful subscription, the consumer (VNFM) is registered to receive notifications about events related to changes of a policy and any detected policy conflicts.

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

7.10.8 Notify operation

7.10.8.1 Description

This operation notifies a subscriber about events related to notifications about changes of a policy and any detected policy conflicts.

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

Table 7.10.8.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.8.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

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

- PolicyChangeNotification. See clause 8.9.3.
- PolicyConflictNotification. See clause 8.9.4.

7.10.9 Terminate Subscription operation

7.10.9.1 Description

This operation enables the VNFM to terminate a particular subscription.

Table 7.10.9.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.9.1-1: Terminate Subscription operation

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

7.10.9.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.9.2-1.

Table 7.10.9.2-1: Terminate Subscription operation input parameters

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

7.10.9.3 Output parameters

None.

7.10.9.4 Operation results

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

7.10.10 Query Subscription Info operation

7.10.10.1 Description

This operation enables the VNFM to query information about subscriptions.

Table 7.10.10.1-1 lists the information flow exchanged between the VNFM and the VIM.

Table 7.10.10.1-1: Query Subscription Info operation

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

7.10.10.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 7.10.10.2-1.

Table 7.10.10.2-1: Query Subscription Info operation input parameters

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

7.10.10.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 7.10.10.3-1.

Table 7.10.10.3-1: Query Subscription Info operation output parameters

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

7.10.10.4 Operation results

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

8 Information element 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 8.2.2-1.

Table 8.2.2-1: Attributes of the SoftwareImageInformation information element

Attribute	Qualifier	Cardinality	Content	Description
softwareImageId	M	1	Identifier	Identifier of this software image.
name	M	1	Not specified	Name of this software image.
provider	M	1	Not specified	Provider of this software image.
version	M	1	Not specified	Version of the software image file.
checksum	M	1	Not specified	Checksum of the software image file.
containerFormat	M	1	Not specified	Container format indicates whether the software image is in a file format that also contains metadata about the actual software.
diskFormat	M	1	Not specified	Disk format of a software image is the format of the underlying disk image.
createdAt	M	1	Not specified	Time this software image was created.
updatedAt	M	1	Not specified	Time this software image was last updated.
minDisk	M	1	Not specified	Minimal disk size for this software image.
minRam	M	1	Not specified	Minimal RAM size for this software image.
size	M	1	Not specified	Size of this software image.

Attribute	Qualifier	Cardinality	Content	Description
status	M	1	Not specified	Status of this software image.
userMetadata	O	0..N	KeyValuePair	User-defined metadata.

8.3 Information elements and notifications related to Consumable Virtualised Resources Information

8.3.1 Introduction

The clauses below define information elements and notifications related to Consumable Virtualised Resources Information.

8.3.2 InformationChangeNotification

8.3.2.1 Description

This notification informs the receiver that information related to consumable virtualised resources is changed.

8.3.2.2 Trigger conditions

- Addition of consumable virtualised resources.
- Removal of consumable virtualised resources.
- Update of consumable virtualised resources.

8.3.2.3 Attributes

The InformationChangeNotification notification shall follow the indications provided in table 8.3.2.3-1.

Table 8.3.2.3-1: Attributes of the InformationChangeNotification notification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the consumable virtualised resource type.
resourceTypeId	M	1	Identifier (Reference to VirtualComputeResourceInformation, VirtualStorageResourceInformation, or VirtualNetworkResourceInformation)	References the consumable virtualised resource type.
vimId	M	1	Identifier	Identifier of the VIM reporting the change.
changeType	M	1	Enum	Categorizes the type of change. VALUES: <ul style="list-style-type: none"> • ADDITION • REMOVAL • UPDATE
changedResourceData	M	0..1	Not specified	Details of the changes of consumable virtualised resource information. Its content can differ based on the values of the resourceTypeId and changeType.

8.3.3 Information elements related to Virtual Compute Resource Information

8.3.3.1 Introduction

The information elements below define the characteristics of consumable virtualised compute resources.

8.3.3.2 VirtualComputeResourceInformation information element

8.3.3.2.1 Description

This clause describes the attributes for the VirtualComputeResourceInformation information element.

8.3.3.2.2 Attributes

The VirtualComputeResourceInformation information element shall follow the indications provided in table 8.3.3.2.2-1.

Table 8.3.3.2.2-1: Attributes of the VirtualComputeResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
computeResourceTypeId	M	1	Identifier	Identifier of the consumable virtualised compute resource type.
virtualMemory	M	0..1	VirtualMemoryResourceInformation	Defines the virtual memory characteristics of the consumable virtualised compute resource. See note.
virtualCpu	M	0..1	VirtualCpuResourceInformation	Defines the virtual CPU(s) characteristics of the consumable virtualised compute resource. See note.
accelerationCapability	M	0..N	Not specified	Acceleration capabilities (e.g. crypto, GPU) for the consumable virtualised compute resource from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided. See also note.
NOTE: Cardinality can be "0" if the attribute refers to a characteristic that is not being reported on a specific query or notification, e.g. through an InformationChangeNotification.				

8.3.3.3 VirtualCpuResourceInformation information element

8.3.3.3.1 Description

The VirtualCpuResourceInformation defines the virtual CPU(s) characteristics of consumable virtualised compute resource.

8.3.3.3.2 Attributes

The VirtualCpuResourceInformation information element shall follow the indications provided in table 8.3.3.3.2-1.

Table 8.3.3.3.2-1: Attributes of the VirtualCpuResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
cpuArchitecture	M	1	String	CPU architecture type. Examples are x86, ARM.
numVirtualCpu	M	0..1	Number	Number of virtual CPUs. Cardinality "1" covers the case where a specific configuration for the consumable resource is advertised.
cpuClock	M	1	Number	Minimum CPU clock rate (e.g. in MHz) available for the virtualised CPU resources.
virtualCpuOversubscriptionPolicy	M	0..1	Not specified	CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 if no concrete policy is defined.
virtualCpuPinningSupported	M	1	Boolean	Defines whether CPU pinning capability is available on the consumable virtualised compute resource.

8.3.3.4 VirtualMemoryResourceInformation information element

8.3.3.4.1 Description

The VirtualMemoryResourceInformation defines the virtual memory characteristics of consumable virtualised compute resource.

8.3.3.4.2 Attributes

The VirtualMemoryResourceInformation information element shall follow the indications provided in table 8.3.3.4.2-1.

Table 8.3.3.4.2-1: Attributes of the VirtualMemoryResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	0..1	Number	Amount of virtual memory (e.g. in MB). Cardinality "1" covers the case where a specific configuration for the consumable resource is advertised.
virtualMemOversubscriptionPolicy	M	0..1	Not specified	Memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 if no concrete policy is defined.
numaSupported	M	1	Boolean	Specifies if the memory allocation can be cognisant of the relevant process/core allocation.

8.3.4 VirtualStorageResourceInformation information element

8.3.4.1 Description

This information element defines the characteristics of consumable virtual storage resources.

8.3.4.2 Attributes

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

Table 8.3.4.2-1: Attributes of the VirtualStorageResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
storageResourceTypeId	M	1	Identifier	Identifier of the consumable virtualised storage resource type.
typeOfStorage	M	1	String	Type of virtualised storage resource (e.g. volume, object).
sizeOfStorage	M	0..1	Number	Size of virtualised storage resource (e.g. size of volume, in GB). Cardinality "1" covers the case where a specific configuration for the consumable resource is advertised.
rdmaSupported	O	0..1	Boolean	Indicates if the storage supports RDMA.

8.3.5 VirtualNetworkResourceInformation information element

8.3.5.1 Description

This information element defines the characteristics of consumable virtual network resources.

8.3.5.2 Attributes

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

Table 8.3.5.2-1: Attributes of the VirtualNetworkResourceInformation information element

Attribute	Qualifier	Cardinality	Content	Description
networkResourceTypeId	M	1	Identifier	Identifier of the network resource type.
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).
networkType	M	0..1	String	The type of network that maps to the virtualised network. Examples are: "local", "vlan", "vxlan", "gre", etc.
networkQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes that the network shall support. See clause 8.4.5.3.

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 VNFM 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 VirtualNetworkInterface 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	0..1	Identifier	Identifier given to the compute flavour. When the VirtualComputeFlavour is used as input in operations to request the creation of a compute flavour, the cardinality can be "0" if VIM assigns the identifier in order to avoid potential identifier assignment conflicts. The flavourId shall be present otherwise.
isPublic	M	0..1	Boolean	Scope of flavour accessibility. It indicates if the compute flavour is accessible and shared across clients. Default value is True, which means public. False means private.
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is requested.
virtualMemory	M	1	VirtualMemoryData	Virtual memory of the virtualised compute. See clause 8.4.3.5.
virtualCpu	M	1	VirtualCpuData	Virtual CPU(s) of the virtualised compute. See clause 8.4.3.3.
storageAttributes	M	0..N	VirtualStorageData	Contains information about the size of virtualised storage resource (e.g. size of volume, in GB), the type of storage (e.g. volume, object), and support for RDMA. See clause 8.4.6.3.
virtualNetworkInterface	M	0..N	VirtualNetworkInterfaceData	Virtual network interfaces of the virtualised compute. See clause 8.4.2.6.

8.4.2.3 VirtualCpuData information element

8.4.2.3.1 Description

Information describing a virtual CPU.

8.4.2.3.2 Attributes

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

Table 8.4.2.3.2-1: Attributes of the VirtualCpuData information element

Attribute	Qualifier	Cardinality	Content	Description
cpuArchitecture	M	0..1	String	CPU architecture type. Examples are x86, ARM. The cardinality can be 0 during the allocation request, if no particular CPU architecture type is requested.
numVirtualCpu	M	1	Integer	Number of virtual CPUs.
cpuClock	M	0..1	Number	Minimum CPU clock rate (e.g. in MHz) available for the virtualised CPU resources. The cardinality can be 0 during the allocation request, if no particular value is requested.
virtualCpuOversubscriptionPolicy	M	0..1	Not specified	CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 during the allocation request, if no particular value is requested.
virtualCpuPinning	M	0..1	VirtualCpuPinningData	Virtual CPU pinning configuration for the virtualised compute resource. See clause 8.4.3.4.

8.4.2.4 VirtualCpuPinningData information element format

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
virtualCpuPinningPolicy	M	1	Enum	Indicates the policy for CPU pinning. VALUES: <ul style="list-style-type: none"> • STATIC • DYNAMIC In case of "STATIC" the virtual CPU cores are requested to be allocated to logical CPU cores according to the rules defined in virtualCpuPinningRules. In case of "DYNAMIC" the allocation of virtual CPU cores to logical CPU cores is decided by the VIM (e.g. SMT (Simultaneous Multi-Threading) requirements).
virtualCpuPinningRules	M	0..N	Not specified	List of rules that should be considered during the allocation of the virtual CPUs to logical CPUs in case of "static" virtualCpuPinningPolicy.

8.4.2.5 VirtualMemoryData information element format

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).
virtualMemOversubscription Policy	M	0..1	Not specified	Memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 during the allocation request, if no particular value is requested.
numaEnabled	M	0..1	Boolean	Specifies the memory allocation to be cognisant of the relevant process/core allocation. The cardinality can be 0 during the allocation request, if no particular value is requested.

8.4.2.6 VirtualNetworkInterfaceData information element

8.4.2.6.1 Description

A virtual network interface is a communication endpoint under a compute resource.

8.4.2.6.2 Attributes

The VirtualNetworkInterfaceData information element shall follow the indications provided in table 8.4.2.6.2-1.

Table 8.4.2.6.2-1: Attributes of the VirtualNetworkInterfaceData information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier	In the case when the virtual network interface is attached to the network, it identifies such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
networkPortId	M	0..1	Identifier	If the virtual network interface is attached to a specific network port, it identifies such a network port. The cardinality can be 0 in the case that a network interface is created without any specific network port attachment.
typeVirtualNic	M	1	Not specified	Type of network interface. The type allows for defining how such interface is to be realized, e.g. normal virtual NIC, with direct PCI pass-through, SR-IOV, etc.
typeConfiguration	M	0..N	Not specified	Extra configuration that the virtual network interface supports based on the type of virtual network interface.
bandwidth	M	0..1	Number	Bandwidth of the virtual network interface (in Mbps).
accelerationCapability	M	0..N	Not specified	Specifies if the virtual network interface requires certain acceleration capabilities (e.g. RDMA, packet dispatch, TCP Chimney). The cardinality can be 0, if no particular acceleration capability is requested.
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 element

Attribute	Qualifier	Cardinality	Content	Description
computeId	M	1	Identifier	Identifier of the virtualised compute resource.
computeName	M	0..1	String	Name of the virtualised compute resource.
flavourId	M	1	Identifier	Identifier of the given compute flavour used to instantiate this virtual compute.
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided.
virtualCpu	M	1	VirtualCpu	Virtual CPU(s) of the virtualised compute. See clause 8.4.3.3.
virtualMemory	M	1	VirtualMemory	Virtual memory of the compute. See clause 8.4.3.5.
virtualNetworkInterface	M	0..N	VirtualNetworkInterface	Provides information of the instantiated virtual network interfaces of the compute resource. See clause 8.4.3.6.
virtualDisks	M	1..N	VirtualStorage	Provides information of the virtualised storage resources (volumes, ephemeral) that are attached to the compute resource. See clause 8.4.7.2.
vclmageId	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	Operational state of the compute resource. VALUES: <ul style="list-style-type: none"> • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.3.3 VirtualCpu information element format

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	Not specified	CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 if no policy has been defined during the allocation request.
virtualCpuPinning	M	0..1	VirtualCpuPinning	Virtual CPU pinning configuration for the virtualised compute resource. See clause 8.4.3.4.

8.4.3.4 VirtualCpuPinning information element format

8.4.3.4.1 Description

This clause describes the attributes for the VirtualCpuPinning information element.

8.4.3.4.2 Attributes

The VirtualCpuPinning information element shall follow the indications provided in table 8.4.3.4.2-1.

Table 8.4.3.4.2-1: Attributes of the VirtualCpuPinning information element

Attribute	Qualifier	Cardinality	Content	Description
cpuPinningPolicy	M	1	Enum	Indicates the policy for CPU pinning. VALUES: <ul style="list-style-type: none"> • STATIC • DYNAMIC In case of "STATIC" the virtual CPU cores have been allocated to physical CPU cores according to the rules defined in cpuPinningRules. In case of "DYNAMIC" the allocation of virtual CPU cores to physical CPU cores is decided by the VIM.
cpuPinningRules	M	0..N	Not specified	List of rules that should be considered during the allocation of the virtual CPU-s to physical CPU-s in case of "static" cpuPinningPolicy.
cpuMap	M	1	Not specified	Describes the association of virtual CPU cores to physical CPU cores.

8.4.3.5 VirtualMemory information element format

8.4.3.5.1 Description

This clause describes the attributes for the VirtualMemory information element.

8.4.3.5.2 Attributes

The VirtualMemory information element shall follow the indications provided in table 8.4.3.5.2-1.

Table 8.4.3.5.2-1: Attributes of the VirtualMemory information element

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	1	Number	Amount of virtual Memory (e.g. in MB).
virtualMemOversubscriptionPolicy	M	0..1	Not specified	Memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 if no policy has been defined during the allocation request.
numaEnabled	M	1	Boolean	Specifies the memory allocation to be cognisant of the relevant process/core allocation.

8.4.3.6 VirtualNetworkInterface information element

8.4.3.6.1 Description

A virtual network interface resource is a communication endpoint under an instantiated compute resource.

8.4.3.6.2 Attributes

The VirtualNetworkInterface information element shall follow the indications provided in table 8.4.3.6.2-1.

Table 8.4.3.6.2-1: Attributes of the VirtualNetworkInterface information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the virtual network interface.
ownerId	M	1	Identifier	Identifier of the owner of the network interface (e.g. a virtualised compute resource).
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	In the case when the virtual network interface is attached to the network, it references such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
networkPortId	M	0..1	Identifier (Reference to VirtualNetworkPort)	If the virtual network interface is attached to a specific network port, it references such a network port. The cardinality can be 0 in the case that a network interface is created without any specific network port attachment.
ipAddress	M	0..N	IpAddress	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network, or when an IP address can be automatically configured, e.g. by DHCP.

Attribute	Qualifier	Cardinality	Content	Description
typeVirtualNic	M	1	Not specified	Type of network interface. The type allows for defining how such interface is to be realized, e.g. normal virtual NIC, with direct PCI pass-through, etc.
typeConfiguration	M	0..N	Not specified	Extra configuration that the virtual network interface supports based on the type of virtual network interface, including support for SR-IOV with configuration of Virtual Functions (VF).
macAddress	M	1	MacAddress	MAC address of the virtual network interface.
bandwidth	M	1	Number	Bandwidth of the virtual network interface (in Mbps).
accelerationCapability	M	0..N	Not specified	Describes the acceleration capabilities utilized by the virtual network interface. The cardinality can be 0, if no acceleration capability is utilized.
operationalState	M	1	Enum	Operational state of the virtual network interface. VALUES: <ul style="list-style-type: none"> • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.3.7 VirtualInterfaceData information element

8.4.3.7.1 Description

A virtual interface represents the data of a virtual network interface specific to a Virtual Compute Resource instance.

8.4.3.7.2 Attributes

The VirtualInterfaceData information element shall follow the indications provided in table 8.4.3.7.2-1.

Table 8.4.3.7.2-1: Attributes of the VirtualInterfaceData information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	In the case when the virtual network interface is attached to the network, it references such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
ipAddress	M	0..N	IpAddress	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network, or when an IP address can be automatically configured, e.g. by DHCP.
macAddress	M	0..1	MacAddress	MAC address desired for the virtual network interface. The cardinality can be 0 to allow for network interface without specific MAC address configuration.

8.4.4 Information elements related to Virtual Network Data

8.4.4.1 Introduction

The information elements in this group encapsulate information to allocate or update virtualised network resources.

8.4.4.2 VirtualNetworkData information element format

8.4.4.2.1 Description

This clause describes the attributes for the VirtualNetworkData information element.

8.4.4.2.2 Attributes

The VirtualNetworkData information element shall follow the indications provided in table 8.4.4.2.2-1.

Table 8.4.4.2.2-1: Attributes of the VirtualNetworkData information element

Attribute	Qualifier	Cardinality	Content	Description
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).
networkType	M	0..1	String	Type of network that maps to the virtualised network. This list is extensible. Examples are: <ul style="list-style-type: none"> • "local"; • "vlan"; • "vxlan"; • "gre"; • "l3-vpn"; • etc. Cardinality can be "0" to cover the case where this attribute is not required to create the virtualised network.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
networkQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes that the network shall support. See clause 8.4.4.3. Cardinality can be "0" for networks without any specified QoS requirements.
isShared	M	0..1	Boolean	Specifies whether the virtualised network is shared among consumers.
sharingCriteria	M	0..1	Not specified	Only present for shared networks. Indicate the sharing criteria/constraint for this network. These criteria might be a list of authorized consumers.
layer3Attributes	M	0..N	NetworkSubnetData	Attribute list 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 format

8.4.4.3.1 Description

This clause describes the attributes for the NetworkQoS information element. This type gives QoS options to be supported on the virtualised network, e.g. latency, jitter, etc.

8.4.4.3.2 Attributes

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

Table 8.4.4.3.2-1: Attributes of the NetworkQoS information element

Attribute	Qualifier	Cardinality	Content	Description
qosName	M	1	String	Name given to the QoS parameter.
qosValue	M	1	Value	Value of the QoS parameter.

8.4.4.4 NetworkSubnetData information element

8.4.4.4.1 Description

The NetworkSubnetData information element encapsulates information to allocate or update virtualised sub-networks.

8.4.4.4.2 Attributes

The NetworkSubnetData information element shall follow the indications provided in table 8.4.4.4.2-1.

Table 8.4.4.4.2-1: Attributes of the NetworkSubnetData information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	0..1	Identifier	Identifier of the virtualised network that the virtualised sub-network is attached to. The cardinality can be 0 to cover the case where this type is used to describe the L3 attributes of a network rather than a subnetwork or when NetworkSubnetData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note.
ipVersion	M	0..1	Enum	IP version of the network/subnetwork. VALUES: <ul style="list-style-type: none"> • IPV4 • IPV6 Cardinality can be 0 when NetworkSubnetData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note.
gatewayIp	M	0..1	IpAddress	Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.
cidr	M	0..1	Not specified	CIDR of the network/subnetwork, i.e. network address and subnet mask. Cardinality can be 0 when NetworkSubnetData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note.
isDhcpEnabled	M	0..1	Boolean	True when DHCP is to be enabled for this network/subnetwork, or false otherwise.
addressPool	M	0..N	Not specified	Address pools for the network/subnetwork. The cardinality can be 0 when VIM is allowed to allocate all addresses in the CIDR except for the address of the network/subnetwork gateway.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE: In these cases, changing the parameter is such a fundamental change that a new virtualised network resource should be created instead of updating an existing network resource.				

8.4.4.5 VirtualNetworkPortData information element

8.4.4.5.1 Description

The VirtualNetworkPortData information element encapsulates information to allocate or update virtual network ports for network resources. A network port resource is a communication endpoint instantiated under a network resource.

8.4.4.5.2 Attributes

The VirtualNetworkPortData information element shall follow the indications provided in table 8.4.4.5.2-1.

Table 8.4.4.5.2-1: Attributes of the VirtualNetworkPortData information element

Attribute	Qualifier	Cardinality	Content	Description
portType	M	0..1	String	Type of network port. Examples of types are access ports (layer 2 or 3), or trunk ports (layer 1) that become transport for multiple layer 2 or layer 3 networks. Cardinality can be "0" if the consumer does not need to provide specific port type to create a "normal port" (i.e. by default, a "normal port" will be created). See note 1.
networkId	M	0..1	Identifier	Identifier of the network that the port belongs to. When creating a port, such port needs to be part of a network. Cardinality can be 0 when VirtualNetworkPortData is part of Update Virtualised Network Resource (see clause 7.4.1.4.2). See note 2.
bandwidth	M	0..1	Number	Bandwidth of the virtual network port (in Mbps). Cardinality can be "0" for virtual network ports without any specified bandwidth requirements.
portQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes applicable to the port. See clause 8.4.4.3. Cardinality can be "0" for the virtual network ports if no specific without any specified QoS requirements are requested.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE 1: After instantiation, the normal port can be referenced as a parent port or sub port in a trunk port resource (See clause 8.4.4.6).				
NOTE 2: In this case, changing the parameter is such a fundamental change that a new virtualised network resource should be created instead of updating an existing network resource.				

8.4.4.6 VirtualTrunkData information element

8.4.4.6.1 Description

The VirtualTrunkData information element encapsulates information to allocate virtual trunk. A virtual trunk is a logical network resource which can be used to multiplex packets coming from and going to multiple networks using one trunk port. Trunk is modelled as a collection of network ports, one parent port and a sequence of subports.

8.4.4.6.2 Attributes

The VirtualTrunkData information element shall follow the indications provided in table 8.4.4.6.2-1.

Table 8.4.4.6.2-1: Attributes of the VirtualTrunkData information element

Attribute	Qualifier	Cardinality	Content	Description
parentPortId	M	1	Identifier (Reference to VirtualNetworkPort)	References the network port that used as parent port of the trunk to be created.
subportList	M	0..N	TrunkSubport	Provides information on subports associate to the trunk to be created. Cardinality can be "0" to allow for trunk without subport at creation time.

8.4.4.7 TrunkSubport information element format

8.4.4.7.1 Description

This clause describes the attributes for the TrunkSubport information element.

8.4.4.7.2 Attributes

The TrunkSubport information element shall follow the indications provided in table 8.4.4.7.2-1.

Table 8.4.4.7.2-1: Attributes of the TrunkSubport information element

Attribute	Qualifier	Cardinality	Content	Description
subportId	M	1	Identifier (Reference to VirtualNetwork Port)	References the network port that used as subport of the trunk.
segmentationType	M	0..1	Enum	The encapsulation type for the traffics coming in and out of the trunk subport. See note. VALUES: <ul style="list-style-type: none"> VLAN: the subport uses VLAN as encapsulation type INHERIT: the subport gets its segmentation type from the network it is connected to. Cardinality 0 means default value VLAN is used.
segmentationId	M	1	Integer	The segmentation identifier of the subport, which is used to differentiate the traffics on different networks coming in and out of the trunk port. See note.
NOTE: The segmentationType and segmentationId specified on the subport is intentionally decoupled from the networkType and segmentationId of the network that the subport attached to. For example, it is possible to configure the Network with (networkType = vxlan, segmentationId = 5 000) and create subport with (segmentationType = vlan, segmentationId = 100).The traffic flow can be remapped as necessary.				

8.4.4.8 UpdateTrunkData information element

8.4.4.8.1 Description

This clause describes the attributes for the UpdateTrunkData information element.

8.4.4.8.2 Attributes

The UpdateTrunkData information element shall follow the indications provided in table 8.4.4.8.2-1.

Table 8.4.4.8.2-1: Attributes of the UpdateTrunkData information element

Attribute	Qualifier	Cardinality	Content	Description
portId	M	0..N	Identifier (Reference to VirtualNetwork Port)	Provides information on subport(s) to be deleted from a trunk resource. See note.
subportList	M	0..N	TrunkSubport	Provides information on subport(s) to be added to a trunk resource. See note.
NOTE: Only one type of the two attributes (portId or subportList) shall be present.				

8.4.5 Information elements related to Virtual Network

8.4.5.1 Introduction

The information elements in this group encapsulates information of an instantiated virtualised network resource. In the NFVI, a virtual network transports information among the network interfaces of VM instances and physical network interfaces, providing the necessary connectivity.

8.4.5.2 VirtualNetwork information element

8.4.5.2.1 Description

This clause describes the attributes for the VirtualNetwork information element.

8.4.5.2.2 Attributes

The VirtualNetwork information element shall follow the indications provided in table 8.4.5.2.2-1.

Table 8.4.5.2.2-1: Attributes of the VirtualNetwork information element

Attribute	Qualifier	Cardinality	Content	Description
networkResourceId	M	1	Identifier	Identifier of the virtualised network resource.
networkResourceName	M	0..1	String	Name of the virtualised network resource.
subnetId	M	0..N	Identifier (Reference to NetworkSubnet)	References the network subnet. Only present if the network provides layer 3 connectivity. See clause 8.4.5.3.
networkPort	M	0..N	VirtualNetworkPort	Provides information on an instantiated virtual network port.
bandwidth	M	1	Number	Minimum network bandwidth (in Mbps).
networkType	M	1	String	Type of network that maps to the virtualised network. This list is extensible. Examples are: <ul style="list-style-type: none"> • "local"; • "vlan"; • "vxlan"; • "gre"; • "l3-vpn"; • etc.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
networkQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes that the network supports. See clause 8.4.4.3. Cardinality can be "0" for virtual network without any QoS requirements.
isShared	M	1	Boolean	Defines whether the virtualised network is shared among consumers.
sharingCriteria	M	0..1	Not specified	Indicates the sharing criteria for this network. This criteria might be a list of authorized consumers. Only present for shared networks.
zoneId	M	0..1	Identifier	If present, it identifies the resource zone where the virtual network resources have been allocated.
operationalState	M	1	Enum	Operational state of the virtualised network. VALUES: <ul style="list-style-type: none"> • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.5.3 NetworkSubnet information element

8.4.5.3.1 Description

The NetworkSubnet information element encapsulates information of an instantiated virtualised sub-network.

8.4.5.3.2 Attributes

The NetworkSubnet information element shall follow the indications provided in table 8.4.5.3.2-1.

Table 8.4.5.3.2-1: Attributes of the NetworkSubnet information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the virtualised sub-network.
networkId	M	0..1	Identifier (Reference to VirtualNetwork)	References the virtualised network that the virtualised sub-network is attached to. The cardinality can be 0 to cover the case where this type is used to describe the L3 attributes of a network rather than a subnetwork.
ipVersion	M	1	Enum	IP version of the network/subnetwork. VALUES: <ul style="list-style-type: none"> • IPV4 • IPV6
gatewayIp	M	1	IpAddress	IP address of the network/subnetwork gateway.
cidr	M	1	Not specified	CIDR of the network/subnetwork, i.e. network address and subnet mask.
isDhcpEnabled	M	1	Boolean	True when DHCP is enabled for this network/subnetwork, or false otherwise.
addressPool	M	0..N	Not specified	Address pools for the network/subnetwork. The cardinality can be 0 when VIM is allowed to allocate all addresses in the CIDR except for the address of the network/subnetwork gateway.
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.5.4 VirtualNetworkPort information element

8.4.5.4.1 Description

The VirtualNetworkPort information element encapsulates information of an instantiated virtual network port. A network port resource is a communication endpoint instantiated under a network resource.

8.4.5.4.2 Attributes

The VirtualNetworkPort information element shall follow the indications provided in table 8.4.5.4.2-1.

Table 8.4.5.4.2-1: Attributes of the VirtualNetworkPort information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1	Identifier	Identifier of the virtual network port.
networkId	M	1	Identifier (Reference to VirtualNetwork)	References the network that the port belongs to. When creating a port, such port needs to be part of a network.
attachedResourceId	M	0..1	Identifier (Reference to VirtualNetworkInterface)	References the attached resource to the network port (e.g. a virtualised compute resource, or identifier of the virtual network interface).

Attribute	Qualifier	Cardinality	Content	Description
				Cardinality can be "0" if there is no specific resource connected to the network port.
portType	M	0..1	String	Type of network port. Examples of types are access ports (layer 2 or 3), or trunk ports (layer 1) that become transport for multiple layer 2 or layer 3 networks. Cardinality can be "0" if the network port is a "normal port". See note.
bandwidth	M	0..1	Number	Bandwidth of the virtual network port (in Mbps). Cardinality can be "0" for virtual network ports without any specific allocated bandwidth.
portQoS	M	0..N	NetworkQoS	Provides information about Quality of Service attributes applicable to the port. See clause 8.4.4.3. Cardinality can be "0" for virtual network ports without any specific QoS requirements.
operationalState	M	1	Enum	Operational state of the virtual network port. VALUES: <ul style="list-style-type: none"> • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE: After instantiation, the normal port can be referenced as a parent port or sub port in a trunk port resource (see clause 8.4.4.6).				

8.4.5.5 VirtualTrunk information element

8.4.5.5.1 Description

The VirtualTrunk information element encapsulates information of an instantiated virtual trunk. A virtual trunk is a logical network resource which can be used to multiplex packets coming from and going to multiple networks using one network port. Trunk is modelled as a collection of network ports, one parent port and a sequence of subports.

8.4.5.5.2 Attributes

The VirtualTrunk information element shall follow the indications provided in table 8.4.5.5.2-1.

Table 8.4.5.5.2-1: Attributes of the VirtualTrunk information element

Attribute	Qualifier	Cardinality	Content	Description
trunkResourceId	M	1	Identifier	Identifier of the virtual trunk.
parentPortId	M	1	Identifier (Reference to VirtualNetworkPort)	References the network port that used as parent port of the trunk.
subportList	M	0..N	TrunkSubport	Provides information on subport of the trunk.
operationalState	M	1	Enum	Operational state of the virtualised network. VALUES: <ul style="list-style-type: none"> • ENABLED • DISABLED

8.4.6 Information elements related to Virtual Storage Flavour

8.4.6.1 Introduction

The information elements in this group encapsulate information to allocate or update virtualised storage resources.

8.4.6.2 VirtualStorageFlavour information element

8.4.6.2.1 Description

This clause describes the attributes for the VirtualStorageFlavour information element. The VirtualStorageFlavour information element encapsulates information for storage flavours. A storage flavour includes information about the size of the storage, and the type of storage.

8.4.6.2.2 Attributes

The VirtualStorageFlavour information element shall follow the indications provided in table 8.4.6.2.2-1.

Table 8.4.6.2.2-1: Attributes of the VirtualStorageFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
flavourId	M	0..1	Identifier	Identifier of the storage flavour. Cardinality can be "0" if no specific virtual storage flavour is referred.
storageAttributes	M	1	VirtualStorageData	Contains information about the size of virtualised storage resource (e.g. size of volume, in GB), the type of storage (e.g. volume, object), and support for RDMA. See clause 8.4.6.3.

8.4.6.3 VirtualStorageData information element

8.4.6.3.1 Description

This clause describes the attributes for the VirtualStorageData information element.

8.4.6.3.2 Attributes

The VirtualStorageData information element shall follow the indications provided in table 8.4.6.3.2-1.

Table 8.4.6.3.2-1: Attributes of the VirtualStorageData information element

Attribute	Qualifier	Cardinality	Content	Description
typeOfStorage	M	1	String	Type of virtualised storage resource (e.g. volume, object).
sizeOfStorage	M	1	Number	Size of virtualised storage resource (e.g. size of volume, in GB).
rdmaEnabled	O	0..1	Boolean	Indicates if the storage supports RDMA.

8.4.7 Information elements related to Virtual Storage

8.4.7.1 Introduction

The information elements in this group encapsulate information of an instantiated virtualised storage resource.

8.4.7.2 VirtualStorage information element

8.4.7.2.1 Description

This clause describes the attributes for the VirtualStorage information element. The VirtualStorage information element encapsulates information of an instantiated virtualised storage resource.

8.4.7.2.2 Attributes

The VirtualStorage information element shall follow the indications provided in table 8.4.7.2.2-1.

Table 8.4.7.2.2-1: Attributes of the VirtualStorage information element

Attribute	Qualifier	Cardinality	Content	Description
storageId	M	1	Identifier	Identifier of the virtualised storage resource.
storageName	M	0..1	String	Name of the virtualised storage resource.
flavourId	M	0..1	Identifier	Identifier of the storage flavour used to instantiate this virtual storage. Cardinality can be "0" if no specific virtual storage flavour is referred.
typeOfStorage	M	1	String	Type of virtualised storage resource (e.g. volume, object).
sizeOfStorage	M	1	Number	Size of virtualised storage resource (e.g. size of volume, in GB).
rdmaEnabled	O	1	Boolean	Indicates if the storage supports RDMA.
ownerId	M	0..1	Identifier	Identifier of the virtualised resource that owns and uses such a virtualised storage resource. The value can be NULL if the virtualised storage is not attached yet to any other resource (e.g. a virtual machine).
zoneId	M	0..1	Identifier	If present, it identifies the resource zone where the virtual storage resources have been allocated.
hostId	M	0..1	Identifier	Identifier of the host where the virtualised storage resource is allocated. A cardinality of 0 refers to distributed storage solutions.
operationalState	M	1	Enum	Operational state of the resource. VALUES: <ul style="list-style-type: none"> • ENABLED • DISABLED
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.4.8 Information elements related to Affinity or AntiAffinity

8.4.8.1 Introduction

This clause defines information elements needed to express affinity and anti-affinity of a given virtualised resource (i.e. a virtualised compute, storage or network resource).

Two ways of specifying affinity or anti-affinity can be distinguished: Explicit resource lists and named resource groups. In case of an explicit resource list, the consumer manages the list of resources the actual resource is requested to be affine or anti-affine with, and builds the list as more resources are created. In case of a named resource group, the consumer needs to create the group first by invoking the appropriate operation to create a Compute/Storage/Network resource affinity or anti-affinity constraints group defined in clauses 7.3.1.9, 7.4.1.6 and 7.5.1.9. Subsequently, as part of resource creation, the consumer passes the name(s) or identifier(s) of the group(s) to the producer which manages and builds the group of resources.

The VIM shall support both explicit resource lists and named resource groups for affinity/anti-affinity. The VNFM shall support at least one of these options.

8.4.8.2 AffinityOrAntiAffinityConstraint information element

8.4.8.2.1 Description

This clause describes the attributes for the AffinityOrAntiAffinityConstraint information element.

8.4.8.2.2 Attributes

The AffinityOrAntiAffinityConstraint information element shall follow the indications provided in table 8.4.8.2.2-1.

Table 8.4.8.2.2-1: Attributes of the AffinityOrAntiAffinityConstraint information element

Attribute	Qualifier	Cardinality	Content	Description
type	M	1	Enum	Indicates whether this is an affinity or anti-affinity constraint. VALUES: <ul style="list-style-type: none"> AFFINITY ANTI_AFFINITY
scope	M	0..1	Enum	Qualifies the scope of the constraint. In case of compute resource, the values are as follows: VALUES: <ul style="list-style-type: none"> NFVI_POP NFVI_NODE etc. In case of ports, the values are as follows: VALUES: <ul style="list-style-type: none"> VIRTUAL_SWITCH_OR_ROUTER PHYSICAL_NIC PHYSICAL_NETWORK NFVI_NODE etc. In case of networks, the values are as follows: VALUES: <ul style="list-style-type: none"> PHYSICAL_NIC PHYSICAL_NETWORK NFVI_NODE etc. In case of subnets, it should be ignored. Defaults to "NFVI_NODE" if absent.
affinityOrAntiAffinityResourceList	M	0..1	AffinityOrAntiAffinityResourceList	Consumer-managed list of identifiers of virtualised resources with which the actual resource is requested to be affine or anti-affine. Either affinityOrAntiAffinityResourceList or affinityOrAntiAffinityResourceGroupId but not both shall be present.
affinityOrAntiAffinityResourceGroupId	M	0..1	Identifier	Identifier of the producer-managed group of virtualised resources with which the actual resource is requested to be affine or anti-affine. Either affinityOrAntiAffinityResourceList or affinityOrAntiAffinityResourceGroupId but not both shall be present.
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.			
CONDITION:	If explicit resource lists for affinity/anti-affinity (see clause 8.4.8.1) are supported, the affinityOrAntiAffinityResourceList information element shall be supported. If named resource groups for affinity/anti-affinity (see clause 8.4.8.1) are supported, the affinityOrAntiAffinityResourceGroupId information element shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (a.k.a VIM tenant).			

8.4.8.3 AffinityOrAntiAffinityResourceList information element

8.4.8.3.1 Description

The AffinityOrAntiAffinityResourceList information element defines an explicit list of resources to express affinity or anti-affinity between these resources and a current resource. The scope of the affinity or anti-affinity can also be defined.

8.4.8.3.2 Attributes

The AffinityOrAntiAffinityResourceList information element shall follow the indications provided in table 8.4.8.3.2-1.

Table 8.4.8.3.2-1: Attributes of the AffinityOrAntiAffinityResourceList information element

Attribute	Qualifier	Cardinality	Content	Description
resourceId	M	1..N	Identifier	List of identifiers of virtualised resources.

8.4.9 VirtualisedResourceChangeNotification

8.4.9.1 Description

This notification informs the receiver of changes in the virtualised resources that are allocated or their groups. The support of the notification is mandatory.

8.4.9.2 Trigger conditions

This notification is produced when the virtualised resource will be impacted due to changes in underlying resources produced by maintenance and operation of the NFVI, including:

- Maintenance of NFVI components, e.g. physical maintenance/repair, hypervisor software updates, etc.
- Evacuation of physical hosts.
- Addition and removal of physical resources.
- Operation and management of NFVI resources, e.g. to support energy efficiency or resource usage optimization.

NOTE 1: All these operations could trigger further actions, e.g. migration of virtualised resources.

The VIM shall evaluate the NFVI operation and maintenance constraints (expressed as policies) (as specified in Annex B) available to the VIM (including system configured constraints and constraints from the VNFD) applicable to the virtualised resources and their groups to determine when notifications need to be produced and what content they need to provide for NFVI operation and maintenance.

The VIM shall provide the capability to provide notifications identifying the group of virtualised resources. If an NFVI operation and maintenance session is going to impact more than one member of a group, this notification about identifying the group of virtualised resources shall be provided to all subscribers before any member of the group is impacted.

NOTE 2: It is up to the protocol design stage to determine whether this notification can be modelled as a "bulk" operation that allows to send multiple notifications in one request, or as a series of operations that notify an (upcoming) impact at a time.

An end of changes to the group shall be notified when all impacts to the group members have been completed.

8.4.9.3 Attributes

The VirtualisedResourceChangeNotification notification shall follow the indications provided in table 8.4.9.3-1.

Table 8.4.9.3-1: Attributes of the VirtualisedResourceChangeNotification notification

Attribute	Qualifier	Cardinality	Content	Description
changedId	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 such virtualised resource was acknowledged.
virtualisedResourceGroupId	M	0..1	Identifier	Identifier of the affinity or anti-affinity group of the virtualised resource for which the change notification is issued. This identifier value shall be the same as the one returned when the affinity or anti-affinity group was created.
endOfChange	M	0..1	Boolean	If the value is True it indicates the end of the changes of virtualised resources for which the notification of type of change is issued.
changeTime	M	1	DateTime	Specifies the anticipated time of change of the virtualised resource for which the change notification is issued or the ending time of changes of virtualised resources if the value of the endOfChange is "true".
vimId	M	1	Identifier	Identifier of the VIM reporting the change.
changeType	M	1	String	Categorizes the type of change. Possible values can be related to maintenance and operation of the NFVI, including e.g. normal, maintenance, evacuation, optimization, etc.
changedResourceData	M	0..1	Not specified	Details of the changes of the resource. Its content can differ based on the different values of the attribute changeType.

8.4.10 UserData information element

8.4.10.1 Description

This clause describes the attributes for the UserData information element.

8.4.10.2 Attributes

The UserData information element shall follow the indications provided in table 8.4.10.2-1.

Table 8.4.10.2-1: Attributes of the UserData information element

Attribute	Qualifier	Cardinality	Content	Description
content	M	1	String	Contains the user data to customize a virtualised compute resource at boot-time.
method	M	0..1	Enum	Method used as transportation media to convey the content of the UserData and the CertificateData to the virtualised compute resource. VALUES: <ul style="list-style-type: none"> • CONFIG_DRIVE • CONFIG_DRIVE_MIME_multi-part • etc.
certificateData	M	0..N	CertificateData	Contains the additional user data to store certificate data for the VNF composed of (fully or partially) virtualised compute resource at boot-time. Shall be present if delegation-mode is used. Otherwise it shall be absent.

8.4.11 CertificateData information element

8.4.11.1 Description

This clause describes the attributes for the CertificateData information element.

8.4.11.2 Attributes

The CertificateData information element shall follow the indications provided in table 8.4.11.2-1.

Table 8.4.11.2-1: Attributes of the CertificateData information element

Attribute	Qualifier	Cardinality	Content	Description
privateKey	M	0..1	Not specified	Private key paired with signed public key. VNFM shall generate both private key and public key and set this attribute. See note.
certificateFile	M	0..1	Not specified	Signed certificate including public key and certificate chain. See note.
keystoreFile	M	0..1	Not specified	Keystore which includes the private key, signed certificate and certificate chain, e.g. pkcs#12, pfx. Credentials to read this file shall be provided to the VNF instance by outbound. See note.
certSubjectData	M	0..1	Not specified	Subject to be signed.
certificateProfileName	M	0..1	Not specified	Name of certificate profile to be signed.
NOTE: Either set of "privatekey" and "certificateFile" or "keystoreFile" but not both shall be present.				

8.5 Information elements and notifications related to Virtualised Resources Performance Management

8.5.1 Introduction

The clauses below define information elements and notifications related to virtualised resources performance management.

8.5.2 ObjectSelection information element

8.5.2.1 Description

This information element allows to specify resources on which performance information will be provided.

The object types for this information element will be the measured object types defined in the ETSI GS NFV-IFA 027 [2] for virtualised resources.

The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

8.5.2.2 Attributes

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

Table 8.5.2.2-1: Attributes of the ObjectSelection information element

Attribute	Qualifier	Cardinality	Content	Description
objectType	M	0..N	String	Provides the measured object type. The object types for this information element will be the measured object types defined in ETSI GS NFV-IFA 027 [2] for virtualised resources. One of the two alternatives (objectType+ objectFilter or objectInstancelid) shall be present.
objectFilter	M	0..1	Filter	Filter applied on the object types to specify on which object instances the performance information is requested to be collected. One of the two alternatives (objectType+ objectFilter or objectInstancelid) shall be present.
objectInstancelid	M	0..N	Identifier	Identifies the object instances for which performance information is requested to be collected. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface. One of the two alternatives (objectType+ objectFilter or objectInstancelid) 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 corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. 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 job.
objectSelector	M	1	ObjectSelection	Defines the object instances for which performance information is requested to be collected. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface. See clause 8.5.1.
performanceMetric	M	0..N	String	Defines the type of performance metric(s) for the specified object instances. Valid values are specified as "Measurement Name" values in clause 7.1 of ETSI GS NFV-IFA 027 [2]. At least one of the two (performance metric or group) shall be present.
performanceMetricGroup	M	0..N	String	Group of performance metrics. A metric group is a pre-defined list of metrics, known to the producer that it can decompose to individual metrics. Valid values are specified as "Measurement Group" values in clause 7.1 of ETSI GS NFV-IFA 027 [2]. At least one of the two (performance metric or group) shall be present.
collectionPeriod	M	1	Not specified	Specifies the periodicity at which the producer will collect performance information. See note.
reportingPeriod	M	1	Not specified	Specifies the periodicity at which the producer will report to the consumer about performance information. See note.
reportingBoundary	O	0..1	Not specified	Identifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE:	At the end of each reportingPeriod, the producer will inform the consumer about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reportingPeriod is part of the protocol design, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.			

8.5.4 Threshold information element

8.5.4.1 Description

This information element provides the details of a threshold.

The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

8.5.4.2 Attributes

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

Table 8.5.4.2-1: Attributes of the Threshold information element

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier	Identifier of the threshold.
objectSelector	M	1	ObjectSelection	Defines the object instances associated with the threshold. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface. See clause 8.5.1.
performanceMetric	M	1	String	Defines the performance metric associated with the threshold. Valid values are specified as "Measurement Name" values in clause 7.1 of ETSI GS NFV-IFA 027 [2].
thresholdType	M	1	Enum	Type of threshold. The list of possible values is part of the protocol design, and might include: single/multi valued threshold, static/dynamic threshold, template based threshold. VALUES: <ul style="list-style-type: none"> • SIMPLE: Single-valued static threshold • etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, details on the notification to be generated.

8.5.5 PerformanceReport information element

8.5.5.1 Description

This information element defines the format of a performance report provided by the producer to the consumer on a specified object instance or a set of them.

The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

8.5.5.2 Attributes

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

Table 8.5.5.2-1: Attributes of the PerformanceReport information element

Attribute	Qualifier	Cardinality	Content	Description
performanceReport	M	1..N	PerformanceReport Entry	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 measured object types defined in ETSI GS NFV-IFA 027 [2] for virtualised resources.

The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

8.5.6.2 Attributes

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

Table 8.5.6.2-1: Attributes of the PerformanceReportEntry information element

Attribute	Qualifier	Cardinality	Content	Description
objectType	M	1	String	Defines the object type The object types for this information element will be the measured object types defined in ETSI GS NFV-IFA 027 [2] for virtualised resources.
objectInstanceId	M	1	Identifier	Object instance for which the performance metric is reported. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.
performanceMetric	M	1	String	Name of the metric collected. This attribute's value contains the related "Measurement Name" value as defined in clause 7.1 of ETSI GS NFV-IFA 027 [2].
performanceValue	M	1..N	PerformanceValueEntry	List of performance values with associated timestamp, and measurement context (see ETSI GS NFV-IFA 027 [2]).

8.5.7 PerformanceValueEntry information element

8.5.7.1 Description

This information element defines a single performance value with its associated time stamp and measurement context (see ETSI GS NFV-IFA 027 [2]).

8.5.7.2 Attributes

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

Table 8.5.7.2-1: Attributes of the PerformanceValueEntry information element

Attribute	Qualifier	Cardinality	Content	Description
timeStamp	M	1	DateTime	Timestamp indicating when the data was collected.
performanceValue	M	1	Value	Value of the metric collected. The type of this attribute correspond to the related "Measurement Unit" as defined in clause 7.1 of ETSI GS NFV-IFA 027 [2].
measurementContext	M	0..1	Not specified	Measurement context of the metric collected. The specific measurement context for each kind of performance metrics is defined in ETSI GS NFV-IFA 027 [2].

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 corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. 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 notification shall follow the indications provided in table 8.5.8.3-1.

Table 8.5.8.3-1: Attributes of the PerformanceInformationAvailableNotification notification

Attribute	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1..N	Identifier	Object instances for which performance information is available. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

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 corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

8.5.9.2 Trigger Condition

A Threshold has been crossed. Depending on threshold type, there might be a single or multiple crossing values.

8.5.9.3 Attributes

The ThresholdCrossedNotification notification shall follow the indications provided in table 8.5.9.3-1.

Table 8.5.9.3-1: Attributes of the ThresholdCrossedNotification notification

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier (Reference to Threshold)	Threshold which has been crossed.
crossingDirection	M	1	Enum	Indication of whether the threshold was crossed in upward or downward direction. VALUES: <ul style="list-style-type: none"> • UP • DOWN
objectInstanceId	M	1	Identifier	Object instance for which the threshold has been crossed. The object instances for this information element will be virtualised resources corresponding to the measured object types defined in ETSI GS NFV-IFA 027 [2]. These resources shall be known by the Virtualised Resource Management interface.

Attribute	Qualifier	Cardinality	Content	Description
performanceMetric	M	1	String	Performance metric associated with the threshold. Valid values are specified as "Measurement Name" values in clause 7.1 of ETSI GS NFV-IFA 027 [2].
performanceValue	M	1	Value	Value of the metric that resulted in threshold crossing.
measurementContext	M	0..1	Not specified	Measurement context of the metric collected. The specific measurement context for each kind of performance metrics is defined in ETSI GS NFV-IFA 027 [2].

8.6 Information elements and notifications related to Virtualised Resources Fault Management

8.6.1 Introduction

This clause defines information elements and notifications 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 notification shall follow the indications provided in table 8.6.2.3-1.

Table 8.6.2.3-1: Attributes of the AlarmNotification notification

Attribute	Qualifier	Cardinality	Content	Description
alarm	M	1	Alarm	Information about an alarm including alarmId, affected resourceId and faultDetails. See clause 8.6.4.

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 notification shall follow the indications provided in table 8.6.3.3-1.

Table 8.6.3.3-1: Attributes of the AlarmClearedNotification notification

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier (Reference to Alarm)	Alarm identifier.
alarmClearedTime	M	1	DateTime	Timestamp indicating when the alarm was cleared.

8.6.4 Alarm information element

8.6.4.1 Description

The Alarm information element encapsulates information about an alarm.

The Managed Objects for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface.

The allowed values for the faultType attribute depend on the type of the related managed object. 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 [i.7]).

8.6.4.2 Attributes

The Alarm information element shall follow the indications provided in table 8.6.4.2-1.

Table 8.6.4.2-1: Attributes of the Alarm information element

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier	Alarm identifier.
managedObjectId	M	1	Identifier	Identifier of the affected managed Object. The Managed Objects for this information element will be virtualised resources. These resources shall be known by the Virtualised Resource Management interface (see clause 7.8).
alarmRaisedTime	M	1	DateTime	Timestamp indicating when the alarm was first raised by the managed object.
alarmChangedTime	M	0..1	DateTime	Timestamp indicating when the alarm was last changed. It shall be present if the alarm has been updated.
alarmClearedTime	M	0..1	DateTime	Timestamp indicating when the alarm was cleared. It shall be present if the alarm has been cleared.
state	M	1	Enum	State of the alarm. VALUES: <ul style="list-style-type: none"> • FIRED • UPDATED • CLEARED
perceivedSeverity	M	1	Enum	Perceived severity of the virtualised managed object failure. VALUES: <ul style="list-style-type: none"> • CRITICAL • MAJOR • MINOR • WARNING • INDETERMINATE • CLEARED
eventTime	M	1	DateTime	Timestamp indicating when the fault was observed.

Attribute	Qualifier	Cardinality	Content	Description
eventType	M	1	Enum	Type of the event. The allowed values for the eventType attribute use the event type defined in Recommendation ITU-T X.733 [1]: VALUES: <ul style="list-style-type: none"> • COMMUNICATION_ALARM • PROCESSING_ALARM • ENVIRONMENT_ALARM • QOS_ALARM • EQUIPMENT_ALARM
faultType	M	0..1	String	Information related to the type of the fault. The allowed values for the faultType attribute depend on the type of the related managed object. 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	Not specified	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 Reservation

8.7.1 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 related to reservation.

8.7.2 ReservedVirtualCompute information element

8.7.2.1 Description

The compute resource reservation information element encapsulates information about a reservation for virtualised compute resources. It includes information about virtual compute resource pool and virtualisation container reservations.

8.7.2.2 Attributes

The ReservedVirtualCompute information element shall follow the indications provided in table 8.7.2.2-1.

Table 8.7.2.2-1: Attributes of the ReservedVirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the resource reservation that has been reserved.
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 8.7.3.2.

Attribute	Qualifier	Cardinality	Content	Description
virtualisationContainerReserved	M	0..N	ReservedVirtualisationContainer	Information about the virtualisation container(s) that have been reserved. See clause 8.7.5.2.
reservationStatus	M	1	Enum	Status of the compute resource reservation, e.g. to indicate if a reservation is being used. VALUES: <ul style="list-style-type: none"> RESERVATION_BEING_USED RESERVATION_NOT_USED
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication when the reservation ends (when it is expected that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

8.7.3 Information elements related to Compute Pool Reservation

8.7.3.1 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.

8.7.3.2 ReservedComputePool information element

8.7.3.2.1 Description

This clause describes the attributes for the ReservedComputePool information element.

8.7.3.2.2 Attributes

The ReservedComputePool information element shall follow the indications provided in table 8.7.3.2.2-1.

Table 8.7.3.2.2-1: Attributes of the ReservedComputePool information element

Attribute	Qualifier	Cardinality	Content	Description
numCpuCores	M	1	Integer	Number of CPU cores that have been reserved.
numVclInstances	M	1	Integer	Number of virtual container instances that have been reserved.
virtualMemSize	M	1	Number	Size of virtual memory that has been reserved.
computeAttributes	M	1	ReservedVirtualComputeAttributes	Information specifying additional attributes of the virtual compute resource that have been reserved. See clause 8.7.3.3.
zoneld	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtual compute resources have been reserved. If not present then the reserved compute resources are not bound to a specific resource zone.

8.7.3.3 ReservedVirtualComputeAttributes information element

8.7.3.3.1 Description

This clause describes the attributes for the ReservedVirtualComputeAttributes information element.

8.7.3.3.2 Attributes

The ReservedVirtualComputeAttributes information element shall follow the indications provided in table 8.7.3.3.2-1.

Table 8.7.3.3.2-1: Attributes of the ReservedVirtualComputeAttributes information element

Attribute	Qualifier	Cardinality	Content	Description
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided.
cpuArchitecture	M	0..1	Not specified	CPU architecture type. Examples are "x86", "ARM". The cardinality can be 0, if no particular CPU architecture type is provided.
virtualCpuOverSubscriptionPolicy	M	0..1	Not specified	CPU core oversubscription policy in terms of virtual CPU cores to physical CPU cores/threads on the platform. The cardinality can be 0, if no particular value is provided.

8.7.4 Information elements related to Network reservation

8.7.4.1 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.

8.7.4.2 ReservedVirtualNetwork information element

8.7.4.2.1 Description

This clause describes the attributes for the ReservedVirtualNetwork information element.

8.7.4.2.2 Attributes

The ReservedVirtualNetwork information element shall follow the indications provided in table 8.7.4.2.2-1.

Table 8.7.4.2.2-1: Attributes of the ReservedVirtualNetwork information element

Attribute	Qualifier	Cardinality	Content	Description
reservationId	M	1	Identifier	Identifier of the resource reservation.
publicIpAddresses	M	0..1	ReservedPublicIpAddresses	Information specifying the list of public IP addresses that have been reserved. See clause 8.7.4.5.
networkAttributes	M	1	ReservedVirtualNetworkAttributes	Information specifying additional attributes of the network resource that has been reserved. See clause 8.7.4.3.
networkPorts	M	0..N	ReservedVirtualNetworkPort	List of specific network ports that have been reserved. See clause 8.7.4.4.

Attribute	Qualifier	Cardinality	Content	Description
reservationStatus	M	1	Enum	Status of the network resource reservation, e.g. to indicate if a reservation is being used. VALUES: <ul style="list-style-type: none"> RESERVATION_BEING_USED RESERVATION_NOT_USED
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication when the reservation ends (when it is expected that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.
zoneId	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtual network resources have been reserved. If not present, the reserved network resources are not bound to a specific resource zone.

8.7.4.3 ReservedVirtualNetworkAttributes information element

8.7.4.3.1 Description

This clause describes the attributes for the ReservedVirtualNetworkAttributes information element.

8.7.4.3.2 Attributes

The ReservedVirtualNetworkAttributes information element shall follow the indications provided in table 8.7.4.3.2-1.

Table 8.7.4.3.2-1: 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: <ul style="list-style-type: none"> "local"; "vlan"; "vxlan"; "gre"; etc.
segmentationId	M	0..1	Integer	The segmentation identifier of the network that maps to the virtualised network that has been reserved, for which, the segmentation model is defined by the networkType attribute. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, it corresponds to a gre key. Cardinality can be "0" to cover the case where networkType is flat network without any specific segmentation.
isShared	M	1	Boolean	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.

8.7.4.4 ReservedVirtualNetworkPort information element

8.7.4.4.1 Description

This clause describes the attributes for the ReservedVirtualNetworkPort information element.

A network port is a communication endpoint under a network.

8.7.4.4.2 Attributes

The ReservedVirtualNetworkPort information element shall follow the indications provided in table 8.7.4.4.2-1.

Table 8.7.4.4.2-1: Attributes of the ReservedVirtualNetworkPort information element

Attribute	Qualifier	Cardinality	Content	Description
portId	M	1	Identifier	Identifier of the network port that has been reserved.
portType	M	1	Not specified	Type of network port. Examples of types are access ports, or trunk ports (layer 1) that become transport for multiple layer 2 or layer 3 networks.
bandwidth	M	0..1	Number	Bitrate of the virtual network port (in Mbps).
metadata	O	0..N	KeyValuePair	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

8.7.4.5 ReservedPublicIpAddresses information element

8.7.4.5.1 Description

This clause describes the attributes for the ReservedPublicIpAddresses information element.

8.7.4.5.2 Attributes

The ReservedPublicIpAddresses information element shall follow the indications provided in table 8.7.4.5.2-1.

Table 8.7.4.5.2-1: Attributes of the ReservedPublicIpAddresses information element

Attribute	Qualifier	Cardinality	Content	Description
networkId	M	1	Identifier	Unique identifier of the network from which public IP addresses have been reserved.
publicIps	M	1..N	IpAddress	List of public IP addresses that have been reserved.

8.7.5 Information elements related to Virtualisation Container Reservation

8.7.5.1 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.

8.7.5.2 ReservedVirtualisationContainer information element

8.7.5.2.1 Description

This clause describes the attributes for the ReservedVirtualisationContainer information element.

8.7.5.2.2 Attributes

The ReservedVirtualisationContainer information element shall follow the indications provided in table 8.7.5.2.2-1.

Table 8.7.5.2.2-1: Attributes of the ReservedVirtualisationContainer information element

Attribute	Qualifier	Cardinality	Content	Description
containerId	M	1	Identifier	Identifier of the virtualisation container that has been reserved.
flavourId	M	1	Identifier	Identifier of the given compute flavour used to reserve the virtualisation container.
accelerationCapability	M	0..N	Not specified	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources. The cardinality can be 0, if no particular acceleration capability is provided.
virtualMemory	M	1	VirtualMemory	Virtual memory of the reserved virtualisation container.
virtualCpu	M	1	VirtualCpu	Virtual CPU(s) of the reserved virtualisation container.
virtualDisks	M	1..N	VirtualStorage	Provides with information of the virtualised storage resources attached to the reserved virtualisation container.
virtualNetworkInterface	M	0..N	VirtualNetworkInterface	Provides 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.

8.7.6 Information elements related to Storage reservation

8.7.6.1 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.

8.7.6.2 ReservedVirtualStorage information element

8.7.6.2.1 Description

This clause describes the attributes for the ReservedVirtualStorage information element.

8.7.6.2.2 Attributes

The ReservedVirtualStorage information element shall follow the indications provided in table 8.7.6.2.2-1.

Table 8.7.6.2.2-1: 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 8.7.6.3.
reservationStatus	M	1	Enum	Status of the storage resource reservation, e.g. to indicate if a reservation is being used. VALUES: <ul style="list-style-type: none"> RESERVATION_BEING_USED RESERVATION_NOT_USED
startTime	M	0..1	DateTime	Indication when the consumption of the resources starts. If not present, resources are reserved for immediate use.
endTime	M	0..1	DateTime	Indication when the reservation ends (when it is expected that the resources will no longer be needed) and used by the VIM to schedule the reservation. If not present, resources are reserved for unlimited usage time.
expiryTime	M	0..1	DateTime	Indication when the VIM can release the reservation in case no allocation request against this reservation was made.

8.7.6.3 ReservedStoragePool information element

8.7.6.3.1 Description

This clause describes the attributes for the ReservedStoragePool information element.

8.7.6.3.2 Attributes

The ReservedStoragePool information element shall follow the indications provided in table 8.7.6.3.2-1.

Table 8.7.6.3.2-1: 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 has been reserved.
numVolumes	M	1	Integer	Number of volumes that has been reserved.
zoneld	M	0..1	Identifier (Reference to ResourceZone)	References the resource zone where the virtual storage resources have been reserved. If not present, the reserved storage resources are not bound to a specific resource zone.

8.7.7 VirtualisedResourceReservationChangeNotification

8.7.7.1 Description

This notification indicates a change in a virtualised resource reservation. Support of this notification is mandatory.

8.7.7.2 Trigger conditions

This notification is triggered when:

- A resource reservation is being updated.

- A resource reservation changed due to changes in underlying resources that are part of this reservation.

8.7.7.3 Attributes

The VirtualisedResourceReservationChangeNotification notification shall follow the indications provided in table 8.7.7.3-1.

Table 8.7.7.3-1: Attributes of the VirtualisedResourceReservationChangeNotification notification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the virtualised resource reservation.
reservationId	M	1	Identifier	Identifies the reservation being changed.
vimId	M	1	Identifier	Identifies the VIM reporting the change.
changeType	M	1	String	Categorizes the type of change. Possible values can be related to an update of the reservation or a change in the resources part of the reservation.
changedReservationData	M	0..1	Not specified	Details of the changes of the reservation.

8.8 Information elements and notifications related to Quota

8.8.1 Introduction

The clauses below define information elements and notifications related to Quota. 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.

8.8.2 Information elements related to Compute Quota

8.8.2.1 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.

8.8.2.2 VirtualComputeQuota information element

8.8.2.2.1 Description

This clause describes the attributes for the VirtualComputeQuota information element.

8.8.2.2.2 Attributes

The VirtualComputeQuota information element shall follow the indications provided in table 8.8.2.2-1.

Table 8.8.2.2-1: 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 virtual container instances that have been restricted by the quota. The cardinality can be 0 if no specific number of virtualisation container instances has been requested to be restricted by the quota.

Attribute	Qualifier	Cardinality	Content	Description
virtualMemSize	M	0..1	Number	Size of virtual memory that has been restricted by the quota. The cardinality can be 0 if no specific size of virtual memory has been requested to be restricted by the quota.

8.8.3 Information elements related to Network Quota

8.8.3.1 Introduction

The network quota information elements encapsulate information about virtual 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.

8.8.3.2 VirtualNetworkQuota information element

8.8.3.2.1 Description

This clause describes the attributes for the VirtualNetworkQuota information element.

8.8.3.2.2 Attributes

The VirtualNetworkQuota 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 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.

8.8.4 Information elements related to Storage Quota

8.8.4.1 Introduction

The storage quota information elements encapsulate information about virtual storage resource quotas. A storage quota includes information about the size of storage, number of snapshots, and number of volumes.

8.8.4.2 VirtualStorageQuota information element

8.8.4.2.1 Description

This clause describes the attributes for the VirtualStorageQuota information element.

8.8.4.2.2 Attributes

The VirtualStorageQuota 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 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. The 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.

8.8.5 VirtualisedResourceQuotaChangeNotification

8.8.5.1 Description

This notification indicates a Quota change in a virtualised resource. Support of this notification is mandatory.

8.8.5.2 Trigger conditions

This notification is triggered when:

- A resource Quota is being updated.

8.8.5.3 Attributes

The VirtualisedResourceQuotaChangeNotification notification shall follow the indications provided in table 8.8.5.3-1.

Table 8.8.5.3-1: Attributes of the VirtualisedResourceQuotaChangeNotification notification

Attribute	Qualifier	Cardinality	Content	Description
changeId	M	1	Identifier	Unique identifier of the change on the virtualised resource Quota.
resourceGroupId	M	1	Identifier	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain.
vimId	M	1	Identifier	Identifies the VIM reporting the change.
changeType	M	1	String	It categorizes the type of change. Possible values can be related to an update of the Quota.
changedQuotaData	M	0..1	Not specified	Details of the changes of the Quota.

8.9 Information elements and notifications related to Policy Management

8.9.1 Introduction

The clauses below define information elements and notifications related to policy management.

8.9.2 Information elements related to Policy Management Operations

8.9.2.1 Introduction

The clauses below define information elements related to policy management operations.

8.9.2.2 PolicyInfo information element

8.9.2.2.1 Description

This information element provides policy related information. It contains the policy itself and additional information related to the policy.

8.9.2.2.2 Attributes

The structure of the PolicyInfo information element shall comply with the provisions for the PolicyInfo information element as defined in clause 8.8.2.2.2 of ETSI GS NFV-IFA 013 [i.9].

8.9.3 PolicyChangeNotification

8.9.3.1 Description

This notification indicates a change of a NFV-MANO policy related to operations of transferring policy, deleting policy, activating policy and deactivating policy.

Support of this notification is mandatory.

8.9.3.2 Trigger Conditions

The notification is produced when:

- A policy has been changed as a result of an operation of TransferPolicy, DeletePolicy, ActivatePolicy or DeactivatePolicy.

8.9.3.3 Attributes

The PolicyChangeNotification shall comply with the provisions in clause 8.8.3.3 of ETSI GS NFV-IFA 013 [i.9].

8.9.4 PolicyConflictNotification

8.9.4.1 Description

This notification indicates a policy conflict is detected by the VIM. A policy conflict can include any conflicted monitored events, conditions or actions among two or more policies enforced by the VIM.

Support of this notification is mandatory.

8.9.4.2 Trigger Conditions

The notification is produced when:

- A policy conflict is detected by the VIM.

8.9.4.3 Attributes

The PolicyConflictNotification shall comply with the provisions in clause 8.8.4.3 of ETSI GS NFV-IFA 013 [i.9].

Annex A (informative): Bibliography

- ETSI GS NFV 002 (V1.1.1): "Network Functions Virtualisation (NFV); Architectural Framework".

Annex B (normative): NFVI operation and maintenance policies

The activities of NFVI operation and maintenance (e.g. NFVI software modification) have impact on VNF instances running on top of those NFVI resources to be changed. To minimize the impact on the service continuity of the VNF instances, a set of constraints shall be applied during this process. Based on this set of constraints, different actions can be taken to mitigate the impact of the NFVI operation and maintenance on the hosted VNF instances.

The VIM and the VNFM shall support the constraints of NFVI operation and maintenance (as specified in clause 5.6 of ETSI GS NFV-IFA 010 [i.7]) expressed through NFVI operation and maintenance policies.

For creating NFVI operation and maintenance policies, the VNFM determines the NFVI operation and maintenance constraints applicable to virtualised resources and their groups, based on the applicable constraints provided e.g.:

- in the VNFD (e.g. NFVI maintenance info); or
- by the EM over Ve-Vnfm-em reference point through NFVI operation and maintenance policies. See Annex C of ETSI GS NFV-IFA 008 [i.6].

NOTE 1: There might be inconsistencies between the NFVI operation and maintenance constraints and the current placement and/or placement constraints of the virtualised resources they apply to because the resource placement which correlates with the NFVI operation and maintenance constraints can be influenced by NFVO and VNFM in addition to the affinity/anti-affinity constraints given in VNFD.

NOTE 2: If the VNFM subscribes to the notification related to virtualised resource changes from VIM, VNFM will receive notification messages of `VirtualisedResourceChangeNotification` from the VIM, which indicates the upcoming change of virtualised resources due to the impact of NFVI operation and maintenance.

NOTE 3: The EM can send constraints (if available) related to the NFVI operation and maintenance to the VNFM at any time, including when it receives alarms of virtualised resource changes from VNFM.

The VNFM converts the constraints into policies, which are then provided (e.g. created or updated) to the VIM via the `TransferPolicyRequest` message of the Policy Management interface over the Vi-Vnfm reference point (see clause 7.10.2).

The NFVI operation and maintenance policy(ies) shall include all the information needed to express the applicable constraints of the virtualised resource(s), or group(s) of virtualised resources (which may include the impacted virtualised resource(s)). From this information the VIM shall be able to establish the association between the NFVI maintenance and operation constraints and the virtualised resource(s), or group(s) of virtualised resources.

Whenever the VIM receives the NFVI operation and maintenance policy(ies), it verifies the constraints expressed in the policy(ies), e.g. checking the consistency of the constraints in the policy(ies) and the information it maintains for the targeted virtualised resource or the group of virtualised resources. In case of any conflict, the VIM responds to the VNFM with a `TransferPolicyResponse` message indicating the failure and any appropriate additional information. Otherwise it responds with success and stores the received constraints in order to apply them for an upcoming or the ongoing NFVI operation and maintenance as applicable.

In addition, the VNFM can delete, query, activate or deactivate the policy containing the constraints applying in NFVI operation and maintenance by using the existing operations (e.g. `DeletePolicy`, `QueryPolicy`, `ActivatePolicy`, `DeactivatePolicy`) of Policy Management interface.

Annex C (informative): Change history

Date	Version	Information about changes
November 2018	V3.1.2	Reference baseline was ETSI GS NFV-IFA 006 V3.1.1 (2018-08) <ul style="list-style-type: none"> NFVIFA(18)000886 - IFA006ed321 update of IEs related to PM interface for ETSI GS NFV-IFA 027 alignment
May 2019	V3.2.2	Base line version for ed331 created from published version 3.2.1
July 2019	V3.2.3	Implements following CRs: <ul style="list-style-type: none"> NFVIFA(19)000543r2 - IFA006ed331 Descriptor support for VR management NFVIFA(19)000545 - IFA006ed331 Remove definitions provided in NFV003 NFVIFA(19)000578 - IFA006ed331 Rel3Mirror Update parameter groupName NFVIFA(19)00040r8 - IFA006 MegaCR FEAT03 NFVI MOD
October 2019	V3.3.2	Base-line version for ed341 created from published version NFV-IFA006 v3.3.1
February 2020	V3.3.3	Implements following CRs: <ul style="list-style-type: none"> NFVIFA(19)000765 - IFA006ed341 8.5.9 measurementContext in ThresholdCrossedNotification NFVIFA(19)000776 - IFA006ed341 Alignment of descriptions NFVIFA(19)000861 - IFA006ed341 Editorial corrections NFVIFA(19)000877 - IFA006ed341 consistency corrections NFVIFA(19)000887 - IFA006ed341 relaxing PM subscriptions NFVIFA(19)000992r1 - IFA006 Improve wording left for protocol design stage
March 2020	V3.3.4	Implements following CRs: <ul style="list-style-type: none"> NFVIFA(20)000103r1 - IFA006ed341 sync to IFA005 work – correction on NetworkQoS NFVIFA(20)000104r1 - IFA006ed341 Fixes issues highlighted in NFVIFA(19)000942r7 except NetworkQoS NFVIFA(20)000105r2 - IFA006ed341 Fixing Mismatch on Cardinality and Content type
April 2020	V3.3.5	Implements following CRs: <ul style="list-style-type: none"> NFVIFA(20)000155 - IFA006ed341 Modify content of attributes thresholdId and alarmId NFVIFA(20)000159 - IFA006ed341 Fix Cardinality of attribute segmentType NFVIFA(20)000161 - IFA006ed341 Fix the attribute related to public IP Addresses for ReservedVirtualNetwork IE NFVIFA(20)000162 - IFA006ed341 Fix attribute typo numSubnet to numSubnets NFVIFA(20)000186r4 - IFA006ed341 fix enum values NFVIFA(20)000260 - IFA006ed341 - Fix Qualifier and Cardinality of ObjectSelection and PmJob IE NFVIFA(20)000308 - IFA006ed341 - Fixing Qualifier for the attributes of AffinityOrAntiAffinityConstraint IE NFVIFA(20)000309 - IFA006ed341 - Editorial change in PerformanceValueEntry IE NFVIFA(20)000347r1 - IFA006ed341 draft review comments
September 2020	V4.0.1	Release 4 initial draft version created from published version 3.4.1.
September 2020	V4.0.2	Implements following CRs: <ul style="list-style-type: none"> NFVIFA(20)000499 – IFA006ed411 mirror of 393r5 Adding Trunk Resource Management Interface. NFVIFA(20)000500 – IFA006ed411 mirror of 412r2 Updating Network Resource Management Interface. NFVIFA(20)000501 - IFA006ed411 mirror of 430r1 Adding Query and Update Trunk Resource Interface.

Date	Version	Information about changes
February 2021	V4.0.3	Implements following CRs: <ul style="list-style-type: none"> • NFVIFA(20)000769 – IFA006ed421 networkId in VirtualNetworkInterface (mirror of NFVIFA(20)000694) • NFVIFA(20)000899 – Release 4 mirror of NFVIFA(20)000828 IFA006 Correct a typo • NFVIFA(20)000915 – IFA006ed421 Mirror of NFVIFA(20)000851 • NFVIFA(20)000935 – IFA006ed421 (Mirror of 718r3) Modifications in VirtualComputeFlavour IE
September 2021	V4.2.2	Release 4 initial draft version for ed431 created from published version 4.2.1.
December 2022	V4.3.2	First draft for ed441 created from published version v4.3.1.
January 2023	V4.3.3	Implements following CRs: <ul style="list-style-type: none"> • NFVIFA(22)000288r2 – IFA006ed441 Changing informative reference from MAN001 to NFV006 • NFVIFA(23)000028r1 - (mirror of NFVIFA(23)000024) IFA006ed441 Policy management alignment with IFA048
March 2023	V4.4.2	Initial draft version for ed451 created from published version 4.4.1.
July 2023	V4.4.3	Implements following CRs: <ul style="list-style-type: none"> • NFVIFA(23)000239r4 - Enh01.01 IFA006ed451 MegaCR And following rapporteur actions: <ul style="list-style-type: none"> • Changed GS to GR for the GR NFV 003 reference in [i.1] • Removed version of ETSI GR NFV 003 from [i.1], to keep it uniform with how NFV003 is referenced in other IFA GSs • Corrected the NFV003 reference in NFVIFA(23)000239r4 from [i.2] to [i.1] • Updated the table of contents

History

Document history		
V4.2.1	May 2021	Publication
V4.3.1	May 2022	Publication
V4.4.1	March 2023	Publication
V4.5.1	September 2023	Publication