



Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; YAML data model specification for descriptor-based virtualised resource management

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Reference

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Foreword

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

Modal verbs terminology

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1 Scope

The present document specifies a set of YAML-based data models for descriptor-based virtualised resource management fulfilling the requirements concerning the input and output information exchanged over the virtualised resource management interfaces specified in the ETSI GS NFV-IFA 005 [1], and the ETSI GS NFV-IFA 006 [2]. The present document focuses on data models used in the virtualised resource descriptors for the Virtualised Compute interfaces, Virtualised Network interfaces and Virtualised Storage interfaces, which are used to perform orchestration and lifecycle management for consumable virtualised resources comprised of compute, network and storage. The present document also focuses on data models used in the virtualised resource descriptors for the Virtualised Resources Change Notification interfaces and Virtualised Resources Fault Management interfaces. Other virtualised resource management interfaces, as well as data models for information specified in ETSI GS NFV-IFA 011 [i.5] and ETSI GS NFV-IFA 014 [i.4], are out of the scope of the present document.

2 References

2.1 Normative references

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

- [1] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".
- [2] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".
- [3] Void.
- [4] "YAML Ain't Markup Language (YAML™) Version 1.2", 3rd Edition. Oren Ben-Kiki, Clark Evans, Ingy döt Net.

NOTE: Available at <http://www.yaml.org/spec/1.2/spec.html>.

- [5] IETF RFC 8259: "The JavaScript Object Notation (JSON) Data Interchange Format".

NOTE: Available at <https://tools.ietf.org/html/rfc8259>.

- [6] ETSI GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; NFV descriptors based on TOSCA specification".
- [7] JSON Schema.

NOTE: Available at <https://json-schema.org/>.

- [8] ETSI GS NFV-SOL 013: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; Specification of common aspects for RESTful NFV MANO APIs".

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

[i.1] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.2] Heat Orchestration Template (HOT) specification.

NOTE: Available at https://docs.openstack.org/heat/latest/template_guide/hot_spec.html.

[i.3] Openstack®-heat - Orchestration service APIs.

NOTE 1: Available at <https://docs.openstack.org/api-ref/orchestration/>.

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[i.4] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Network Service Templates Specification".

[i.5] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; VNF Descriptor and Packaging Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

3.2 Symbols

Void.

3.3 Abbreviations

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

JSON	JavaScript Object Notation
YAML	YAML Ain't Markup Language

4 General aspects

4.1 Overview

The present document defines the data model for the following interfaces used over the Vi-Vnfm and Or-Vi reference point, using YAML [4] as a data-serialization language:

- Virtualised Compute interfaces.
- Virtualised Network interfaces.
- Virtualised Storage interfaces.
- Virtualised Resources Change Notification interfaces.
- Virtualised Resources Fault Management interfaces.

The design of the data model for the above interfaces is based on the information model and requirements defined in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]. Protocols that use these data models are out of the scope of the present version of the present document.

In clause 4, general aspects are specified that apply to multiple data model on the Vi-Vnfm and Or-Vi reference point. The present document defines data models for input and output parameters derived from the above-mentioned information model. The data instances are used as input and output parameters specified in a virtualised resource descriptor, e.g. a HOT [i.2]. As an alternative, output parameters can also be obtained from an API provided by the template system of the underlying VIM implementation, e.g. the HEAT API [i.3], and be mapped to the data model defined in the present document.

In the subsequent clauses, the data model of the parameters to be used in virtualised resource descriptors as input and output for the individual interfaces are specified. Annex A provides examples of the use of the input and output parameters using HOT [i.2].

4.2 Definition of input and output parameters in YAML

4.2.1 Introduction

Clause 4.2 specifies the types and section definitions in YAML that are applicable for the present document, in particular, for the declaration of the input and output parameters.

4.2.2 Input parameters syntax definition

The set of parameters that are used as input to an operation for which a corresponding template is defined shall be prefixed by a tag named "nfv" and shall comply with the following YAML syntax definition:

```
nfv:
  <parameter_name>:
    type: <the type of parameter>
    description: <description of the parameter>
    default: <default value of the parameter>
    enum:
      - <enumerated values 1>
      - <enumerated values 2>
      ...
  <parameter_name_N>:
    ...
```

Where applicable, then name of a structured input parameter ends with the string "Data" (e.g. subnetData). A description of the syntax definition fields for declaring an input parameter follows. The fields shall comply with the provisions set out in Table 4.2.2-1.

Table 4.2.2-1: Input parameters syntax definition

Field	Required	Description
nfv	yes	The tag emphasizes a group of parameters defined in the present document.
<parameter_name_1>	yes	The name of the first parameter.
<parameter_name_N>	no	The name of the last parameter.
type	yes	The type of each parameter. It shall be a simple data type as defined in clause 4.4.2 or structured data types in clause 4.4.3.
description	yes	A human readable description for each parameter.
default	no	A default value for each parameter.
enum	no	A set of enumerated values for a parameter to restrict the value. It is applicable to parameters of type string or number.

4.2.3 Output parameters syntax definition

If a set of output parameters of an operation is defined in a template, these parameters shall comply with the following YAML [4] syntax definition:

```
<parameter_name>: value
  description: <description of the parameter>
  type: <type>
```

Where applicable, then name of a structured output parameter ends with the string "Info" (e.g. nfvSubnetInfo). A description of the syntax definition fields for declaring an output parameter follows. The fields shall comply with the provisions set out in Table 4.2.3-1.

Table 4.2.3-1: Output parameters syntax definition

Field	Required	Description
parameter_name	yes	The name of the parameter, which shall start with the prefix "nfv".
type	yes	The type of the parameter.
description	yes	A human readable description for the parameter.

4.3 Definition of output parameters as mapping to an API

The present document defines the set of attributes for each output parameter in the data model in clauses 6, 7 and 8. Besides providing the output parameters that are defined in the data model using the output parameters facility of a template (e.g. parameters in the "outputs" section of a HOT [i.2]), it is also possible to obtain these parameters via VIM-level APIs such as (such as the HEAT API [i.3]). In the latter case, the output parameters of a VIM-level API can be mapped to the data model for the output parameters defined in the present document. Taking this approach can offer performance advantages in case many resources are required to be managed by the same template. The choice of the mapping of a parameter to a template output parameter, or to a VIM-level API is a deployment decision outside the scope of the present document.

4.4 Common data types

4.4.1 Introduction

Clause 4.4 specifies the common data types that are used for declaring the parameters and grammar elements throughout the present document.

4.4.2 Simple data types

The present document uses the following simple data types as defined in Table 4.4.2-1. In order to accommodate tags with a broader meaning, the YAML specification recommends JSON schema [7] to be supported as an option. JSON schema is commonly supported by modern computing languages. Virtualised resource descriptors complying with the present document shall comply with the YAML v1.2 [4] and JSON schema [7] specifications.

Table 4.4.2-1: Simple data types

Type name	Description	Example(s)
String	A string as defined in YAML v1.2 [4].	"a string"
Number	A number as defined in IETF RFC 8259 [5] referred in JSON Schema [7].	"23", "-1.023E3"
Boolean	A data type that can take the following values: true, false. The type is defined in JSON Schema [7] and referred in YAML v1.2 [4].	"true", "false"

4.4.3 Structured data types

Following the format stated with the label of "nfv" in Table 4.4.3-1, individual structured data type is represented in the present document using ">" recursively as inline definition.

Table 4.4.3-1: Input or Output data model for {parameter name}

Parameter Name and Attributes	Type	Description
{parameter name}	{object, array}	Type of the parameter
{description}	-	Description of the parameter
{attribute}	{attribute type}	Type of {attribute}
>{sub attribute}	{sub attribute type in the attribute}	Type of {sub attribute}

object in JSON schema [7] is a type representing mapping from "keys" to "values". The syntax of object for parameter definition is represented with the following definition:

```
{parameter name}:
  description: <description of the parameter>
  type: object
  required:
    - {1st mandatory attribute}
    - {2nd mandatory attribute}
    - ...
  properties:
    {1st attribute}:
      type: e.g. object
      properties:
        {sub attribute}
    {2nd attribute}:
      ...
```

array in JSON schema [7] is a type representing an ordered list of elements. The syntax of array for parameter definition is represented with the following definition:

```
{parameter name}:
  description: <description of the parameter>
  type: array
  minItems: {lower bound of cardinality}
  maxItems: {upper bound of cardinality}
  items:
    - type: e.g. object
      properties:
        {sub attribute}
```

5 Common data model

5.1 Description

This clause specifies data models for input and output parameters commonly used in different resource management.

5.2 Parameters to be used as input

5.2.1 Parameter: reservationId

The parameter used when pointing to a virtualised compute, network or storage resource shall follow the indications provided in Table 5.2.1-1.

Table 5.2.1-1: Input data model for reservationId

Parameter Name and Attributes	Type	Description
reservationId	String	Identifier of the resource reservation applicable to this virtualised resource management operation

The syntax of the reservationId shall comply with the following definition:

```
reservationId:
  type: string
  description: >
    Identifier of the resource reservation applicable to this virtualised resource
    management operation
  default: ""
```

5.2.2 Parameter: resourceGroupId

The parameter used when pointing to a logical grouping of virtual resources assigned to a tenant shall follow the indications provided in Table 5.2.2-1.

Table 5.2.2-1: Input data model for resourceGroupId

Parameter Name and Attributes	Type	Description
resourceGroupId	String	Unique identifier of the "infrastructure resource group", logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain

The syntax of the resourceGroupId shall comply with the following definition:

```
resourceGroupId:
  description: >
    The identifier of the infrastructure resource group, logical grouping of virtual
    resources assigned to a tenant within an Infrastructure Domain of this
    virtualised resource management operation
  type: string
  default: ""
```

5.2.3 Parameter: groupName

The parameter used when giving a group name of a virtualised compute, network or storage resource affinity or anti-affinity constraints group to be created shall follow the indications provided in Table 5.2.3-1.

Table 5.2.3-1: Input data model for groupName

Parameter Name and Attributes	Type	Description
groupName	String	Name of the group, given by the consumer

The syntax of the `groupName` shall comply with the following definition:

```
groupName:
  type: string
  description: >
    Name of the group, given by the consumer
  default: ""
```

5.2.4 Parameter: `typeOfAffinityOrAntiAffinityConstraints`

The parameter used when indicating whether this is an affinity or anti-affinity group for virtualised compute, network or storage resources shall follow the indications provided in Table 5.2.4-1.

Table 5.2.4-1: Input data model for `typeOfAffinityOrAntiAffinityConstraints`

Parameter Name and Attributes	Type	Description
<code>typeOfAffinityOrAntiAffinityConstraints</code>	String	Indicates whether this is an affinity or anti-affinity group

The syntax of the `typeOfAffinityOrAntiAffinityConstraints` shall comply with the following definition:

```
typeOfAffinityOrAntiAffinityConstraints:
  description: >
    Indicates whether this is an affinity or anti-affinity group.
  type: string
  enum:
    - affinity
    - anti-affinity
```

5.2.5 Parameter: `stackName`

The parameter used when pointing to a stack of virtual resources defined by a descriptor shall follow the indications provided in Table 5.2.5-1.

Table 5.2.5-1: Input data model for `stackName`

Parameter Name and Attributes	Type	Description
<code>stackName</code>	String	Name of the stack, given by the consumer

The syntax of the `stackName` shall comply with the following definition:

```
stackName:
  type: string
  description: >
    Name of the stack, given by the consumer
  default: ""
```

5.3 Parameters to be used as output

None.

6 Data model for Virtualised Compute Management

6.1 Description

This clause specifies data models for input and output parameters for Virtualised Compute Management.

6.2 Parameters to be used as input

6.2.1 Parameter: computeName

The parameter used when providing a name for a virtualised compute resource to be allocated shall follow the indications provided in Table 6.2.1-1.

Table 6.2.1-1: Input data model for computeName

Parameter Name and Attributes	Type	Description
computeName	String	Name for a virtualised compute resource to be allocated

The syntax of the computeName shall comply with the following definition:

```
computeName:
  type: string
  description: >
    Name provided by the consumer for the virtualised compute resource to
    allocate
  default: ""
```

6.2.2 Parameter: computeFlavourId

The parameter used when providing an identifier of the Compute Flavour for a virtualised compute resource to be allocated shall follow the indications provided in Table 6.2.2-1.

Table 6.2.2-1: Input data model for computeFlavourId

Parameter Name and Attributes	Type	Description
computeFlavourId	String	Identifier of the Compute Flavour that provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate

The syntax of the computeFlavourId shall comply with the following definition:

```
computeFlavourId:
  type: string
  description: >
    Identifier of the Compute Flavour that provides information about the particular
    memory, CPU and disk resources for virtualised compute resource to allocate
  default: ""
```

6.2.3 Parameter: vclmageId

The parameter used when providing an identifier of the virtualisation container software image for a virtualised compute resource to be allocated shall follow the indications provided in Table 6.2.3-1.

Table 6.2.3-1: Input data model for vclmageId

Parameter Name and Attributes	Type	Description
vclmageId	String	Identifier of the virtualisation container software image

The syntax of the vcImageId shall comply with the following definition:

```
vcImageId:
  type: string
  description: >
    Identifier of the virtualisation container software image
  default: ""
```

6.2.4 Parameter: locationConstraints

The parameter used when providing a location constraints for a virtualised compute resource to be allocated shall follow the indications provided in Table 6.2.4-1.

Table 6.2.4-1: Input data model for locationConstraints

Parameter Name and Attributes	Type	Description
locationConstraints	String	If present, it defines location constraints for the resource(s) is (are) requested to be allocated, e.g. in what particular resource zone

The syntax of the locationConstraints shall comply with the following definition:

```
locationConstraints:
  type: string
  description: >
    If present, it defines location constraints for the resource(s) is (are)
    requested to be allocated, e.g. in what particular resource zone.
  default: ""
```

6.2.5 Parameter: affinityOrAntiAffinityConstraintsForCompute

The parameter used when giving resource affinity or anti-affinity constraints related to virtualised compute resources shall follow the indications provided in Table 6.2.5-1. The parameter is a list of elements with affinity or anti affinity information of the virtualised compute resource to be allocated ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]. All the listed constraints shall be fulfilled for a successful operation.

Table 6.2.5-1: Input data model for affinityOrAntiAffinityConstraintsForCompute

Parameter Name and Attributes	Type	Description
affinityOrAntiAffinityConstraintsForCompute	Array of Object	Name of the parameter.
>typeOfAffinityOrAntiAffinityConstraintForCompute	String	Indicates whether this is an affinity or anti-affinity constraint. Allowed to affinity and anti-affinity.
>scopeOfAffinityOrAntiAffinityConstraintForCompute	String	Qualifies the scope of the constraint. In case of compute resource: e.g. "NFVI-PoP" or "NFVI-Node". Allowed to NFVI-PoP, NFVI-Node. Defaults to "NFVI-Node" if absent.
>affinityAntiAffinityResourceList	Object	Consumer-managed list of identifiers of virtualised resources with which the actual resource is requested to be affine or anti-affine. See note and condition.
>>resource	Array of Object	List of identifiers of virtualised resources.
>affinityAntiAffinityResourceGroup	String	Identifier of the producer-managed group of virtualised resources with which the actual resource is requested to be affine or anti-affine. See note and condition.
NOTE:	It is a prerequisite for the consumer to create a VirtualisedComputeResourceAffinityOrAntiAffinityConstraintsGroup and get groupId using the appropriate operation, Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group, defined in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2].	
CONDITION:	If explicit resource lists for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, the affinityAntiAffinityResourceList shall be supported. If named resource groups for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, affinityAntiAffinityResourceGroup shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (aka VIM tenant).	

The syntax of the affinityOrAntiAffinityConstraintsForCompute shall comply with the following definition:

```

affinityOrAntiAffinityConstraintsForCompute:
  description: >
    A list of elements with affinity or antiaffinity information of
    the virtualised compute resource to allocate.
  oneOf:
    - type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
        required:
          - typeOfAffinityOrAntiAffinityConstraintForCompute
        properties:
          typeOfAffinityOrAntiAffinityConstraintForCompute:
            type: string
            enum:
              - affinity
              - anti-affinity
          scopeOfAffinityOrAntiAffinityConstraintForCompute:
            type: string
            enum:
              - NFVI-PoP
              - NFVI-Node
            default: NFVI-Node
          affinityAntiAffinityResourceList:
            type: object
            required:
              - resource
            properties:
              resource:
                type: array
                minItems: 1 # lower bound of cardinality
                maxItems: N # upper bound of cardinality
                items:
                  type: string
    - type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
        required:
          - typeOfAffinityOrAntiAffinityConstraintForCompute
        properties:
          typeOfAffinityOrAntiAffinityConstraintForCompute:
            type: string
            enum:
              - affinity
              - anti-affinity
          scopeOfAffinityOrAntiAffinityConstraintForCompute:
            type: string
            enum:
              - NFVI-PoP
              - NFVI-Node
            default: NFVI-Node
          affinityAntiAffinityResourceGroup:
            type: string

```

6.2.6 Parameter: interfaceData

The parameter used when giving interfaceData related to virtualised compute resources shall follow the indications provided in Table 6.2.6-1. The parameter is a list of data about network interface data which are specific to a Virtual Compute Resource instance.

NOTE: ">" is used to specify an "inline definition".

Table 6.2.6-1: Input data model for interfaceData

Parameter Name and Attributes	Type	Description
interfaceData	Array of Object	Name of the parameter.
>ipAddress	Array of Object	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to.
>macAddress	String	The MAC address desired for the virtual network interface.

The syntax of the interfaceData shall comply with the following definition:

```
interfaceData: # VirtualInterfaceData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
description: >
  The data of network interfaces which are specific to a Virtual Compute
  Resource instance
type: array
minItems: 0 # lower bound of cardinality
maxItems: N # upper bound of cardinality
items:
  type: object
  properties:
    ipAddress: # IPAddress IE in SOL013
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
    macAddress: # MacAddress IE in ETSI GS NFV-SOL 013
      type: string
```

6.2.7 Parameter: computeId

The parameter used when pointing to an identifier of the virtualised compute resource to operate shall follow the indications provided in Table 6.2.7-1.

Table 6.2.7-1: Input data model for computeId

Parameter Name and Attributes	Type	Description
computeId	String	Identifier of the virtualised compute resource to operate

The syntax of the computeId shall comply with the following definition:

```
computeId:
type: string
description: >
  Identifier of the virtualised compute resource to operate
default: ""
```

6.2.8 Parameter: networkInterfaceNew

The parameter used when giving networkInterfaceNew related to virtualised compute resources shall follow the indications provided in Table 6.2.8-1. The parameter is a list of data about new virtual network interface(s) to add to the compute resource.

NOTE: ">" is used to specify an "inline definition".

Table 6.2.8-1: Input data model for networkInterfaceNew

Parameter Name and Attributes	Type	Description
networkInterfaceNew	Array of Object	Name of the parameter.
>networkId	String	In the case when the virtual network interface is attached to the network, it identifies such a network.
>networkPortId	String	If the virtual network interface is attached to a specific network port, it identifies such a network port.
>typeVirtualNic	String (see note)	Type of network interface. Allowed value: normal-virtual-NIC.
>typeConfiguration	Array of String (see note)	Extra configuration that the virtual network interface supports based on the type of virtual network interface.
>bandwidth	Number	The bandwidth of the virtual network interface (in Mbps).
>accelerationCapabilityForVirtualNetworkInterface	Array of String (see note)	It specifies if the virtual network interface requires certain acceleration capabilities (e.g. RDMA, packet dispatch, TCP Chimney).
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: networkInterfaceNew parameter is used in Update Virtualised Compute Resource operation. In the case, the virtualised compute resource has been allocated with resource constraints (e.g. supported hardware). The new network interface, extra configurations and acceleration capability may not be accepted if those requests are unmatched to the constraints.		

The syntax of the networkInterfaceNew shall comply with the following definition:

```

networkInterfaceNew: # VirtualNetworkInterfaceData in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
description: >
  The new virtual network interface(s) to add to the compute resource.
type: array
minItems: 0 # lower bound of cardinality
maxItems: N # upper bound of cardinality
items:
  type: object
  required:
  - typeVirtualNic
  properties:
    networkId:
      type: string
    networkPortId:
      type: string
    typeVirtualNic:
      type: string
    typeConfiguration:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
    bandwidth:
      type: number
    accelerationCapabilityForVirtualNetworkInterface:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object

```

6.2.9 Parameter: networkInterfaceUpdate

The parameter used when giving networkInterfaceUpdate related to virtualised compute resources shall follow the indications provided in Table 6.2.9-1. The parameter is a list of data about virtual network interface(s) to update on the compute resource.

NOTE: ">" is used to specify an "inline definition".

Table 6.2.9-1: Input data model for networkInterfaceUpdate

Parameter Name and Attributes	Type	Description
networkInterfaceUpdate	Array of Object	Name of the parameter.
>resourceId	String	Identifier of the virtual network interface.
>ownerId	String	Identifier of the owner of the network interface (e.g. a virtualised compute resource).
>networkId	String	In the case when the virtual network interface is attached to the network, it identifies such a network.
>networkPortId	String	If the virtual network interface is attached to a specific network port, it identifies such a network port.
>ipAddress	Array of String	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to.
>typeVirtualNic	String (see note)	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	Array of String (see note)	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	String	The MAC address of the virtual network interface.
>bandwidth	Number	The bandwidth of the virtual network interface (in Mbps).
>accelerationCapabilityForVirtualNetworkInterface	Array of String (see note)	Shows the acceleration capabilities utilized by the virtual network interface.
>operationalState	String	The operational state of the virtual network interface. Allowed value: enabled, disabled.
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: networkInterfaceUpdate parameter is used in Update Virtualised Compute Resource operation. In the case, the virtualised compute resource has been allocated with resource constraints (e.g. supported hardware). The new network interface, extra configurations and accelerationCapabilityForVirtualNetworkInterface may not be accepted if those requests are unmatched to the constraints.		

The syntax of the networkInterfaceUpdate shall comply with the following definition:

```
networkInterfaceUpdate: # VirtualNetworkInterface IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA
006
description: >
  The virtual network interface(s) to update on the compute resource.
type: array
minItems: 0 # lower bound of cardinality
maxItems: N # upper bound of cardinality
items:
  type: object
  required:
    - resourceId
    - ownerId
    - typeVirtualNic
    - macAddress
    - bandwidth
```

```

- operationalState
properties:
  resourceId:
    type: string
  ownerId:
    type: string
  networkId:
    type: string
  networkPortId:
    type: string
  ipAddress: # IPAddress IE in ETSI GS NFV-SOL 013
    type: array
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: string
  typeVirtualNic:
    type: string
  typeConfiguration:
    type: array
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: string
  macAddress:
    type: string
  bandwidth:
    type: number
  accelerationCapabilityForVirtualNetworkInterface:
    type: array
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: string
  operationalState:
    type: string
    enum:
      - enabled
      - disabled
  metadata:
    description: >
      metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
    type: array
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: object

```

6.2.10 Parameter: flavour

The parameter used when requesting operations related to the creation of flavours shall follow the indications provided in Table 6.2.10-1. This parameter is applicable only for Or-Vi interface.

NOTE: ">" is used to specify an "inline definition".

Table 6.2.10-1: Input data model for flavour

Parameter Name and Attributes	Type	Description
flavour	Object	Name of the parameter.
>flavourId	String	Identifier given to the compute flavour.
>accelerationCapabilityForVirtualComputeFlavour	Array of String	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources.
>virtualMemory	Object	The virtual memory of the virtualised compute.
>>virtualMemSize	Number	Amount of virtual Memory (e.g. in MB).
>>virtualMemOversubscriptionPolicy	String	The memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 during the allocation request, if no particular value is requested. E.g. virtual memory : physical memory.

Parameter Name and Attributes	Type	Description
>>numaEnabled	Boolean	It specifies the memory allocation to be cognisant of the relevant process/core allocation. The cardinality can be 0 during the allocation request, if no particular value is requested.
>virtualCpu	Object	The virtual CPU(s) of the virtualised compute. The cardinality can be 0 during the allocation request, if no particular CPU architecture type is requested.
>>cpuArchitecture	String	CPU architecture type. Examples are x86, ARM®.
>>numVirtualCpu	Number	Number of virtual CPUs.
>>cpuClock	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	String	The CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 during the allocation request, if no particular value is requested. E.g. virtual CPU core : physical CPU core= 4:1.
>>virtualCpuPinning	Object	The virtual CPU pinning configuration for the virtualised compute resource.
>>>virtualCpuPinningPolicy	String	The policy can take values of "static" or "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). Allowed value: static, dynamic.
>>>>virtualCpuPinningRules	Array of Object	A list of rules that should be considered during the allocation of the virtual CPU-s to logical CPU-s in case of "static" virtualCpuPinningPolicy.
>>>>>cores	Number	The number of core in the virtual CPU.
>>>>>sockets	Number	The number of socket in the virtual CPU.
>>>>>threads	Number	The number of thread in the virtual CPU.
>storageAttributes	Array of Object	Element containing information about the size of virtualised storage resource (e.g. size of volume, in GB), the type of storage (e.g. volume, object), and support for RDMA.
>>typeOfStorage	String	Type of virtualised storage resource (e.g. volume, object).
>>sizeOfStorage	Number	Size of virtualised storage resource (e.g. size of volume, in GB).
>virtualNetworkInterface	Array of Object	The virtual network interfaces of the virtualised compute.
>>networkId	String	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	String	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	Not specified (see note)	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	Not specified (see note)	Extra configuration that the virtual network interface supports based on the type of virtual network interface.
>>bandwidth	Number	The bandwidth of the virtual network interface (in Mbps).

Parameter Name and Attributes	Type	Description
>>accelerationCapabilityForVirtualNetworkInterface	Array of String	It 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	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
<p>NOTE: There is only part of <code>flavour</code> as specified in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2] are included in this version of the present document, the following are attributes not included:</p> <ul style="list-style-type: none"> • <code>typeVirtualNic</code>; • <code>typeConfiguration</code>. 		

The syntax of the `flavour` shall comply with the following definition:

```

flavour:
  description: >
    The flavour provides information about the particular memory, CPU
    and disk resources for virtualised compute resource to allocate
  type: object
  required:
    - flavourId
    - virtualMemory
    - virtualCpu
  properties:
    flavourId:
      type: string
    accelerationCapabilityForVirtualComputeFlavour:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
    virtualMemory:
      type: object
      required:
        - virtualMemSize
      properties:
        virtualMemSize:
          type: number
        virtualMemOversubscriptionPolicy:
          type: string
        numaEnabled:
          type: boolean
    virtualCpu:
      type: object
      required:
        - numVirtualCpu
      properties:
        cpuArchitecture:
          type: string
        numVirtualCpu:
          type: number
        cpuClock:
          type: number
        virtualCpuOversubscriptionPolicy:
          type: string
        virtualCpuPinning:
          type: object
          required:
            - cpuPinningPolicy
          properties:
            cpuPinningPolicy:
              type: string
              enum:
                - static
                - dynamic
            cpuPinningRules:
              type: array
              minItems: 0 # lower bound of cardinality
              maxItems: N # upper bound of cardinality

```

```

    items:
      type: object
      properties:
        cores:
          type: number
        sockets:
          type: number
        threads:
          type: number
storageAttributes:
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: object
    properties:
      typeOfStorage:
        type: string
      sizeOfStorage:
        type: number
virtualNetworkInterface:
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: object
    properties:
      networkId:
        type: string
      networkPortId:
        type: string
      bandwidth:
        type: number
      accelerationCapabilityForVirtualNetworkInterface:
        type: array
        minItems: 0 # lower bound of cardinality
        maxItems: N # upper bound of cardinality
        items:
          type: string
      metadata:
        description: >
          metadata is optional. It is out of scope to detail what are the sub-keys and
possible values.
        type: array
        minItems: 0 # lower bound of cardinality
        maxItems: N # upper bound of cardinality
        items:
          type: object

```

6.2.11 Parameter: userData

The parameter used when providing user data to customize the virtualised compute resource at boot time shall follow the indications provided in Table 6.2.11-1.

Table 6.2.11-1: Input data model for userData

Parameter Name and Attributes	Type	Description
userData	Object	Name of the parameter.
>content	String	Contains the user data to customize the virtualised compute resource at boot-time.
>method	String	Method used as transportation media to convey the content of the userData to the virtualised compute resource. Allowed value: CONFIG_DRIVE.

The syntax of the userData shall comply with the following definition:

```

userData:
  description: >
    Contains user data to customize the virtualised compute resource at boot time
  type: object
  required:
    - content
  properties:
    content:
      type: string
    method:
      type: string
    enum:
      - CONFIG_DRIVE
  default: ""

```

6.3 Parameters to be used as output

6.3.1 Parameter: nfVComputeInfo

The parameter is used when returning information for a virtualised compute resource, and its output data model shall follow the indications provided in Table 6.3.1-1. This parameter maps to the "computeData" parameter defined in ETSI GS NFV-IFA 005 [1].

Table 6.3.1-1: Output data model for nfVComputeInfo

Parameter Name and Attributes	Type	Description
nfVComputeInfo	Object	Element containing information of the newly instantiated virtualised compute resource as VirtualCompute.
>computeId	String	Identifier of the virtualised compute resource.
>computeName	String	Name of the virtualised compute resource.
>flavourId	String	Identifier of the given compute flavour used to instantiate this virtual compute.
>accelerationCapabilityForVirtualComputeFlavour	Array of String	Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources.
>virtualCpu	Object	The virtual CPU(s) of the virtualised compute as VirtualCpu.
>>cpuArchitecture	String	CPU architecture type. Examples are x86, ARM®. See note.
>>numVirtualCpu	Number	Number of virtual CPUs.
>>cpuClock	Number	Minimum CPU clock rate in Hz available for the virtualised CPU resources.
>>virtualCpuOversubscriptionPolicy	String	The CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 if no policy has been defined during the allocation request.
>>virtualCpuPinning	Object	The virtual CPU pinning configuration for the virtualised compute resource.
>>>cpuPinningPolicy	String	The policy can take values of "static" or "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). Allowed value: static, dynamic.
>>>cpuPinningRules	Array of Object	A list of rules that should be considered during the allocation of the virtual CPU-s to logical CPU-s in case of "static" virtualCpuPinningPolicy.
>>>>core	Number	The number of core in the virtual CPU.
>>>>sockets	Number	The number of socket in the virtual CPU.
>>>>threads	Number	The number of thread in the virtual CPU.

Parameter Name and Attributes	Type	Description
>virtualMemory	Object	The virtual memory of the compute as VirtualMemory.
>>virtualMemSize	Number	Amount of virtual memory in byte.
>>virtualMemOversubscriptionPolicy	String	The memory core oversubscription policy in terms of virtual memory to physical memory on the platform. The cardinality can be 0 if no policy has been defined during the allocation request.
>>numaEnabled	Boolean	It specifies the memory allocation to be cognisant of the relevant process/core allocation.
>virtualNetworkInterface	Array of Object	Element with information of the instantiated virtual network interfaces of the compute resource.
>>resourceId	String	Identifier of the virtual network interface.
>>ownerId	String	Identifier of the owner of the network interface (e.g. a virtualised compute resource).
>>networkId	String (Reference to VirtualNetwork)	In the case when the virtual network interface is attached to the network, it identifies such a network. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network.
>>networkPortId	String (Reference to VirtualNetworkPort)	If the virtual network interface is attached to a specific network port, it identifies such a network port. The cardinality can be 0 in the case that a network interface is created without any specific network port attachment.
>>ipAddress	Array of String	The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to. The cardinality can be 0 in the case that a network interface is created without being attached to any specific network, or when an IP address can be automatically configured, e.g. by DHCP.
>>typeVirtualNic	String	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	Array of String	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	String	The MAC address of the virtual network interface.
>>bandwidth	Number	The bandwidth of the virtual network interface (in Mbps).
>>accelerationCapabilityForVirtualNetworkInterface	Array of String	Shows the acceleration capabilities utilized by the virtual network interface. The cardinality can be 0, if no acceleration capability is utilized.
>>operationalState	String	The operational state of the virtualised subnetwork. Allowed values are: enabled, disabled.
>>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
>>virtualDisks	Array of Object	Element with information of the virtualised storage resources (volumes, ephemeral) that are attached to the compute resource.
>>>storageId	String	Identifier of the virtualised storage resource.
>>>storageName	String	Name of the virtualised storage resource.
>>>flavourId	String	Identifier of the storage flavour used to instantiate this virtual storage.
>>>typeOfStorage	String	Type of virtualised storage resource (e.g. volume, object).
>>>sizeOfStorage	Number	Size of virtualised storage resource (e.g. size of volume, in GB).
>>>rdmaEnabled	Boolean	Indicates if the storage supports RDMA.

Parameter Name and Attributes	Type	Description
>>>ownerId	String	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	String	It identifies the resource zone where the virtual storage resources have been allocated.
>>>hostId	String	Identifier of the host where the virtualised storage resource is allocated.
>>>operationalState	String	Operational state of the resource. Allowed value: enabled, disabled.
>>>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
>vclmagId	String	Identifier of the virtualisation container software image (e.g. virtual machine image).
>zoneId	String	If present, it identifies the resource zone where the virtual compute resources have been allocated.
>hostId	String	Identifier of the host the virtualised compute resource is allocated on.
>operationalState	String	Operational state of the compute resource. Possible values are: "enabled" or "disabled".
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: See "cpu_architecture" in <code>tosca.datatypes.nfv.VirtualCpu</code> , ETSI GS NFV-SOL 001 [6].		

When used as an output parameter in a template, the syntax of the `nfvComputeInfo` shall comply with the following definition:

```
nfvComputeInfo:
  description: >
    Element containing information of the newly instantiated virtualised
    compute resource.
  type: object
  required:
    - computeId
    - flavourId
    - virtualCpu
    - virtualMemory
    - virtualDisks
    - hostId
    - operationalState
  properties:
    computeId:
      description: >
        Identifier of the virtualised compute resource.
      type: string
    computeName:
      description: >
        Name of the virtualised compute resource.
      type: string
    flavourId:
      description: >
        Identifier of the given compute flavour used to instantiate this
        virtual compute.
      type: string
    accelerationCapabilityForVirtualComputeFlavour:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
    virtualCpu:
      description: >
```

```

The virtual CPU(s) of the virtualised compute.
type: object
properties:
  cpuArchitecture:
    description: >
      CPU architecture type.
    type: string
  numVirtualCpu:
    description: >
      Number of virtual CPUs.
    type: number
  cpuClock:
    description: >
      Minimum CPU clock rate in Hz available for the virtualised
      CPU resources.
    type: number
  virtualCpuOversubscriptionPolicy:
    description: >
      The CPU core oversubscription policy, e.g. the relation of
      virtual CPU cores to physical CPU cores/threads. The cardinality
      can be 0 if no policy has been defined during the allocation request.
    type: string
  virtualCpuPinning:
    description: >
      The virtual CPU pinning configuration for the virtualised
      compute resource.
    type: object
    required:
      - cpuPinningPolicy
    properties:
      cpuPinningPolicy:
        type: string
        enum:
          - static
          - dynamic
      cpuPinningRules:
        type: array
        minItems: 0 # lower bound of cardinality
        maxItems: N # upper bound of cardinality
        items:
          type: object
          properties:
            cores:
              type: number
            sockets:
              type: number
            threads:
              type: number
  virtualMemory:
    description: >
      The virtual memory of the compute.
    type: object
    properties:
      virtualMemSize:
        description: >
          Amount of virtual memory in byte.
        type: number
      virtualMemOversubscriptionPolicy:
        description: >
          The memory core oversubscription policy in terms of virtual memory
          to physical memory on the platform. The cardinality can be 0 if
          no policy has been defined during the allocation request.
        type: string
      numaEnabled:
        description: >
          It specifies the memory allocation to be cognisant of
          the relevant process/core allocation.
        type: boolean
  virtualNetworkInterface:
    description: >
      Element with information of the instantiated virtual network
      interfaces of the compute resource.
    resourceId:
      type: string
    ownerId:
      type: string
    networkId:
      type: string

```

```

networkPortId:
  type: string
ipAddress: # IpAddress IE in ETSI GS NFV-SOL 013
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # maximum value of cardinality
  items:
    type: string
typeVirtualNic:
  type: string
typeConfiguration:
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: string
macAddress:
  type: string
bandwidth:
  type: number
accelerationCapabilityForVirtualNetworkInterface":
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: string
operationalState:
  type: string
  enum:
    - enabled
    - disabled
metadata:
  description: >
    metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: object
virtualDisks:
  description: >
    Element with information of the virtualised storage resources
    (volumes, ephemeral) that are attached to the compute resource.
  type: array
  minItems: 1 # lower bound of cardinality
  maxItems: N # maximum value of cardinality
  items:
    type: object
    required:
      - storageId
      - flavourId
      - typeOfStorage
      - sizeOfStorage
      - operationalState
    properties:
      storageId:
        description: >
          Identifier of the virtualised storage resource
        type: string
      storageName:
        description: >
          Name of the virtualised storage resource
        type: string
      flavourId:
        description: >
          Identifier of the storage flavour used to instantiate
          this virtual storage
        type: string
      typeOfStorage:
        description: >
          Type of virtualised storage resource
        type: string
      sizeOfStorage:
        description: >
          Size of virtualised storage resource
        type: number
      rdmaEnabled:

```

```

    description: >
      Indicates if the storage supports RDMA.
    type: boolean
  ownerId:
    description: >
      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
    type: string
  zoneId:
    description: >
      It identifies the resource zone where the virtual storage
      resources have been allocated
    type: string
  hostId:
    description: >
      Identifier of the host where the virtualised storage resource
      is allocated.
    type: string
  operationalState:
    description: >
      Operational state of the resource.
    type: string
    enum:
      - enabled
      - disabled
  metadata:
    description: >
      metadata is optional. It is out of scope to detail what are the sub-keys and
possible values.
    type: array
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: object
  vcImageId:
    description: >
      Identifier of the virtualisation container software image.
    type: string
  zoneId:
    description: >
      If present, it identifies the resource zone where the virtual
      compute resources have been allocated.
    type: string
  hostId:
    description: >
      Identifier of the host the virtualised compute resource is allocated on.
    type: string
  operationalState:
    description: >
      Operational state of the compute resource.
    type: string
    enum:
      - enabled
      - disabled
  metadata:
    description: >
      metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
    type: array
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: object

```

7 Data model for Virtualised Network Management

7.1 Description

This clause specifies data models for input and output parameters for Virtualised Network Management.

7.2 Parameters to be used as input

7.2.1 Parameter: networkResourceName

The parameter used when providing a name for a virtualised network resource shall follow the indications provided in Table 7.2.1-1.

Table 7.2.1-1: Input data model for networkResourceName

Parameter Name and Attributes	Type	Description
networkResourceName	String	Name for a virtualised compute resource.

The syntax of the networkResourceName shall comply with the following definition:

```
networkResourceName:
  description: >
    Name provided by the consumer for the virtualised network resource
  type: string
  default: ""
```

7.2.2 Parameter: networkResourceType

The parameter used when setting the type of a virtualised network resource shall follow the indications provided in Table 7.2.2-1.

Table 7.2.2-1: Input data model for networkResourceType

Parameter Name and Attributes	Type	Description
networkResourceType	String	The network data provides information about the particular virtual network resource. Possible values are: "network", "subnet", or "network-port".

The syntax of the networkResourceType shall comply with the following definition:

```
networkResourceType:
  description: >
    The network data information applicable to the particular virtual network
    resource of the virtualised resource management operation
  type: string
  enum:
    - network
    - subnet
    - network-port
  default: ""
```

7.2.3 Parameter: typeNetworkData

The parameter used when providing the network data information about the particular virtual network shall follow the indications provided in Table 7.2.3-1.

Table 7.2.3-1: Input data model for typeNetworkData

Parameter Name and Attributes	Type	Description
typeNetworkData	Object	The network data provides information about the particular virtual network resource.
>bandwidth	Number	Minimum network bandwidth (in Mbps).
>networkType	String	The type of network that maps to the virtualised network. This list is extensible. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn", etc.
>segmentType	String	The isolated segment for the virtualised network. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key.

Parameter Name and Attributes	Type	Description
>networkQos	Array of Object	Element providing information about Quality of Service attributes that the network is requested to support.
>>qosName	String	Name given to the QoS parameter.
>>qosValue	Number	Value of the QoS parameter.
>isShared	Boolean	It defines whether the virtualised network is shared among consumers.
>sharingCriteria	String	Only present for shared networks. Indicate the sharing criteria/constraint for this network. These criteria might be a list of authorized consumers.
>layer3Attributes	Array of Object	The attribute list allows setting up a network providing defined layer 3 connectivity.
>>networkId	String	The identifier of the virtualised network that the virtualised sub-network is attached to.
>>ipVersion	String	The IP version of the network/subnetwork. Allowed values: IPv4, IPv6.
>>gatewayIp	String	Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.
>>cidr	String	The CIDR of the network/subnetwork, i.e. network address and subnet mask.
>>isDhcpEnabled	Boolean	True when DHCP is to be enabled for this network/subnetwork, or false otherwise.
>>addressPool	Array of Object	Address pools for the network/subnetwork.
>>>start	String	The first IP address in the addressPool. See note.
>>>end	String	The last IP address in the addressPool. See note.
>>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. Metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. Metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: In case of an IPV4 address, string that consists of four decimal integers separated by dots, each integer ranging from 0 to 255. In case of an IPV6 address, string that consists of groups of zero to four hexadecimal digits, separated by colons.		

The syntax of the typeNetworkData shall comply with the following definition:

```

typeNetworkData:
  description: >
    The network data information about the particular virtual network
    resource of the virtualised resource management operation
  required:
    - bandwidth
  type: object # VirtualNetworkData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  properties:
    bandwidth:
      type: number
    networkType:
      type: string
    segmentType:
      type: string
    networkQos:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
        properties:
          qosName:
            type: string
          qosValue:
            type: number

```

```

isShared:
  type: boolean
sharingCriteria:
  type: string
layer3Attributes: # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: object
    properties:
      networkId:
        type: string
      ipVersion:
        type: string
        enum:
          - IPv4
          - IPv6
      gatewayIp:
        type: string
      cidr:
        type: string
      isDhcpEnabled:
        type: boolean
      addressPool:
        type: array
        minItems: 0 # lower bound of cardinality
        maxItems: N # upper bound of cardinality
        items:
          type: object
          properties:
            start:
              type: string
            end:
              type: string
      metadata:
        description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and
possible values.
        type: array
        minItems: 0 # lower bound of cardinality
        maxItems: N # upper bound of cardinality
        items:
          type: object
      metadata:
        description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
        type: array
        minItems: 0 # lower bound of cardinality
        maxItems: N # upper bound of cardinality
        items:
          type: object
      default: ""

```

7.2.4 Parameter: typeNetworkPortData

The parameter used when setting the network port data provides information about the particular network port shall follow the indications in Table 7.2.4-1.

Table 7.2.4-1: Input data model for typeNetworkPortData

Parameter Name and Attributes	Type	Description
typeNetworkPortData	Object	The network port data provides information about the particular network port.
>portType	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.
>networkId	String	Identifier of the network that the port belongs to.
>segmentId	String	The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key.
>bandwidth	Number	The bandwidth of the virtual network port (in Mbps).

Parameter Name and Attributes	Type	Description
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.

The syntax of the typeNetworkPortData shall comply with the following definition:

```

typeNetworkPortData:
  description: >
    The network port data information about the particular network port
    of the virtualised resource management operation
  required:
    - portType
  type: object # VirtualNetworkPortData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  properties:
    portType:
      type: string
    networkId:
      type: string
    segmentId:
      type: string
    bandwidth:
      type: number
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
        values.
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
    default: ""

```

7.2.5 Parameter: typeSubnetData

The parameter used when setting the subnet data information about the particular subnetwork resource shall follow the indications in Table 7.2.5-1.

Table 7.2.5-1: Input data model for typeSubnetData

Parameter Name and Attributes	Type	Description
typeSubnetData	Object	The subnet data provides information about the particular sub-network resource.
>networkId	String	The identifier of the virtualised network that the virtualised sub-network is attached to.
>ipVersion	String	The IP version of the network/subnetwork. Allowed Value: IPv4, IPv6.
>gatewayIp	String	The identifier of the virtualised network that the virtualised sub-network is attached to.
>cidr	String	The IP version of the network/subnetwork. Allowed Value: IPv4, IPv6.
>isDhcpEnabled	Boolean	Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.
>addressPool	Array of Object	The CIDR of the network/subnetwork, i.e. network address and subnet mask.
>>start	String	The first IP address in the addressPool. See note.
>>end	String	The last IP address in the addressPool. See note.

Parameter Name and Attributes	Type	Description
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: In case of an IPV4 address, string that consists of four decimal integers separated by dots, each integer ranging from 0 to 255. In case of an IPV6 address, string that consists of groups of zero to four hexadecimal digits, separated by colons.		

The syntax of the typeSubnetData shall comply with the following definition:

```

typeSubnetData:
  description: >
    The subnet data information about the particular subnetwork of
    the virtualised resource management operation
  type: object # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  properties:
    networkId:
      type: string
    ipVersion:
      type: string
      enum:
        - IPv4
        - IPv6
    gatewayIp:
      type: string
    cidr:
      type: string
    isDhcpEnabled:
      type: boolean
    addressPool:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
        properties:
          start:
            type: string
          end:
            type: string
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
        values.
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
  default: ""

```

7.2.6 Parameter: affinityOrAntiAffinityConstraintsForNetwork

The parameter used when providing the list of elements with affinity or anti affinity information of the virtualised network resource shall follow the indications in Table 7.2.6-1.

Table 7.2.6-1: Input data model for affinityOrAntiAffinityConstraintsForNetwork

Parameter Name and Attributes	Type	Description
affinityOrAntiAffinityConstraintsForNetwork	Array of Object	A list of elements with affinity or anti affinity information of the virtualised network resource. All the listed constraints shall be fulfilled for a successful operation.
>typeOfAffinityOrAntiAffinityConstraintForNetwork	String	Indicates whether this is an affinity or anti-affinity constraint. Allowed_values: affinity, anti-affinity.

Parameter Name and Attributes	Type	Description
>scopeOfAffinityOrAntiAffinityConstraintForNetwork	String	Qualifies the scope of the constraint. In case of ports: e.g. "virtual switch or router" or "physical NIC", or "physical network" or "NFVI Node". In case of networks: e.g. "physical NIC", "physical network" or "NFVI Node". In case of subnets: it should be ignored. Defaults to "NFVI Node" if absent. Allowed_values: virtual-switch, router, physical-NIC, physical-network, NFVI-Node.
>affinityAntiAffinityResourceList	Array	Consumer-managed list of identifiers of virtualised resources with which the actual resource is requested to be affine or anti-affine. See note and condition.
>>resource	Array of String	List of identifiers of virtualised resources.
>affinityAntiAffinityResourceGroup	String	Identifier of the producer-managed group of virtualised resources with which the actual resource is requested to be affine or anti-affine. See note and condition.
NOTE:	It is a prerequisite for the consumer to create a VirtualisedNetworkResourceAffinityOrAntiAffinityConstraintsGroup and get groupIdIdentifier using the appropriate operation, Create Virtualised Network Resource Affinity Or AntiAffinity Constraints Group, defined in ETSI GS NFV-IFA 005 [1], and the ETSI GS NFV-IFA 006 [2].	
CONDITION:	If explicit resource lists for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, the affinityAntiAffinityResourceList shall be supported. If named resource groups for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1], and the ETSI GS NFV-IFA 006 [2]) are supported, affinityAntiAffinityResourceGroup shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (aka VIM tenant).	

The syntax of the affinityOrAntiAffinityConstraintsForNetwork shall comply with the following definition:

```

affinityOrAntiAffinityConstraintsForNetwork:
  description: >
    A list of elements with affinity or anti affinity information of the virtualised
    network resource of the virtualised resource management
    operation
  oneOf:
    - type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        required:
          - typeOfAffinityOrAntiAffinityConstraintForNetwork
        type: object
        properties:
          typeOfAffinityOrAntiAffinityConstraintForNetwork:
            type: string
            enum:
              - affinity
              - anti-affinity
          scopeOfAffinityOrAntiAffinityConstraintForNetwork:
            type: string
            enum:
              - virtual-switch
              - router
              - physical-NIC
              - physical-network
              - NFVI-Node
            default: NFVI-Node
          affinityAntiAffinityResourceList:
            required:
              - resource
            type: object
            properties:
              resource:
                type: array
                minItems: 1 # lower bound of cardinality
                maxItems: N # upper bound of cardinality
                items:
                  type: string
    - type: array
      minItems: 0 # lower bound of cardinality

```

```

maxItems: N # upper bound of cardinality
items:
  required:
    - typeOfAffinityOrAntiAffinityConstraintForNetwork
  type: object
  properties:
    typeOfAffinityOrAntiAffinityConstraintForNetwork:
      type: string
      enum:
        - affinity
        - anti-affinity
    scopeOfAffinityOrAntiAffinityConstraintForNetwork:
      type: string
      enum:
        - virtual-switch
        - router
        - physical-NIC
        - physical-network
        - NFVI-Node
      default: NFVI-Node
    affinityAntiAffinityResourceGroup:
      type: string
  default: ""

```

7.2.7 Void

7.2.8 Parameter: locationConstraintsForNetwork

The parameter used when defining the location constraints for the resource(s) shall follow the indicators provided in Table 7.2.8-1.

Table 7.2.8-1: Input data model for locationConstraints

Parameter Name and Attributes	Type	Description
locationConstraintsForNetwork	String	Defines location constraints for the resource(s), e.g. in what particular resource zone.

The syntax of the locationConstraintsForNetwork shall comply with the following definition:

```

locationConstraintsForNetwork:
  description: >
    The definition of the location constraints for the resource(s),
    e.g. in what particular resource zone, of the virtualised resource management
    operation
  type: string
  default: ""

```

7.2.9 Parameter: queryNetworkFilter

The parameters used when invoking the operation shall follow the indications provided in Table 7.2.9-1.

Table 7.2.9-1: Input data model for queryNetworkFilter

Parameter Name and Attributes	Type	Description
queryNetworkFilter	Not specified (see note)	Query filter based on e.g. name, identifier, metadata 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.
NOTE: Query operation is not covered in the present document.		

The syntax of the queryNetworkFilter shall comply with the following definition:

```

queryNetworkFilter:
  description: >
    The query filter based on name, identifier, metadata information or status
    information, expressing the type of information to be retrieved of the
    virtualised resource management operation

```

```

type: Not specified
default: ""

```

7.2.10 Parameter: networkResourceId

The parameter used when pointing to a virtualised network resource shall follow the indications provided in Table 7.2.10-1.

Table 7.2.10-1: Input data model for networkResourceId

Parameter Name and Attributes	Type	Description
networkResourceId	String	Identifier of a virtualised resource.

The syntax of the networkResourceId shall comply with the following definition:

```

networkResourceId:
  description: >
    Identifier of a virtualised network resource
  type: string
  default: ""

```

7.2.11 Parameter: updateNetworkData

The parameter used when providing the network data information about the particular virtual network shall follow the indications provided in Table 7.2.11-1.

Table 7.2.11-1: Input data model for updateNetworkData

Parameter Name and Attributes	Type	Description
updateNetworkData	Object	Network data information about the particular virtual network resource.
>bandwidth	Number	Minimum network bandwidth (in Mbps).
>networkType	String	The type of network that maps to the virtualised network. This list is extensible. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn", etc.
>segmentType	String	The isolated segment for the virtualised network. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key.
>networkQos	Array of Object	Element providing information about Quality of Service attributes that the network is requested to support.
>>qosName	String	Name given to the QoS parameter.
>>qosValue	Number	Value of the QoS parameter.
>isShared	Boolean	It defines whether the virtualised network is shared among consumers.
>sharingCriteria	String	Only present for shared networks. Indicate the sharing criteria/constraint for this network. These criteria might be a list of authorized consumers.
>layer3Attributes	Array of Object	The attribute list allows setting up a network providing defined layer 3 connectivity.
>>networkId	String	The identifier of the virtualised network that the virtualised sub-network is attached to.
>>ipVersion	String	The IP version of the network/subnetwork. Allowed values: IPv4, IPv6.
>>gatewayIp	String	Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.
>>cidr	String	The CIDR of the network/subnetwork, i.e. network address and subnet mask.
>>isDhcpEnabled	Boolean	True when DHCP is to be enabled for this network/subnetwork, or false otherwise.
>>addressPool	Array of Object	Address pools for the network/subnetwork.
>>>start	String	The first IP address in the addressPool. See note.

Parameter Name and Attributes	Type	Description
>>>end	String	The last IP address in the addressPool. See note.
>>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. Metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. Metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: In case of an IPV4 address, string that consists of four decimal integers separated by dots, each integer ranging from 0 to 255. In case of an IPV6 address, string that consists of groups of zero to four hexadecimal digits, separated by colons.		

The syntax of the updateNetworkData shall comply with the following definition:

```

updateNetworkData:
  description: >
    This element contains the network data information of a particular
    virtual network resource
  required:
    - bandwidth
  type: object # VirtualNetworkData in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  properties:
    bandwidth:
      type: number
    networkType:
      type: string
    segmentType:
      type: string
    networkQos:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # maximum value of cardinality
      items:
        type: object
        required:
          - qosName
          - qosValue
        properties:
          qosName:
            type: string
          qosValue:
            type: number
    isShared:
      type: boolean
    sharingCriteria:
      type: string
    layer3Attributes: # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
      type: array
      items:
        type: object
        properties:
          networkId:
            type: string
          ipVersion:
            type: string
            enum:
              - IPv4
              - IPv6
          gatewayIp:
            type: string
          cidr:
            type: string
          isDhcpEnabled:
            type: boolean
          addressPool:
            type: array
            minItems: 0 # lower bound of cardinality
            maxItems: N # upper bound of cardinality
            items:

```

```

    type: object
    properties:
      start:
        type: string
      end:
        type: string
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and
possible values.
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        - type: object
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: object
    default: ""

```

7.2.12 Parameter: updateSubnetData

The parameter used when setting the subnet data information about the particular subnetwork resource shall follow the indications in Table 7.2.12-1.

Table 7.2.12-1: Input data model for updateSubnetData

Parameter Name and Attributes	Type	Description
updateSubnetData	Object	Subnet data information about the particular virtual subnet resource.
>networkId	String	The identifier of the virtualised network that the virtualised sub-network is attached to.
>ipVersion	String	The IP version of the network/subnetwork. Allowed Value: IPv4, IPv6.
>gatewayIp	String	Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.
>cidr	String	The CIDR of the network/subnetwork, i.e. network address and subnet mask.
>isDhcpEnabled	Boolean	True when DHCP is to be enabled for this network/subnetwork, or false otherwise.
>addressPool	Array of Object	Address pools for the network/subnetwork.
>>start	String	The first IP address in the addressPool. See note.
>>end	String	The last IP address in the addressPool. See note.
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.
NOTE:	In case of an IPV4 address, string that consists of four decimal integers separated by dots, each integer ranging from 0 to 255. In case of an IPV6 address, string that consists of groups of zero to four hexadecimal digits, separated by colons.	

The syntax of the updateSubnetData shall comply with the following definition:

```

updateSubnetData:
  description: >
    The subnet data information of a particular subnet resource
  type: object
  properties:
    networkId:
      type: string
    ipVersion:
      type: string

```

```

enum:
  - IPv4
  - IPv6
gatewayIp:
  type: string
cidr:
  type: string
isDhcpEnabled:
  type: boolean
addressPool:
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # maximum value of cardinality
  items:
    type: object
    properties:
      start:
        type: string
      end:
        type: string
metadata:
  description: >
    metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: object
default: ""

```

7.2.13 Parameter: updateNetworkPort

The parameter used when providing the network port data provides information about the particular network port shall follow the indications in Table 7.2.13-1.

Table 7.2.13-1: Input data model for updateNetworkPort

Parameter Name and Attributes	Type	Description
updateNetworkPort	Object	Network port data information about the particular virtual network port resource.
>portType	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.
>networkId	String	Identifier of the network that the port belongs to.
>segmentId	String	The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key.
>bandwidth	Number	The bandwidth of the virtual network port (in Mbps).
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.

The syntax of the updateNetworkPort shall comply with the following definition:

```

updateNetworkPort:
  description: >
    The network port data information of a particular network port
resource
  required:
    - portType    type: object # VirtualNetworkData in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA
006
  properties:
    portType:
      type: string
    networkId:
      type: string
    segmentId:
      type: string
    bandwidth:
      type: number
    metadata:

```



```

description: >
  metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
  type: array
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: object
  default: ""

```

7.2.14 Parameter: scopeOfAffinityOrAntiAffinityConstraintForNetwork

The parameter used when providing the type of the affinity or anti-affinity group shall follow the indications in Table 7.2.14-1.

Table 7.2.14-1: Input data model for scopeOfAffinityOrAntiAffinityConstraintForNetwork

Parameter Name and Attributes	Type	Description
scopeOfAffinityOrAntiAffinityConstraintForNetwork	String	Qualifies the scope of the constraint, e.g. NFVI Node, NIC. Defaults to NFVI Node if absent.

The syntax of the scopeOfAffinityOrAntiAffinityConstraintForNetwork shall comply with the following definition:

```

scopeOfAffinityOrAntiAffinityConstraintForNetwork:
description: >
  It qualifies the scope of the constraint, e.g. NFVI Node, NIC of the
  virtualised resource management operation
type: string
enum:
- NFVI-Node
- NIC
default: NFVI-Node

```

7.3 Parameters to be used as output

7.3.1 Parameter: nfvNetworkInfo

The parameter is used when returning information for a virtualised network resource, and its output data model shall follow the indications provided in Table 7.3.1-1. This parameter maps to the "networkData" parameter defined in ETSI GS NFV-IFA 005 [1].

Table 7.3.1-1: Output data model for nfvNetworkInfo

Parameter Name and Attributes	Type	Description
nfvNetworkInfo	Object	If network types are created satisfactorily, it contains the data relative to the instantiated virtualised network resource as VirtualNetwork.
>networkResourceId	String	Identifier of the virtualised network resource.
>networkResourceName	String	Name of the virtualised network resource.
>subnet	String	Only present if the network provides layer 3 connectivity.
>networkPort	Not specified (see note)	Element providing information of an instantiated virtual network port.
>bandwidth	Number	Minimum network bandwidth (in Mbps).
>networkType	String	The type of network that maps to the virtualised network. Examples are: "local", "vlan", "vxlan", "gre", "l3-vpn". The cardinality can be "0" to cover the case where this attribute is not required to create the virtualised network.
>segmentType	String	The isolated segment for the virtualised network. For instance, for a "vlan" networkType, it corresponds to the vlan identifier; and for a "gre" networkType, this corresponds to a gre key. The cardinality can be "0" for flat networks without any specific segmentation.
>networkQoS	Array of Object	Element providing information about Quality of Service attributes that the network supports. Cardinality can be "0" for virtual network without any QoS requirements.

Parameter Name and Attributes	Type	Description
>>qosName	String	Name given to the QoS parameter.
>>qosValue	Number	Value of the QoS parameter.
>isShared	Boolean	It defines whether the virtualised network is shared among consumers.
>sharingCriteria	String	Only present for shared networks. Indicate the sharing criteria for this network. This criteria might be a list of authorized consumers.
>zoneId	String	If present, it identifies the Resource Zone where the virtual network resources have been allocated.
>operationalState	String	The operational state of the virtualised network. Possible values are: "enabled", "disabled".
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. Metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE: In Allocate Virtualised Network Resource operation output parameters, ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2], networkPort attribute is specified with duplication. The data model is specified as an attribute in networkData parameter as well as networkPortData as a parameter in the operation.		

When used as an output parameter in a template, the syntax of the networkInfo shall comply with the following definition:

```

nfvNetworkInfo:
  type: object
  required:
    - networkResourceId
    - bandwidth
    - networkType
    - isShared
    - operationalState
  properties:
    networkResourceId:
      type: string
    networkResourceName:
      type: string
    subnet:
      type: string
    bandwidth:
      type: number
    networkType:
      type: string
    segmentType:
      type: string
    networkQoS:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # maximum value of cardinality
      items:
        - type: object
          properties:
            qosName:
              type: string
            qosValue:
              type: number
    isShared:
      type: boolean
    sharingCriteria:
      type: string
    zoneId:
      type: string
    operationalState:
      type: string
      description: >
        Operational state of the compute resource.
      enum:
        - enabled
        - disabled
    metadata:
      type: array
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.

```

```

minItems: 0 # lower bound of cardinality
maxItems: N # upper bound of cardinality
items:
  type: object

```

7.3.2 Parameter: nfvSubnetInfo

The parameter is used when returning information for a subnet resource, and its output data model shall follow the indications provided in Table 7.3.2-1. This parameter maps to the "subnetData" parameter defined in ETSI GS NFV-IFA 005 [1].

Table 7.3.2-1: Output data model for nfvSubnetInfo

Parameter Name and Attributes	Type	Description
nfvSubnetInfo	Object	If subnet types are created satisfactorily, it contains the data relative to the allocated subnet as NetworkSubnet.
>resourceId	String	Identifier of the virtualised sub-network.
>networkId	String	The identifier of the virtualised network that the virtualised sub-network is attached to. The cardinality can be 0 to cover the case where this type is used to describe the L3 attributes of a network rather than a subnetwork.
>ipVersion	String	The IP version of the network/subnetwork. Possible values are: "IPv4", "IPv6".
>gatewayIp	String	The IP V4 or IPV6 address of the network/subnetwork gateway.
>cidr	String	The CIDR of the network/subnetwork, i.e. network address and subnet mask.
>isDhcpEnabled	Boolean	True when DHCP is enabled for this network/subnetwork, or false otherwise.
>addressPool	Array of Object	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.
>>start	String	The first IP address in the addressPool. See note.
>>end	String	The last IP address in the addressPool. See note.
>operationalState	String	The operational state of the virtualised subnetwork. Allowed values are: enabled, disabled.
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
NOTE:		In case of an IPV4 address, string that consists of four decimal integers separated by dots, each integer ranging from 0 to 255. In case of an IPV6 address, string that consists of groups of zero to four hexadecimal digits, separated by colons.

When used as an output parameter in a template, the syntax of the `nfvSubnetInfo` shall comply with the following definition:

```

nfvSubnetInfo:
  type: object
  required:
    - resourceId
    - ipVersion
    - gatewayIp
    - cidr
    - isDhcpEnabled
    - operationalState
  object:
    resourceId:
      type: string
    networkId:
      type: string
    ipVersion:
      type: string
    enum:
      - IPv4

```

```

- IPv6
gatewayIp:
  type: string
cidr:
  type: string
isDhcpEnabled:
  type: boolean
addressPool:
  type: array
  items:
    - type: object
      properties:
        start:
          type: string
        end:
          type: string
operationalState:
  type: string
  enum:
    - enabled
    - disabled
metadata:
  type: array
  description: >
    metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
minItems: 0 # lower bound of cardinality
maxItems: N # upper bound of cardinality
items:
  type: object

```

7.3.3 Parameter: nfvNetworkPortInfo

The parameter is used when returning information for a network port resource, and its output data model shall follow the indications provided in Table 7.3.3-1. This parameter maps to the "networkPortData" parameter defined in ETSI GS NFV-IFA 005 [1].

Table 7.3.3-1: Output data model for nfvNetworkPortInfo

Parameter Name and Attributes	Type	Description
nfvNetworkPortInfo	Object	If network port types are created satisfactorily, it contains the data relative to the allocated network port as VirtualNetworkPort.
>resourceId	String	Identifier of the virtual network port.
>networkId	String	Identifier of the network that the port belongs to.
>attachedResourceId	String	Identifier of the attached resource to the network port (e.g. a virtualised compute resource, or identifier of the virtual network interface). The cardinality can be "0" if there is no specific resource connected to the network port.
>portType	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. Possible values are: "access ports", "trunk ports".
>segmentId	String	The isolated segment the network port belongs to. For instance, for a "vlan", it corresponds to the vlan identifier; and for a "gre", this corresponds to a gre key. The cardinality can be "0" for flat networks without any specific segmentation.
>bandwidth	Number	The bandwidth of the virtual network port (in Mbps). Cardinality can be "0" for virtual network ports without any specific allocated bandwidth.
>operationalState	String	The operational state of the virtualised network port. Possible values are: "enabled", "disabled".
>metadata	Array of Object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.

When used as an output parameter in a template, the syntax of the `nfvNetworkPortInfo` shall comply with the following definition:

```
nfvNetworkPortInfo:
  type: object
  required:
    - resourceId
    - portType
    - operationalState
  properties:
    resourceId:
      type: string
    attachedResourceId:
      type: string
    portType:
      type: string
      enum:
        - access ports
        - trunk ports
    segmentId:
      type: string
    bandwidth:
      type: number
    operationalState:
      type: string
      enum:
        - enabled
        - disabled
    metadata:
      type: array
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    items:
      type: object
```

8 Data model for Virtualised Storage Management

8.1 Description

This clause specifies data models for input and output parameters for Virtualised Storage Management.

8.2 Parameters to be used as input

8.2.1 Parameter: storageName

The parameter used when providing a name for a virtualised storage resource shall follow the indications provided in Table 8.2.1-1.

Table 8.2.1-1: Input data model for storageName

Parameter Name and Attributes	Type	Description
storageName	String	Name provided by the consumer for the virtualised storage resource to allocate. It can be used for identifying resources from consumer side.

The syntax of the `storageName` shall comply with the following definition:

```
storageName:
  description: >
    Name provided by the consumer for the virtualised storage resource to allocate.
    It can be used for identifying resources from consumer side.
  type: string
  default: ""
```

8.2.2 Parameter: `affinityOrAntiAffinityConstraintsForStorage`

The parameter used when giving resource affinity or anti-affinity constraints related to virtualised storage resources shall follow the indications provided in Table 8.2.2-1. The parameter is a list of elements with affinity or anti affinity information of the virtualised storage resource to be allocated ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]. All the listed constraints shall be fulfilled for a successful operation.

Table 8.2.2-1: Input data model for `affinityOrAntiAffinityConstraintsForStorage`

Parameter Name and Attributes	Type	Description
<code>affinityOrAntiAffinityConstraintsForStorage</code>	Array of Object	A list of elements with affinity or anti-affinity information of the virtualised storage resource to be allocated.
<code>>typeOfAffinityOrAntiAffinityConstraintForStorage</code>	String	Indicates whether this is an affinity or anti-affinity constraint. Allowed to affinity and anti-affinity.
<code>>scopeOfAffinityOrAntiAffinityConstraintForStorage</code>	String	Qualifies the scope of the constraint for the virtualised storage resource. In case of storage resource: e.g. NFVI-Node. Persistent storage node is a type of NFVI-Node which supports, for example, Object, Block or File-based storage service. Ephemeral storage service is supported in a compute node. So this is not included in this attribute. Allowed to NFVI-Node. Defaults to "NFVI-Node" if absent.
<code>>affinityAntiAffinityResourceList</code>	Object	Consumer-managed list of identifiers of virtualised resources with which the actual resource is requested to be affine or anti-affine. See note and condition.
<code>>>resource</code>	Array of String	List of identifiers of virtualised resources.
<code>>affinityAntiAffinityResourceGroup</code>	String	Identifier of the producer-managed group of virtualised resources with which the actual resource is requested to be affine or anti-affine. See note and condition.
NOTE:	It is a prerequisite for the consumer to create a <code>VirtualisedStorageResourceAffinityOrAntiAffinityConstraintsGroup</code> and get <code>groupIdentifier</code> using the appropriate operation, <code>Create Virtualised Storage Resource Affinity Or AntiAffinity Constraints Group</code> , defined in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2].	
CONDITION:	If explicit resource lists for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, the <code>affinityAntiAffinityResourceList</code> shall be supported. If named resource groups for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, <code>affinityAntiAffinityResourceGroup</code> shall be supported. The mechanisms shall not be mixed in the scope of a <code>resourceGroup</code> (aka VIM tenant).	

The syntax of the `affinityOrAntiAffinityConstraintsForCompute` shall comply with the following definition:

```
affinityOrAntiAffinityConstraintsForStorage:
  description: >
    A list of elements with affinity or anti-affinity information of
    the virtualised storage resource to allocate.
  oneOf:
    - type: array
      minItems: 0 # lower bound of cardinality
```

```

maxItems: N # upper bound of cardinality
items:
  type: object
  required:
    - typeOfAffinityOrAntiAffinityContrraintForStorage
  properties:
    typeOfAffinityOrAntiAffinityConstraintForStorage:
      type: string
      enum:
        - affinity
        - anti-affinity
    scopeOfAffinityOrAntiAffinityConstraintForStorage:
      type: string
      enum:
        - NFVI-Node
      default: NFVI-Node
    affinityAntiAffinityResourceList:
      type: object
      required:
        - resource
      properties:
        resource:
          type: array
          minItems: 1 # lower bound of cardinality
          maxItems: N # upper bound of cardinality
          items:
            type: string
- type: array
minItems: 0 # lower bound of cardinality
maxItems: N # upper bound of cardinality
items:
  type: object
  required:
    - typeOfAffinityOrAntiAffinityContrraintForStorage
  properties:
    typeOfAffinityOrAntiAffinityConstraintForStorage:
      type: string
      enum:
        - affinity
        - anti-affinity
    scopeOfAffinityOrAntiAffinityConstraintForStorage:
      type: string
      enum:
        - NFVI-Node
      default: NFVI-Node
    affinityAntiAffinityResourceGroup:
      type: string

```

8.2.3 Parameter: storageData

The parameter used when providing information about the type and size of the storage shall follow the indications provided in Table 8.2.3-1.

Table 8.2.3-1: Input data model for storageData

Parameter Name and Attributes	Type	Description
storageData	Object	The storage data provides information about the type and size of the storage.
NOTE: This storageData is specified for input parameter with VirtualStorageFlavour IE in allocate Virtualised Storage Resource operation.		

The syntax of the storageData shall comply with the following definition:

```

storageData:
  description: >
    The storage data provides information about the type and size of the storage.
  type: object
  required:
    - flavourId
    - storageAttributes
  properties:
    flavourId:
      type: string

```

```

storageAttributes:
  type: object
  properties:
    typeOfStorage:
      type: string
    sizeOfStorage:
      type: number

```

8.2.4 Parameter: updateStorageData

The parameter used when providing information about the type and size of the storage to be updated shall follow the indications provided in Table 8.2.4-1.

Table 8.2.4-1: Input data model for updateStorageData

Parameter Name and Attributes	Type	Description
updateStorageData	Object	The element contains the fields that can be updated of a storage resource.

The syntax of the updateStorageData shall comply with the following definition:

```

updateStorageData:
  description: >
    The element contains the fields that can be updated of a storage resource.
  type: object
  required:
    - flavourId
    - storageAttributes
  properties:
    flavourId:
      type: string
    storageAttributes:
      typeOfStorage:
        type: string
      sizeOfStorage:
        type: number

```

8.2.5 Parameter: storageOperation

The parameter used when providing a type of operation for a virtualised storage operation shall follow the indications provided in Table 8.2.5-1.

Table 8.2.5-1: Input data model for storageOperation

Parameter Name and Attributes	Type	Description
storageOperation	String	Type of operation to perform on the virtualised storage resource. Possible values include: "create snapshot", and "delete snapshot".

The syntax of the storageOperation shall comply with the following definition:

```

storageOperation:
  description: >
    Type of operation to perform on the virtualised storage resource.
  type: string
  enum:
    - create-snapshot
    - delete-snapshot
  default: ""

```

8.2.6 Parameter: newSize

The parameter used when providing a resized amount of an allocated virtualised storage resource shall follow the indications provided in Table 8.2.6-1.

Table 8.2.6-1: Input data model for storageOperation

Parameter Name and Attributes	Type	Description
newSize	Number	Resized amount of allocated virtualised storage resource.

The syntax of the newSize shall comply with the following definition:

```
newSize:
  description: >
    Resized amount of allocated virtualised storage resource.
  type: number
  default: ""
```

8.2.7 Parameter: scopeOfAffinityOrAntiAffinityConstraintsForStorage

The parameter used when qualifying the scope of the affinity constraint shall follow the indications provided in Table 8.2.7-1.

Table 8.2.7-1: Input data model for scopeOfAffinityOrAntiAffinityConstraintsForStorage

Parameter Name and Attributes	Type	Description
scopeOfAffinityOrAntiAffinityConstraintsForStorage	String	If applicable. Qualifies the scope of the affinity constraint, e.g. NFVI-Node. Defaults to NFVI-Node if absent.

The syntax of the scopeOfAffinityOrAntiAffinityConstraints shall comply with the following definition:

```
scopeOfAffinityOrAntiAffinityConstraints:
  description: >
    Qualifies the scope of the affinity constraint,
  type: string
  enum:
    - NFVI-Node
  default: NFVI-Node
```

8.3 Parameters to be used as output

8.3.1 Parameter: nfvStorageInfo

The parameter is used when returning information for a virtualised storage resource, and its output data model shall follow the indications provided in Table 8.3.1-1. This parameter maps to the "storageResource" parameter defined in ETSI GS NFV-IFA 005 [1].

Table 8.3.1-1: Output data model for nfvStorageInfo

Parameter Name and Attributes	Type	Description
nfvStorageInfo	Object	Information of an instantiated virtualised storage resource.
>storageId	String	Identifier of the virtualised storage resource.
>storageName	String	Name of the virtualised storage resource.
>flavourId	String	Identifier of the storage flavour used to instantiate this virtual storage.
>sizeOfStorage	Number	Size of virtualised storage resource (e.g. size of volume, in GB).
>rdmaEnabled	Boolean	Indicates if the storage supports RDMA.
>ownerId	String	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	String	It identifies the resource zone where the virtual storage resources have been allocated.
>hostId	String	Identifier of the host where the virtualised storage resource is allocated.

Parameter Name and Attributes	Type	Description
>operationalState	String	Operational state of the resource. Allowed value: enabled, disabled.
>metadata	Array of object	List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource. metadata is optional. It is out of scope to detail what are the sub-keys and possible values.

When used as an output parameter in a template, the syntax of the `nfvStorageInfo` shall comply with the following definition:

```

nfvStorageInfo:
  description: >
    Information of an instantiated virtualised storage resource
  type: object
  required:
    - storageId
    - flavourId
    - typeOfStorage
    - sizeOfStorage
    - operationalState
  properties:
    storageId:
      description: >
        Identifier of the virtualised storage resource
      type: string
    storageName:
      description: >
        Name of the virtualised storage resource
      type: string
    flavourId:
      description: >
        Identifier of the storage flavour used to instantiate this virtual storage
      type: string
    typeOfStorage:
      description: >
        Type of virtualised storage resource
      type: string
    sizeOfStorage:
      description: >
        Size of virtualised storage resource
      type: number
    rdmaEnabled:
      description: >
        Indicates if the storage supports RDMA.
      type: boolean
    ownerId:
      description: >
        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
      type: string
    zoneId:
      description: >
        It identifies the resource zone where the virtual
storage resources have been allocated
      type: string
    hostId:
      description: >
        Identifier of the host where the virtualised storage resource is allocated.
      type: string
    operationalState:
      description: >
        Operational state of the resource.
      type: string
      enum:
        - enabled
        - disabled
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
      type: array
      minItems: 0 # lower bound of cardinality

```

```

maxItems: N # upper bound of cardinality
items:
  type: object

```

9 Data model for Virtualised Resources Change Notification

9.1 Description

This clause specifies data models for input and output parameters for Virtualised Resources Change Notification.

9.2 Parameters to be used as input

9.2.1 Parameter: callbackUriForChangeNotify

The parameter used when providing a URI of the endpoint to send change notifications to in a subscribe operation shall follow the indications provided in Table 9.2.1-1.

Table 9.2.1-1: Input data model for callbackUriForChangeNotify

Parameter Name and Attributes	Type	Description
callbackUriForChangeNotify	String	The URI of the endpoint to send the change notification to.

The syntax of the `callbackUri` shall comply with the following definition:

```

callbackUri:
  description: >
    The URI of the endpoint to send the change notification to.
  type: string
  default: ""

```

9.2.2 Parameter: inputFilter

The parameter used when selecting change notifications to in a subscribe operation shall follow the indications provided in Table 9.2.2-1.

Table 9.2.2-1: Input data model for inputFilter

Parameter Name and Attributes	Type	Description
inputFilter	Object	Input filter for selecting change notifications.
>hostId	String	Identifier of the host. When selected host will change (e.g. maintenance), VIM will send the change notification.

The syntax of the `inputFilter` shall comply with the following definition:

```

inputFilter:
  description: >
    Input filter for selecting change notifications.
  type: object
  properties:
    hostId:
      description: >
        Identifier of the host. When selected host will change (e.g. maintenance), VIM will send
        the change notification.
      type: string

```

9.2.3 Parameter: changeld

The parameter used when providing an identifier of the change on the virtualised resource in a change notification shall follow the indications provided in Table 9.2.3-1.

Table 9.2.3-1: Input data model for changeld

Parameter Name and Attributes	Type	Description
changeld	String	Unique identifier of the change on the virtualised resource.

The syntax of the `changeId` shall comply with the following definition:

```
changeId:
  description: >
    Unique identifier of the change on the virtualised resource.
  type: string
  default: ""
```

9.2.4 Parameter: virtualisedResourceId

The parameter used when providing the identifier of the instantiated virtualised resource for which the change notification is issued shall follow the indications provided in Table 9.2.4-1.

Table 9.2.4-1: Input data model for virtualisedResourceId

Parameter Name and Attributes	Type	Description
virtualisedResourceId	String	Identifier of the instantiated virtualised resource for which the change notification is issued.

The syntax of the `virtualisedResourceId` shall comply with the following definition:

```
virtualisedResourceId:
  description: >
    Identifier of the instantiated virtualised resource for which the change notification is
    issued.
  type: string
  default: ""
```

9.2.5 Parameter: virtualisedResourceGroupId

The parameter used when providing the identifier of the affinity or anti-affinity group of the virtualised resource for which the change notification is issued shall follow the indications provided in Table 9.2.5-1.

Table 9.2.5-1: Input data model for virtualisedResourceGroupId

Parameter Name and Attributes	Type	Description
virtualisedResourceGroupId	String	Identifier of the affinity or anti-affinity group of the virtualised resource for which the change notification is issued.

The syntax of the `virtualisedResourceGroupId` shall comply with the following definition:

```
virtualisedResourceGroupId:
  description: >
    Identifier of the affinity or anti-affinity group of the virtualised resource for which the
    change notification is issued.
  type: string
  default: ""
```

9.2.6 Parameter: endOfChange

The parameter used when providing whether this change notification is the end of the changes shall follow the indications provided in Table 9.2.6-1.

Table 9.2.6-1: Input data model for endOfChange

Parameter Name and Attributes	Type	Description
endOfChange	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.

The syntax of the `endOfChange` shall comply with the following definition:

```

endOfChange:
  description: >
    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.
  type: boolean
  default: "true"

```

9.2.7 Parameter: changeTime

The parameter used when providing the time of changes in a change notification shall follow the indications provided in Table 9.2.7-1.

Table 9.2.7-1: Input data model for changeTime

Parameter Name and Attributes	Type	Description
changeTime	String	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 <code>endOfChange</code> is "true".

The syntax of the `changeTime` shall comply with the following definition:

```

changeTime:
  description: >
    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".
  type: string
  default: ""

```

9.2.8 Parameter: vimId

The parameter used when providing the identifier of the VIM reporting the change notification shall follow the indications provided in Table 9.2.8-1.

Table 9.2.8-1: Input data model for vimId

Parameter Name and Attributes	Type	Description
vimId	String	Identifier of the VIM reporting the change.

The syntax of the `vimId` shall comply with the following definition:

```

vimId:
  description: >
    Identifier of the VIM reporting the change.
  type: string
  default: ""

```

9.2.9 Parameter: changeType

The parameter used when providing the type of change notification shall follow the indications provided in Table 9.2.9-1.

Table 9.2.9-1: Input data model for changeType

Parameter Name and Attributes	Type	Description
changeType	String	Categorizes the type of change. Possible values can be related to maintenance and operation of the NFVI. Allowed value: normal, maintenance, evacuation, optimization.

The syntax of the changeType shall comply with the following definition:

```
changeType:
  description: >
    Categorizes the type of change. Possible values can be related to maintenance and operation of
the NFVI.
  type: string
  enum:
    - normal
    - maintenance
    - evacuation
    - optimization
  default: ""
```

9.2.10 Parameter: changedResourceData

The parameter used when providing details of the changes of the resource in a change notification shall follow the indications provided in Table 9.2.10-1.

Table 9.2.10-1: Input data model for changedResourceData

Parameter Name and Attributes	Type	Description
changedResourceData	String	Details of the changes of the resource. Its content can differ based on the different values of the attribute changeType.

The syntax of the changedResourceData shall comply with the following definition:

```
changedResourceData:
  description: >
    Details of the changes of the resource. Its content can differ based on the different values
of the attribute changeType.
  type: string
  default: ""
```

9.3 Parameters to be used as output

None.

10 Data model for Virtualised Resources Fault Management

10.1 Description

This clause specifies data models for input and output parameters for Virtualised Resources Fault Management.

10.2 Parameters to be used as input

10.2.1 Parameter: callbackUriForFaultNotify

The parameter used when providing a URI of the endpoint to send fault notifications to in a subscribe operation shall follow the indications provided in Table 10.2.1-1.

Table 10.2.1-1: Input data model for callbackUriForFaultNotify

Parameter Name and Attributes	Type	Description
callbackUriForFaultNotify	String	The URI of the endpoint to send the fault notification to.

The syntax of the `callbackUri` shall comply with the following definition:

```
callbackUriForFaultNotify:
  description: >
    The URI of the endpoint to send the fault notification to.
  type: string
  default: ""
```

10.2.2 Parameter: filter

The parameter used when selecting fault notifications to in a subscribe operation shall follow the indications provided in Table 10.2.2-1.

Table 10.2.2-1: Input data model for filter

Parameter Name and Attributes	Type	Description
filter	Object	Input filter for selecting fault notifications.
>computeId	String	Identifier of the virtualised compute resource. When selected virtualised compute resource was affected by faults, VIM will send notifications.
>networkResourceId	String	Identifier of the virtualised network resource. When selected virtualised network resource was affected by faults, VIM will send notifications.
>storageId	String	Identifier of the virtualised storage resource. When selected virtualised storage resource was affected by faults, VIM will send notifications.

The syntax of the `filter` shall comply with the following definition:

```
filter:
  description: >
    Input filter for selecting fault notifications.
  type: object
  properties:
    computeId:
      description: >
        Identifier of the virtualised compute resource. When selected virtualised compute resource
        was affected by faults, VIM will send notifications.
      type: string
    networkResourceId:
      description: >
        Identifier of the virtualised network resource. When selected virtualised network resource
        was affected by faults, VIM will send notifications.
      type: string
    storageId:
      description: >
        Identifier of the virtualised storage resource. When selected virtualised storage resource
        was affected by faults, VIM will send notifications.
      type: string
```

10.2.3 Parameter: alarm

The parameter used when providing Information about an alarm in a fault notification shall follow the indications provided in Table 10.2.3-1.

Table 10.2.3-1: Input data model for alarm

Parameter Name and Attributes	Type	Description
alarm	Object	Information about an alarm.
>alarmId	String	Alarm identifier.
>managedObjectId	String	Identifier of the affected managed Object. The Managed Objects for this information element will be virtualised resources.
>alarmRaisedTime	String	Timestamp indicating when the alarm was first raised by the managed object.
>alarmChangedTime	String	Timestamp indicating when the alarm was last changed. It shall be present if the alarm has been updated.
>alarmClearedTime	String	Timestamp indicating when the alarm was cleared. It shall be present if the alarm has been cleared.
>state	String	State of the alarm. Allowed value: FIRED, UPDATED, CLEARED.
>perceivedSeverity	String	Perceived severity of the virtualised managed object failure. Allowed value: CRITICAL, MAJOR, MINOR, WARNING, INDETERMINATE, CLEARED.
>eventTime	String	Timestamp indicating when the fault was observed.
>eventType	String	Type of the event. Allowed value: COMMUNICATION_ALARM, PROCESSING_ALARM, ENVIRONMENT_ALARM, QOS_ALARM, EQUIPMENT_ALARM.
>faultType	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	String	Information about the probable cause of the fault.
>isRootCause	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	Array of String	List of other alarms correlated to this fault.
>faultDetails	Array of String	Provides additional information about the fault, e.g. information about the threshold, monitored attributes, indication of the trend of the monitored parameter, etc.

The syntax of the alarm shall comply with the following definition:

```
alarm:
  description: >
    Information about an alarm.
  type: object
  properties:
    alarmId:
      type: string
    managedObjectId:
      type: string
    alarmRaisedTime:
      type: string
    alarmChangedTime:
      type: string
    alarmClearedTime:
      type: string
    state:
      type: string
      enum:
        - FIRED
        - UPDATED
        - CLEARED
    perceivedSeverity:
      type: string
      enum:
        - CRITICAL
        - MAJOR
```



```
- MINOR
- WARNING
- INDETERMINATE
- CLEARED
eventTime:
  type: string
eventType:
  type: string
  enum:
    - COMMUNICATION_ALARM
    - PROCESSING_ALARM
    - ENVIRONMENT_ALARM
    - QOS_ALARM
    - EQUIPMENT_ALARM
faultType:
  type: string
probableCause:
  type: string
isRootCause:
  type: boolean
correlatedAlarmId:
  type: array
  minItems: 1 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: string
faultDetails:
  type: array
  minItems: 1 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: string
```

10.3 Parameters to be used as output

None.

Annex A (informative): Examples using OpenStack® Heat Orchestration Template

A.1 Introduction

The present annex provides implementation examples of the data models defined for the various interfaces over the Or-Vi and Vi-Vnfm reference points using the OpenStack's Heat Orchestration Template (HOT). The purpose is to describe how the input and output parameters of the interfaces' operations can be mapped onto the HOT. In this context, an overview of the HOT template and its structure is provided, followed by selected implementation examples of interface operations using HOT templates.

A.2 Overview

A.2.1 Introduction

An OpenStack's HOT template describes the intended virtualised resource topology, the relationship between the virtualised resources to be provisioned, the type of virtualised resources and their setup in YAML text files. The template is treated as "code" by the orchestration engine while provisioning the set of virtualised resources that are declared. In addition, the template specifies input and output parameters to be exchanged with the user (e.g. the API client).

A.2.2 Template structure

The structure of a HOT is specified in HOT template guide [i.2].

A.3 Examples

A.3.1 Example#1: Allocate Virtualised Compute Resource operation

This is an example of "Create stack" in OpenStack Orchestration Service API corresponding to the Allocate Virtualised Compute Resource operation (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". Parameters grouped by "nfv" are specified in the present document. The input data is expressed in JSON format, as this is determined by the HOT specification.

Following the input parameter specifications in the present example (see further below), input parameters "computeName", "affinityOrAntiAffinityConstraints", "computeFlavourId", "vcImageId", "interfaceData", "metaData", "locationConstraints", "userData" are given as keys with their values. This covers the input parameter values part.

The following example illustrates the input parameters that can be passed to a HEAT API call for the Allocate Virtualised Compute Resource operation.

```
{
  "parameters": {
    "nfv": {
      "computeName": "test-instance-from-stack",
      "affinityOrAntiAffinityConstraintsForCompute": {
        "type": "affinity",
        "scope": "NFVI Node",
        "affinityAntiAffinityResourceGroup": "d10312a4-9d68-4cd4-831e-fd0edf3c0649"
      },
      "computeFlavourId": 10,
    }
  }
}
```

```

"vcImageId": "2fe6b099-f936-429b-b644-048b96b70417",
"interfaceData": {
  "count": 3,
  "0": {
    "ipAddress": "172.17.1.15",
    "macAddress": "fa:16:3e:aa:bb:cc",
  },
  "1": {
    "ipAddress": "20.20.20.15",
    "macAddress": "fa:16:3e:ab:ca:bc",
  },
  "2": {
    "ipAddress": "30.30.30.15",
    "macAddress": "fa:16:3e:dd:ee:ff",
  }
},
"metaData": {
  "test-key": "test-value"
},
"locationConstraints": "nova",
"userData": "test-userData"
},
"gap": {
  "networkId": {
    "0": "c4440f4f-66ef-4e42-9c41-7b3b449813d1",
    "1": "f6a6471d-032d-4c58-9432-c17ealf72873",
    "2": "91652985-5fed-43f9-adae-8af0471bda03"
  }
}
},
"stack_name": "compute-test-stack"
}

```

Below is the corresponding example of the referred HOT that uses the parameters provided in the example above.

The "parameters" section in the template has definitions for input data to be provided when instantiating the template. In this case the parameter "nfv" is represented in the JSON format.

When input data, "computeName": "test-instance-from-stack", is given, then test-instance-from-stack as a string value is assigned to the input parameter, computeName. In the same way, other values are captured and assigned to the other input parameters in the template.

The resources section describes what type and how virtualised resources are provisioned. In the resource handling, actual values of the input parameters are assigned to parameters used by OpenStack when performing the resource handling. For example, the line:

```
external_id: { get_param: computeFlavourId }
```

assigns 3 (see in the example of input data above) to external_id.

The outputs section of the template describes output data for the user, e.g. when in terms of the Allocate Virtualised Compute Resource the nfvComputeInfo is requested. The naming and structure of output parameters in the present document and the ones used and provided by default by the OpenStack Heat Orchestration can differ. Because of this, name translation and output parameter structuring are necessary. The template section in the nfvComputeInfo resolves such a translation. For instance, a key/value pair for computeId is written with:

```
"computeId": "$computeId"
```

and the value of computeId, which is determined by the variable \$computeId, whose value is assigned by using an intrinsic function as shown below:

```
$computeId: { get_attr: [ virtualisedComputeResource, show, id ] }
```

The intrinsic function, get_attr, gets the virtualised compute identifier from the virtualisedComputeResource.

NOTE: An alternative to putting output parameters in the template is to use API mapping, as defined in clause 4.3.

The "stack_name" is a required parameter to generate an identifier that points to a stack of the virtualised resources, as shown in clause A.3.6.

The following is an example of a HOT for the Allocate Virtualised Compute Resource operation.

```

heat_template_version: 2018-08-31
description: Allocate Virtualised Compute Resource operation

parameters:
  nfv:
    type: json
    description:
    default: ""

  gap:
    type: json
    description:
    default: ""

conditions:
  Constraints_ResourceList_is_null: { equals: [ { get_param: [ nfv,
affinityOrAntiAffinityConstraintsForCompute, affinityAntiAffinityResourceList ] }, "" ] }
  Constraints_type_is_affinity: { equals : [ { get_param: [ nfv,
affinityOrAntiAffinityConstraintsForCompute, type ] }, "affinity" ] }

resources:
  interfaceResource:
    type: OS::Heat::ResourceGroup
    properties:
      count: { get_param: [ nfv, interfaceData, count ] }
      resource_def:
        type: http://controller/Allocate-Virtualised-Compute-Resource-operation/createPort.yaml
        properties:
          interfaceData: { get_param: [ nfv, interfaceData ] }
          networkId: { get_param: [ gap, networkId ] }
          index: "%index%"

  forOutput-flavorResource:
    type: OS::Nova::Flavor
    external_id: { get_param: [ nfv, computeFlavourId ] }

  forOutput-flavorExtraSpecs:
    type: OS::Heat::ResourceGroup
    depends_on: [ forOutput-flavorResource ]
    properties:
      count: 1
      resource_def:
        type: http://controller/Allocate-Virtualised-Compute-Resource-
operation/getFlavorExtraSpecs.yaml
        properties:
          policy: { get_attr: [ forOutput-flavorResource, extra_specs, "hw:cpu_policy" ] }
          cores: { get_attr: [ forOutput-flavorResource, extra_specs, "hw:cpu_cores" ] }
          sockets: { get_attr: [ forOutput-flavorResource, extra_specs, "hw:cpu_sockets" ] }
          threads: { get_attr: [ forOutput-flavorResource, extra_specs, "hw:cpu_threads" ] }

  forOutput-portStatusResource:
    type: OS::Heat::ResourceGroup
    depends_on: [ virtualisedComputeResource ]
    properties:
      count: { get_param: [ nfv, interfaceData, count ] }
      resource_def:
        type: http://controller/Allocate-Virtualised-Compute-Resource-operation/getPortStatus.yaml
        properties:
          status: { get_attr: [ interfaceResource, show, status ] }
          index: "%index%"

  forOutput-virtualisedComputeResourceStatus:
    type: OS::Heat::ResourceGroup
    depends_on: [ virtualisedComputeResource ]
    properties:
      count: 1
      resource_def:
        type: http://controller/Allocate-Virtualised-Compute-Resource-
operation/getComputeResourceStatus.yaml
        properties:
          status: { get_attr: [ virtualisedComputeResource, show, status ] }

  virtualisedComputeResource:
    type: OS::Nova::Server
    depends_on: [ interfaceResource ]
    properties:

```

```

name: { get_param: [ nfv, computeName ] }
scheduler_hints:
  if:
    - Constraints_ResourceList_is_null
    - group: { get_param: [ nfv, affinityOrAntiAffinityConstraintsForCompute,
affinityAntiAffinityResourceGroup ] }
      - if:
        - Constraints_type_is_affinity
        - same_host:
            repeat:
              for_each:
                <%Resource%>: { get_param: [ nfv, affinityOrAntiAffinityConstraintsForCompute,
affinityAntiAffinityResourceList ] }
                template:
                  <%Resource%>
      - different_host:
        repeat:
          for_each:
            <%Resource%>: { get_param: [ nfv, affinityOrAntiAffinityConstraintsForCompute,
affinityAntiAffinityResourceList ] }
            template:
              <%Resource%>
flavor: { get_param: [ nfv, computeFlavourId ] }
image: { get_param: [ nfv, vcImageId ] }
networks:
  repeat:
    for_each:
      <%Port%>: { get_attr: [ interfaceResource, id ] }
    template:
      port: <%Port%>
metadata: { get_param: [ nfv, metaData ] }
availability_zone: { get_param: [ nfv, locationConstraints ] }
user_data: { get_param: [ nfv, userData ] }
user_data_format: "RAW"

outputs:
  nfvComputeInfo:
    value:
      str_replace:
        template: |
          {
            "computeId": "$computeId",
            "computeName": "$computeName",
            "flavourId": "$flavourId",
            "virtualCpu": {
              "numVirtualCpu": "$numVirtualCpu",
              "virtualCpuPinning": "$virtualCpuPinning"
            },
            "virtualMemory": {
              "virtualMemSize": "$virtualMemSize"
            },
            "virtualNetworkInterface": "$virtualNetworkInterface",
            "virtualDisks": [
              {
                "storageId": "$storageId",
                "typeOfStorage": "disk",
                "sizeOfStorage": "$sizeOfStorageDisk",
                "operationalState": "$storageOperationalState"
              },
              {
                "storageId": "$storageId",
                "typeOfStorage": "ephemeral",
                "sizeOfStorage": "$sizeOfStorageEphemeral",
                "operationalState": "$storageOperationalState"
              },
              {
                "storageId": "$storageId",
                "typeOfStorage": "swap",
                "sizeOfStorage": "$sizeOfStorageSwap",
                "operationalState": "$storageOperationalState"
              }
            ],
            "vcImageId": "$vcImageId",
            "zoneId": "$zoneId",
            "hostId": "$hostId",
            "operationalState": "$operationalState",
            "metaData": "$metadata"
          }

```

```

params:
  $computeId: { get_attr: [ virtualisedComputeResource, show, id ] }
  $computeName: { get_attr: [ virtualisedComputeResource, show, name ] }
  $flavourId: { get_attr: [ forOutput-flavorResource, show, id ] }
  $numVirtualCpu: { get_attr: [ forOutput-flavorResource, show, vcpus ] }
  $virtualCpuPinning: { get_attr: [ forOutput-flavorExtraSpecs, resource.0.cpuPinning ] }
  $virtualMemSize: { get_attr: [ forOutput-flavorResource, show, ram ] }
  $virtualNetworkInterface:
    repeat:
      for_each:
        <%resourceId%>: { get_attr: [ interfaceResource, show, id ] }
        <%ownerId%>: { get_attr: [ interfaceResource, show, device_id ] }
        <%networkId%>: { get_attr: [ interfaceResource, show, network_id ] }
        <%ipAddress%>: { get_attr: [ interfaceResource, show, fixed_ips, 0, ip_address ] }
        <%typeVirtualNic%>: { get_attr: [ interfaceResource, show, "binding:vnic_type" ] }
        <%macAddress%>: { get_attr: [ interfaceResource, show, mac_address ] }
        <%operationalState%>: { get_attr: [ forOutput-portStatusResource, status ] }
      template:
        "resourceId": <%resourceId%>
        "ownerId": <%ownerId%>
        "networkId": <%networkId%>
        "ipAddress": <%ipAddress%>
        "typeVirtualNic": <%typeVirtualNic%>
        "macAddress": <%macAddress%>
        "operationalState": <%operationalState%>
      permutations: false
  $storageId: { get_attr: [ virtualisedComputeResource, show, id ] }
  $sizeOfStorageDisk: { get_attr: [ forOutput-flavorResource, show, disk ] }
  $sizeOfStorageEphemeral: { get_attr: [ forOutput-flavorResource, show, "OS-FLV-EXT-
DATA:ephemeral" ] }
  $sizeOfStorageSwap:
    yaql:
      expression: $.data.swap_MB/1024
      data:
        swap_MB: { get_attr: [ forOutput-flavorResource, show, swap ] }
  $storageOperationalState: { get_attr: [ forOutput-virtualisedComputeResourceStatus,
resource.0.status ] }
  $svcImageId: { get_attr: [ virtualisedComputeResource, show, image, id ] }
  $zoneId: { get_attr: [ virtualisedComputeResource, show, "OS-EXT-AZ:availability_zone" ] }
  $hostId: { get_attr: [ virtualisedComputeResource, show, "OS-EXT-SRV-ATTR:host" ] }
  $operationalState: { get_attr: [ forOutput-virtualisedComputeResourceStatus,
resource.0.status ] }
  $metadata: { get_attr: [ virtualisedComputeResource, show, metadata ] }

```

Below is an output example using template output parameters related to the allocated compute resource as provided by "Show output" in OpenStack Orchestration Service API [i.2]. Attributes defined in "nfvComputeInfo" of the HOT can be seen in the body of "output_value". virtualDisks is prepared in the ephemeral storage in the hypervisor of the host compute node in this sample. Thus, the value of storageId is equal to the computeId. The storage resource is managed in the hypervisor of the host compute node.

```

{
  "output":
    "output_value":
      {
        "computeId": "735ee7f9-92ce-4c00-8c7d-63eeeda75368",
        "computeName": "test-instance-from-stack",
        "flavourId": "10",
        "virtualCpu":
          {
            "numVirtualCpu": "1",
            "virtualCpuPinning":
              {
                "cpuPinningPolicy": "dynamic"
              }
          },
        "virtualMemory":
          {
            "virtualMemSize": "64"
          },
        "virtualNetworkInterface":
          [
            {
              "ipAddress": "172.17.1.15",
              "macAddress": "fa:16:3e:aa:bb:cc",
              "networkId": "c4440f4f-66ef-4e42-9c41-7b3b449813d1",
              "operationalState": "disabled",
              "ownerId": "735ee7f9-92ce-4c00-8c7d-63eeeda75368",

```

```

"resourceId": "658fdc3b-679e-49bd-9dbb-9d19a60f0321",
"typeVirtualNic": "normal"
},
{
  "ipAddress": "20.20.20.15",
  "macAddress": "fa:16:3e:ab:ca:bc",
  "networkId": "f6a6471d-032d-4c58-9432-c17ealf72873",
  "operationalState": "disabled",
  "ownerId": "735ee7f9-92ce-4c00-8c7d-63eeda75368",
  "resourceId": "5b090b65-81bc-43a8-abbb-b306dlac87c1",
  "typeVirtualNic": "normal"},
{
  "ipAddress": "30.30.30.15",
  "macAddress": "fa:16:3e:dd:ee:ff",
  "networkId": "91652985-5fed-43f9-adae-8af0471bda03",
  "operationalState": "disabled",
  "ownerId": "735ee7f9-92ce-4c00-8c7d-63eeda75368",
  "resourceId": "e840e0b4-4cf0-4e14-82c5-481e086abd4a",
  "typeVirtualNic": "normal"
}
],
"virtualDisks":
[
  {
    "storageId": "735ee7f9-92ce-4c00-8c7d-63eeda75368",
    "typeOfStorage": "disk",
    "sizeOfStorage": "10",
    "operationalState": "enable"
  },
  {
    "storageId": "735ee7f9-92ce-4c00-8c7d-63eeda75368",
    "typeOfStorage": "ephemeral",
    "sizeOfStorage": "5",
    "operationalState": "enable"
  },
  {
    "storageId": "735ee7f9-92ce-4c00-8c7d-63eeda75368",
    "typeOfStorage": "swap",
    "sizeOfStorage": "1",
    "operationalState": "enable"
  }
],
"vcImageId": "2fe6b099-f936-429b-b644-048b96b70417",
"zoneId": "nova",
"hostId": "compute3",
"operationalState": "enable",
"metaData":
{
  "test-key": "test-value"
}
},
"output_key": "nfvComputeInfo",
"description": "No description given"
}
}

```

A.3.2 Example#2: Allocate Virtualised Network Resource operation

This is an example of "Create stack" in OpenStack Orchestration Service API [i.2] corresponding to the Allocate Virtualised Network Resource operation (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification.

Parameters grouped by "nfv" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters, networkResourceName, networkResourceType, typeNetworkData, are given as keys with their values. This covers the input parameter values part.

The following example illustrates the input parameters that can be passed to a HEAT API call for the Allocate Virtualised Network Resource operation.

```
{
  "parameters": {
    "nfv": {
      "networkResourceName": "test-network-from-stack",
      "networkResourceType": "network",
      "typeNetworkData": {
        "bandwidth": 100,
        "networkType": "flat",
        "isShared": false,
        "layer3Attributes": {
          "ipVersion": "IPv4",
          "gatewayIp": "10.0.0.1",
          "cidr": "10.0.0.0/24",
          "isDhcpEnabled": false,
          "addressPool": [
            {
              "start": "10.0.0.101",
              "end": "10.0.0.110"
            }
          ]
        }
      }
    }
  },
  "stack_name": "network-test-stack"
}
```

NOTE 1: `resourceGroupId` is not covered in the present example. ETSI GS NFV-IFA 005 [1], and the ETSI GS NFV-IFA 006 [2] do not specify the required operations for the management of resource groups for infrastructure tenants (e.g. creation of a resource group, etc.).

NOTE 2: The example is prepared to highlight only an allocation of virtualised network resource. The parameters of `affinityOrAntiAffinityConstraintsForNetwork` and `locationConstraintForNetwork` are not used in this example (cardinality is 0).

Below is the corresponding example of the HOT that uses the parameters provided in the example above.

The `parameters` section in the template has definitions for input data to be provided when instantiating the template. In this case, parameter, `nfv` is typed as JSON format.

When input data `"networkResourceName": "test-network-from-stack"`, is given, then `test-network-from-stack` as a string value is assigned to the input parameter `networkResourceName`. In the same way, other values are captured and assigned to the other input parameters in the template.

In this use case, `networkType` is `flat`; the cardinality of `segmentType` can be "0" to allow for the flat networks without any specific segmentation.

The `resources` section describes what type and how virtualised resources are provisioned. In the resource handling, actual values of the input parameters are assigned to parameters used by OpenStack when performing the resource handling. For example, the line:

```
name: { get_param: networkResourceName }
```

gets the value, `test-network-from-stack` (see in the example of input data above), of the input parameter, `networkResourceName`, and then assigns `test-network-from-stack` to `name`.

The `outputs` section of the template describes output data for the user, e.g. when in terms of the Allocate Virtualised Network Resource the `networkResource` is requested. The naming and structure of output parameter in the present document and the ones used and provided by default by the OpenStack Heat Orchestration can differ. Because of this, name translation and output parameter structuring are necessary.

The template section in the `nfvNetworkInfo` resolves such a translation. For instance, a key/value pair for `networkResourceId` is written with:

```
"networkResourceId": "$networkResourceId"
```

and the value of `networkResourceId`, which is determined by the variable `$networkResourceId`, whose value is assigned by using an intrinsic function as shown below:

```
$networkResourceId: { get_attr: [ networkResource, resource.0.show, id ] }
```

The intrinsic function `get_attr` gets the virtualised network identifier from the `networkResource`.

NOTE 3: An alternative to putting output parameters in the template is to use API mapping, as defined in clause 4.3.

The `"stack_name"` is a required parameter to generate an identifier that points to a stack of the virtualised resources, as shown in clause A.3.6.

The following is an example of a HOT for the Allocate Virtualised Network Resource operation.

```
heat_template_version: 2018-08-31
description: Allocate Virtualised Network Resource operation.

parameters:
  nfv:
    type: json
    description:
    default: ""

conditions:
  networkResourceType_is_network: { equals: [ { get_param: [ nfv, networkResourceType ] }, "network" ] }
  networkResourceType_is_subnet: { equals: [ { get_param: [ nfv, networkResourceType ] }, "subnet" ] }
  networkResourceType_is_network-port: { equals: [ { get_param: [ nfv, networkResourceType ] }, "network-port" ] }
  layer3Attributes_is_null: { equals: [ { get_param: [ nfv, typeNetworkData, layer3Attributes ] }, "" ] }
  layer3Attributes_ipVersion_is_IPv4: { equals: [ { get_param: [ nfv, typeNetworkData, layer3Attributes, ipVersion ] }, "IPv4" ] }
  typeSubnetData_ipVersion_is_IPv4: { equals: [ { get_param: [ nfv, typeSubnetData, ipVersion ] }, "IPv4" ] }

resources:
  forOutput-networkStatusResource:
    type: OS::Heat::ResourceGroup
    depends_on: networkResource
    properties:
      count: 1
      resource_def:
        type: http://controller/Allocate-Virtualised-Network-Resource-operation/getResourceStatus.yaml
    properties:
      status: { get_attr: [ networkResource, resource.0.show, status ] }

  forOutput-networkPortStatusResource:
    type: OS::Heat::ResourceGroup
    depends_on: networkPortResource
    properties:
      count: 1
      resource_def:
        type: http://controller/Allocate-Virtualised-Network-Resource-operation/getResourceStatus.yaml
    properties:
      status: { get_attr: [ networkPortResource, resource.0.show, status ] }

  portTypeDecidedByExistingNetwork:
    type: OS::Heat::ResourceGroup
    properties:
      count: 1
      resource_def:
        if:
          - networkResourceType_is_network-port
          - type: http://controller/Allocate-Virtualised-Network-Resource-operation/getPortTypeDecidedByExistingNetwork.yaml
```

```

    properties:
      network_id: { get_param: [ nfv, typeNetworkPortData, networkId ] }
    - type: OS::Heat::None

networkResource:
  type: OS::Heat::ResourceGroup
  properties:
    count: 1
    resource_def:
      if:
        - networkResourceType_is_network
        - type: OS::Neutron::ProviderNet
        properties:
          name: { get_param: [ nfv, networkResourceName ] }
          network_type: { get_param: [ nfv, typeNetworkData, networkType ] }
          shared: { get_param: [ nfv, typeNetworkData, isShared ] }
          physical_network: "provider_network"
        - type: OS::Heat::None

subnetOfNewNetworkResource:
  type: OS::Heat::ResourceGroup
  depends_on: networkResource
  properties:
    count: 1
    resource_def:
      if:
        - layer3Attributes_is_null
        - type: OS::Heat::None
        - type: OS::Neutron::Subnet
        properties:
          network: { get_attr: [ networkResource, refs, 0 ] }
          ip_version: { if: [ layer3Attributes_ipVersion_is_IPv4, 4, 6 ] }
          gateway_ip: { get_param: [ nfv, typeNetworkData, layer3Attributes, gatewayIp ] }
          cidr: { get_param: [ nfv, typeNetworkData, layer3Attributes, cidr ] }
          enable_dhcp: { get_param: [ nfv, typeNetworkData, layer3Attributes, isDhcpEnabled ] }
          allocation_pools: { get_param: [ nfv, typeNetworkData, layer3Attributes, addressPool ] }
}

subnetResource:
  type: OS::Heat::ResourceGroup
  properties:
    count: 1
    resource_def:
      if:
        - networkResourceType_is_subnet
        - type: OS::Neutron::Subnet
        properties:
          name: { get_param: [ nfv, networkResourceName ] }
          network: { get_param: [ nfv, typeSubnetData, networkId ] }
          ip_version: { if: [ typeSubnetData_ipVersion_is_IPv4, 4, 6 ] }
          gateway_ip: { get_param: [ nfv, typeSubnetData, gatewayIp ] }
          cidr: { get_param: [ nfv, typeSubnetData, cidr ] }
          enable_dhcp: { get_param: [ nfv, typeSubnetData, isDhcpEnabled ] }
          allocation_pools: { get_param: [ nfv, typeSubnetData, addressPool ] }
        - type: OS::Heat::None

networkPortResource:
  type: OS::Heat::ResourceGroup
  depends_on: portTypeDecidedByExistingNetwork
  properties:
    count: 1
    resource_def:
      if:
        - networkResourceType_is_network-port
        - type: OS::Neutron::Port
        properties:
          name: { get_param: [ nfv, networkResourceName ] }
          network: { get_param: [ nfv, typeNetworkPortData, networkId ] }
          binding:vnic_type: { get_attr: [ portTypeDecidedByExistingNetwork, resource.0.type ] }
        - type: OS::Heat::None

outputs:
  nfvNetworkInfo:
    value:
      if:
        - networkResourceType_is_network
        - str_replace:
            template: |

```

```

    {
      "networkResourceId": "$networkResourceId",
      "networkResourceName": "$networkResourceName",
      "subnet": {
        "resourceId": "$resourceId",
        "networkId": "$networkId",
        "ipVersion": "IPv$ipVersion",
        "gatewayIp": "$gatewayIp",
        "cidr": "$cidr",
        "isDhcpEnabled": "$isDhcpEnabled",
        "addressPool": "$addressPool"
      },
      "networkType": "$networkType",
      "isShared": "$isShared",
      "zoneId": "$zoneId",
      "operationalState": "$operationalState"
    }
  }
  params:
    $networkResourceId: { get_attr: [ networkResource, resource.0.show, id ] }
    $networkResourceName: { get_attr: [ networkResource, resource.0.show, name ] }
    $resourceId: { get_attr: [ subnetOfNewNetworkResource, resource.0.show, id ] }
    $networkId: { get_attr: [ subnetOfNewNetworkResource, resource.0.show, network_id ] }
    $ipVersion: { get_attr: [ subnetOfNewNetworkResource, resource.0.show, ip_version ] }
    $gatewayIp: { get_attr: [ subnetOfNewNetworkResource, resource.0.show, gateway_ip ] }
    $cidr: { get_attr: [ subnetOfNewNetworkResource, resource.0.show, cidr ] }
    $isDhcpEnabled: { get_attr: [ subnetOfNewNetworkResource, resource.0.show, enable_dhcp
] }
    $addressPool: { get_attr: [ subnetOfNewNetworkResource, resource.0.show,
allocation_pools ] }
    $networkType: { get_attr: [ networkResource, resource.0.show, "provider:network_type" ]
}
    $isShared: { get_attr: [ networkResource, resource.0.show, shared ] }
    $zoneId: { list_concat: { get_attr: [ networkResource, show, availability_zones ] } }
    $operationalState: { get_attr: [ forOutput-networkStatusResource, resource.0.status ] }
- str_replace:
  template:
    This is output of Network.
    Please specify output of $resourceType.
  params:
    $resourceType: { get_param: [ nfvi, networkResourceType ] }

nfviSubnetInfo:
  value:
    if:
      - networkResourceType_is_subnet
      - str_replace:
          template: |
            {
              "resourceId": "$resourceId",
              "networkId": "$networkId",
              "ipVersion": "IPv$ipVersion",
              "gatewayIp": "$gatewayIp",
              "cidr": "$cidr",
              "isDhcpEnabled": "$isDhcpEnabled",
              "addressPool": "$addressPool"
            }
          params:
            $resourceId: { get_attr: [ subnetResource, resource.0.show, id ] }
            $networkId: { get_attr: [ subnetResource, resource.0.show, network_id ] }
            $ipVersion: { get_attr: [ subnetResource, resource.0.show, ip_version ] }
            $gatewayIp: { get_attr: [ subnetResource, resource.0.show, gateway_ip ] }
            $cidr: { get_attr: [ subnetResource, resource.0.show, cidr ] }
            $isDhcpEnabled: { get_attr: [ subnetResource, resource.0.show, enable_dhcp ] }
            $addressPool: { get_attr: [ subnetResource, resource.0.show, allocation_pools ] }
          - str_replace:
              template:
                This is output of Subnet.
                Please specify output of $resourceType.
              params:
                $resourceType: { get_param: [ nfvi, networkResourceType ] }

nfviNetworkPortInfo:
  value:
    if:
      - networkResourceType_is_network-port
      - str_replace:
          template: |
            {

```

```

        "resourceId": "$resourceId",
        "networkId": "$networkId",
        "attachedResourceId": "$attachedResourceId",
        "operationalState": "$portOperationalState"
    }
    params:
    $resourceId: { get_attr: [ networkPortResource, resource.0.show, id ] }
    $networkId: { get_attr: [ networkPortResource, resource.0.show, network_id ] }
    $attachedResourceId: { get_attr: [ networkPortResource, resource.0.show, id ] }
    $portOperationalState: { get_attr: [ forOutput-networkPortStatusResource,
resource.0.status ] }
    - str_replace:
    template:
    This is output of NetworkPort.
    Please specify output of $resourceType.
    params:
    $resourceType: { get_param: [ nfV, networkResourceType ] }

```

Below is an output example using template output parameters related to the allocated network resource as provided by "Show output" in OpenStack Orchestration Service API [i.2]. Attributes defined in `nfVNetworkInfo` of the HOT can be seen in the body of `output_value`.

Parameters grouped by "nfV" are specified in the present document.

```

{
  "output": {
    "output_value": {
      "networkResourceId": "8b6fbb50-9382-40fc-9adf-1e1ed3a6e6b0",
      "networkResourceName": "test-network-from-stack",
      "subnet": {
        "resourceId": "bbfee0fb-e28e-465b-8982-5aaaa0ef5afe",
        "networkId": "8b6fbb50-9382-40fc-9adf-1e1ed3a6e6b0",
        "ipVersion": "IPv4",
        "gatewayIp": "10.0.0.1",
        "cidr": "10.0.0.0/24",
        "isDhcpEnabled": false,
        "addressPool": [
          {
            "end": "10.0.0.110",
            "start": "10.0.0.101"
          }
        ]
      },
      "networkType": "flat",
      "isShared": false,
      "zoneId": [
        "nova"
      ],
      "operationalState": "enable"
    },
    "output_key": "nfVNetworkInfo",
    "description": "No description given"
  }
}

```

A.3.3 Example#3: Allocate Virtualised Storage Resource operation

This is an input parameter example of "Create stack" in OpenStack Orchestration Service API [i.2] corresponding to the Allocate Virtualised Storage Resource operation (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification.

Parameters grouped by "nfV" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters "storageName", "affinityOrAntiAffinityConstraintsForStorage", "storageData", "locationConstraints", "metaData", "stack_name" are given as keys with their values. This covers the input parameter values part.

The following example illustrates the input parameters that can be passed to a HEAT API call for the Allocate Virtualised Storage Resource operation.

```
{
  "parameters":
  {
    "nfv":
    {
      "storageName": "test-volume-from-stack",
      "affinityOrAntiAffinityConstraintsForStorage":
      {
        "typeOfAffinityOrAntiAffinityConstraintForStorage": "affinity",
        "scopeOfAffinityOrAntiAffinityConstraintForStorage": "NFVI-Node",
        "affinityAntiAffinityResourceList":
        {
          "resource": [
            "4fc36790-ce40-439e-bc72-05a821a59b2b",
            "3f26f7ac-df5c-43bb-bace-87d6ec7b5374"
          ]
        }
      },
      "storageData":
      {
        "storageAttributes":
        {
          "typeOfStorage": "volume",
          "sizeOfStorage": 1
        }
      },
      "locationConstraints": "nova",
      "metaData":
      {
        "test-key": "test-value"
      }
    }
  },
  "stack_name": "storage-test-stack"
}
```

Below is the corresponding example of the HOT that uses the parameters provided in the example above.

The `parameters` section in the template has definitions for input data to be provided when instantiating the template. In this case, parameter, `nfv`, is typed as JSON format.

When the input data `"storageName": "test-volume-from-stack"` is given, then `test-volume-from-stack` as a string value is assigned to the input parameter `storageName`. In the same way, other values are captured and assigned to the other input parameters in the template.

JSON format is used for the structured data (e.g. `affinityOrAntiAffinityConstraintsForStorage`, `storageData`, `metaData`) as determined by the HOT specification. The input data is accepted as a JSON data and then used in the resource handlings written in the resource section.

When the input attribute data `"typeOfAffinityOrAntiAffinityConstraintForStorage": "affinity"` is given, and the condition `Constraints_type_is_affinity` becomes true, then `same_host` of `scheduler_hints` is selected in the `if_clause`. Finally, the virtualised storage resource is instantiated on an NFVI-Node, which hosts the resources specified by `affinityAntiAffinityResourceList`.

The affinity/anti-affinity attributes, e.g. `scopeOfAffinityOrAntiAffinityConstraintForStorage`, `affinityAntiAffinityResourceGroup`, are passed because those parameters are specified in the present document, but are not defined in OpenStack HEAT specification. Those attribute values are therefore not used in HEAT operations, however, are used by the logic of the example template. The parameter `"flavourId"` is specified in the present document but it is not specified and used in OpenStack HEAT; it is therefore omitted from the example.

The `resources` section describes what type and how virtualised resources are provisioned. In the resource handling, actual values of the input parameters are assigned to parameters used by OpenStack when performing the resource handling. For example, the line:

```
name: { get_param: storageName }
```

gets the value `test-volume-from-stack` (see in the example of input data above), of the input parameter `storageName`, and then assigns `test-volume-from-stack` to `name`.

The `outputs` section of the template describes output data for the user, e.g. when in terms of the Allocate Virtualised Storage Resource the `nfvStorageInfo` is requested. The naming and structure of output parameters in the present document and the ones used and provided by default by the OpenStack Heat Orchestration may differ. Because of this, name translation and output parameter structuring are necessary.

The `template` section in the `nfvStorageInfo` resolves such a translation. For instance, a key/value pair for `storageId` is written with:

```
"storageId": "$storageId"
```

and the value of `storageId`, which is determined by the variable `$storageId`, whose value is assigned by using an intrinsic function as shown below:

```
$storageId: { get_attr: [ virtualisedStorageResource, resource.0.show, id ] }
```

The intrinsic function `get_attr` gets the virtualised storage identifier from the `virtualisedStorageResource`.

NOTE 1: An alternative to putting output parameters in the template is to use API mapping, as defined in clause 4.3.

The `"stack_name"` is a required parameter to generate an identifier that points to a stack of the virtualised resources, as shown in clause A.3.6.

The following is an example of a HOT for the Allocate Virtualised Storage Resource operation.

```
heat_template_version: 2018-08-31
description: Allocate Virtualised Storage Resource operation

parameters:
  nfv:
    type: json
    description:
    default: {}

conditions:
  typeOfStorage_if_volume: { equals : [ { get_param: [ nfv, storageData, storageAttributes,
typeOfStorage ] }, "volume" ] }
  Constraints_type_is_affinity: { equals : [ { get_param: [ nfv,
affinityOrAntiAffinityConstraintsForStorage, typeOfAffinityOrAntiAffinityConstraintForStorage ] },
"affinity" ] }

resources:
  virtualisedStorageResource:
    type: OS::Heat::ResourceGroup
    properties:
      count: 1
      resource_def:
        if:
          - typeOfStorage_if_volume
          - type: OS::Cinder::Volume
        properties:
          name: { get_param: [ nfv, storageName ] }
          scheduler_hints:
            if:
              - Constraints_type_is_affinity
              - same_host:
                  repeat:
                    for_each:
                      <%Resource%>: { get_param: [ nfv,
affinityOrAntiAffinityConstraintsForStorage, affinityAntiAffinityResourceList, resource ] }
            template:
              <%Resource%>
```

```

- different_host:
  repeat:
    for_each:
      <%Resource%>: { get_param: [ nfv,
affinityOrAntiAffinityConstraintsForStorage, affinityAntiAffinityResourceList, resource ] }
      template:
        <%Resource%>
          size: { get_param: [ nfv, storageData, storageAttributes, sizeOfStorage ] }
          availability_zone: { get_param: [ nfv, locationConstraints ] }
          metadata: { get_param: [ nfv, metaData ] }
- type: OS::Heat::None

forOutput-virtualisedStorageResourceStatus:
  type: OS::Heat::ResourceGroup
  depends_on: virtualisedStorageResource
  properties:
    count: 1
    resource_def:
      type: http://controller/Allocate-Virtualised-Storage-Resource-
operation/getVirtualisedStorageResourceStatus.yaml
      properties:
        status: { get_attr: [ virtualisedStorageResource, resource.0.show, status ] }

outputs:
  nfvStorageInfo:
    value:
      str_replace:
        template: |
          {
            "storageId": "$storageId",
            "storageName": "$storageName",
            "typeOfStorage": "$typeOfStorage",
            "sizeOfStorage": "$sizeOfStorage",
            "ownerId": "$ownerId",
            "zoneId": "$zoneId",
            "hostId": "$hostId",
            "operationalState": "$operationalState",
            "metadata": "$metadata"
          }
      params:
        $storageId: { get_attr: [ virtualisedStorageResource, resource.0.show, id ] }
        $storageName: { get_attr: [ virtualisedStorageResource, resource.0.show, name ] }
        $typeOfStorage: { get_param: [ nfv, storageData, storageAttributes, typeOfStorage ] }
        $sizeOfStorage: { get_attr: [ virtualisedStorageResource, resource.0.show, size ] }
        $ownerId: { get_attr: [ virtualisedStorageResource, resource.0.show, attachments, 0,
server_id ] }
        $zoneId: { get_attr: [ virtualisedStorageResource, resource.0.show, availability_zone ] }
        $hostId: { get_attr: [ virtualisedStorageResource, resource.0.show, "os-vol-host-
attr:host" ] }
        $operationalState: { get_attr: [ forOutput-virtualisedStorageResourceStatus,
resource.0.status ] }
        $metadata: { get_attr: [ virtualisedStorageResource, resource.0.show, metadata ] }

```

Below is an output example of the output parameters related to the allocated storage resource as provided by "Show output" in OpenStack Orchestration Service API [i.2]. Specified attributes defined in `nfvStorageInfo` of the HOT can be seen in the body of `output_value`.

NOTE 2: An alternative to model output parameters is API mapping, as defined in clause 4.3.

Parameters grouped by "nfv" are specified in the present document.

```

{
  "output":
  {
    "output_value":
    {
      "storageId": "f4e0afb5-1165-46a4-95e7-2405bfed9b5e",
      "storageName": "test-volume-from-stack",
      "typeOfStorage": "volume",
      "sizeOfStorage": 1,
      "ownerId": "",
      "zoneId": "nova",
      "hostId": "compute1@lvm#LVM",
      "operationalState": "enable",
      "metadata":
      {
        "test-key": "test-value"
      }
    }
  }
}

```

```

    },
    "output_key": "nfvStorageInfo",
    "description": "No description given"
  }
}

```

A.3.4 Example#4: Create Compute Flavour operation

This is an example of "Create stack" in OpenStack Orchestration Service API [i.2] corresponding to the Create Compute Flavour operation (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification.

Parameters grouped by "nfv" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters flavourId, accelerationCapabilityForVirtualComputeFlavor, virtualMemory, virtualCpu, virtualNetworkInterface are given as keys with their corresponding values. This example covers the input parameter values part.

The following example illustrates the input parameters that can be passed to a HEAT API call for the Compute Flavour operation.

```

{
  "parameters": {
    "nfv": {
      "flavourId": 10,
      "accelerationCapabilityForVirtualComputeFlavor": "gpu",
      "virtualMemory": {
        "virtualMemSize": 100
      },
      "virtualCpu": {
        "numVirtualCpu": 8,
        "virtualCpuPinning": {
          "cpuPinningPolicy": "static",
          "cpuPinningRules": {
            "cores": 2,
            "sockets": 2,
            "threads": 2
          }
        }
      }
    },
    "storageAttributes": [
      {
        "typeOfStorage": "disk",
        "sizeOfStorage": 10
      },
      {
        "typeOfStorage": "ephemeral",
        "sizeOfStorage": 20
      },
      {
        "typeOfStorage": "swap",
        "sizeOfStorage": 30
      }
    ],
    "virtualNetworkInterface": {
      "accelerationCapabilityForVirtualNetworkInterface": "dpdk"
    }
  },
  "stack_name": "flavour-test-stack"
}

```

Below is the corresponding example of the HOT that uses the parameters provided in the example above.

The parameters section in the template has definitions for input data to be provided when instantiating the template. In this case, parameter, nfv is typed as JSON format.

By the function `get_param`, the value of the input parameters are taken from input parameters and paired with resource keys in the property section; `flavorid` is paired with 10 of `flavourId`, `ram` is paired with 100 of `virtualMemSize` and `vcpus` is paired with 8 of `numVirtualCpu`.

The value of `disk` is determined by the result of the if-clauses. The status of `typeOfStorage_0_is_disk`, `typeOfStorage_1_is_disk`, `typeOfStorage_2_is_disk` is determined by the comparison with each element of `typeOfStorage` in the input parameters. In this example, `typeOfStorage_0_is_disk` becomes true because the value of the element `storageAttributes[0].typeOfStorage` is equal to "disk". So the value of `storageAttributes[0].sizeOfStorage` is taken and `disk` is paired with 10.

In the same way, `ephemeral` and `swap` are paired with 20 and 30 respectively.

`extra_specs` are key/value pairs in OpenStack. In this use case, input parameters:

```
"cpuPinningPolicy": "static"
"accelerationCapabilityForVirtualNetworkInterface": "dpdk"
"accelerationCapabilityForVirtualComputeFlavor": "gpu"
```

are given, so the value of `cores`, `sockets`, `threads` are paired as follows:

```
"hw:cpu_sockets": 2
"hw:cpu_cores": 2
"hw:cpu_threads": 2
```

More `extra_specs` are specified but those are not defined in the present document.

More resource handling (e.g. crypto, RDMA, packet dispatch, TCP Chimney, dynamic) can be added but this example does not propose to cover all.

The "stack_name" is a required parameter to generate an identifier that points to a stack of the virtualised resources, as shown in clause A.3.6.

```
heat_template_version: 2018-08-31
description: Create Compute Flavour operation.

parameters:
  nfv:
    type: json
    description:
    default: {}

conditions:
  cpuPinningPolicy_is_static: { equals: [ { get_param: [ nfv, virtualCpu, virtualCpuPinning,
cpuPinningPolicy ] }, "static" ] }
  accelerationCapabilityForVirtualNetworkInterface_is_dpdk: { equals: [ { get_param: [ nfv,
virtualNetworkInterface, accelerationCapabilityForVirtualNetworkInterface ] }, "dpdk" ] }
  accelerationCapabilityForVirtualComputeFlavor_is_gpu: { equals: [ { get_param: [ nfv,
accelerationCapabilityForVirtualComputeFlavor ] }, "gpu" ] }
  typeOfStorage_0_is_disk: { equals: [ { get_param: [ nfv, storageAttributes, 0, typeOfStorage ] },
"disk" ] }
  typeOfStorage_1_is_disk: { equals: [ { get_param: [ nfv, storageAttributes, 1, typeOfStorage ] },
"disk" ] }
  typeOfStorage_2_is_disk: { equals: [ { get_param: [ nfv, storageAttributes, 2, typeOfStorage ] },
"disk" ] }
  typeOfStorage_0_is_ephemeral: { equals: [ { get_param: [ nfv, storageAttributes, 0, typeOfStorage
] }, "ephemeral" ] }
  typeOfStorage_1_is_ephemeral: { equals: [ { get_param: [ nfv, storageAttributes, 1, typeOfStorage
] }, "ephemeral" ] }
  typeOfStorage_2_is_ephemeral: { equals: [ { get_param: [ nfv, storageAttributes, 2, typeOfStorage
] }, "ephemeral" ] }
  typeOfStorage_0_is_swap: { equals: [ { get_param: [ nfv, storageAttributes, 0, typeOfStorage ] },
"swap" ] }
  typeOfStorage_1_is_swap: { equals: [ { get_param: [ nfv, storageAttributes, 1, typeOfStorage ] },
"swap" ] }
  typeOfStorage_2_is_swap: { equals: [ { get_param: [ nfv, storageAttributes, 2, typeOfStorage ] },
"swap" ] }

resources:
  virtualisedComputeFlavour:
    type: OS::Nova::Flavor
    properties:
      flavorid: { get_param: [ nfv, flavourId ] }
      ram: { get_param: [ nfv, virtualMemory, virtualMemSize ] }
```

```

vcpus: { get_param: [ nfv, virtualCpu, numVirtualCpu ] }
disk:
  if:
    - typeOfStorage_0_is_disk
    - { get_param: [ nfv, storageAttributes, 0, sizeOfStorage ] }
    - if:
      - typeOfStorage_1_is_disk
      - { get_param: [ nfv, storageAttributes, 1, sizeOfStorage ] }
      - if:
        - typeOfStorage_2_is_disk
        - { get_param: [ nfv, storageAttributes, 2, sizeOfStorage ] }
        - 0
ephemeral:
  if:
    - typeOfStorage_0_is_ephemeral
    - { get_param: [ nfv, storageAttributes, 0, sizeOfStorage ] }
    - if:
      - typeOfStorage_1_is_ephemeral
      - { get_param: [ nfv, storageAttributes, 1, sizeOfStorage ] }
      - if:
        - typeOfStorage_2_is_ephemeral
        - { get_param: [ nfv, storageAttributes, 2, sizeOfStorage ] }
        - 0
swap:
  if:
    - typeOfStorage_0_is_swap
    - { get_param: [ nfv, storageAttributes, 0, sizeOfStorage ] }
    - if:
      - typeOfStorage_1_is_swap
      - { get_param: [ nfv, storageAttributes, 1, sizeOfStorage ] }
      - if:
        - typeOfStorage_2_is_swap
        - { get_param: [ nfv, storageAttributes, 2, sizeOfStorage ] }
        - 0
extra_specs:
  if:
    - cpuPinningPolicy_is_static
    - if:
      - accelerationCapabilityForVirtualNetworkInterface_is_dpdk
      - if:
        - accelerationCapabilityForVirtualComputeFlavor_is_gpu
        - {
            "hw:cpu_policy": "dedicated",
            "hw:cpu_sockets": { get_param: [ nfv, virtualCpu, virtualCpuPinning,
cpuPinningRules, sockets ] },
            "hw:cpu_cores": { get_param: [ nfv, virtualCpu, virtualCpuPinning,
cpuPinningRules, cores ] },
            "hw:cpu_threads": { get_param: [ nfv, virtualCpu, virtualCpuPinning,
cpuPinningRules, threads ] },
            "hw:mem_page_size": "large",
            "pci_passthrough:alias": "al:2"
          }
        - {} ### another pattern's process(e.g. crypto).
        - {} ### another pattern's process(e.g. RDMA, packet dispatch, TCP Chimney).
        - {} ### another pattern's process(e.g. dynamic).

```

NOTE: The unit of sizeOfStorage is GB, but the unit of swap area is MB in OpenStack.

There are no output parameters related to the flavour creation, as the flavour can be identified based on the `stackId` attribute passed as part of the input parameters.

A.3.5 Example#5: API mapping of output parameters for Allocate Virtualised Storage Resource operation

Clause A.3.3 provides an example of the Allocate Virtualised Storage Resource operation using template outputs. The present clause illustrates the alternative of API parameter mapping to allow a client to access the output information defined in the present document data model in clause 8.3.1 using the OpenStack HEAT API. Table A.3.5-1 lists the attributes that a client would obtain from invoking "resource show" in the HEAT API in order to access the output information defined in the present document data model. For the input part, this alternative uses the same approach as clause A.3.3.

Table A.3.5-1: Output attributes mapping between the present document data model and Openstack HEAT API

Attribute per the present document data model	Attribute per HEAT API
nfvStorageInfo	
>storageId	resource/attributes/id
>storageName	resource/attributes/name
>flavourId	(not supported by HEAT)
>sizeOfStorage	resource/attributes/size
>rdmaEnabled	(not supported by HEAT)
>ownerId	resource/attributes/attachments/server_id
>zoneId	resource/attributes/availability_zone
>hostId	os-vol-host-attr:host
>operationalState	resource/attributes/status
>metadata	resource/attributes/metadata

A.3.6 Example#6: OpenStack Heat API sequence

Clause A.3 provides examples of resource management operation interfaces using OpenStack Orchestration Service API [i.2] and templates. The present clause illustrates sequence diagrams which show how to use the APIs.

Figure A.3.6-1 illustrates the sequence diagram of Allocate Virtualised Compute/Network/Storage Resource operation, Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group operation and Attach Virtualised Storage Resource operation using "create stack" and "show stack".

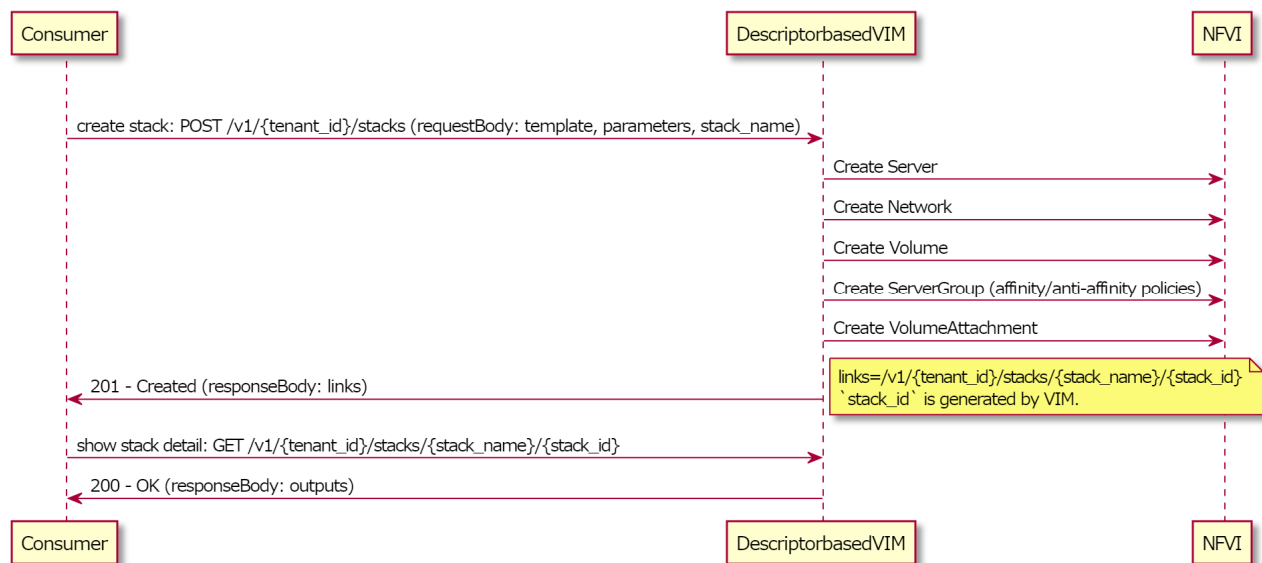


Figure A.3.6-1

Figure A.3.6-2 illustrates the sequence diagram of Query Virtualised Compute/Network/Storage Resource operation using "find stack" and "show stack".

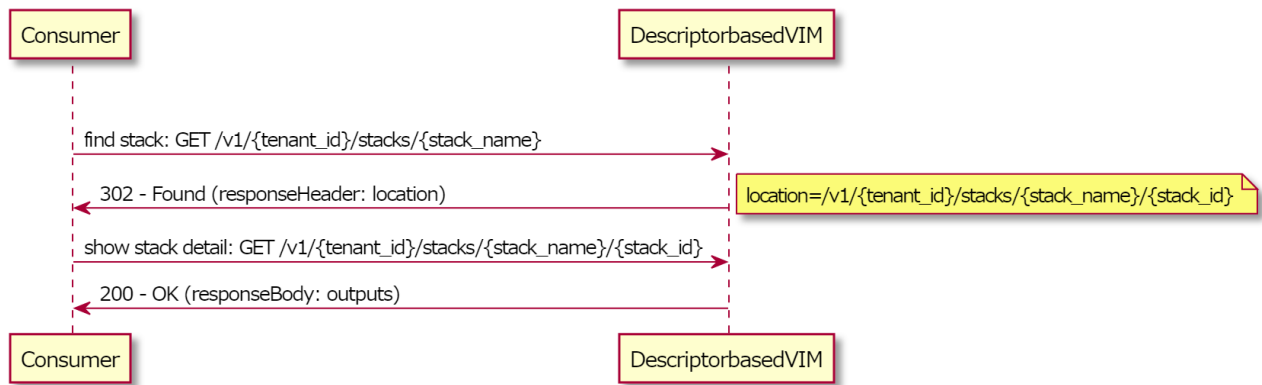


Figure A.3.6-2

Figure A.3.6-3 illustrates the sequence diagram of Update Virtualised Compute/Network/Storage Resource operation using "find stack", "update stack" and "show stack".

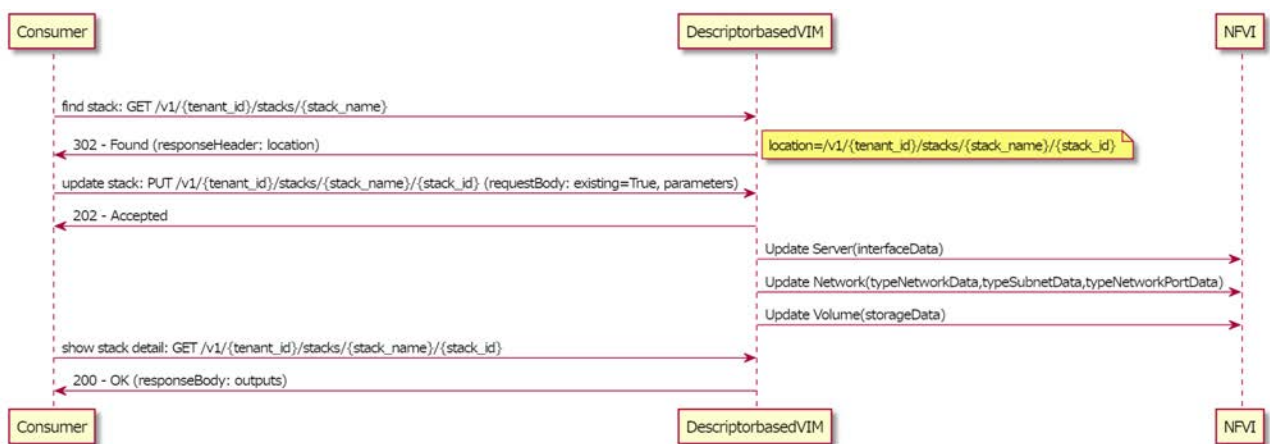


Figure A.3.6-3

Figure A.3.6-4 illustrates the sequence diagram of Scale Virtualised Compute/Storage Resource operation using "find stack", "update stack" and "show stack". In the case of Storage, only increase operation is supported.

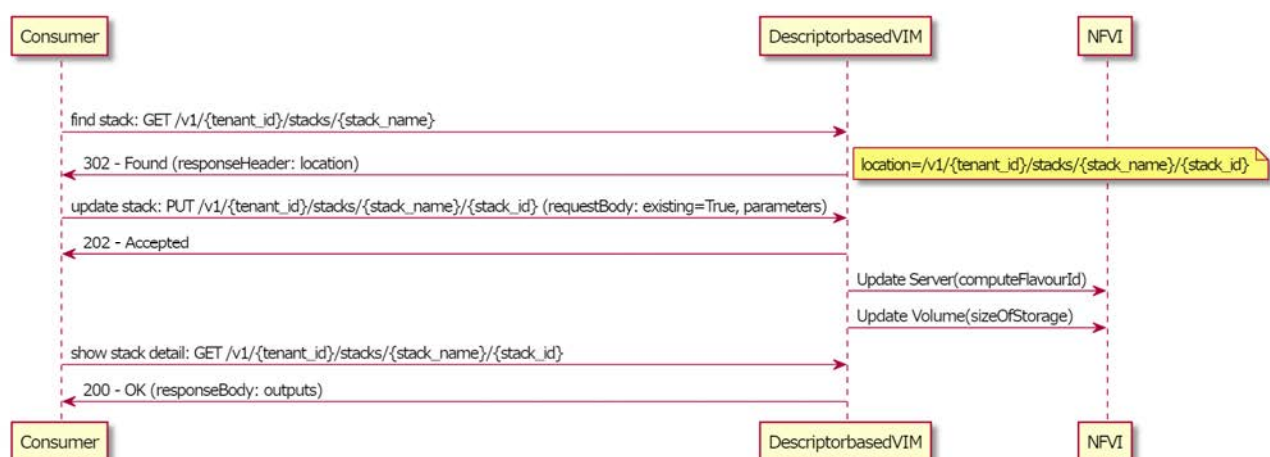


Figure A.3.6-4

Figure A.3.6-5 illustrates the sequence diagram of Terminate Virtualised Compute/Network/Storage Resource operation and Detach Virtualised Storage Resource operation using "find stack" and "delete stack". The consumer gets stack_name associated with identifier of the resource using Query Virtualised Compute/Network/Storage Resource operation. This sequence terminates all resources associated with stack_name.

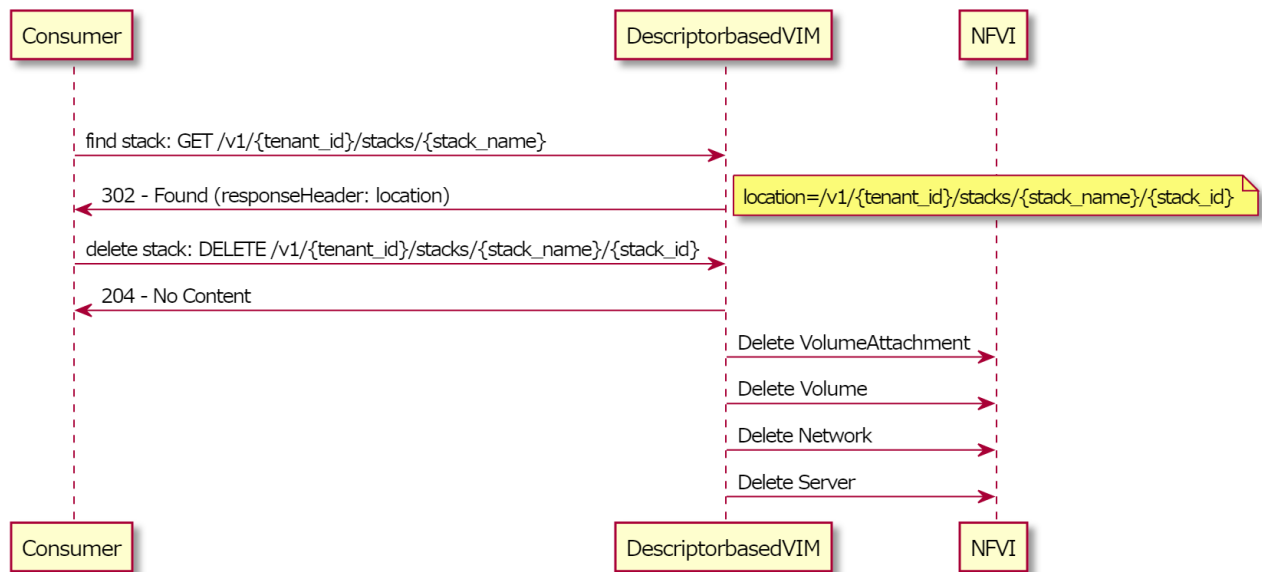


Figure A.3.6-5

In the case of Heat, parameter "stackName" in clause 5.2.5 is passed as parameter "stack_name". That is, Consumer manages virtualised resources by generating an identifier that points to a stack of the virtualised resources defined in a descriptor and passing the identifier as input parameter "stack_name".

A.3.7 Example#7: Virtualised Resources Change Notification Interface Subscribe operation

This is an example of "Create stack" in OpenStack Orchestration Service API [i.2] corresponding to the Subscribe operation in the Change Notification Interface (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification.

Parameters grouped by "nfv" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters callbackUriForChangeNotify, inputFilter are given as keys with their corresponding values. This example covers the input parameter values part.

The following example illustrates the input parameters that can be passed to a HEAT API call for the Subscribe operation.

```

{
  "parameters": {
    "nfv": {
      "callbackUriForChangeNotify": "http://10.0.0.56",
      "inputFilter": {
        "hostId": "ussuri-compute1"
      }
    }
  },
  "stack_name": "change-notify-compute"
}

```

Below is the corresponding example of the HOT that uses the parameters provided in the example above.

The parameters section in the template has definitions for input data to be provided when instantiating the template. In this case, parameter, nfv is typed as JSON format.

By the function get_param, the values of the input parameters are taken from input parameters and paired with resource keys in the property section; alarm_actions is paired with "http://10.0.0.56" of callbackUriForChangeNotify, value of traits.host in query is paired with "ussuri-compute1" of hostId of inputFilter.

This HOT is intended to subscribe for change notifications of compute hosts. The conditions for change notifications should be matched to the operation rule for change notifications. This HOT assumes the following operation rule:

When maintenance a compute host, operators allocate a virtualised compute resource on the maintenance target compute host, and this is executed by the VIM user whose user_id is "c794077f19f142819716e3116724ccfe".

```
heat_template_version: 2018-08-31
description: Virtualised Compute Resources Change Notification Interface Subscribe operation.

parameters:
  nfv:
    type: json
    description:
    default: {}

resources:
  maintenance:
    type: OS::Aodh::EventAlarm
    properties:
      event_type: compute.instance.create.end
      alarm_actions:
        - { get_param: [ nfv, callbackUriForChangeNotify ] }
      query:
        - field: traits.host
          op: eq
          value: { get_param: [ nfv, inputFilter, hostId ] }
        - field: traits.user_id
          op: eq
          value: c794077f19f142819716e3116724ccfe
      repeat_actions: true
```

The following is an example of a change notification by OpenStack Aodh.

```
{
  "alarm_name": "change-notify-compute-maintenance-dricxhhg53iq",
  "alarm_id": "a76dd860-daad-456c-8ff3-0e7cbed12117",
  "severity": "low",
  "previous": "insufficient data",
  "current": "alarm",
  "reason": "Event <id=1cafb631-0c9a-4fdc-8d3c-d4ff9b0eba43,event_type=compute.instance.create.end>
hits the query <query=[{field: traits.host, op: eq, type: string, value: ussuri-computel}, {field:
traits.user_id, op: eq, type: string, value: c794077f19f142819716e3116724ccfe}]>.",
  "reason_data": {
    "type": "event",
    "event": {
      "message_id": "1cafb631-0c9a-4fdc-8d3c-d4ff9b0eba43",
      "event_type": "compute.instance.create.end",
      "generated": "2021-08-19T05:11:35.822867",
      "traits": [
        [
          "service",
          1,
          "compute"
        ],
        [
          "request_id",
          1,
          "req-462d2144-88e7-4307-bbec-cd972a07bfa0"
        ],
        [
          "project_id",
          1,
          "f4453d4fab274ff4a1e9cfe76a82d928"
        ],
        [
          "user_id",
          1,
          "c794077f19f142819716e3116724ccfe"
        ],
        [
          "tenant_id",
          1,
          "f4453d4fab274ff4a1e9cfe76a82d928"
        ],
        [
          "instance_id",
          1,
```

```

    "c33af9b4-7ebd-4894-944c-e16880630d5b"
  ],
  [
    "display_name",
    1,
    "vm-for-maintenance"
  ],
  [
    "resource_id",
    1,
    "c33af9b4-7ebd-4894-944c-e16880630d5b"
  ],
  [
    "cell_name",
    1,
    ""
  ],
  [
    "host",
    1,
    "ussuri-computel"
  ],
  [
    "memory_mb",
    2,
    64
  ],
  [
    "disk_gb",
    2,
    15
  ],
  [
    "root_gb",
    2,
    10
  ],
  [
    "ephemeral_gb",
    2,
    5
  ],
  [
    "vcpus",
    2,
    1
  ],
  [
    "instance_type_id",
    1,
    "11"
  ],
  [
    "instance_type",
    1,
    "m1.nano"
  ],
  [
    "state",
    1,
    "active"
  ],
  [
    "launched_at",
    4,
    "2021-08-19T05:11:35.661283"
  ],
  [
    "availability_zone",
    1,
    "nova"
  ]
],
"raw": {},
"message_signature": "86cfec1c900658c76dd0e5efe9ed8e4e074c97d76718c898d36ae43aef269630"
}
}
}

```

Table A.3.7-1 illustrates the mapping between the input parameters for change notifications defined in the present document data model and the information in change notifications by OpenStack Aodh.

Table A.3.7-1: Mapping between the present document change notification parameters and notification from Openstack Aodh

Parameter in the present document	Notification from Openstack Aodh
changedId	reason_data/event/message_id
virtualisedResourceId	(not supported by Aodh)
virtualisedResourceGroupId	(not supported by Aodh)
endOfChange	(not supported by Aodh)
changeTime	reason_data/event/generated
vimId	(not supported by Aodh)
changeType	alarm_name (see note)
changedResourceData	(not supported by Aodh)
NOTE: Due to current specifications of OpenStack Heat and OpenStack Aodh, "alarm_name" is determined to be a concatenation of "stack_name", "resource name in HOT" and "random string generated by Heat". This is not matched to allowed value of changeType, but like changeType, "alarm_name" is used to distinguish the type of notification.	

A.3.8 Example#8: Virtualised Resources Fault Management Interface Subscribe operation

This is an example of "Create stack" in OpenStack Orchestration Service API [i.2] corresponding to the Subscribe operation in the Fault Management Interface (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification.

Parameters grouped by "nfv" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters callbackUriForFaultNotify, filter is given as keys with their corresponding values. This example covers the input parameter values part.

The following example illustrates the input parameters that can be passed to a HEAT API call for the Subscribe operation.

```
{
  "parameters": {
    "nfv": {
      "callbackUriForFaultNotify": "http://10.0.0.56",
      "filter": {
        "computeId": "3e5cb24b-044d-4c65-8488-60ebd2c797cc"
      }
    }
  },
  "stack_name": "fault-notify-compute"
}
```

Below is the corresponding example of the HOT that uses the parameters provided in the example above.

The parameters section in the template has definitions for input data to be provided when instantiating the template. In this case, parameter, nfv is typed as JSON format.

By the function get_param, the values of the input parameters are taken from input parameters and paired with resource keys in the property section; alarm_actions is paired with "http://10.0.0.56" of callbackUriForFaultNotify, value of traits.instance_id in query is paired with "3e5cb24b-044d-4c65-8488-60ebd2c797cc" of computeId of filter.

This HOT is intended to subscribe for fault notifications of virtualised compute resources. The conditions for fault notifications should be matched to the operation when faults were observed. This HOT assumes the following operation:

When the monitoring system observes faults relating a virtualised compute resource, the monitoring system changes the state of the virtualised compute resource to "error" or shutdown the virtualised compute resource.


```

heat_template_version: 2018-08-31
description: Virtualised Compute Resources Fault Management Interface Subscribe operation.

parameters:
  nfv:
    type: json
    description:
    default: {}

resources:
  errorState:
    type: OS::Aodh::EventAlarm
    properties:
      alarm_actions:
        - { get_param: [ nfv, callbackUriForFaultNotify ] }
      query:
        - field: traits.instance_id
          op: eq
          value: { get_param: [ nfv, filter, computeId ] }
        - field: traits.state
          op: eq
          value: error
      repeat_actions: true

  stoppedState:
    type: OS::Aodh::EventAlarm
    properties:
      event_type: compute.instance.power_off.*
      alarm_actions:
        - { get_param: [ nfv, callbackUriForFaultNotify ] }
      query:
        - field: traits.instance_id
          op: eq
          value: { get_param: [ nfv, filter, computeId ] }
      repeat_actions: true

```

The following is an example of a fault notification by OpenStack Aodh.

```

{
  "alarm_name": "fault-notify-compute-stoppedState-bla6fvjo5nrf",
  "alarm_id": "5429876f-c8c4-42e6-a8be-5a5dae68b5c4",
  "severity": "low",
  "previous": "alarm",
  "current": "alarm",
  "reason": "Event <id=4a55319f-dc22-413d-b21a-34d3728c72c0,event_type=compute.instance.power_off.end> hits the query <query=[{field: traits.instance_id, op: eq, type: string, value: 3e5cb24b-044d-4c65-8488-60ebd2c797cc}]>.",
  "reason_data": {
    "type": "event",
    "event": {
      "message_id": "4a55319f-dc22-413d-b21a-34d3728c72c0",
      "event_type": "compute.instance.power_off.end",
      "generated": "2021-08-19T08:12:20.805018",
      "traits": [
        [
          "service",
          1,
          "compute"
        ],
        [
          "request_id",
          1,
          "req-72fd8bda-9444-4e65-8b02-8485cddb843c"
        ],
        [
          "project_id",
          1,
          "f4453d4fab274ff4a1e9cfe76a82d928"
        ],
        [
          "user_id",
          1,
          "4d75edbddee64505878e5c59c042b70c"
        ],
        [
          "tenant_id",
          1,
          "f4453d4fab274ff4a1e9cfe76a82d928"
        ]
      ]
    }
  }
}

```

```

],
[
  "instance_id",
  1,
  "3e5cb24b-044d-4c65-8488-60ebd2c797cc"
],
[
  "display_name",
  1,
  "test-vm"
],
[
  "resource_id",
  1,
  "3e5cb24b-044d-4c65-8488-60ebd2c797cc"
],
[
  "cell_name",
  1,
  ""
],
[
  "host",
  1,
  "ussuri-compute2"
],
[
  "memory_mb",
  2,
  64
],
[
  "disk_gb",
  2,
  1
],
[
  "root_gb",
  2,
  1
],
[
  "ephemeral_gb",
  2,
  0
],
[
  "vcpus",
  2,
  1
],
[
  "instance_type_id",
  1,
  "9"
],
[
  "instance_type",
  1,
  "ml.nano"
],
[
  "state",
  1,
  "stopped"
],
[
  "launched_at",
  4,
  "2021-08-06T01:30:56"
]
],
"raw": {},
"message_signature": "e01fc1dc4fbb2f50168a99da48973dc4964d50bb7ee6c5c5be9f8101a10bd94"
}
}
}

```

Table A.3.8-1 illustrates the mapping between the input parameter and attributes for fault notifications defined in the present document data model and the information in fault notifications by OpenStack Aodh.

Table A.3.8-1: Mapping between the present document fault notification parameters and notification from Openstack Aodh

Attribute in the present document	Notification from Openstack Aodh
alarm	
>alarmId	reason_data/event/message_id
>managedObjectId	reason_data/event/traits/instance_id
>alarmRaisedTime	reason_data/event/generated
>alarmChangedTime	(not supported by Aodh)
>alarmClearedTime	(not supported by Aodh)
>state	(not supported by Aodh)
>perceivedSeverity	severity
>eventTime	(not supported by Aodh)
>eventType	(not supported by Aodh)
>faultType	alarm_name (see note)
>probableCause	(not supported by Aodh)
>isRootCause	(not supported by Aodh)
>correlatedAlarmId	(not supported by Aodh)
>faultDetails	(not supported by Aodh)
NOTE:	Due to current specifications of OpenStack Heat and OpenStack Aodh, "alarm_name" is determined to be a concatenation of "stack_name", "resource name in HOT" and "random string generated by Heat". Like faultType, "alarm_name" is used to distinguish the type of notification.

A.4 Complex templates

ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2] define interfaces for the management of individual resources, and the examples in the present document are introduced to be consistent with those specifications.

On the other hand, HEAT is primarily used to manage a group of different types of virtualised resources, called "stack".

Sets of virtualised resources that are commonly used in the different stacks can be written in individual dedicated templates, so that they can be referenced in other templates. Such templates can be referred to as "nested templates".

Multiple levels of nesting of templates are allowed.

Annex B (informative): Explanations of concepts

B.1 Introduction

This annex provides explanations of certain concepts introduced in the present document.

B.2 Concept of descriptor-based virtualised resource management

In the present document, input and output parameter data models are specified using YAML [4].

The input parameter data model consists of:

- an input section defined in the virtualised resource descriptor;
- the corresponding actual input data as arguments to exchange when invoking operations over the Vi-Vnfm and Or-Vi reference points;
- the corresponding input data definitions in YAML [4], which are presented in the "parameter to be used as input" clauses 5 to 8 of the present document.

The input data to be used over the reference points in virtualised resource descriptor is compliant with input data definition.

The output parameter data model consists of:

- an output section defined in the virtualised resource descriptor;
- the corresponding actual output data as return values to exchange in a response to an operation invoked over Vi-Vnfm and Or-Vi reference points;
- the corresponding output data definitions in YAML [4], which are presented in the "parameter to be used as output" clauses 5 to 8 of the present document.

The output data to be exposed over the reference points from virtualised resource descriptor is compliant with output data definition.

Descriptor-based virtualised resource management provisions virtualised resource via virtualised resource descriptor that includes input section and output section.

Figure B.2-1 illustrates the concepts described above. The method for passing input data as arguments and output data as return values is out of the scope of the present document. The present document provides examples of virtualised resource descriptors, arguments and return values for each solution identified in Annex A.

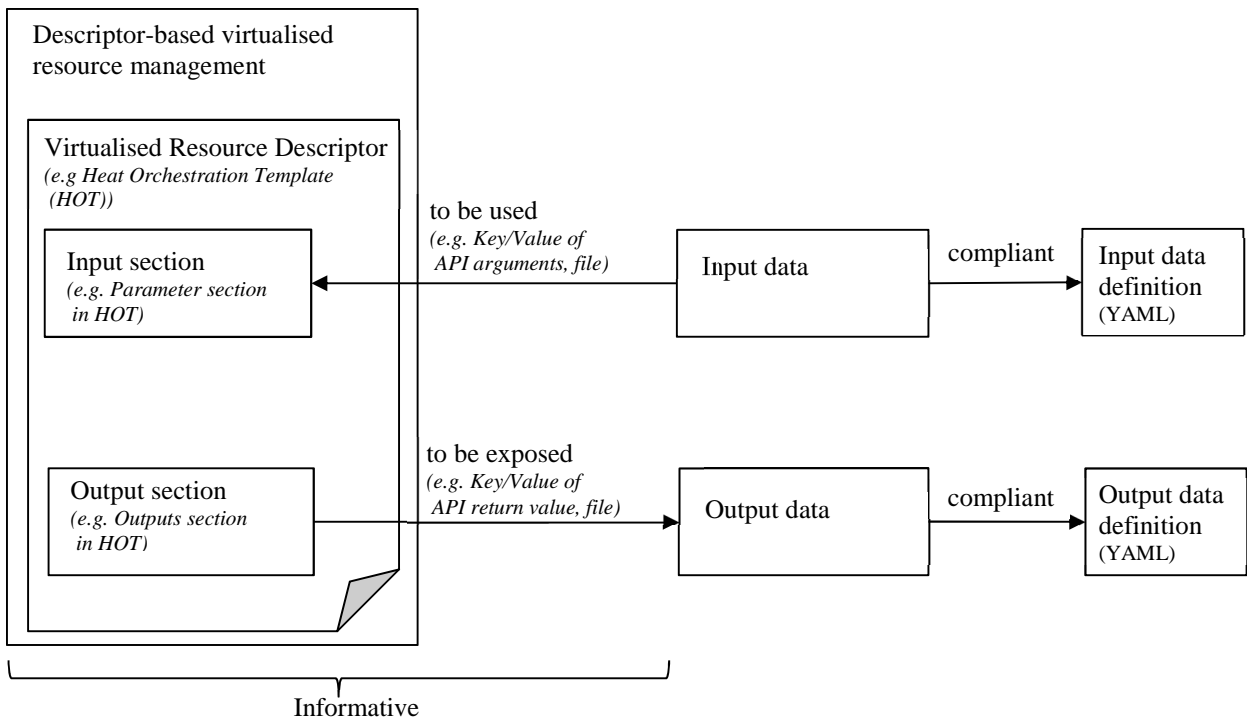


Figure B.2-1: Concept of descriptor-based virtualised resource management

Annex C (informative): Change History

Date	Version	Information about changes
February 2021	3.0.1	Initial draft for SOL014ed351
March 2021	3.0.2	Implemented <ul style="list-style-type: none"> - NFVSOL(21)000166 Improvements towards OpenAPI-based data models for general aspects - NFVSOL(21)000160r1 SOL014ed351 Improvements towards OpenAPI-based data models in virtualised storage resource data model - NFVSOL(21)000143r1 SOL014ed351 Improvements towards OpenAPI-based data models in virtualised compute resource data model - NFVSOL(21)000142 SOL014ed Improvements towards OpenAPI-based data models in common data model - NFVSOL(21)000119 SOL014ed351 Improvements towards OpenAPI-based data models in Virtualised Network Management - NFVSOL(21)000059 SOL014 networkResourceName in OpenAPI
September 2021	3.5.2	Implemented <ul style="list-style-type: none"> - NFVSOL(21)000452r1 - SOL014ed361 OpenStack Heat API sequence examples and new parameter stackName - NFVSOL(21)000453 - SOL014e361 Example of Change Notification Interface - NFVSOL(21)000462 - SOL014e361 New data models for Change and Fault management - NFVSOL(21)000485 - SOL014ed361 Update Heat template and parameter examples to upgrade version and support required parameter
October 2021	3.5.3	Implemented <ul style="list-style-type: none"> - NFVSOL(21)0000486r4 - SOL014ed361 Profiling OpenStack Orchestration API to map IFA operations to resource declarations
November 2021	3.5.4	Implemented <ul style="list-style-type: none"> - NFVSOL(21)000571 - SOL014ed361 new parameter userData

History

Document history		
V3.5.1	May 2021	Publication
V3.6.1	January 2022	Publication