Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; YAML data model specification for descriptor-based virtualised resource management

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### 7.2.5 Parameter: typeSubnetData

<table>
<thead>
<tr>
<th>Parameters to be used as input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvNetworkInfo</td>
<td>Parameter: storageName</td>
</tr>
<tr>
<td>nfvsubnetInfo</td>
<td>Parameter: affinityOrAntiAffinityConstraintsForStorage</td>
</tr>
<tr>
<td>nfvNetworkInfo</td>
<td>Parameter: storageData</td>
</tr>
<tr>
<td>nfvNetworkPortInfo</td>
<td>Parameter: updateStorageData</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: storageOperation</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: newSize</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: scopeOfAffinityOrAntiAffinityConstraintsForStorage</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: storageName</td>
</tr>
</tbody>
</table>

### 7.2.6 Parameter: affinityOrAntiAffinityConstraintsForNetwork

<table>
<thead>
<tr>
<th>Parameters to be used as input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvNetworkInfo</td>
<td>Parameter: storageName</td>
</tr>
<tr>
<td>nfvsubnetInfo</td>
<td>Parameter: affinityOrAntiAffinityConstraintsForStorage</td>
</tr>
<tr>
<td>nfvNetworkInfo</td>
<td>Parameter: storageData</td>
</tr>
<tr>
<td>nfvNetworkPortInfo</td>
<td>Parameter: updateStorageData</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: storageOperation</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: newSize</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: scopeOfAffinityOrAntiAffinityConstraintsForStorage</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: storageName</td>
</tr>
</tbody>
</table>

### 7.2.7 Void

<table>
<thead>
<tr>
<th>Parameters to be used as input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvNetworkInfo</td>
<td>Parameter: storageName</td>
</tr>
<tr>
<td>nfvsubnetInfo</td>
<td>Parameter: affinityOrAntiAffinityConstraintsForStorage</td>
</tr>
<tr>
<td>nfvNetworkInfo</td>
<td>Parameter: storageData</td>
</tr>
<tr>
<td>nfvNetworkPortInfo</td>
<td>Parameter: updateStorageData</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: storageOperation</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: newSize</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: scopeOfAffinityOrAntiAffinityConstraintsForStorage</td>
</tr>
<tr>
<td>nfvStorageInfo</td>
<td>Parameter: storageName</td>
</tr>
</tbody>
</table>

---

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

#### A.1 Introduction

Parameters to be used as input:
- nfvNetworkInfo
- nfvsubnetInfo
- nfvNetworkPortInfo
- nfvStorageInfo

### Annex B (informative): Explanations of concepts

#### B.1 Introduction

Concept of descriptor-based virtualised resource management

### Annex C (informative): Change History

History
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Foreword

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

Modal verbs terminology

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

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1 Scope

The present document specifies 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. Other virtualised resource management interfaces, as well as data models for information specified in ETSI GS NFV-IFA 011 [3] and ETSI GS NFV-IFA 014 [i.4], are out of the scope of the present document.

2 References

2.1 Normative references

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

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

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

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

[1] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".


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


[6] ETSI GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; NFV descriptors based on TOSCA specification".


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

[8] ETSI GS NFV-SOL 013: "Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; Specification of common aspects for RESTful NFV MANO APIs".
2.2 Informative references

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

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

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

[i.1] ETSI GS NFV 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: Available at https://docs.openstack.org/api-ref/orchestration/.

[i.4] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Network Service Templates 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:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>JSON</td>
<td>JavaScript Object Notation</td>
</tr>
<tr>
<td>YAML</td>
<td>YAML Ain't Markup Language</td>
</tr>
</tbody>
</table>

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.
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. Further, a syntax is defined for the use of input and output parameters in a template which can be mapped to template parameters for use by a concrete VIM implementation, 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>
    constraints:
      - <constraint_type>: <constraint_definition>
      - description: <description of the constraint>
      ...
  <parameter_name_N>:
  ...
```

Where applicable, the 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>
<thead>
<tr>
<th>Field</th>
<th>Required</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfv</td>
<td>yes</td>
<td>The tag emphasizes a group of parameters defined in the present document.</td>
</tr>
<tr>
<td>&lt;parameter_name_1&gt;</td>
<td>yes</td>
<td>The name of the first parameter.</td>
</tr>
<tr>
<td>&lt;parameter_name_N&gt;</td>
<td>no</td>
<td>The name of the last parameter.</td>
</tr>
<tr>
<td>type</td>
<td>yes</td>
<td>The type of each parameter. It shall be a simple data type as defined in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>clause 4.4.2 or structured data types in clause 4.4.3.</td>
</tr>
<tr>
<td>description</td>
<td>yes</td>
<td>A human readable description for each parameter.</td>
</tr>
<tr>
<td>default</td>
<td>no</td>
<td>A default value for each parameter.</td>
</tr>
<tr>
<td>constraints</td>
<td>no</td>
<td>A list of constraints that is applied to the value taken by the parameter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It shall be provided when the value of the parameter can only take a value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>according to a specified set of allowed values.</td>
</tr>
</tbody>
</table>

The fields for the definition of a constraint shall comply with the provisions set out in Table 4.2.2-2.
Table 4.2.2-2: Parameter constraints syntax definition

<table>
<thead>
<tr>
<th>Field</th>
<th>Required</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>constraint_type</td>
<td>yes</td>
<td>The type of constraint. Permitted values:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• allowed_values: It specifies a set of possible values for a parameter. It is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>applicable to parameters of type string or number.</td>
</tr>
<tr>
<td>constraint_definition</td>
<td>yes</td>
<td>The definition of the constraint. The value depends on the type of constraint.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• for allowed_values: an array of strings or numbers. Example [ &lt;value1&gt;,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;value2&gt; ].</td>
</tr>
<tr>
<td>description</td>
<td>no</td>
<td>A human readable description for the constraint.</td>
</tr>
</tbody>
</table>

### 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:

```yaml
<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

<table>
<thead>
<tr>
<th>Field</th>
<th>Required</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>parameter_name</td>
<td>yes</td>
<td>The name of the parameter, which shall start with the prefix &quot;nfv&quot;.</td>
</tr>
<tr>
<td>type</td>
<td>yes</td>
<td>The type of the parameter.</td>
</tr>
<tr>
<td>description</td>
<td>yes</td>
<td>A human readable description for the parameter.</td>
</tr>
</tbody>
</table>

### 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-levels 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 specification uses the following simple data types as defined in Table 4.4.2-1. In YAML v1.2 [4], FailSafe schema defines only mapping, sequence and string tags. 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>
<thead>
<tr>
<th>Type name</th>
<th>Description</th>
<th>Example(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>String</td>
<td>A string as defined in YAML v1.2 [4].</td>
<td>&quot;a string&quot;</td>
</tr>
<tr>
<td>Number</td>
<td>A number as defined in IETF RFC 8259 [5] referred in JSON Schema [7].</td>
<td>&quot;23&quot;, &quot;-1.023E3&quot;</td>
</tr>
<tr>
<td>Boolean</td>
<td>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].</td>
<td>&quot;true&quot;, &quot;false&quot;</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>{parameter name}</td>
<td>(map, sequence)</td>
<td>Type of the parameter</td>
</tr>
<tr>
<td>(description)</td>
<td></td>
<td>Description of the parameter</td>
</tr>
<tr>
<td>(attribute)</td>
<td>(attribute type)</td>
<td>Type of (attribute)</td>
</tr>
<tr>
<td>&gt;{sub attribute}</td>
<td>(sub attribute type in the attribute)</td>
<td>Type of (sub attribute)</td>
</tr>
</tbody>
</table>

The tags defined in section 10.1 of the YAML 1.2 [4] specification shall be used.

map in YAML 1.2 [4] is a type representing mapping. The type maps "keys" to "values". The syntax of map for parameter definition is represented with the following definition:

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

seq in YAML 1.2 [4] is a type representing sequence. The type represent ordered elements. The syntax of seq for parameter definition is represented with the following definition:

```
{parameter name}:
  description: <description of the parameter>
  type: seq
  minItems: {lower bound of cardinality}
  maxItems: {upper bound of cardinality}
  sequence:
    - type: e.g. map
      mapping:
        {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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>reservationId</td>
<td>String</td>
<td>Identifier of the resource reservation applicable to this virtualised resource management operation</td>
</tr>
</tbody>
</table>

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

```python
ingreservationId:
    type: str
    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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>resourceGroupId</td>
<td>String</td>
<td>Unique identifier of the &quot;infrastructure resource group&quot;, logical grouping of virtual resources assigned to a tenant within an Infrastructure Domain</td>
</tr>
</tbody>
</table>

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

```python
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: str
    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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>groupName</td>
<td>String</td>
<td>Name of the group, given by the consumer</td>
</tr>
</tbody>
</table>
The syntax of the `groupName` shall comply with the following definition:

```python
groupName:
  type: str
  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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>typeOfAffinityOrAntiAffinityConstraints</code></td>
<td>String</td>
<td>Indicates whether this is an affinity or anti-affinity group</td>
</tr>
</tbody>
</table>

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

```python
typeOfAffinityOrAntiAffinityConstraints:
  description: >
    Indicates whether this is an affinity or anti-affinity group.
  type: str
  constraints:
    allowed_values:
    - affinity
    - anti-affinity
```

### 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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>computeName</code></td>
<td>String</td>
<td>Name for a virtualised compute resource to be allocated</td>
</tr>
</tbody>
</table>

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

```python
computeName:
  type: str
  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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>computeFlavourId</td>
<td>String</td>
<td>Identifier of the Compute Flavour that provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate</td>
</tr>
</tbody>
</table>

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

```python
computeFlavourId:
  type: str
  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: vcImageId

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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vcImageId</td>
<td>String</td>
<td>Identifier of the virtualisation container software image</td>
</tr>
</tbody>
</table>

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

```python
vcImageId:
  type: str
  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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>locationConstraints</td>
<td>String</td>
<td>If present, it defines location constraints for the resource(s) is (are) requested to be allocated, e.g. in what particular resource zone</td>
</tr>
</tbody>
</table>

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

```python
locationConstraints:
  type: str
  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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>affinityOrAntiAffinityConstraintsForCompute</td>
<td>Sequence of map</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>&gt;typeOfAffinityOrAntiAffinityConstraintForCompute</td>
<td>String</td>
<td>Indicates whether this is an affinity or anti-affinity constraint. Allowed to affinity and anti-affinity.</td>
</tr>
<tr>
<td>&gt;scopeOfAffinityOrAntiAffinityConstraintForCompute</td>
<td>String</td>
<td>Qualifies the scope of the constraint. In case of compute resource: e.g. &quot;NFVI-PoP&quot; or &quot;NFVI-Node&quot;. Allowed to NFVI-PoP, NFVI-Node. Defaults to &quot;NFVI-Node&quot; if absent.</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResourceList</td>
<td>Map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;resource</td>
<td>Sequence of map</td>
<td>List of identifiers of virtualised resources.</td>
</tr>
<tr>
<td>&gt;&gt;affinityAntiAffinityResoruceGroup</td>
<td>String</td>
<td>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.</td>
</tr>
</tbody>
</table>

NOTE: It is a prerequisite for the consumer to create a VirtualisedComputeResourceAffinityOrAntiAffinityConstraintsGroup and get groupIdentifier 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, affinityAntiAffinityResoruceGroup 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:

```json
affinityOrAntiAffinityConstraintsForCompute:
  description: >
    A list of elements with affinity or anti-affinity information of the virtualised compute resource to allocate.
  oneOf:
    - type: seq
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      sequence:
        - type: seq
          required:
            - typeOfAffinityOrAntiAffinityConstraintForCompute
          mapping:
            typeOfAffinityOrAntiAffinityConstraintForCompute:
              type: str
              constraints:
                allowed_values:
                  - affinity
                  - anti-affinity
            scopeOfAffinityOrAntiAffinityConstraintForCompute:
              type: str
              constraints:
                allowed_values:
                  - NFVI-PoP
                  - NFVI-Node
              default: NFVI-Node
            affinityAntiAffinityResourceList:
              type: map
```

ETSI
required:
  - resource
  mapping:
    resource:
      type: seq
      minItems: 1  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      sequence:
        - type: str
  - type: seq
    minItems: 0  # lower bound of cardinality
    maxItems: N  # upper bound of cardinality
    sequence:
      - type: seq
        minItems: 0  # lower bound of cardinality
        maxItems: N  # upper bound of cardinality
        sequence:
          - type: str
            required:
            - typeOfAffinityOrAntiAffinityConstraintForCompute
        mapping:
          typeOfAffinityOrAntiAffinityConstraintForCompute:
            type: str
            constraints:
            allowed_values:
              - affinity
              - anti-affinity
          scopeOfAffinityOrAntiAffinityConstraintForCompute:
            type: str
            constraints:
            allowed_values:
              - NFVI-PoP
              - NFVI-Node
            default: NFVI-Node
          affinityAntiAffinityResourceGroup:
            type: str

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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>interfaceData</td>
<td>Sequence of map</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>&gt;ipAddress</td>
<td>Sequence of string</td>
<td>The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to.</td>
</tr>
<tr>
<td>&gt;macAddress</td>
<td>String</td>
<td>The MAC address desired for the virtual network interface.</td>
</tr>
</tbody>
</table>

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

```plaintext
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: seq
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
sequence:
  - type: map
    mapping:
      ipAddress:  # IpAddress IE in SOL013
type: seq
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      sequence:
        - type: str
      macAddress:  # MacAddress IE in ETSI GS NFV-SOL 013
type: str
```

ETSII
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>computeId</td>
<td>String</td>
<td>Identifier of the virtualised compute resource to operate</td>
</tr>
</tbody>
</table>

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

```python
computeId:
  type: str
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: ">

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkInterfaceNew</td>
<td>Sequence of map</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>&gt;networkId</td>
<td>String</td>
<td>In the case when the virtual network interface is attached to the network, it identifies such a network.</td>
</tr>
<tr>
<td>&gt;networkPortId</td>
<td>String</td>
<td>If the virtual network interface is attached to a specific network port, it identifies such a network port.</td>
</tr>
<tr>
<td>&gt;typeVirtualNic</td>
<td>String (see note)</td>
<td>Type of network interface. Allowed value: normal-virtual-NIC.</td>
</tr>
<tr>
<td>&gt;typeConfiguration</td>
<td>Sequence of string (see note)</td>
<td>Extra configuration that the virtual network interface supports based on the type of virtual network interface.</td>
</tr>
<tr>
<td>&gt;bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network interface (in Mbps).</td>
</tr>
<tr>
<td>&gt;accelerationCapabilityForVirtualNetworkInterface</td>
<td>Sequence of string (see note)</td>
<td>It specifies if the virtual network interface requires certain acceleration capabilities (e.g. RDMA, packet dispatch, TCP Chimney).</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

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:

```python
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: seq
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
sequence:
  - type: map
    required:
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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkInterfaceUpdate</td>
<td>Sequence of map</td>
<td>Name of the parameter</td>
</tr>
<tr>
<td>&gt;resourceId</td>
<td>String</td>
<td>Identifier of the virtual network interface.</td>
</tr>
<tr>
<td>&gt;ownerId</td>
<td>String</td>
<td>Identifier of the owner of the network interface (e.g. a virtualised compute resource).</td>
</tr>
<tr>
<td>&gt;networkId</td>
<td>String</td>
<td>In the case when the virtual network interface is attached to the network, it identifies such a network.</td>
</tr>
<tr>
<td>&gt;networkPortId</td>
<td>String</td>
<td>If the virtual network interface is attached to a specific network port, it identifies such a network port.</td>
</tr>
<tr>
<td>&gt;ipAddress</td>
<td>Sequence of string</td>
<td>The virtual network interface can be configured with specific IP address(es) associated to the network to be attached to.</td>
</tr>
<tr>
<td>&gt;typeVirtualNic</td>
<td>String (see note)</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;typeConfiguration</td>
<td>Sequence of string (see note)</td>
<td>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).</td>
</tr>
<tr>
<td>&gt;macAddress</td>
<td>String</td>
<td>The MAC address of the virtual network interface.</td>
</tr>
<tr>
<td>&gt;bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network interface (in Mbps).</td>
</tr>
<tr>
<td>&gt;accelerationCapabilityForVirtualNetworkInterface</td>
<td>Sequence of string (see note)</td>
<td>Shows the acceleration capabilities utilized by the virtual network interface.</td>
</tr>
<tr>
<td>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>operationalState</td>
<td>String</td>
<td>The operational state of the virtual network interface. Allowed value: enabled, disabled.</td>
</tr>
<tr>
<td>metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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:

```json
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: seq
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    sequence:
        - type: map
          required:
            - resourceId
            - ownerId
            - typeVirtualNic
            - macAddress
            - bandwidth
            - operationalState
          mapping:
            resourceId:
                type: str
            ownerId:
                type: str
            networkId:
                type: str
            networkPortId:
                type: str
            ipAddress:  # IpAddress IE in ETSI GS NFV-SOL 013
                type: seq
                minItems: 0 # lower bound of cardinality
                maxItems: N # upper bound of cardinality
            sequence:
                - type: str
            typeVirtualNic:
                type: str
            typeConfiguration:
                type: seq
                minItems: 0 # lower bound of cardinality
                maxItems: N # upper bound of cardinality
                sequence:
                    - type: str
            macAddress:
                type: str
            bandwidth:
                type: number
            accelerationCapabilityForVirtualNetworkInterface:
                type: seq
                minItems: 0 # lower bound of cardinality
                maxItems: N # upper bound of cardinality
                sequence:
                    - type: str
            operationalState:
                type: str
            constraints:
                allowed_values:
                    - enabled
                    - disabled
            metadata:
                type: seq
```
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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>flavour</td>
<td>Map</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>&gt;flavourId</td>
<td>String</td>
<td>Identifier given to the compute flavour.</td>
</tr>
<tr>
<td>&gt;accelerationCapabilityForVirtualComputeFlavour</td>
<td>Sequence of string</td>
<td>Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources.</td>
</tr>
<tr>
<td>&gt;&gt;virtualMemory</td>
<td>Map</td>
<td>The virtual memory of the virtualised compute.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualMemSize</td>
<td>Number</td>
<td>Amount of virtual Memory (e.g. in MB).</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualMemOversubscriptionPolicy</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;numaEnabled</td>
<td>Boolean</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;virtualCpu</td>
<td>Map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuArchitecture</td>
<td>String</td>
<td>CPU architecture type. Examples are x86, ARM®.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;numVirtualCpu</td>
<td>Number</td>
<td>Number of virtual CPUs.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuClock</td>
<td>Number</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualCpuOversubscriptionPolicy</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualCpuPinning</td>
<td>Map</td>
<td>The virtual CPU pinning configuration for the virtualised compute resource.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualCpuPinningPolicy</td>
<td>String</td>
<td>The policy can take values of &quot;static&quot; or &quot;dynamic&quot;. In case of &quot;static&quot; the virtual CPU cores are requested to be allocated to logical CPU cores according to the rules defined in virtualCpuPinningRules. In case of &quot;dynamic&quot; 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</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualCpuPinningRules</td>
<td>Sequence of Map</td>
<td>A list of rules that should be considered during the allocation of the virtual CPU-s to logical CPU-s in case of &quot;static&quot; virtualCpuPinningPolicy.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;&gt;&gt;cores</td>
<td>Number</td>
<td>The number of core in the virtual CPU.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;&gt;&gt;sockets</td>
<td>Number</td>
<td>The number of socket in the virtual CPU.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;&gt;&gt;threads</td>
<td>Number</td>
<td>The number of thread in the virtual CPU.</td>
</tr>
</tbody>
</table>
### Parameter Name and Attributes

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;storageAttributes</td>
<td>Sequence of Map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;typeOfStorage</td>
<td>String</td>
<td>Type of virtualised storage resource (e.g. volume, object).</td>
</tr>
<tr>
<td>&gt;&gt;sizeOfStorage</td>
<td>Number</td>
<td>Size of virtualised storage resource (e.g. size of volume, in GB).</td>
</tr>
<tr>
<td>&gt;virtualNetworkInterface</td>
<td>Sequence of Map</td>
<td>The virtual network interfaces of the virtualised compute.</td>
</tr>
<tr>
<td>&gt;&gt;networkId</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;networkPortId</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;typeVirtualNic</td>
<td>Not specified (see note)</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;typeConfiguration</td>
<td>Not specified (see note)</td>
<td>Extra configuration that the virtual network interface supports based on the type of virtual network interface.</td>
</tr>
<tr>
<td>&gt;&gt;bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network interface (in Mbps).</td>
</tr>
<tr>
<td>&gt;&gt;accelerationCapabilityForVirtualNetworkInterface</td>
<td>Sequence of string</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

**NOTE:** There is only part of **flavour** 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:
- typeVirtualNic;
- typeConfiguration.

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

```yaml
flavour:
  description: >
    The flavour provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate
  type: map
  required:
  - flavourId
  - virtualMemory
  - virtualCpu
  mapping:
    flavourId:
      type: str
    accelerationCapabilityForVirtualComputeFlavour:
      type: seq
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      sequence:
      - type: str
        virtualMemory:
          type: map
          required:
          - virtualMemSize
```
mapping:
  virtualMemSize:
    type: number
  virtualMemOversubscriptionPolicy:
    type: str
  numaEnabled:
    type: boolean
virtualCpu:
  type: map
  required:
    - numVirtualCpu
  mapping:
    cpuArchitecture:
      type: str
    numVirtualCpu:
      type: number
    cpuClock:
      type: number
  virtualCpuOversubscriptionPolicy:
    type: str
virtualCpuPinning:
  type: map
  required:
    - cpuPinningPolicy
  mapping:
    cpuPinningPolicy:
      type: str
    constraints:
      allowed_values:
        - static
        - dynamic
    cpuPinningRules:
      type: seq
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      sequence:
        - type: map
          mapping:
            cores:
              type: number
            sockets:
              type: number
            threads:
              type: number
storageAttributes:
  type: seq
  minItems: 0  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  sequence:
    - type: map
      mapping:
        typeOfStorage:
          type: str
        sizeOfStorage:
          type: number
virtualNetworkInterface:
  type: seq
  minItems: 0  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  sequence:
    - type: map
      mapping:
        networkId:
          type: str
        networkPortId:
          type: str
        bandwidth:
          type: number
        accelerationCapabilityForVirtualNetworkInterface:
          type: seq
          minItems: 0  # lower bound of cardinality
          maxItems: N  # upper bound of cardinality
          sequence:
            - type: str
        metadata:
          type: seq
          minItems: 0  # lower bound of cardinality
          maxItems: N  # upper bound of cardinality
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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvComputeInfo</td>
<td>Map</td>
<td>Element containing information of the newly instantiated virtualised compute resource as VirtualCompute.</td>
</tr>
<tr>
<td>&gt;computeId</td>
<td>String</td>
<td>Identifier of the virtualised compute resource.</td>
</tr>
<tr>
<td>&gt;computeName</td>
<td>String</td>
<td>Name of the virtualised compute resource.</td>
</tr>
<tr>
<td>&gt;flavourId</td>
<td>String</td>
<td>Identifier of the given compute flavour used to instantiate this virtual compute.</td>
</tr>
<tr>
<td>&gt;accelerationCapabilityForVirtualComputeFlavour</td>
<td>Sequence of string</td>
<td>Selected acceleration capabilities (e.g. crypto, GPU) from the set of capabilities offered by the compute node acceleration resources.</td>
</tr>
<tr>
<td>&gt;virtualCpu</td>
<td>Map</td>
<td>The virtual CPU(s) of the virtualised compute as VirtualCpu.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuArchitecture</td>
<td>String</td>
<td>CPU architecture type. Examples are x86, ARM®. See note.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;numVirtualCpu</td>
<td>Number</td>
<td>Number of virtual CPUs.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuClock</td>
<td>Number</td>
<td>Minimum CPU clock rate in Hz available for the virtualised CPU resources.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualCpuOversubscriptionPolicy</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualCpuPinning</td>
<td>Map</td>
<td>The virtual CPU pinning configuration for the virtualised compute resource.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuPinningPolicy</td>
<td>String</td>
<td>The policy can take values of &quot;static&quot; or &quot;dynamic&quot;. In case of &quot;static&quot; the virtual CPU cores are requested to be allocated to logical CPU cores according to the rules defined in virtualCpuPinningRules. In case of &quot;dynamic&quot; 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.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuPinningRules</td>
<td>Sequence of map</td>
<td>A list of rules that should be considered during the allocation of the virtual CPU-s to logical CPU-s in case of &quot;static&quot; virtualCpuPinningPolicy.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;core</td>
<td>Number</td>
<td>The number of core in the virtual CPU.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;sockets</td>
<td>Number</td>
<td>The number of socket in the virtual CPU.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;threads</td>
<td>Number</td>
<td>The number of thread in the virtual CPU.</td>
</tr>
<tr>
<td>&gt;virtualMemory</td>
<td>Map</td>
<td>The virtual memory of the compute as VirtualMemory.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualMemSize</td>
<td>Number</td>
<td>Amount of virtual memory in byte.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;virtualMemOversubscriptionPolicy</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;numaEnabled</td>
<td>Boolean</td>
<td>It specifies the memory allocation to be cognisant of the relevant process/core allocation.</td>
</tr>
<tr>
<td>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>&gt;virtualNetworkInterface</td>
<td>Sequence of Map</td>
<td>Element with information of the instantiated virtual network interfaces of the compute resource.</td>
</tr>
<tr>
<td>&gt;&gt;resourceId</td>
<td>String</td>
<td>Identifier of the virtual network interface.</td>
</tr>
<tr>
<td>&gt;&gt;ownerId</td>
<td>String</td>
<td>Identifier of the owner of the network interface (e.g. a virtualised compute resource).</td>
</tr>
<tr>
<td>&gt;&gt;networkId</td>
<td>String (Reference to VirtualNetwork)</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;networkPortId</td>
<td>String (Reference to VirtualNetworkPort)</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;ipAddress</td>
<td>Sequence of string</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;typeVirtualNic</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;typeConfiguration</td>
<td>Sequence of string</td>
<td>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).</td>
</tr>
<tr>
<td>&gt;&gt;macAddress</td>
<td>String</td>
<td>The MAC address of the virtual network interface.</td>
</tr>
<tr>
<td>&gt;&gt;bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network interface (in Mbps).</td>
</tr>
<tr>
<td>&gt;&gt;accelerationCapabilityForVirtualNetworkInterface</td>
<td>Sequence of string</td>
<td>Shows the acceleration capabilities utilized by the virtual network interface. The cardinality can be 0, if no acceleration capability is utilized.</td>
</tr>
<tr>
<td>&gt;&gt;operationalState</td>
<td>String</td>
<td>The operational state of the virtualised subnetwork. Allowed values are: enabled, disabled.</td>
</tr>
<tr>
<td>&gt;&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;virtualDisks</td>
<td>Sequence of Map</td>
<td>Element with information of the virtualised storage resources (volumes, ephemeral) that are attached to the compute resource.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;storageId</td>
<td>String</td>
<td>Identifier of the virtualised storage resource.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;storageName</td>
<td>String</td>
<td>Name of the virtualised storage resource.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;flavourId</td>
<td>String</td>
<td>Identifier of the storage flavour used to instantiate this virtual storage.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;typeOfStorage</td>
<td>String</td>
<td>Type of virtualised storage resource (e.g. volume, object).</td>
</tr>
<tr>
<td>&gt;&gt;&gt;sizeOfStorage</td>
<td>Number</td>
<td>Size of virtualised storage resource (e.g. size of volume, in GB).</td>
</tr>
<tr>
<td>&gt;&gt;&gt;rdmaEnabled</td>
<td>Boolean</td>
<td>Indicates if the storage supports RDMA.</td>
</tr>
<tr>
<td>&gt;&gt;ownerId</td>
<td>String</td>
<td>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).</td>
</tr>
<tr>
<td>&gt;&gt;zonedId</td>
<td>String</td>
<td>It identifies the resource zone where the virtual storage resources have been allocated.</td>
</tr>
<tr>
<td>&gt;&gt;hostId</td>
<td>String</td>
<td>Identifier of the host where the virtualised storage resource is allocated.</td>
</tr>
<tr>
<td>&gt;&gt;operationalState</td>
<td>String</td>
<td>Operational state of the resource. Allowed value: enabled, disabled.</td>
</tr>
<tr>
<td>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>&gt;&gt;&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;vcImageId</td>
<td>String</td>
<td>Identifier of the virtualisation container software image (e.g. virtual machine image).</td>
</tr>
<tr>
<td>&gt;zoneld</td>
<td>String</td>
<td>If present, it identifies the resource zone where the virtual compute resources have been allocated.</td>
</tr>
<tr>
<td>&gt;hostId</td>
<td>String</td>
<td>Identifier of the host the virtualised compute resource is allocated on.</td>
</tr>
<tr>
<td>&gt;operationalState</td>
<td>String</td>
<td>Operational state of the compute resource. Possible values are: &quot;enabled&quot; or &quot;disabled&quot;.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

NOTE: See "cpu_architecture" in tosca.datatypes.nfv.VirtualCpu, 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:

```yaml
nfvComputeInfo:
  description: >
    Element containing information of the newly instantiated virtualised compute resource.
  type: map
  required:
    - computeId
    - flavourId
    - virtualCpu
    - virtualMemory
    - virtualDisks
    - hostId
    - operationalState
  mapping:
    computeId:
      description: >
        Identifier of the virtualised compute resource.
      type: str
    computeName:
      description: >
        Name of the virtualised compute resource.
      type: str
    flavourId:
      description: >
        Identifier of the given compute flavour used to instantiate this virtual compute.
      type: str
    accelerationCapabilityForVirtualComputeFlavour:
      type: seq
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      sequence:
        type: str
    virtualCpu:
      description: >
        The virtual CPU(s) of the virtualised compute.
      type: map
      mapping:
        cpuArchitecture:
          description: >
            CPU architecture type.
          type: str
        numVirtualCpu:
          description: >
            Number of virtual CPUs.
          type: number
        cpuClock:
          description: >
```

ETSNI
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: str

virtualCpuPinning:
  - description: > The virtual CPU pinning configuration for the virtualised compute resource.
  - type: map
  - required:
    - cpuPinningPolicy
  - mapping:
    - cpuPinningPolicy:
      - type: str
      - constraints:
        - allowed_values:
          - static
          - dynamic
      - cpuPinningRules:
        - type: seq
        - minItems: 0 # lower bound of cardinality
        - maxItems: N # upper bound of cardinality
        - sequence:
          - type: map
          - mapping:
            - cores:
              - type: number
            - sockets:
              - type: number
            - threads:
              - type: number

virtualMemory:
  - description: > The virtual memory of the compute.
  - type: map
  - mapping:
    - 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: str
    - 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.
  - resourceIds:
    - type: str
  - ownerId:
    - type: str
  - networkId:
    - type: str
  - networkPortId:
    - type: str
  - ipAddress:
    - # IpAddress IE in ETSI GS NFV-SOL 013
    - type: seq
    - minItems: 0 # lower bound of cardinality
    - maxItems: N # maximum value of cardinality
    - sequence:
      - type: str
  - typeVirtualNic:
    - type: str
  - typeConfiguration:
    - type: seq
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
sequence:
  - type: str
macAddress:
type: str
bandwidth:
type: number
accelerationCapabilityForVirtualNetworkInterface*:
type: seq
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
sequence:
  - type: str
operationalState:
type: str
constraints:
  allowed_values:
  - enabled
  - disabled
metadata:
type: seq
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
sequence:
  - type: map
    mapping:
    # metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
virtualDisks:
description: >
Element with information of the virtualised storage resources (volumes, ephemeral) that are attached to the compute resource.
type: seq
minItems: 1  # lower bound of cardinality
maxItems: N  # maximum value of cardinality
sequence:
  - type: map
    required:
    - storageId
    - flavourId
    - typeOfStorage
    - sizeOfStorage
    - operationalState
    mapping:
    storageId:
description: >
Identifier of the virtualised storage resource
type: str
storageName:
description: >
Name of the virtualised storage resource
type: str
flavourId:
description: >
Identifier of the storage flavour used to instantiate this virtual storage
type: str
typeOfStorage:
description: >
Type of virtualised storage resource
type: str
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: str
zoneId:
description: >
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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkResourceName</td>
<td>String</td>
<td>Name for a virtualised compute resource.</td>
</tr>
</tbody>
</table>

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

```python
definition:
    description: >
        Name provided by the consumer for the virtualised network resource
    type: str
    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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkResourceType</td>
<td>String</td>
<td>The network data provides information about the particular virtual network resource. Possible values are: &quot;network&quot;, &quot;subnet&quot;, or &quot;network-port&quot;.</td>
</tr>
</tbody>
</table>

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

```python
definition:
    description: >
        The network data information applicable to the particular virtual network resource of the virtualised resource management operation
    type: str
    constraints:
        allowed_values:
            - 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

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

**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:

```json
typeNetworkData:
  description: >
    The network data information about the particular virtual network resource of the virtualised resource management operation
  type: map # VirtualNetworkData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  required:
    - bandwidth
  mapping:
    bandwidth:
      type: number
    networkType:
      type: str
    segmentType:
      type: str
    networkQos:
      type: seq
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
    sequence:
      - type: map
        mapping:
          qosName:
            type: str
          qosValue:
            type: number
    isShared:
      type: boolean
    sharingCriteria:
      type: str
  layer3Attributes: # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  type: seq
  minItems: 0 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
```
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>typeNetworkPortData</td>
<td>Map</td>
<td>The network port data provides information about the particular network port.</td>
</tr>
<tr>
<td>portType</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>networkId</td>
<td>String</td>
<td>Identifier of the network that the port belongs to.</td>
</tr>
<tr>
<td>segmentId</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network port (in Mbps).</td>
</tr>
<tr>
<td>metadata</td>
<td>Sequence of maps</td>
<td>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.</td>
</tr>
</tbody>
</table>
The syntax of the typeNetworkPortData shall comply with the following definition:

```plaintext
typeNetworkPortData:
  description: >
    The network port data information about the particular network port
    of the virtualised resource management operation
  type: map # VirtualNetworkPortData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  required:
    - portType
  mapping:
    portType:
      type: str
    networkId:
      type: str
    segmentId:
      type: str
    bandwidth:
      type: number
    metadata:
      type: seq
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      sequence:
        - type: map
          mapping:
            # metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
            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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>typeSubnetData</td>
<td>Map</td>
<td>The subnet data provides information about the particular sub-network resource.</td>
</tr>
<tr>
<td>&gt;networkId</td>
<td>String</td>
<td>The identifier of the virtualised network that the virtualised sub-network is attached to.</td>
</tr>
<tr>
<td>&gt;gatewayIp</td>
<td>String</td>
<td>The identifier of the virtualised network that the virtualised sub-network is attached to.</td>
</tr>
<tr>
<td>&gt;isDhcpEnabled</td>
<td>Boolean</td>
<td>Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.</td>
</tr>
<tr>
<td>&gt;addressPool</td>
<td>Sequence of map</td>
<td>The CIDR of the network/subnetwork, i.e. network address and subnet mask.</td>
</tr>
<tr>
<td>&gt;&gt;start</td>
<td>String</td>
<td>The first IP address in the addressPool. See note.</td>
</tr>
<tr>
<td>&gt;&gt;end</td>
<td>String</td>
<td>The last IP address in the addressPool. See note.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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:

```json
typeSubnetData:
  description: >
    The subnet data information about the particular subnetwork of
    the virtualised resource management operation
  type: map
  mapping:
    networkId:
      type: str
    ipVersion:
      type: str
    constraints:
      allowed_values:
        - IPv4
        - IPv6
    gatewayIp:
      type: str
    cidr:
      type: str
    isDhcpEnabled:
      type: boolean
    addressPool:
      type: seq
      minItems: 0
      maxItems: N
      sequence:
        - type: map
          mapping:
            start:
              type: str
            end:
              type: str
    metadata:
      type: seq
      minItems: 0
      maxItems: N
      sequence:
        - type: map
          mapping:
            # metadata is optional. It is out of scope to detail what are the sub-keys and
            possible values.
            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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>affinityOrAntiAffinityConstraintsForNetwork</td>
<td>Sequence of Map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;typeOfAffinityOrAntiAffinityConstraintForNetwork</td>
<td>String</td>
<td>Indicates whether this is an affinity or anti-affinity constraint. Allowed_values: affinity, anti-affinity.</td>
</tr>
<tr>
<td>&gt;scopeOfAffinityOrAntiAffinityConstraintForNetwork</td>
<td>String</td>
<td>Qualifies the scope of the constraint. In case of ports: e.g. &quot;virtual switch or router&quot; or &quot;physical NIC&quot;, or &quot;physical network&quot; or &quot;NFVI Node&quot;. In case of networks: e.g. &quot;physical NIC&quot;, &quot;physical network&quot; or &quot;NFVI Node&quot;. In case of subnets: it should be ignored. Defaults to &quot;NFVI Node&quot; if absent. Allowed_values: virtual-switch, router, physical-NIC, physical-network, NFVI-Node.</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResourceId</td>
<td>Map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;resource</td>
<td>Sequence of string</td>
<td>List of identifiers of virtualised resources.</td>
</tr>
<tr>
<td>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResourceGroup</td>
<td>String</td>
<td>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.</td>
</tr>
</tbody>
</table>

NOTE: It is a prerequisite for the consumer to create a VirtualisedNetworkResourceAffinityOrAntiAffinityConstraintsGroup and get groupIdentifier 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:

```json
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: seq
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      sequence:
        - type: map
          required:
            - typeOfAffinityOrAntiAffinityConstraintForNetwork
          mapping:
            typeOfAffinityOrAntiAffinityConstraintForNetwork:
              type: str
              constraints:
                allowed_values:
                  - affinity
                  - anti-affinity
            scopeOfAffinityOrAntiAffinityConstraintForNetwork:
              type: str
              constraints:
                allowed_values:
                  - virtual-switch
                  - router
                  - physical-NIC
                  - physical-network
                  - NFVI-Node
              default: NFVI-Node
            affinityAntiAffinityResourceList:
              type: map
              required:
                - resource
              mapping:
                resource:
                  type: seq
                  minItems: 1  # lower bound of cardinality
                  maxItems: N  # upper bound of cardinality
                  sequence:
                    - type
                    - Sequence:
                      - type
                      - type: seq
                        minItems: 0  # lower bound of cardinality
                        maxItems: N  # upper bound of cardinality
                        sequence:
                          - type
                          - required:
                            - typeOfAffinityOrAntiAffinityConstraintForNetwork
                          mapping:
                            typeOfAffinityOrAntiAffinityConstraintForNetwork:
                              type: str
                              constraints:
                                allowed_values:
                                  - affinity
                                  - anti-affinity
```

ETSI
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>locationConstraintsForNetwork</td>
<td>String</td>
<td>Defines location constraints for the resource(s), e.g. in what particular resource zone.</td>
</tr>
</tbody>
</table>

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: str
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>queryNetworkFilter</td>
<td>Not specified (see note)</td>
<td>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.</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkResourceId</td>
<td>String</td>
<td>Identifier of a virtualised resource.</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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:

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

---

**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.
### 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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>updateSubnetData</td>
<td>Map</td>
<td>Subnet data information about the particular virtual subnet resource.</td>
</tr>
<tr>
<td>&gt; networkId</td>
<td>String</td>
<td>The identifier of the virtualised network that the virtualised sub-network is attached to.</td>
</tr>
<tr>
<td>&gt; gatewayIp</td>
<td>String</td>
<td>Specifies the IP address of the network/subnetwork gateway when the gateway is selected by the requestor.</td>
</tr>
<tr>
<td>&gt; cidr</td>
<td>String</td>
<td>The CIDR of the network/subnetwork, i.e. network address and subnet mask.</td>
</tr>
<tr>
<td>&gt; isDhcpEnabled</td>
<td>Boolean</td>
<td>True when DHCP is to be enabled for this network/subnetwork, or false otherwise.</td>
</tr>
<tr>
<td>&gt; addressPool</td>
<td>Sequence of Map</td>
<td>Address pools for the network/subnetwork</td>
</tr>
<tr>
<td>&gt;&gt; start</td>
<td>String</td>
<td>The first IP address in the addressPool. See note.</td>
</tr>
<tr>
<td>&gt;&gt; end</td>
<td>String</td>
<td>The last IP address in the addressPool. See note.</td>
</tr>
<tr>
<td>&gt; metadata</td>
<td>Sequence of map</td>
<td>List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.</td>
</tr>
</tbody>
</table>

**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:

```yaml
updateSubnetData:
  description: >
    The subnet data information of a particular subnet resource
  type: map
  mapping:
    networkId:
      type: str
    ipVersion:
      type: str
    constraints:
      allowed_values:
```
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>updateNetworkPort</td>
<td>Map</td>
<td>Network port data information about the particular virtual network port resource.</td>
</tr>
<tr>
<td>&gt;portType</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;networkId</td>
<td>String</td>
<td>Identifier of the network that the port belongs to.</td>
</tr>
<tr>
<td>&gt;segmentId</td>
<td>String</td>
<td>The isolated segment the network port belongs to. For instance, for a &quot;vlan&quot;, it corresponds to the vlan identifier; and for a &quot;gre&quot;, this corresponds to a gre key.</td>
</tr>
<tr>
<td>&gt;bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network port (in Mbps).</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>List of metadata key-value pairs used by the consumer to associate meaningful metadata to the related virtualised resource.</td>
</tr>
</tbody>
</table>

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

```json
updateNetworkPort:
  description: >
    The network port data information of a particular network port resource
  type: map  # VirtualNetworkData in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  required:
    - portType
  mapping:
    portType:
      type: str
    networkId:
      type: str
    segmentId:
      type: str
    bandwidth:
      type: number
    metadata:
      type: seq
```
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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>scopeOfAffinityOrAntiAffinityConstraintForNetwork</td>
<td>String</td>
<td>Qualifies the scope of the constraint, e.g. NFVI Node, NIC. Defaults to NFVI Node if absent.</td>
</tr>
</tbody>
</table>

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

```json
scopeOfAffinityOrAntiAffinityConstraintForNetwork:
  description: >
    It qualifies the scope of the constraint, e.g. NFVI Node, NIC of the
    virtualised resource management operation
  type: str
  constraints:
    allowed_values:
      - 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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvNetworkInfo</td>
<td>Map</td>
<td>If network types are created satisfactorily, it contains the data relative to the instantiated virtualised network resource as VirtualNetwork.</td>
</tr>
<tr>
<td>&gt;networkResourceId</td>
<td>String</td>
<td>Identifier of the virtualised network resource.</td>
</tr>
<tr>
<td>&gt;networkResourceName</td>
<td>String</td>
<td>Name of the virtualised network resource.</td>
</tr>
<tr>
<td>&gt;subnet</td>
<td>String</td>
<td>Only present if the network provides layer 3 connectivity.</td>
</tr>
<tr>
<td>&gt;networkPort</td>
<td>Not specified</td>
<td>Element providing information of an instantiated virtual network port.</td>
</tr>
<tr>
<td>&gt;bandwidth</td>
<td>Number</td>
<td>Minimum network bandwidth (in Mbps).</td>
</tr>
<tr>
<td>&gt;networkType</td>
<td>String</td>
<td>The type of network that maps to the virtualised network. Examples are: &quot;local&quot;, &quot;vlan&quot;, &quot;vxlan&quot;, &quot;gre&quot;, &quot;l3-vpn&quot;. The cardinality can be &quot;0&quot; to cover the case where this attribute is not required to create the virtualised network.</td>
</tr>
<tr>
<td>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td><code>segmentType</code></td>
<td>String</td>
<td>The isolated segment for the virtualised network. For instance, for a &quot;vlan&quot; networkType, it corresponds to the vlan identifier; and for a &quot;gre&quot; networkType, this corresponds to a gre key. The cardinality can be &quot;0&quot; for flat networks without any specific segmentation.</td>
</tr>
<tr>
<td><code>networkQoS</code></td>
<td>Sequence of Map</td>
<td>Element providing information about Quality of Service attributes that the network supports. Cardinality can be &quot;0&quot; for virtual network without any QoS requirements.</td>
</tr>
<tr>
<td><code>qosName</code></td>
<td>String</td>
<td>Name given to the QoS parameter.</td>
</tr>
<tr>
<td><code>qosValue</code></td>
<td>Number</td>
<td>Value of the QoS parameter.</td>
</tr>
<tr>
<td><code>isShared</code></td>
<td>Boolean</td>
<td>It defines whether the virtualised network is shared among consumers.</td>
</tr>
<tr>
<td><code>sharingCriteria</code></td>
<td>String</td>
<td>Only present for shared networks. Indicate the sharing criteria for this network. This criteria might be a list of authorized consumers.</td>
</tr>
<tr>
<td><code>zoneId</code></td>
<td>String</td>
<td>If present, it identifies the Resource Zone where the virtual network resources have been allocated.</td>
</tr>
<tr>
<td><code>operationalState</code></td>
<td>String</td>
<td>The operational state of the virtualised network. Possible values are: &quot;enabled&quot;, &quot;disabled&quot;.</td>
</tr>
<tr>
<td><code>metadata</code></td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

```json
nfvNetworkInfo:
  type: map
  required:
    - networkResourceId
    - bandwidth
    - networkType
    - isShared
    - operationalState
  mapping:
    networkResourceId:
      type: str
    networkResourceName:
      type: str
    subnet:
      type: str
    bandwidth:
      type: number
    networkType:
      type: str
    segmentType:
      type: str
    networkQoS:
      type: seq
      minItems: 0  # lower bound of cardinality
      maxItems: N  # maximum value of cardinality
    sequence:
      - type: map
        mapping:
          qosName:
            type: str
          qosValue:
            type: number
    isShared:
      type: boolean
    sharingCriteria:
      type: str
    zoneId:
```

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvSubnetInfo</td>
<td>Map</td>
<td>If subnet types are created satisfactorily, it contains the data relative to the allocated subnet as NetworkSubnet.</td>
</tr>
<tr>
<td>&gt;resourceId</td>
<td>String</td>
<td>Identifier of the virtualised sub-network.</td>
</tr>
<tr>
<td>&gt;networkId</td>
<td>String</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;ipVersion</td>
<td>String</td>
<td>The IP version of the network/subnetwork. Possible values are: &quot;IPv4&quot;, &quot;IPv6&quot;.</td>
</tr>
<tr>
<td>&gt;gatewayIp</td>
<td>String</td>
<td>The IP V4 or IPV6 address of the network/subnetwork gateway.</td>
</tr>
<tr>
<td>&gt;cidr</td>
<td>String</td>
<td>The CIDR of the network/subnetwork, i.e. network address and subnet mask.</td>
</tr>
<tr>
<td>isDhcpEnabled</td>
<td>Boolean</td>
<td>True when DHCP is enabled for this network/subnetwork, or false otherwise.</td>
</tr>
<tr>
<td>&gt;addressPool</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;start</td>
<td>String</td>
<td>The first IP address in the addressPool. See note.</td>
</tr>
<tr>
<td>&gt;&gt;end</td>
<td>String</td>
<td>The last IP address in the addressPool. See note.</td>
</tr>
<tr>
<td>operationalState</td>
<td>String</td>
<td>The operational state of the virtualised subnetwork. Allowed values are: enabled, disabled.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

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:

```python
def nfvSubnetInfo:
    type: map
    required:
        - resourceId
```
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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvNetworkPortInfo</td>
<td>Map</td>
<td>If network port types are created satisfactorily, it contains the data relative to the allocated network port as VirtualNetworkPort.</td>
</tr>
<tr>
<td>&gt;resourceId</td>
<td>String</td>
<td>Identifier of the virtual network port.</td>
</tr>
<tr>
<td>&gt;networkId</td>
<td>String</td>
<td>Identifier of the network that the port belongs to.</td>
</tr>
<tr>
<td>&gt;attachedResourceId</td>
<td>String</td>
<td>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 &quot;0&quot; if there is no specific resource connected to the network port.</td>
</tr>
<tr>
<td>&gt;portType</td>
<td>String</td>
<td>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: &quot;access ports&quot;, &quot;trunk ports&quot;.</td>
</tr>
<tr>
<td>&gt;segmentId</td>
<td>String</td>
<td>The isolated segment the network port belongs to. For instance, for a &quot;vlan&quot;, it corresponds to the vlan identifier; and for a &quot;gre&quot;, this corresponds to a gre key. The cardinality can be &quot;0&quot; for flat networks without any specific segmentation.</td>
</tr>
</tbody>
</table>
### Parameter Name and Attributes

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network port (in Mbps). Cardinality can be &quot;0&quot; for virtual network ports without any specific allocated bandwidth.</td>
</tr>
<tr>
<td>operationalState</td>
<td>String</td>
<td>The operational state of the virtualised network port. Possible values are: &quot;enabled&quot;, &quot;disabled&quot;.</td>
</tr>
<tr>
<td>metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

```json
nfvNetworkPortInfo:
  type: map
  required:
    - resourceId
    - portType
    - operationalState
  mapping:
    resourceId:
      type: str
    attachedResourceId:
      type: str
    portType:
      type: str
    segmentId:
      type: str
    bandwidth:
      type: number
    operationalState:
      type: str
  constraints:
    allowed_values:
      - access ports
      - trunk ports
    segmentId:
      type: str
    bandwidth:
      type: number
    operationalState:
      type: str
  constraints:
    allowed_values:
      - enabled
      - disabled
  metadata:
    type: seq
    minItems: 0 # lower bound of cardinality
    maxItems: N # upper bound of cardinality
    sequence:
      - type: map
        mapping:
          # metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
```

---

## 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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>storageName</td>
<td>String</td>
<td>Name provided by the consumer for the virtualised storage resource to allocate. It can be used for identifying resources from consumer side.</td>
</tr>
</tbody>
</table>

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

```python
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: str
  - 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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>affinityOrAntiAffinityConstraintsForStorage</td>
<td>Sequence of map</td>
<td>A list of elements with affinity or anti-affinity information of the virtualised storage resource to be allocated.</td>
</tr>
<tr>
<td>&gt;typeOfAffinityOrAntiAffinityConstraintForStorage</td>
<td>String</td>
<td>Indicates whether this is an affinity or anti-affinity constraint. Allowed to affinity and anti-affinity.</td>
</tr>
<tr>
<td>&gt;scopeOfAffinityOrAntiAffinityConstraintForStorage</td>
<td>String</td>
<td>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 &quot;NFVI-Node&quot; if absent.</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResourceList</td>
<td>Map</td>
<td>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.</td>
</tr>
<tr>
<td>&gt;&gt;resource</td>
<td>Sequence of string</td>
<td>List of identifiers of virtualised resources.</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResoruceGroup</td>
<td>String</td>
<td>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.</td>
</tr>
</tbody>
</table>

**NOTE:** It is a prerequisite for the consumer to create a `VirtualisedStorageResourceAffinityOrAntiAffinityConstraintsGroup` and get `groupIdentifier` using the appropriate operation, Create Virtualised Storage 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, `affinityAntiAffinityResoruceGroup` 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:

```yaml
affinityOrAntiAffinityConstraintsForStorage:
  description: >
    A list of elements with affinity or anti-affinity information of
    the virtualised storage resource to allocate.
  oneOf:
    - type: seq
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      sequence:
        - type: map
          required:
            - typeOfAffinityOrAntiAffinityConstraintForStorage:
              mapping:
                typeOfAffinityOrAntiAffinityConstraintForStorage:
                  type: str
                  constraints:
                    allowed_values:
                      - affinity
                      - anti-affinity
                  scopeOfAffinityOrAntiAffinityConstraintForStorage:
                    type: str
                    constraints:
                      allowed_values:
                        - NFVI-Node
                      default: NFVI-Node
                affinityAntiAffinityResourceList:
                  type: map
                  required:
                    - resource
                  mapping:
                    resource:
                      type: seq
                      minItems: 1 # lower bound of cardinality
                      maxItems: N # upper bound of cardinality
                      sequence:
                        - type: str
    - type: seq
      minItems: 0 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      sequence:
        - type: map
          required:
            - typeOfAffinityOrAntiAffinityConstraintForStorage:
              mapping:
                typeOfAffinityOrAntiAffinityConstraintForStorage:
                  type: str
                  constraints:
                    allowed_values:
                      - affinity
                      - anti-affinity
                  scopeOfAffinityOrAntiAffinityConstraintForStorage:
                    type: str
                    constraints:
                      allowed_values:
                        - NFVI-Node
                      default: NFVI-Node
                affinityAntiAffinityResourceGroup:
                  type: str
```

### 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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>storageData</td>
<td>Map</td>
<td>The storage data provides information about the type and size of the storage.</td>
</tr>
</tbody>
</table>

**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:

```yaml
storageData:
  description: >
    The storage data provides information about the type and size of the storage.
  type: map
  required:
  - flavourId
  - storageAttributes
  mapping:
    flavourId:
      type: str
    storageAttributes:
      type: map
      mapping:
        typeOfStorage:
          type: str
        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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>updateStorageData</td>
<td>Map</td>
<td>The element contains the fields that can be updated of a storage resource.</td>
</tr>
</tbody>
</table>

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

```yaml
updateStorageData:
  description: >
    The element contains the fields that can be updated of a storage resource.
  type: map
  required:
  - flavourId
  - storageAttributes
  mapping:
    flavourId:
      type: str
    storageAttributes:
      typeOfStorage:
        type: str
      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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>storageOperation</td>
<td>String</td>
<td>Type of operation to perform on the virtualised storage resource. Possible values include: &quot;create snapshot&quot;, and &quot;delete snapshot&quot;.</td>
</tr>
</tbody>
</table>

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

```yaml
storageOperation:
  description: >
    Type of operation to perform on the virtualised storage resource.
  type: str
  constraints:
    allowed_values:
    - create-snapshot
```
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>newSize</td>
<td>Number</td>
<td>Resized amount of allocated virtualised storage resource.</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>scopeOfAffinityOrAntiAffinityConstraintsForStorage</td>
<td>String</td>
<td>If applicable. Qualifies the scope of the affinity constraint, e.g. NFVI-Node. Defaults to NFVI-Node if absent.</td>
</tr>
</tbody>
</table>

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

```
scopeOfAffinityOrAntiAffinityConstraints: {
  description: >
  Qualifies the scope of the affinity constraint,
  type: str
  constraints:
    allowed_values:
    - 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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvStorageInfo</td>
<td>Map</td>
<td>Information of an instantiated virtualised storage resource.</td>
</tr>
<tr>
<td>&gt;storageId</td>
<td>String</td>
<td>Identifier of the virtualised storage resource.</td>
</tr>
<tr>
<td>&gt;storageName</td>
<td>String</td>
<td>Name of the virtualised storage resource.</td>
</tr>
<tr>
<td>&gt;flavourId</td>
<td>String</td>
<td>Identifier of the storage flavour used to instantiate this virtual storage.</td>
</tr>
<tr>
<td>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>sizeOfStorage</td>
<td>Number</td>
<td>Size of virtualised storage resource (e.g. size of volume, in GB).</td>
</tr>
<tr>
<td>rdmaEnabled</td>
<td>Boolean</td>
<td>Indicates if the storage supports RDMA.</td>
</tr>
<tr>
<td>ownerId</td>
<td>String</td>
<td>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).</td>
</tr>
<tr>
<td>zoneId</td>
<td>String</td>
<td>It identifies the resource zone where the virtual storage resources have been allocated.</td>
</tr>
<tr>
<td>hostId</td>
<td>String</td>
<td>Identifier of the host where the virtualised storage resource is allocated.</td>
</tr>
<tr>
<td>operationalState</td>
<td>String</td>
<td>Operational state of the resource. Allowed value: enabled, disabled.</td>
</tr>
<tr>
<td>metadata</td>
<td>Sequence of map</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

```json
nfvStorageInfo:
  description: >
  Information of an instantiated virtualised storage resource
type: map
required:
  - storageId
  - flavourId
  - typeOfStorage
  - sizeOfStorage
  - operationalState
mapping:
  storageId:
    description: >
    Identifier of the virtualised storage resource
type: str
storageName:
  description: >
  Name of the virtualised storage resource
type: str
flavourId:
  description: >
  Identifier of the storage flavour used to instantiate this virtual storage
type: str
typeOfStorage:
  description: >
  Type of virtualised storage resource
type: str
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: str
zoneId:
  description: >
  It identifies the resource zone where the virtual storage resources have been allocated
type: str
hostId:
  description: >
  Identifier of the host where the virtualised storage resource is allocated.
```
type: str
operationalState:
  description: >
    Operational state of the resource.
  type: str
  constraints:
    allowed_values:
    - enabled
    - disabled
metadata:
  type: seq
  minItems: 0  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  sequence:
    - type: map
      mapping:
        # metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
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.

```json
{
  "parameters": {
    "nfv": {
      "computeName": "test-instance-from-stack",
      "affinityOrAntiAffinityConstraintsForCompute": {
        "type": "affinity",
        "scope": "NFVI Node",
        "affinityAntiAffinityResourceGroup": "d10312a4-9d68-4cd4-831e-fd0edf3c0649"
      },
      "computeFlavourId": 10,
```
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 following is an example of a HOT for the Allocate Virtualised Compute Resource operation.

```yaml
heat_template_version: pike
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" 
        }
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 [1,2]. 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.

```json
{
  "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"
      }
    }
  }
}
```
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.

```json
{
  "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"
            }
          ]
        }
      }
    }
  }
}
```

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:

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

```yaml
heat_template_version: pike
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 ] }

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": "$ipVersion",
"gatewayIp": "$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, enable_dhcp ] }
$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: [ nfv, networkResourceType ] }

nfvSubnetInfo:
value:
  if:
  - networkResourceType_is_subnet
  - str_replace:
    template: |
    |
    "resourceId": "$resourceId",
    "networkId": "$networkId",
    "ipVersion": "$ipVersion",
    "gatewayIp": "$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: [ nfv, networkResourceType ] }

nfvNetworkPortInfo:
value:
  if:
  - networkResourceType_is_network-port
  - str_replace:
    template: |
    |
    "resourceId": "$resourceId",
    "networkId": "$networkId",
    "attachedResourceId": "$attachedResourceId",
    "operationalState": "$portOperationalState"
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"
      },
      "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.

```json
{
  "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"
    }
  }
}
```

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:

```yaml
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 nfvsStorageInfo 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 nfvsStorageInfo 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 following is an example of a HOT for the Allocate Virtualised Storage Resource operation.

```yaml
heat_template_version: pike
description: Allocate Virtualised Storage Resource operation
parameters:
  nfvs:
    type: json
    description:
    default: {}  
conditions:
  typeOfStorage_if_volume: { equals : [ { get_param: [ nfvs, storageData, storageAttributes, typeOfStorage ] }, "volume" ] }  
  Constraints_type_is_affinity: { equals : [ { get_param: [ nfvs, 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: [ nfvs, storageName ] }
            scheduler_hints:
              if:
              - Constraints_type_is_affinity
              - same_host:
                repeat:
                  for_each:
                    <%Resource%>: { get_param: [ nfvs, affinityOrAntiAffinityConstraintsForStorage, affinityAntiAffinityResourceList, resource ] }  
template:
  <%Resource%>
  - different_host:
    repeat:
      for_each:
        <%Resource%>: { get_param: [ nfvs, affinityOrAntiAffinityConstraintsForStorage, affinityAntiAffinityResourceList, resource ] }  
template:
  <%Resource%>
  size: { get_param: [ nfvs, storageData, storageAttributes, sizeOfStorage ] }
  availability_zone: { get_param: [ nfvs, locationConstraints ] }
  metadata: { get_param: [ nfvs, 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 ] }
          $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": "f4e0af8b-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.

```json
{
  "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"
      }
    }
  }
}
```

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.

```
heat_template_version: pike
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": "a1:2"
        - |
      - {} ### 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>
<thead>
<tr>
<th>Attribute per the present document data model</th>
<th>Attribute per HEAT API</th>
</tr>
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<tbody>
<tr>
<td>nfvStorageInfo</td>
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</tr>
<tr>
<td>&gt;storageId resource/attributes/id</td>
<td></td>
</tr>
<tr>
<td>&gt;storageName resource/attributes/name</td>
<td></td>
</tr>
<tr>
<td>&gt;flavourId (not supported by HEAT)</td>
<td></td>
</tr>
<tr>
<td>&gt;sizeOfStorage resource/attributes/size</td>
<td></td>
</tr>
<tr>
<td>&gt;rdmaEnabled (not supported by HEAT)</td>
<td></td>
</tr>
<tr>
<td>&gt;ownerId resource/attributes/attachments/server_id</td>
<td></td>
</tr>
<tr>
<td>&gt;zoneId resource/attributes/availability_zone</td>
<td></td>
</tr>
<tr>
<td>&gt;hostId os-vol-host-attr:host</td>
<td></td>
</tr>
<tr>
<td>&gt;operationalState resource/attributes/status</td>
<td></td>
</tr>
<tr>
<td>&gt;metadata resource/attributes/metadata</td>
<td></td>
</tr>
</tbody>
</table>
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" subclause of 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" subclause of clause 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

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<td>0.0.1</td>
<td>Skeleton and scope</td>
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<td>January 2019</td>
<td>0.1.0</td>
<td>Implemented NFVSOL(19)000013 SOL014 Scope.</td>
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<tr>
<td>February 2019</td>
<td>0.2.0</td>
<td>Implemented NFVSOL(19)00098r1 Clause 4.2 and 4.3 Adding YAML grammar</td>
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| March 2019   | 0.3.0  | Implemented:  
- NFVSOL(19)000161r2 SOL014 Data models for Virtualised Compute Management  
- NFVSOL(19)000171r2 SOL014 Output data models for parameter: computeData |
| March 2019   | 0.4.0  | Implemented:  
- NFVSOL(19)000185 SOL014 Clause 4.2.2 Input parameters syntax definition  
- NFVSOL(19)000186r2 SOL014 Clause: 4.3.3 Structured data types  
- NFVSOL(19)000187r3 SOL014 More string-formatted parameters for Virtualised Compute Management  
- NFVSOL(19)000188r1 SOL014_Annex_OpenStack Heat Orchestration Template |
| April 2019   | 0.4.1  | Implemented:  
- NFVSOL(19)000230r1 SOL014 Clause: 5.2.1.x Parameter: affinityOrAntiAffinityConstraints |
| May 2019     | 0.4.2  | Implemented:  
- NFVSOL(19)000234r1 SOL014 Multiple editorial corrections for consistency of v0.4.1 |
| May 2019     | 0.5.0  | Implemented:  
- NFVSOL(19)000257r3 SOL014ed271 – Input data models for virtualised network mgmt. |
| June 2019    | 0.5.1  | Implemented:  
- NFVSOL(19)000260r3 SOL014 Clause 5.3.1.1 refactor VirtualCompute  
- NFVSOL(19)000295r2 SOL014 Clause 4.1 General aspects |
| June 2019    | 0.6.0  | Implemented:  
- NFVSOL(19)000271r2 SOL014 Clause: 5.2.1.x Parameter: interfaceData networkInterfaceNew networkInterfaceUpdate flavour  
- NFVSOL(19)000297r2 SOL014: 6.2.x Input structured data models for virtualised network mgmt.  
- NFVSOL(19)000357 SOL014 Annex A (informative): Examples using OpenStack Heat Orchestration Template  
- NFVSOL(19)000376r1 SOL014 Parameters for virtualised storage management  
- NFVSOL(19)000377r1 SOL014 Clause 6.3 output data models for virtualised network |
| August 2019  | 0.7.0  | Implemented:  
- NFVSOL(19)000394r2 SOL014 Informative References OpenStack  
- NFVSOL(19)000395r1 SOL014 Syntaxes for map and sequence  
- NFVSOL(19)000396 SOL014 JSON schema as another option  
- NFVSOL(19)000406 SOL014 Merged descriptions for Parameter: reservationId  
- NFVSOL(19)000423 SOL014 Structured input data for virtualised storage management  
- NFVSOL(19)000431 SOL014 Structured input data for affinityOrAntiAffinityConstraints  
- Removed the duplicated section 7.3.1 |
| Oct 2019     | 0.8.0  | Implemented:  
- NFVSOL(19)000515r5 SOL014 Annex A: HOT Example: Allocate Virtualised Storage Resource operation  
- NFVSOL(19)000587r3 SOL014 Annex A: HOT Example: Allocate Virtualised Network Resource operation  
- Applied the style of Editor’s note  
- Fixed parameter type to start with a capital letter  
- Replaced “SOL014” with “the present document” |
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