Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; YAML data model specification for descriptor-based virtualised resource management

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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. The present document also focuses on data models used in the virtualised resource descriptors for the Virtualised Resources Change Notification interfaces and Virtualised Resources Fault Management interfaces. Other virtualised resource management interfaces, as well as data models for information specified in ETSI GS NFV-IFA 011 [i.5] and ETSI GS NFV-IFA 014 [i.4], are out of the scope of the present document.

2 References

2.1 Normative references

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 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification”.


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2.2 Informative references

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

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

[i.1] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".
[i.2] Heat Orchestration Template (HOT) specification.
[i.3] Openstack®-heat: "Orchestration Service APIs".

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[i.4] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Network Service Templates Specification".
[i.5] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

3.2 Symbols

Void.

3.3 Abbreviations

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

<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.
- Virtualised Resources Change Notification interfaces.
- Virtualised Resources Fault Management interfaces.

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

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

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

4.2 Definition of input and output parameters in YAML

4.2.1 Introduction

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

4.2.2 Input parameters syntax definition

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

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

Where applicable, then name of a structured input parameter ends with the string "Data" (e.g. subnetData).

A description of the syntax definition fields for declaring an input parameter follows. The fields shall comply with the provisions set out in Table 4.2.2-1.
### 4.2.2 Input parameters syntax definition

<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 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>enum</td>
<td>no</td>
<td>A set of enumerated values for a parameter to restrict the value. It is applicable to parameters of type string or number.</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>
<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 document uses the following simple data types as defined in Table 4.4.2-1. In order to accommodate tags with a broader meaning, the YAML specification recommends JSON schema [7] to be supported as an option. JSON schema is commonly supported by modern computing languages. Virtualised resource descriptors complying with the present document shall comply with the YAML v1.2 [4] and JSON schema [7] specifications.

<table>
<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 inlined definition.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>{parameter name} {object, array}</td>
<td>Type of the parameter</td>
<td></td>
</tr>
<tr>
<td>{description}</td>
<td>Description of the parameter</td>
<td></td>
</tr>
<tr>
<td>{attribute} {attribute type}</td>
<td>Type of {attribute}</td>
<td></td>
</tr>
<tr>
<td>{sub attribute} {sub attribute type in the attribute}</td>
<td>Type of {sub attribute}</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

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

5.1 Description

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

5.2 Parameters to be used as input

5.2.1 Parameter: reservationId

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

<table>
<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:

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

5.2.2 Parameter: resourceGroupId

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

<table>
<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:

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

5.2.3 Parameter: groupName

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

<table>
<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:

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

### 5.2.4 Parameter: `typeOfAffinityOrAntiAffinityConstraints`

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

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

<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:

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

### 5.2.5 Parameter: `stackName`

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

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>stackName</code></td>
<td>String</td>
<td>Name of the stack, given by the consumer.</td>
</tr>
</tbody>
</table>

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

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

### 5.2.6 Parameter: `startTime`

The parameter used when giving a date and time when the consumption of the resources starts shall follow the indications provided in Table 5.2.6-1.

**Table 5.2.6-1: Input data model for `startTime`**

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>startTime</code></td>
<td>String</td>
<td>Specifies when the consumption of the resources starts.</td>
</tr>
</tbody>
</table>

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

```json
startTime:
  type: string
  description: >
    Specifies when the consumption of the resources starts
  default: ""
```
5.2.7 Parameter: endTime

The parameter used when giving a date and time when the reservation ends shall follow the indications provided in Table 5.2.7-1.

Table 5.2.7-1: Input data model for endTime

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>endTime</td>
<td>String</td>
<td>Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation.</td>
</tr>
</tbody>
</table>

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

```json
endTime:
  type: string
description: >
  Specifies when the reservation ends (when the issuer of the request expects that the resources will no longer be needed) and used by the VIM to schedule the reservation
default: ""
```

5.2.8 Parameter: expiryTime

The parameter used when giving a date and time when the VIM can release the reservation in case no allocation request against this reservation was made shall follow the indications provided in Table 5.2.8-1.

Table 5.2.8-1: Input data model for expiryTime

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>expiryTime</td>
<td>String</td>
<td>Specifies when the VIM can release the reservation in case no allocation request against this reservation was made.</td>
</tr>
</tbody>
</table>

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

```json
expiryTime:
  type: string
description: >
  Specifies when the VIM can release the reservation in case no allocation request against this reservation was made
default: ""
```

5.3 Parameters to be used as output

None.

6 Data model for Virtualised Compute Management

6.1 Description

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

6.2 Parameters to be used as input

6.2.1 Parameter: computeName

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>computeName</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:

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

6.2.2 Parameter: computeFlavourId

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

Table 6.2.2-1: Input data model for computeFlavourId

<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:

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

6.2.3 Parameter: 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 6.2.3-1: Input data model for vcImageId

<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:

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

6.2.4 Parameter: locationConstraints

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

<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:

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

### 6.2.5 Parameter: affinityOrAntiAffinityConstraintsForCompute

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

Table 6.2.5-1: Input data model for affinityOrAntiAffinityConstraintsForCompute

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>affinityOrAntiAffinityConstraintsForCompute</td>
<td>Array of Object</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>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>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;. Defaults to &quot;NFVI-Node&quot; if absent.</td>
</tr>
<tr>
<td>affinityAntiAffinityResourceList</td>
<td>Object</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>Array of Object</td>
<td>List of identifiers of virtualised resources.</td>
</tr>
<tr>
<td>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 VirtualisedComputeResourceAffinityOrAntiAffinityConstraintsGroup and get groupId using the appropriate operation, Create Virtualised Compute Resource Affinity Or AntiAffinity Constraints Group, defined in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2].

CONDITION: If explicit resource lists for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, the affinityAntiAffinityResourceList shall be supported. If named resource groups for affinity/anti-affinity (see clause 8.4.8.1 in ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]) are supported, affinityAntiAffinityResourceGroup shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (also known as 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: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
```

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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 "inlined definition".

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>interfaceData</td>
<td>Array of Object</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>&gt;ipAddress</td>
<td>Array of Object</td>
<td>The virtual network interface can be configured with specific IP address(es)</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:

```
interfaceData: # VirtualInterfaceData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
description: >
The data of network interfaces which are specific to a Virtual Compute Resource instance
type: array
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
```
6.2.7 Parameter: computeId

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

Table 6.2.7-1: Input data model for computeId

<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:

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

6.2.8 Parameter: networkInterfaceNew

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

NOTE: “>” is used to specify an "inlined definition".

Table 6.2.8-1: Input data model for networkInterfaceNew

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkInterfaceNew</td>
<td>Array of Object</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>Array of String</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>Array 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>Array of Object</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:

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

### 6.2.9 Parameter: `networkInterfaceUpdate`

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

**NOTE:** ">" is used to specify an "inlined definition".

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>networkInterfaceUpdate</td>
<td>Array of Object</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>resourceId</td>
<td>String</td>
<td>Identifier of the virtual network interface.</td>
</tr>
<tr>
<td>ownerId</td>
<td>String</td>
<td>Identifier of the owner of the network interface (e.g. a virtualised compute resource).</td>
</tr>
<tr>
<td>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>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>ipAddress</td>
<td>Array 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>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>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>-typeConfiguration</td>
<td>Array 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>-macAddress</td>
<td>String</td>
<td>The MAC address of the virtual network interface.</td>
</tr>
<tr>
<td>-bandwidth</td>
<td>Number</td>
<td>The bandwidth of the virtual network interface (in Mbps).</td>
</tr>
<tr>
<td>-accelerationCapabilityForVirtualNetworkInterface</td>
<td>Array of String (see note)</td>
<td>Shows the acceleration capabilities utilized by the virtual network interface.</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>Array of Object</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: array
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
items:
type: object
required:
  - resourceId
  - ownerId
  - typeVirtualNic
  - macAddress
  - bandwidth
  - operationalState
properties:
  resourceId:
type: string
ownerId:
type: string
networkId:
type: string
networkPortId:
type: string
ipAddress:  # IpAddress IE in ETSI GS NFV-SOL 013
type: array
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
items:
type: string
typeVirtualNic:
type: string
typeConfiguration:
type: array
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
items:
type: string
macAddress:
type: string
bandwidth:
type: number
accelerationCapabilityForVirtualNetworkInterface:
type: array
minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
```
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 "inlined 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>object</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>array 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>object</td>
<td>The virtual memory of the virtualised compute.</td>
</tr>
<tr>
<td>&gt;&gt;virtualMemSize</td>
<td>number</td>
<td>Amount of virtual Memory (e.g. in MB).</td>
</tr>
<tr>
<td>&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;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>object</td>
<td>The virtual CPU(s) of the virtualised compute.</td>
</tr>
<tr>
<td>&gt;&gt;cpuArchitecture</td>
<td>string</td>
<td>CPU architecture type. Examples are x86, ARM®.</td>
</tr>
<tr>
<td>&gt;&gt;numVirtualCpu</td>
<td>number</td>
<td>Number of virtual CPUs.</td>
</tr>
<tr>
<td>&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;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;virtualCpuPinning</td>
<td>object</td>
<td>The virtual CPU pinning configuration for the virtualised compute resource.</td>
</tr>
<tr>
<td>&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>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;virtualCpuPinningRules</td>
<td>Array of Object</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>
<tr>
<td>&gt;storageAttributes</td>
<td>Array of Object</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;&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;virtualNetworkInterface</td>
<td>Array of Object</td>
<td>The virtual network interfaces of the virtualised compute.</td>
</tr>
<tr>
<td>&gt;&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;&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;accelerationCapabilityForVirtualNic</td>
<td>Array 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;&gt;metadata</td>
<td>Array of Object</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:

```json
flavour:
  description: >
    The flavour provides information about the particular memory, CPU and disk resources for virtualised compute resource to allocate
  type: object
  required:
    - flavourId
    - virtualMemory
      - virtualCpu
  properties:
    flavourId:
      type: string
    accelerationCapabilityForVirtualComputeFlavour:
      type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        type: string
    virtualMemory:
      type: object
      required:
        - virtualMemSize
      properties:
        virtualMemSize:
          type: number
    virtualMemOversubscriptionPolicy:
      type: string
```
numaEnabled:
  type: boolean
virtualCpu:
  type: object
  required:
    - numVirtualCpu
  properties:
    cpuArchitecture:
      type: string
    numVirtualCpu:
      type: number
    cpuClock:
      type: number
    virtualCpuOversubscriptionPolicy:
      type: string
    virtualCpuPinning:
      type: object
      required:
        - cpuPinningPolicy
      properties:
        cpuPinningPolicy:
          type: string
          enum:
            - static
            - dynamic
        cpuPinningRules:
          type: array
          minItems: 0  # lower bound of cardinality
          maxItems: N  # upper bound of cardinality
          items:
            type: object
            properties:
              cores:
                type: number
              sockets:
                type: number
              threads:
                type: number
storageAttributes:
  type: array
  minItems: 0  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  items:
    type: object
    properties:
      typeOfStorage:
        type: string
      sizeOfStorage:
        type: number
      type: number
virtualNetworkInterface:
  type: array
  minItems: 0  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  items:
    type: object
    properties:
      networkId:
        type: string
      networkPortId:
        type: string
      bandwidth:
        type: number
      accelerationCapabilityForVirtualNetworkInterface:
        type: array
        minItems: 0  # lower bound of cardinality
        maxItems: N  # upper bound of cardinality
        items:
          type: string
          metadata:
            description: >
              metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
          items:
            type: object
6.2.11 Parameter: userData

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

Table 6.2.11-1: Input data model for userData

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>userData</td>
<td>Object</td>
<td>Name of the parameter.</td>
</tr>
<tr>
<td>&gt;content</td>
<td>String</td>
<td>Contains the user data to customize the virtualised compute resource at boot-time.</td>
</tr>
<tr>
<td>&gt;method</td>
<td>String</td>
<td>Method used as transportation media to convey the content of the userData to the virtualised compute resource. Allowed values: CONFIG_DRIVE, CONFIG_DRIVE_MIME_multi-part.</td>
</tr>
<tr>
<td>&gt;certificateData</td>
<td>Object</td>
<td>Contains the additional user data to store certificate data for the VNF composed of (fully or partially) virtualised compute resource at boot-time. Shall be present if delegation-mode is used. Otherwise it shall be absent.</td>
</tr>
<tr>
<td>&gt;&gt;privateKey</td>
<td>String</td>
<td>Private key paired with signed public key. VNFM shall generate both private key and public key and set this attribute. See note.</td>
</tr>
<tr>
<td>&gt;&gt;certificateFile</td>
<td>String</td>
<td>Signed certificate including public key and certificate chain. See note.</td>
</tr>
<tr>
<td>&gt;&gt;keystoreFile</td>
<td>String</td>
<td>Keystore which includes the private key, signed certificate and certificate chain, e.g. pkcs#12, pfx. Credentials to read this file shall be provided to the VNF instance by outbound. See note.</td>
</tr>
<tr>
<td>&gt;&gt;certSubjectData</td>
<td>String</td>
<td>Subject to be signed.</td>
</tr>
<tr>
<td>&gt;&gt;certificateProfileName</td>
<td>String</td>
<td>Name of certificate profile to be signed.</td>
</tr>
</tbody>
</table>

NOTE: Either set of "privateKey" and "certificateFile" or "keystoreFile" but not both shall be present.

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

```
userData:
  description: >
    Contains user data to customize the virtualised compute resource at boot time
  type: object
  required:
    - content
  properties:
    content:
      type: string
    method:
      type: string
      enum:
      - CONFIG_DRIVE
      - CONFIG_DRIVE_MIME_multi-part
  certificateData:
    type: object
    properties:
      privateKey:
        type: string
      certificateFile:
        type: string
      keystoreFile:
        type: string
      certSubjectData:
        type: string
      certificateProfileName:
        type: string
    default: ""
```

6.2.12 Parameter: computePoolReservation

The parameter used when giving amount of compute resources to be reserved shall follow the indications provided in Table 6.2.12-1.
Table 6.2.12-1: Input data model for computePoolReservation

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>computePoolReservation</td>
<td>Object</td>
<td>Amount of compute resources to be reserved.</td>
</tr>
<tr>
<td>&gt;numCpuCores</td>
<td>Number</td>
<td>Number of CPU cores to be reserved.</td>
</tr>
<tr>
<td>&gt;numVcInstances</td>
<td>Number</td>
<td>Number of virtualised container instances to be reserved.</td>
</tr>
<tr>
<td>&gt;virtualMemSize</td>
<td>Number</td>
<td>Size of virtual memory to be reserved (in MB).</td>
</tr>
<tr>
<td>&gt;computeAttributes</td>
<td>Object</td>
<td>Information specifying additional attributes of the compute resource to be reserved.</td>
</tr>
<tr>
<td>&gt;&gt;accelerationCapabilityForVirtualComputePoolReservation</td>
<td>Array 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;cpuArchitecture</td>
<td>String</td>
<td>CPU architecture type. Examples are x86, ARM.</td>
</tr>
<tr>
<td>&gt;&gt;virtualCpuOversubscriptionPolicy</td>
<td>String</td>
<td>CPU core oversubscription policy in terms of virtual CPU cores to physical CPU cores/threads on the platform.</td>
</tr>
</tbody>
</table>

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

```
computePoolReservation:
  description: >
    Amount of compute resources to be reserved.
  type: object
  required:
    - numCpuCores
    - numVcInstances
    - virtualMemSize
  properties:
    numCpuCores:
      type: number
    numVcInstances:
      type: number
    virtualMemSize:
      type: number
  computeAttributes:
    type: object
    properties:
      accelerationCapabilityForVirtualComputePoolReservation:
        type: array
        minItems: 0  # lower bound of cardinality
        maxItems: N  # upper bound of cardinality
        items:
          type: string
        cpuArchitecture
          type: string
        virtualCpuOversubscriptionPolicy
          type: string
    default: ""
```

6.2.13 Parameter: minAmount

The parameter used when giving minimum amount of compute hosts to be reserved shall follow the indications provided in Table 6.2.13-1.

Table 6.2.13-1: Input data model for minAmount

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>minAmount</td>
<td>Number</td>
<td>Minimum amount of compute hosts to be reserved.</td>
</tr>
</tbody>
</table>

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

```
minAmount:
  type: number
  description: >
    Minimum amount of compute hosts to be reserved
```
6.2.14 Parameter: maxAmount

The parameter used when giving maximum amount of compute hosts to be reserved shall follow the indications provided in Table 6.2.14-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxAmount</td>
<td>Number</td>
<td>Maximum amount of compute hosts to be reserved.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxAmount</td>
<td>Number</td>
<td>Maximum amount of compute hosts to be reserved.</td>
</tr>
</tbody>
</table>

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

```json
maxAmount:
  type: number
  description: >
    Maximum amount of compute hosts to be reserved
```

6.2.15 Parameter: computeHostProperties

The parameter used when giving set of properties that specify the capabilities associated to the compute hosts to be reserved shall follow the indications provided in Table 6.2.15-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>computeHostProperties</td>
<td>Array</td>
<td>Set of properties that specify the capabilities associated to the compute hosts to be reserved. Allowed value: ssd, dpdk, sriov, gpu, fpga, cpu_pin, numa.</td>
</tr>
</tbody>
</table>

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

```json
computeHostProperties:
  description: >
    Set of properties that specify the capabilities associated to the compute hosts to be reserved
  type: array
  minItems: 1 # lower bound of cardinality
  maxItems: N # upper bound of cardinality
  items:
    type: string
    enum:
    - ssd
    - dpdk
    - sriov
    - gpu
    - fpga
    - cpu_pin
    - numa
```

6.2.16 Parameter: callbackUriForComputeHostCapacityChangeNotify

The parameter used when providing a URI of the endpoint to send compute host capacity change notifications to in a subscribe operation shall follow the indications provided in Table 6.2.16-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>callbackUriForComputeHostCapacityChangeNotify</td>
<td>String</td>
<td>The URI of the endpoint to send the compute host capacity change notification to.</td>
</tr>
</tbody>
</table>
The syntax of the `callbackUriForComputeHostCapacityChangeNotify` shall comply with the following definition:

```json
callbackUriForComputeHostCapacityChangeNotify:
  description: >
    The URI of the endpoint to send the compute host capacity change notification to.
  type: string
  default: ""
```

### 6.2.17 Parameter: inputFilterForComputeHostCapacityChangeNotify

The parameter used when selecting compute host capacity change notifications to in a subscribe operation shall follow the indications provided in Table 6.2.17-1.

**Table 6.2.17-1: Input data model for inputFilterForComputeHostCapacityChangeNotify**

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>inputFilterForComputeHostCapacityChangeNotify</td>
<td>Object</td>
<td>Input filter for selecting compute host capacity change notifications.</td>
</tr>
<tr>
<td>&gt;zoneId</td>
<td>String</td>
<td>Identifier of the resource zone for which the capacity change notifications are requested. When not specified the total capacity managed by the VIM instance will be notified.</td>
</tr>
<tr>
<td>&gt;threshold</td>
<td>Object</td>
<td>When specified this parameter indicates a capacity value which, once crossed, will trigger a notification. When not specified, notifications are issued at every change (see note).</td>
</tr>
<tr>
<td>&gt;&gt;resourceType</td>
<td>String</td>
<td>Resource type of capacity to check. Allowed value: cpu, memory, disk.</td>
</tr>
<tr>
<td>&gt;&gt;capacityInformationType</td>
<td>String</td>
<td>Information type of capacity to check. Allowed value: available, total, reserved, allocated.</td>
</tr>
<tr>
<td>&gt;&gt;valueOfThreshold</td>
<td>Number</td>
<td>Value to check.</td>
</tr>
<tr>
<td>&gt;&gt;crossingDirection</td>
<td>String</td>
<td>Direction to check. Allowed value: UP, DOWN. In case of &quot;UP&quot;, notification is triggered when the value is greater than &quot;valueOfThreshold&quot;. In case of &quot;DOWN&quot;, notification is triggered when the value is less than &quot;valueOfThreshold&quot;.</td>
</tr>
<tr>
<td>&gt;capacityInformationType</td>
<td>Array of String</td>
<td>Input parameter for selecting which capacity information the subscription refers to. When not present, all four values are requested. Allowed value: available, total, reserved, allocated.</td>
</tr>
</tbody>
</table>

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

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

```json
inputFilterForComputeHostCapacityChangeNotify:
  description: >
    Input filter for selecting compute host capacity change notifications.
  type: object
  properties: 
    zoneId:
      type: string
    threshold:
      type: object
      properties:
        resourceType:
          type: string
          enum:
            - cpu
            - memory
            - disk
        capacityInformationType:
          type: string
          enum:
            - available
            - total
            - reserved
            - allocated
        valueOfThreshold:
          type: number
        crossingDirection:
          type: string
          enum:
```

ETSI
6.2.18 Parameter: changeIdForComputeHostCapacityChangeNotify

The parameter used when providing an identifier of the change in the compute host capacity change notification shall follow the indications provided in Table 6.2.18-1.

Table 6.2.18-1: Input data model for changeIdForComputeHostCapacityChangeNotify

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>changeIdForComputeHostCapacityChangeNotify</td>
<td>String</td>
<td>Identifies a change in the capacity.</td>
</tr>
</tbody>
</table>

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

changeIdForComputeHostCapacityChangeNotify:
  description: >
  Identifies a change in the capacity.
  type: string
  default: ""

6.2.19 Parameter: zoneIdForComputeHostCapacityChangeNotify

The parameter used when providing an identifier of the resource zone in the compute host capacity change notification shall follow the indications provided in Table 6.2.19-1.

Table 6.2.19-1: Input data model for zoneIdForComputeHostCapacityChangeNotify

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>zoneIdForComputeHostCapacityChangeNotify</td>
<td>String</td>
<td>Identifies the resource zone for which the capacity has changed. When omitted the total capacity managed by the VIM is reported.</td>
</tr>
</tbody>
</table>

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

zoneIdForComputeHostCapacityChangeNotify:
  description: >
  Identifies the resource zone for which the capacity has changed. When omitted the total capacity managed by the VIM is reported.
  type: string
  default: ""

6.2.20 Parameter: resourceDescriptorForComputeHostCapacityChangeNotify

The parameter used when providing a resource type in the compute host capacity change notification shall follow the indications provided in Table 6.2.20-1.

Table 6.2.20-1: Input data model for resourceDescriptorForComputeHostCapacityChangeNotify

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>resourceDescriptorForComputeHostCapacityChangeNotify</td>
<td>String</td>
<td>Resource type for which the capacity is changed. Allowed value: cpu, memory, disk.</td>
</tr>
</tbody>
</table>
The syntax of the resourceDescriptorForComputeHostCapacityChangeNotify shall comply with the following definition:

```
resourceDescriptorForComputeHostCapacityChangeNotify:
  description: >
    Resource type for which the capacity is changed.
  type: string
  enum:
    - cpu
    - memory
    - disk
```

### 6.2.21 Parameter: capacityInformationForComputeHostCapacityChangeNotify

The parameter used when providing a resource type in the compute host capacity change notification shall follow the indications provided in Table 6.2.21-1.

**Table 6.2.21-1: Input data model for capacityInformationForComputeHostCapacityChangeNotify**

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>capacityInformationForComputeHostCapacityChangeNotify</td>
<td>Object</td>
<td>Available, total, reserved and/or allocated/used capacity of the Resource Zone, or the available, total, reserved and/or allocated/used capacity of the VIM in case the zoneIdForComputeHostCapacityChangeNotify is omitted.</td>
</tr>
<tr>
<td>&gt; availableCapacity</td>
<td>Number</td>
<td>Free capacity available for allocation and reservation.</td>
</tr>
<tr>
<td>&gt; reservedCapacity</td>
<td>Number</td>
<td>Reserved capacity.</td>
</tr>
<tr>
<td>&gt; totalCapacity</td>
<td>Number</td>
<td>The total capacity is usually specified as a fixed capacity without variations in time (see note 1).</td>
</tr>
<tr>
<td>&gt; allocatedCapacity</td>
<td>Number</td>
<td>The allocated capacity is usually specified as the current allocated capacity (see note 2).</td>
</tr>
</tbody>
</table>

**NOTE 1:** VIM does not keep schedules for equipment build-out.

**NOTE 2:** The allocated capacity is given without time variation since the VIM does not have a schedule of future allocations and de-allocations.

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

```
capacityInformationForComputeHostCapacityChangeNotify:
  description: >
    Available, total, reserved and/or allocated/used capacity of the Resource Zone, or the available, total, reserved and/or allocated/used capacity of the VIM in case the zoneIdForComputeHostCapacityChangeNotify is omitted.
  type: object
  properties:
    availableCapacity:
      type: number
    reservedCapacity:
      type: number
    totalCapacity:
      type: number
    allocatedCapacity:
      type: number
```

### 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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvComputeInfo</td>
<td>Object</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>Array 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;virtualCpu</td>
<td>Object</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®.</td>
</tr>
<tr>
<td>See note.</td>
<td></td>
<td></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>Object</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 “static” or “dynamic”. In case of “static” the virtual CPU cores are requested to be allocated to logical CPU cores according to the rules defined in virtualCpuPinningRules. In case of “dynamic” the allocation of virtual CPU cores to logical CPU cores is decided by the VIM (e.g. SMT (Simultaneous Multi-Threading) requirements). Allowed value: static, dynamic.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;cpuPinningRules</td>
<td>Array of Object</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>Object</td>
<td>The virtual memory of the compute as VirtualMemory.</td>
</tr>
<tr>
<td>&gt;virtualMemSize</td>
<td>Number</td>
<td>Amount of virtual memory in byte.</td>
</tr>
<tr>
<td>&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;&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>&gt;virtualNetworkInterface</td>
<td>Array of Object</td>
<td>Element with information of the instantiated virtual network interfaces of the compute resource.</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 (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;networkPortId</td>
<td>String (Reference to VirtualNetwork Port)</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>Array 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>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;typeConfiguration</td>
<td>Array 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;&gt;macAddress</td>
<td>String</td>
<td>The MAC address of the virtual network interface.</td>
</tr>
<tr>
<td>&gt;&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>Array 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;&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;&gt;metadata</td>
<td>Array of Object</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;&gt;virtualDisks</td>
<td>Array of Object</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;&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;&gt;zoneId</td>
<td>String</td>
<td>It identifies the resource zone where the virtual storage resources have been allocated.</td>
</tr>
<tr>
<td>&gt;&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;&gt;operationalState</td>
<td>String</td>
<td>Operational state of the resource. Allowed value: enabled, disabled.</td>
</tr>
<tr>
<td>&gt;&gt;&gt;metadata</td>
<td>Array of Object</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;zoneId</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>Array of Object</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:

```json
nfVComputeInfo:
  description: >
    Element containing information of the newly instantiated virtualised compute resource.
  type: object
  required:
    - computeId
    - flavourId
    - virtualCpu
```
- `virtualMemory`  
- `virtualDisks`  
- `hostId`  
- `operationalState`  

**properties:**

- `computeId`:
  - description: > Identifier of the virtualised compute resource.
  - type: string
- `computeName`:
  - description: > Name of the virtualised compute resource.
  - type: string
- `flavourId`:
  - description: > Identifier of the given compute flavour used to instantiate this virtual compute.
  - type: string
- `accelerationCapabilityForVirtualComputeFlavour`:
  - type: array
    - minItems: 0  # lower bound of cardinality
    - maxItems: N  # upper bound of cardinality
  - items:
    - type: string
- `virtualCpu`:
  - description: > The virtual CPU(s) of the virtualised compute.
  - type: object
    properties:
    - `cpuArchitecture`:
      - description: > CPU architecture type.
      - type: string
    - `numVirtualCpu`:
      - description: > Number of virtual CPUs.
      - type: number
    - `cpuClock`:
      - description: > Minimum CPU clock rate in Hz available for the virtualised CPU resources.
      - type: number
    - `virtualCpuOversubscriptionPolicy`:
      - description: > The CPU core oversubscription policy, e.g. the relation of virtual CPU cores to physical CPU cores/threads. The cardinality can be 0 if no policy has been defined during the allocation request.
      - type: string
    - `virtualCpuPinning`:
      - description: > The virtual CPU pinning configuration for the virtualised compute resource.
      - type: object
      required:
      - cpuPinningPolicy
    properties:
    - `cpuPinningPolicy`:
      - type: string
      enum:
      - static
      - dynamic
    - `cpuPinningRules`:
      - type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
    - `virtualMemory`:
      - description: > The virtual memory of the compute.
      - type: object
properties:
  virtualMemSize:
    description: >
      Amount of virtual memory in byte.
    type: number
  virtualMemOversubscriptionPolicy:
    description: >
      The memory core oversubscription policy in terms of virtual memory
to physical memory on the platform. The cardinality can be 0 if
no policy has been defined during the allocation request.
    type: string
  numaEnabled:
    description: >
      It specifies the memory allocation to be cognisant of
the relevant process/core allocation.
    type: boolean
  virtualNetworkInterface:
    description: >
        Element with information of the instantiated virtual network
interfaces of the compute resource.
    resourceId:
      type: string
    ownerId:
      type: string
    networkId:
      type: string
    networkPortId:
      type: string
    ipAddress:  # IpAddress IE in ETSI GS NFV-SOL 013
      type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # maximum value of cardinality
      items:
        type: string
    typeVirtualNic:
      type: string
    typeConfiguration:
      type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        type: string
    macAddress:
      type: string
    bandwidth:
      type: number
    accelerationCapabilityForVirtualNetworkInterface":
      type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        type: string
    operationalState:
      type: string
      enum:
        - enabled
        - disabled
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
values.
      type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # maximum value of cardinality
      items:
        type: object
    virtualDisks:
      description: >
        Element with information of the virtualised storage resources
(volumes, ephemeral) that are attached to the compute resource.
      type: array
      minItems: 1  # lower bound of cardinality
      maxItems: N  # maximum value of cardinality
      items:
        type: object
        required:
          - storageId
          - flavourId
- `typeOfStorage`
- `sizeOfStorage`
- `operationalState`

**properties:**

- `storageId`:
  - description: Identifier of the virtualised storage resource
  - type: string

- `storageName`:
  - description: Name of the virtualised storage resource
  - type: string

- `flavourId`:
  - description: Identifier of the storage flavour used to instantiate this virtual storage
  - type: string

- `typeOfStorage`:
  - description: Type of virtualised storage resource
  - type: string

- `sizeOfStorage`:
  - description: Size of virtualised storage resource
  - type: number

- `rdmaEnabled`:
  - description: Indicates if the storage supports RDMA.
  - type: boolean

- `ownerId`:
  - description: Identifier of the virtualised resource that owns and uses such a virtualised storage resource. The value can be NULL if the virtualised storage is not attached yet to any other resource
  - type: string

- `zoneId`:
  - description: It identifies the resource zone where the virtual storage resources have been allocated
  - type: string

- `hostId`:
  - description: Identifier of the host where the virtualised storage resource is allocated.
  - type: string

- `operationalState`:
  - description: Operational state of the resource.
  - type: string
    - enum:
      - enabled
      - disabled

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

- `vcImageId`:
  - description: Identifier of the virtualisation container software image.
  - type: string

- `zoneId`:
  - description: If present, it identifies the resource zone where the virtual compute resources have been allocated.
  - type: string

- `hostId`:
  - description: Identifier of the host the virtualised compute resource is allocated on.
  - type: string

- `operationalState`:
  - description: Operational state of the compute resource.
  - type: string
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>
<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:

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

7.2.2 Parameter: networkResourceType

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

<table>
<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;, &quot;network-port&quot; or &quot;routing-resource&quot;.</td>
</tr>
</tbody>
</table>

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

networkResourceType:
  description: >
    The network data information applicable to the particular virtual network resource of the virtualised resource management operation
type: string
enum:
  - network
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>typeNetworkData</td>
<td>Object</td>
<td>The network data provides information about the particular virtual network</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>networkType, it corresponds to the vlan identifier; and for a &quot;gre&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>networkType, this corresponds to a gre key.</td>
</tr>
<tr>
<td>&gt;networkQos</td>
<td>Array of Object</td>
<td>Element providing information about Quality of Service attributes that the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for this network. These criteria might be a list of authorized consumers.</td>
</tr>
<tr>
<td>&gt;layer3Attributes</td>
<td>Array of Object</td>
<td>The attribute list allows setting up a network providing defined layer 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>connectivity.</td>
</tr>
<tr>
<td>&gt;&gt;networkId</td>
<td>String</td>
<td>The identifier of the virtualised network that the virtualised sub-network</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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;isDhcpEnabled</td>
<td>Boolean</td>
<td>True when DHCP is to be enabled for this network/subnetwork, or false</td>
</tr>
<tr>
<td></td>
<td></td>
<td>otherwise.</td>
</tr>
<tr>
<td>&gt;&gt;addressPool</td>
<td>Array of Object</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.</td>
</tr>
<tr>
<td>&gt;&gt;metadata</td>
<td>Array of Object</td>
<td>List of metadata key-value pairs used by the consumer to associate meaningful</td>
</tr>
<tr>
<td></td>
<td></td>
<td>metadata to the related virtualised resource. Metadata is optional. It is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>out of scope to detail what are the sub-keys and possible values.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Array of Object</td>
<td>List of metadata key-value pairs used by the consumer to associate meaningful</td>
</tr>
<tr>
<td></td>
<td></td>
<td>metadata to the related virtualised resource. Metadata is optional. It is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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:

typeNetworkData:
    description: >
    The network data information about the particular virtual network resource of the virtualised resource management operation
required:
  - bandwidth
  type: object  # VirtualNetworkData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  properties:
    bandwidth:
      type: number
    networkType:
      type: string
    segmentType:
      type: string
    networkQos:
      type: array  # lower bound of cardinality
      minItems: 0  # upper bound of cardinality
      maxItems: N  # lower bound of cardinality
      items:
        type: object
        properties:
          qosName:
            type: string  # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
          qosValue:
            type: number
          isShared:
            type: boolean
          sharingCriteria:
            type: string
          layer3Attributes:
            type: array  # lower bound of cardinality
            maxItems: N  # upper bound of cardinality
            items:
              type: object
              properties:
                networkId:
                  type: string
                ipVersion:
                  type: string
                enum:
                  - IPv4
                  - IPv6
                gatewayIp:
                  type: string
                cidr:
                  type: string
                isDhcpEnabled:
                  type: boolean
                addressPool:
                  type: array  # lower bound of cardinality
                  maxItems: N  # upper bound of cardinality
                  items:
                    type: object
                    properties:
                      start:
                        type: string
                      end:
                        type: string
                metadata:
                  description: >
                    metadata is optional. It is out of scope to detail what are the sub-keys and
                    possible values.
                    type: array
                    maxItems: N
                    items:
                      type: object
                      metadata:
                        description: >
                          metadata is optional. It is out of scope to detail what are the sub-keys and
                          possible values.
                        type: array
                        maxItems: N
                        items:
                          type: object
                          default: ""
7.2.4 Parameter: typeNetworkPortData

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>typeNetworkPortData</td>
<td>Object</td>
<td>The network port data provides information about the particular 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.</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 “vlan”, it corresponds to the vlan identifier; and for a “gre”, 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>Array of Object</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:

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

7.2.5 Parameter: typeSubnetData

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>typeSubnetData</td>
<td>Object</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>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</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>Array of Object</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>Array of Object</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: object  # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006  
  properties:  
    networkId:  
      type: string  
    ipVersion:  
      type: string  
      enum:  
        - IPv4  
        - IPv6  
    gatewayIp:  
      type: string  
    cidr:  
      type: string  
    isDhcpEnabled:  
      type: boolean  
    addressPool:  
      type: array  
      minItems: 0  # lower bound of cardinality  
      maxItems: N  # upper bound of cardinality  
      items:  
        type: object  
        properties:  
          start:  
            type: string  
          end:  
            type: string  
        metadata:  
          description: > 
          metadata is optional. It is out of scope to detail what are the sub-keys and possible values.  
          type: array  
          minItems: 0  # lower bound of cardinality  
          maxItems: N  # upper bound of cardinality  
          items:  
            type: object  
            default: "  
```

7.2.6 Parameter: affinityOrAntiAffinityConstraintsForNetwork

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>affinityOrAntiAffinityConstraintsForNetwork</td>
<td>Array of Object</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. Allowed_values: virtual-switch, router, physical-NIC, physical-network, NFVI-Node.</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResourceList</td>
<td>Array</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>Array of String</td>
<td>List of identifiers of virtualised resources.</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 ETSI GS NFV-IFA 006 [2]) are supported, affinityAntiAffinityResourceGroup shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (also known as 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: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        required:
          - typeOfAffinityOrAntiAffinityConstraintForNetwork
definition:
  type: object
  properties:
    typeOfAffinityOrAntiAffinityConstraintForNetwork:
      type: string
      enum:
        - affinity
        - anti-affinity
    scopeOfAffinityOrAntiAffinityConstraintForNetwork:
      type: string
      enum:
        - virtual-switch
        - router
        - physical-NIC
        - physical-network
        - NFVI-Node
default: NFVI-Node
    affinityAntiAffinityResourceList:
      required:
        - resource
```
type: object
properties:
  resource:
    type: array
    minItems: 1  # lower bound of cardinality
    maxItems: N  # upper bound of cardinality
    items:
      type: string
- type: array
  minItems: 0  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  items:
    required:
    - typeOfAffinityOrAntiAffinityConstraintForNetwork
type: object
properties:
  typeOfAffinityOrAntiAffinityConstraintForNetwork:
    type: string
    enum:
    - affinity
    - anti-affinity
  scopeOfAffinityOrAntiAffinityConstraintForNetwork:
    type: string
    enum:
    - virtual-switch
    - router
    - physical-NIC
    - physical-network
    - NFVI-Node
default: NFVI-Node
  affinityAntiAffinityResourceGroup:
    type: string
default: ""

7.2.7 Void

7.2.8 Parameter: locationConstraintsForNetwork

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

<table>
<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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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: string
default: ""
```

7.2.9 Parameter: queryNetworkFilter

The parameters used when invoking the operation shall follow the indications provided in Table 7.2.9-1.
### Table 7.2.9-1: Input data model for `queryNetworkFilter`

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>queryNetworkFilter</code></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:

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

type: Not specified
default: ""
```

#### 7.2.10 Parameter: `networkResourceId`

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

### Table 7.2.10-1: Input data model for `networkResourceId`

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>networkResourceId</code></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:

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

#### 7.2.11 Parameter: `updateNetworkData`

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

### Table 7.2.11-1: Input data model for `updateNetworkData`

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>updateNetworkData</code></td>
<td>Object</td>
<td>Network data information about the particular virtual network resource.</td>
</tr>
<tr>
<td><code>bandwidth</code></td>
<td>Number</td>
<td>Minimum network bandwidth (in Mbps).</td>
</tr>
<tr>
<td><code>networkType</code></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><code>segmentType</code></td>
<td>String</td>
<td>The isolated segment for the virtualised network. For instance, for a &quot;vlan&quot; <code>networkType</code>, it corresponds to the vlan identifier; and for a &quot;gre&quot; <code>networkType</code>, this corresponds to a gre key.</td>
</tr>
<tr>
<td><code>networkQos</code></td>
<td>Array of Object</td>
<td>Element providing information about Quality of Service attributes that the network is requested to support.</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/constraint for this network. These criteria might be a list of authorized consumers.</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>&gt;&gt;layer3Attributes</td>
<td>Array of Object</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>Array of Object</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>
<tr>
<td>&gt;&gt;metadata</td>
<td>Array of Object</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
  required:
    - bandwidth
  type: object  # VirtualNetworkData in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
  properties:
    bandwidth:
      type: number
    networkType:
      type: string
    segmentType:
      type: string
    networkQos:
      type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # maximum value of cardinality
      items:
        type: object
        required:
          - qosName
          - qosValue
        properties:
          qosName:
            type: string
          qosValue:
            type: number
    isShared:
      type: boolean
    sharingCriteria:
      type: string
    layer3Attributes:  # NetworkSubnetData IE in ETSI GS NFV-IFA 005 and ETSI GS NFV-IFA 006
      type: array
      items:
        type: object
        properties:
          networkId:
            type: string
          ipVersion:
```
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>Object</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>Array of Object</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>Array of Object</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:

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

### 7.2.13 Parameter: updateNetworkPort

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>updateNetworkPort</td>
<td>Object</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>Array of Object</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:

```yaml
updateNetworkPort:
  description: >
    The network port data information of a particular network port
  required:
    - portType
  properties:
    portType:
      type: string
    networkId:
      type: string
    segmentId:
      type: string
    bandwidth:
      type: number
    metadata:
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible
        values.
      type: array
      minItems: 0
      maxItems: N
      items:
        type: object
        default: ""
```

7.2.14 Parameter: `scopeOfAffinityOrAntiAffinityConstraintForNetwork`

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>scopeOfAffinityOrAntiAffinityConstraintForNetwork</code></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:

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

7.2.15 Parameter: `typeRoutingResourceData`

The parameter used when setting the routing resource data provides information about the particular routing resource shall follow the indications in Table 7.2.15-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>typeRoutingResourceData</code></td>
<td>Object</td>
<td>The routing resource data provides information about the particular routing resource.</td>
</tr>
<tr>
<td><code>$name</code></td>
<td>String</td>
<td>Name of the routing resource.</td>
</tr>
<tr>
<td><code>$distributed</code></td>
<td>Boolean</td>
<td>If present, it specifies whether the routing resource is requested to be distributed.</td>
</tr>
<tr>
<td><code>$operationalState</code></td>
<td>String</td>
<td>Operational state of the routing resource. Possible values are: &quot;enabled&quot;, &quot;disabled&quot;.</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>ha</td>
<td>Boolean</td>
<td>If present, it specifies whether the routing resource is requested to have high availability.</td>
</tr>
<tr>
<td>zoneId</td>
<td>String</td>
<td>If present, it identifies the Resource Zone where the routing resource is requested to be allocated.</td>
</tr>
<tr>
<td>subnet</td>
<td>Array of String</td>
<td>Identifier of the subnet(s) that the routing resource is associated with.</td>
</tr>
<tr>
<td>routingSet</td>
<td>Array of Object</td>
<td>Specifies the information used to set the routing resource.</td>
</tr>
<tr>
<td>&gt;&gt;destination</td>
<td>String</td>
<td>The destination address of one route.</td>
</tr>
<tr>
<td>&gt;&gt;nexthop</td>
<td>String</td>
<td>The nexthop IP address of one route.</td>
</tr>
<tr>
<td>&gt;&gt;ipVersion</td>
<td>String</td>
<td>Specifies IP version of the destination and nexthop addresses. Possible values are: &quot;IPv4&quot;, &quot;IPv6&quot;.</td>
</tr>
<tr>
<td>metadata</td>
<td>Array of Object</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 typeRoutingResourceData shall comply with the following definition:

```json
typeRoutingResourceData:
  description: >
    The routing resource data provides information about the particular routing resource.
  required:
    - name
    - operationalState
  type: object
  properties:
    name:
      type: string
distributed:
  type: Boolean
operationalState:
  type: string
enum:
  - enabled
  - disabled
ha:
  type: Boolean
zoneId:
  type: string
subnet:
  type: array
  minItems: 1  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  items:
    type: string
routingSet:
  type: array
  minItems: 1  # lower bound of cardinality
  maxItems: N  # upper bound of cardinality
  items:
    required:
      - destination
      - nexthop
      - ipVersion
    type: object
    properties:
      destination:
        type: string
      nexthop:
        type: string
      ipVersion:
        type: string
        enum:
          - IPv4
          - IPv6
  metadata:
    type: array
  description: >
    metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
```

minItems: 0  # lower bound of cardinality
maxItems: N  # upper bound of cardinality
items:
7.2.16 Parameter: mirroringJobName

The parameter used when providing a name of a data flow mirroring job shall follow the indications provided in Table 7.2.16-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mirroringJobName</td>
<td>String</td>
<td>Name of Data Flow Mirroring Job.</td>
</tr>
</tbody>
</table>

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

```json
mirroringJobName:
  description: >
  Name of Data Flow Mirroring Job
  type: string
  default: ""
```

7.2.17 Parameter: descriptionForDataFlowMirroringJob

The parameter used when providing a description of a data flow mirroring job shall follow the indications provided in Table 7.2.17-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>descriptionForDataFlowMirroringJob</td>
<td>String</td>
<td>Information description of Data Flow Mirroring Job.</td>
</tr>
</tbody>
</table>

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

```json
descriptionForDataFlowMirroringJob:
  description: >
  Information description of Data Flow Mirroring Job
  type: string
  default: ""
```

7.2.18 Parameter: collectorDetails

The parameter used when providing information about where the mirrored flow is to be delivered shall follow the indications provided in Table 7.2.18-1.

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>collectorDetails</td>
<td>Object</td>
<td>Information about where the mirrored flow is to be delivered.</td>
</tr>
<tr>
<td>networkPortId</td>
<td>String</td>
<td>Identifier of the collector network port managed by VIM where the mirrored flow is to be delivered.</td>
</tr>
</tbody>
</table>

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

```json
collectorDetails:
  description: >
  Information about where the mirrored flow is to be delivered
  type: object
  required:
    - networkPortId
  properties:
    networkPortId:
      type: string
      default: ""
```
7.2.19 Parameter: dataFlowDetails

The parameter used when providing information about the data flows that need to be mirrored shall follow the indications provided in Table 7.2.19-1.

Table 7.2.19-1: Input data model for dataFlowDetails

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dataFlowDetails</td>
<td>Object</td>
<td>Information about the data flows that need to be mirrored.</td>
</tr>
<tr>
<td>-&gt;networkPortId</td>
<td>String</td>
<td>Identifier of the network port which acts as the mirroring point of the data flow to be mirrored.</td>
</tr>
<tr>
<td>-&gt;direction</td>
<td>String</td>
<td>The direction of the data flow that are requested to be mirrored. Possible values are: &quot;in&quot;, &quot;out&quot;, &quot;both&quot;.</td>
</tr>
<tr>
<td>-&gt;targetIpAddress</td>
<td>String</td>
<td>If present, only the data flow to or/and from the target IP address shall be mirrored.</td>
</tr>
</tbody>
</table>

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

```json
dataFlowDetails:  
  description: >  
    Information about the data flows that need to be mirrored  
  type: object  
  required:  
    - networkPortId  
  properties:  
    networkPortId:  
      type: string  
    direction:  
      type: string  
      enum:  
        - in  
        - out  
        - both  
    targetIpAddress:  
      type: string  
      default: ""
```

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>Object</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>Not specified (see note)</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;i3-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>
</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><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>Array of Object</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>Array of Object</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 Allocate Virtualised Network Resource operation output parameters, ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2], networkPort attribute is specified with duplication. The data model is specified as an attribute in `networkData` parameter as well as `networkPortData` as a parameter in the operation.

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

```json
nfvNetworkInfo:
  type: object
  required:
    - networkResourceId
    - bandwidth
    - networkType
    - isShared
    - operationalState
  properties:
    networkResourceId:
      type: string
    networkResourceName:
      type: string
    subnet:
      type: string
    bandwidth:
      type: number
    networkType:
      type: string
    segmentType:
      type: string
    networkQoS:
      type: array
      minItems: 0 # lower bound of cardinality
      maxItems: N # maximum value of cardinality
      items:
        - type: object
          properties:
            qosName:
              type: string
            qosValue:
              type: number
    isShared:
      type: boolean
    sharingCriteria:
      type: string
    zoneId:
      type: string
    operationalState:
      type: string
  description: >
    Operational state of the compute resource.
```
### 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>Object</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>&gt;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>Array of Object</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>&gt;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>Array of Object</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:

```json
nfvSubnetInfo:
  type: object
  required:
    - resourceId
    - ipVersion
    - gatewayIp
    - cidr
    - isDhcpEnabled
    - operationalState
  object:
    resourceId:
      type: string
```
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>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvNetworkPortInfo</td>
<td>Object</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>
<tr>
<td>&gt;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>&gt;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>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>metadata</td>
<td>Array of Object</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: object
  required:
    - resourceId
    - portType
    - operationalState
  properties:
    resourceId:
      type: string
    attachedResourceId:
      type: string
    portType:
      type: string
      enum:
        - access ports
        - trunk ports
    segmentId:
      type: string
    bandwidth:
      type: number
    operationalState:
      type: string
      enum:
        - enabled
        - disabled
    metadata:
      type: array
      description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        type: object
```

### 7.3.4 Parameter: nfvRoutingResourceInfo

The parameter is used when returning information for a routing resource, and its output data model shall follow the indications provided in Table 7.3.4-1. This parameter maps to the “routingResourceData” 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>nfvRoutingResourceInfo</td>
<td>Object</td>
<td>If routing resource types are created satisfactorily, it contains the data relative to the allocated routing resource.</td>
</tr>
<tr>
<td>&gt;resourceId</td>
<td>String</td>
<td>Identifier of the routing resource.</td>
</tr>
<tr>
<td>&gt;name</td>
<td>String</td>
<td>Name of the routing resource.</td>
</tr>
<tr>
<td>&gt;subnet</td>
<td>Array of String</td>
<td>References the network subnet(s).</td>
</tr>
<tr>
<td>&gt;operationalState</td>
<td>String</td>
<td>Operational state of the routing resource. Possible values are: &quot;enabled&quot;, &quot;disabled&quot;.</td>
</tr>
<tr>
<td>&gt;ha</td>
<td>Boolean</td>
<td>Specifies whether the routing resource has high availability. It shall be present when support for high availability is enabled.</td>
</tr>
<tr>
<td>&gt;zoneld</td>
<td>String</td>
<td>If present, it identifies the Resource Zone where the routing resource has been allocated.</td>
</tr>
<tr>
<td>&gt;distributed</td>
<td>Boolean</td>
<td>Specifies whether the routing resource is distributed. It shall be present when support for distributed routing resource is enabled.</td>
</tr>
<tr>
<td>&gt;routingSet</td>
<td>Array of Object</td>
<td>Specifies the information used to set the routing resource.</td>
</tr>
<tr>
<td>&gt;&gt;destination</td>
<td>String</td>
<td>The destination address of one route.</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><strong>nexthop</strong></td>
<td>String</td>
<td>The nexthop IP address of one route.</td>
</tr>
<tr>
<td><strong>ipVersion</strong></td>
<td>String</td>
<td>Specifies IP version of the destination and nexthop addresses. Possible values are: &quot;IPv4&quot;, &quot;IPv6&quot;.</td>
</tr>
<tr>
<td><strong>metadata</strong></td>
<td>Array of Object</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 nfvRoutingResourceInfo shall comply with the following definition:

```json
nfvRoutingResourceInfo:
  type: object
  required:
  - resourceId
  - name
  - operationalState
  properties:
    resourceId:
      type: string
    name:
      type: string
    subnet:
      type: array
      minItems: 1  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        type: string
    operationalState:
      type: string
      enum:
      - enabled
      - disabled
    ha:
      type: Boolean
    zoneId:
      type: string
    distributed:
      type: Boolean
  routingSet:
    type: array
    minItems: 1  # lower bound of cardinality
    maxItems: N  # upper bound of cardinality
    items:
      required:
      - destination
      - nexthop
      - ipVersion
      type: object
      properties:
        destination:
          type: string
        nexthop:
          type: string
        ipVersion:
          type: string
          enum:
          - IPv4
          - IPv6
      metadata:
        type: array
        description: >
        metadata is optional. It is out of scope to detail what are the sub-keys and possible values.
        minItems: 0  # lower bound of cardinality
        maxItems: N  # upper bound of cardinality
        items:
          type: object
```
7.3.5 Parameter: nfvMirroringJob

The parameter is used returning information for a data flow mirroring job, and its output data model shall follow the indications provided in Table 7.3.5-1. This parameter maps to the "mirroringJob" 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>nfvMirroringJob</td>
<td>Object</td>
<td>Information about the Data Flow Mirroring Job that has been created.</td>
</tr>
<tr>
<td>&gt;mirroringJobId</td>
<td>String</td>
<td>Unique identifier of the Data Flow Mirroring Job.</td>
</tr>
<tr>
<td>&gt;mirroringJobName</td>
<td>String</td>
<td>Name of the Data Flow Mirroring Job.</td>
</tr>
<tr>
<td>&gt;&gt;networkPortId</td>
<td>Object</td>
<td>Information about where the mirrored flow is to be delivered.</td>
</tr>
<tr>
<td>&gt;&gt;networkPortId</td>
<td>String</td>
<td>Identifier of the collector network port managed by VIM where the mirrored flow is to be delivered.</td>
</tr>
<tr>
<td>&gt;&gt;direction</td>
<td>String</td>
<td>The direction of the data flow that are requested to be mirrored. Possible values are: “in”, “out”, “both”.</td>
</tr>
<tr>
<td>&gt;&gt;targetIpAddress</td>
<td>String</td>
<td>If present, only the data flow to or/and from the target IP address shall be mirrored.</td>
</tr>
</tbody>
</table>

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

```json
nfvMirroringJob:
  type: object
  required:
    - mirroringJobId
    - mirroringJobName
    - description
    - collectorDetails
    - dataFlowDetails
  properties:
    mirroringJobId:
      type: string
    mirroringJobName:
      type: string
    description:
      type: string
    collectorDetails:
      type: object
      required:
        - networkPortId
        properties:
          networkPortId:
            type: string
    dataFlowDetails:
      type: object
      required:
        - networkPortId
        properties:
          networkPortId:
            type: string
          direction:
            type: string
            enum: [in, out, both]
          targetIpAddress:
            type: string
```
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>
<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:

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

8.2.2 Parameter: affinityOrAntiAffinityConstraintsForStorage

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>affinityOrAntiAffinityConstraintsForStorage</td>
<td>Array of Object</td>
<td>A list of elements with affinity or anti-affinity information of the virtualised storage resource to be allocated.</td>
</tr>
<tr>
<td>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>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>Parameter Name and Attributes</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>&gt;affinityAntiAffinityResourceList</td>
<td>Object</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>Array of String</td>
<td>List of identifiers of virtualised resources.</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 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, affinityAntiAffinityResourceGroup shall be supported. The mechanisms shall not be mixed in the scope of a resourceGroup (also known as VIM tenant).

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

```json
affinityOrAntiAffinityConstraintsForStorage:
  description: &gt; 
  A list of elements with affinity or anti-affinity information of the virtualised storage resource to allocate.
  oneOf:
    - type: array
      minItems: 0  # lower bound of cardinality
      maxItems: N  # upper bound of cardinality
      items:
        type: object
        required:
          - typeOfAffinityOrAntiAffinityConstraintForStorage
        properties:
          typeOfAffinityOrAntiAffinityConstraintForStorage:
            type: string
            enum:
              - affinity
              - anti-affinity
          scopeOfAffinityOrAntiAffinityConstraintForStorage:
            type: string
            enum:
              - NFVI-Node 
            default: NFVI-Node
          affinityAntiAffinityResourceList:
            type: object
            required:
              resource:
                type: array
                minItems: 1  # lower bound of cardinality
                maxItems: N  # upper bound of cardinality
                items:
                  type: string
              - type: array
                minItems: 0  # lower bound of cardinality
                maxItems: N  # upper bound of cardinality
                items:
                  type: object
                  required:
                    - typeOfAffinityOrAntiAffinityConstraintForStorage
                  properties:
                    typeOfAffinityOrAntiAffinityConstraintForStorage:
                      type: string
                      enum:
                        - affinity
                        - anti-affinity
                    scopeOfAffinityOrAntiAffinityConstraintForStorage:
                      type: string
```

**ETSI**
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>Object</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: object
  required:
    - flavourId
    - storageAttributes
  properties:
    flavourId:
      type: string
    storageAttributes:
      type: object
      properties:
        typeOfStorage:
          type: string
        sizeOfStorage:
          type: number
```

8.2.4 Parameter: updateStorageData

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>updateStorageData</td>
<td>Object</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: object
  required:
    - flavourId
    - storageAttributes
  properties:
    flavourId:
      type: string
    storageAttributes:
      typeOfStorage:
        type: string
      sizeOfStorage:
        type: number
```

8.2.5 Parameter: storageOperation

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

<table>
<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:

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

8.2.6 Parameter: newSize

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

<table>
<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:

```json
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:

```json
scopeOfAffinityOrAntiAffinityConstraints:
  description: >
    Qualifies the scope of the affinity constraint,
  type: string
  enum:
    - NFVI-Node
  default: NFVI-Node
```
8.3 Parameters to be used as output

8.3.1 Parameter: nfvStorageInfo

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfvStorageInfo</td>
<td>Object</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>&gt;sizeOfStorage</td>
<td>Number</td>
<td>Size of virtualised storage resource (e.g. size of volume, in GB).</td>
</tr>
<tr>
<td>&gt;rdmaEnabled</td>
<td>Boolean</td>
<td>Indicates if the storage supports RDMA.</td>
</tr>
<tr>
<td>&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;zoneld</td>
<td>String</td>
<td>It identifies the resource zone where the virtual storage resources have been allocated.</td>
</tr>
<tr>
<td>&gt;hostId</td>
<td>String</td>
<td>Identifier of the host where the virtualised storage resource is allocated.</td>
</tr>
<tr>
<td>&gt;operationalState</td>
<td>String</td>
<td>Operational state of the resource. Allowed value: enabled, disabled.</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>Array of object</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: object
  required:
    - storageId
    - flavourId
    - typeOfStorage
    - sizeOfStorage
    - operationalState
  properties:
    storageId:
      description: >
        Identifier of the virtualised storage resource
      type: string
    storageName:
      description: >
        Name of the virtualised storage resource
      type: string
    flavourId:
      description: >
        Identifier of the storage flavour used to instantiate this virtual storage
      type: string
    typeOfStorage:
      description: >
        Type of virtualised storage resource
      type: string
    sizeOfStorage:
      description: >
        Size of virtualised storage resource
      type: number
    rdmaEnabled:
      description: >
```


9 Data model for Virtualised Resources Change Notification

9.1 Description

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

9.2 Parameters to be used as input

9.2.1 Parameter: callbackUriForChangeNotify

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>callbackUriForChangeNotify</td>
<td>String</td>
<td>The URI of the endpoint to send the change notification to.</td>
</tr>
</tbody>
</table>

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

```json
callbackUri:
  description: >
  The URI of the endpoint to send the change notification to.
  type: string
  default: ""
```
9.2.2 Parameter: inputFilter

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

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

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

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

9.2.3 Parameter: changeld

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>changeld</td>
<td>String</td>
<td>Unique identifier of the change on the virtualised resource.</td>
</tr>
</tbody>
</table>

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

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

9.2.4 Parameter: virtualisedResourceld

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>virtualisedResourceld</td>
<td>String</td>
<td>Identifier of the instantiated virtualised resource for which the change notification is issued.</td>
</tr>
</tbody>
</table>

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

```json
virtualisedResourceld:
  description: >
  Identifier of the instantiated virtualised resource for which the change notification is issued.
  type: string
  default: ""
```
9.2.5 Parameter: virtualisedResourceGroupId

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>virtualisedResourceGroupId</td>
<td>String</td>
<td>Identifier of the affinity or anti-affinity group of the virtualised resource for which the change notification is issued.</td>
</tr>
</tbody>
</table>

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

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

9.2.6 Parameter: endOfChange

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>endOfChange</td>
<td>Boolean</td>
<td>If the value is True it indicates the end of the changes of virtualised resources for which the notification of type of change is issued.</td>
</tr>
</tbody>
</table>

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

```javascript
endOfChange:
  description: >
    If the value is True it indicates the end of the changes of virtualised resources for which the notification of type of change is issued.
  type: boolean
  default: "true"
```

9.2.7 Parameter: changeTime

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>changeTime</td>
<td>String</td>
<td>Specifies the anticipated time of change of the virtualised resource for which the change notification is issued or the ending time of changes of virtualised resources if the value of the endOfChange is &quot;true&quot;.</td>
</tr>
</tbody>
</table>

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

```javascript
changeTime:
  description: >
    Specifies the anticipated time of change of the virtualised resource for which the change notification is issued or the ending time of changes of virtualised resources if the value of the endOfChange is "true".
  type: string
  default: ""
```
9.2.8 Parameter: vimId

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

Table 9.2.8-1: Input data model for vimId

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vimId</td>
<td>String</td>
<td>Identifier of the VIM reporting the change.</td>
</tr>
</tbody>
</table>

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

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

9.2.9 Parameter: changeType

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

Table 9.2.9-1: Input data model for changeType

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>changeType</td>
<td>String</td>
<td>Categorizes the type of change. Possible values can be related to maintenance and operation of the NFVI. Allowed value: normal, maintenance, evacuation, optimization.</td>
</tr>
</tbody>
</table>

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

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

9.2.10 Parameter: changedResourceData

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

Table 9.2.10-1: Input data model for changedResourceData

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>changedResourceData</td>
<td>String</td>
<td>Details of the changes of the resource. Its content can differ based on the different values of the attribute changeType.</td>
</tr>
</tbody>
</table>

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

```json
changedResourceData:
  description: >
  Details of the changes of the resource. Its content can differ based on the different values of the attribute changeType.
  type: string
  default: ""
```
9.3 Parameters to be used as output

None.

10 Data model for Virtualised Resources Fault Management

10.1 Description

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

10.2 Parameters to be used as input

10.2.1 Parameter: callbackUriForFaultNotify

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>callbackUriForFaultNotify</td>
<td>String</td>
<td>The URI of the endpoint to send the fault notification to.</td>
</tr>
</tbody>
</table>

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

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

10.2.2 Parameter: filter

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>filter</td>
<td>Object</td>
<td>Input filter for selecting fault notifications.</td>
</tr>
<tr>
<td>&gt;computeId</td>
<td>String</td>
<td>Identifier of the virtualised compute resource. When selected virtualised compute resource was affected by faults, VIM will send notifications.</td>
</tr>
<tr>
<td>&gt;networkResourceId</td>
<td>String</td>
<td>Identifier of the virtualised network resource. When selected virtualised network resource was affected by faults, VIM will send notifications.</td>
</tr>
<tr>
<td>&gt;storageId</td>
<td>String</td>
<td>Identifier of the virtualised storage resource. When selected virtualised storage resource was affected by faults, VIM will send notifications.</td>
</tr>
</tbody>
</table>

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

```
filter:
  description: >
    Input filter for selecting fault notifications.
  type: object
  properties:
    computeId:
      description: >
        Identifier of the virtualised compute resource. When selected virtualised compute resource was affected by faults, VIM will send notifications.
```
10.2.3 Parameter: alarm

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

<table>
<thead>
<tr>
<th>Parameter Name and Attributes</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>alarm</td>
<td>Object</td>
<td>Information about an alarm.</td>
</tr>
<tr>
<td>&gt;alarmId</td>
<td>String</td>
<td>Alarm identifier.</td>
</tr>
<tr>
<td>&gt;managedObjectId</td>
<td>String</td>
<td>Identifier of the affected managed Object. The Managed Objects for this information element will be virtualised resources. A virtualised resource can have fault monitored sub-object types and identification information is carried as defined in the respective Alarm definition as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9], e.g. using the &quot;faultDetails&quot; attribute.</td>
</tr>
<tr>
<td>&gt;alarmRaisedTime</td>
<td>String</td>
<td>Timestamp indicating when the alarm was first raised by the managed object.</td>
</tr>
<tr>
<td>&gt;alarmChangedTime</td>
<td>String</td>
<td>Timestamp indicating when the alarm was last changed. It shall be present if the alarm has been updated.</td>
</tr>
<tr>
<td>&gt;alarmClearedTime</td>
<td>String</td>
<td>Timestamp indicating when the alarm was cleared. It shall be present if the alarm has been cleared.</td>
</tr>
<tr>
<td>&gt;state</td>
<td>String</td>
<td>State of the alarm. Allowed values: FIRED, UPDATED, CLEARED.</td>
</tr>
<tr>
<td>&gt;perceivedSeverity</td>
<td>String</td>
<td>Perceived severity of the virtualised managed object failure. Allowed values: CRITICAL, MAJOR, MINOR, WARNING, INDETERMINATE, CLEARED. Valid values applicable to specific Alarms are specified as &quot;Perceived severity&quot; values of the Alarm applicable to Vi-Vnfm or Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].</td>
</tr>
<tr>
<td>&gt;eventTime</td>
<td>String</td>
<td>Timestamp indicating when the fault was observed.</td>
</tr>
<tr>
<td>&gt;eventType</td>
<td>String</td>
<td>Type of the event. Allowed values: COMMUNICATION_ALARM, PROCESSING_ALARM, ENVIRONMENT_ALARM, QOS_ALARM, EQUIPMENT_ALARM. Valid values applicable to specific Alarms are specified as &quot;Event type&quot; values of the Alarm applicable to Vi-Vnfm or Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].</td>
</tr>
<tr>
<td>&gt;faultType</td>
<td>String</td>
<td>Information related to the type of the fault. The allowed values for the faultType attribute depend on the type of the related managed object. Valid values applicable to specific Alarms are specified as &quot;Alarm definition identifier&quot; values of the Alarm applicable to Vi-Vnfm or Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].</td>
</tr>
<tr>
<td>&gt;probableCause</td>
<td>String</td>
<td>Information about the probable cause of the fault. Valid values applicable to specific Alarms are specified as &quot;Probable cause&quot; values of the Alarm applicable to Vi-Vnfm or Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].</td>
</tr>
<tr>
<td>&gt;isRootCause</td>
<td>Boolean</td>
<td>Parameter indicating if this fault is the root for other correlated alarms. If &quot;true&quot;, then the alarms listed in the parameter correlatedAlarmId are caused by this fault.</td>
</tr>
<tr>
<td>&gt;correlatedAlarmId</td>
<td>Array of String</td>
<td>List of other alarms correlated to this fault.</td>
</tr>
<tr>
<td>&gt;faultDetails</td>
<td>Array of String</td>
<td>Provides additional information about the fault. Valid values applicable to specific Alarms are specified as &quot;Fault details&quot; values of the Alarm applicable to Vi-Vnfm or Or-Vi reference point, as defined in clause 7.2 of ETSI GS NFV-IFA 045 [9].</td>
</tr>
</tbody>
</table>
The syntax of the alarm shall comply with the following definition:

```json
alarm:
  description: >
    Information about an alarm.
  type: object
  properties:
    alarmId:
      type: string
    managedObjectId:
      type: string
    alarmRaisedTime:
      type: string
    alarmChangedTime:
      type: string
    alarmClearedTime:
      type: string
    state:
      type: string
      enum:
        - FIRED
        - UPDATED
        - CLEARED
    perceivedSeverity:
      type: string
      enum:
        - CRITICAL
        - MAJOR
        - MINOR
        - WARNING
        - INDETERMINATE
        - CLEARED
    eventTime:
      type: string
    eventType:
      type: string
      enum:
        - COMMUNICATION_ALARM
        - PROCESSING_ALARM
        - ENVIRONMENT_ALARM
        - QOS_ALARM
        - EQUIPMENT_ALARM
    faultType:
      type: string
    probableCause:
      type: string
    isRootCause:
      type: boolean
    correlatedAlarmId:
      type: array
      minItems: 1 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
    faultDetails:
      type: array
      minItems: 1 # lower bound of cardinality
      maxItems: N # upper bound of cardinality
      items:
        type: string
```

### 10.3 Parameters to be used as output

None.
Annex A (informative): Examples using OpenStack® Heat Orchestration Template

A.1 Introduction

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

A.2 Overview

A.2.1 Introduction

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

A.2.2 Template structure

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

A.3 Examples

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

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

The input data is given as an argument and starts with "parameters". Parameters grouped by "nfv" are specified in the present document. The input data is expressed in JSON format, as this is determined by the HOT specification [i.2].

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 10 (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, \texttt{get\_attr}, gets the virtualised compute identifier from the \texttt{virtualisedComputeResource}.

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

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

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

```yaml
heat_template_version: 2021-04-16
description: Allocate Virtualised Compute Resource operation

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

conditions:
  Constraints\_ResourceList\_is\_null:
    equals:
      - \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{affinityOrAntiAffinityConstraints\_for\_Compute}, \texttt{affinity\_AntiAffinity\_Resource\_List} ], "\"" \} 
  Constraints\_type\_is\_affinity:
    equals:
      - \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{affinityOrAntiAffinityConstraints\_for\_Compute}, \texttt{type} ], "affinity" \} 
  userData\_method\_is\_CONFIG\_DRIVE:
    equals:
      - \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{userData}, \texttt{method} ], "CONFIG\_DRIVE" \} 
  userData\_method\_is\_CONFIG\_DRIVE\_MIME\_multi\_part:
    equals:
      - \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{userData}, \texttt{method} ], "CONFIG\_DRIVE\_MIME\_multi\_part" \}

resources:
  interfaceResource:
    type: OS::Heat::ResourceGroup
    properties:
      count:
        \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{interfaceData}, \texttt{count} ] \}
    resource\_def:
      type: http://controller/Allocate\_Virtualised\_Compute\_Resource\_operation/createPort.yaml
  forOutput\_flavorResource:
    type: OS::Nova::Flavor
    external\_id:
      \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{compute\_flavour\_id} ] \}
  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
  forOutput\_portStatusResource:
    type: OS::Heat::ResourceGroup
    depends\_on:
      - virtualised\_Compute\_Resource
    properties:
      count:
        \{ \texttt{get\_param}: [ \texttt{nfv}, \texttt{interfaceData}, \texttt{count} ] \}
    resource\_def:
      type: http://controller/Allocate\_Virtualised\_Compute\_Resource\_operation/getPortStatus.yaml
  forOutput\_virtualised\_Compute\_Resource\_Status:
    type: OS::Heat::ResourceGroup
```

ETSI
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 ] }

userDataContentResource:
  type: OS::Heat::SoftwareConfig
  properties:
    config: { get_param: [ nfv, userData, content ] }

userDataCertificateDataResource:
  type: OS::Heat::SoftwareConfig
  properties:
    config: { get_param: [ nfv, userData, certificateData ] }

configDriveMIMEMultiPartResource:
  type: OS::Heat::MultipartMime
  properties:
    parts:
      - config: { get_resource: userDataContentResource }
      - config: { get_resource: userDataCertificateDataResource }

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 ] }
    config_drive:
      if:
        - userData_method_is_CONFIG_DRIVE
        - true
        - if:
          - userData_method_is_CONFIG_DRIVE_MIME_multi-part
          - true
          - false
      user_data:
        if:
          - userData_method_is_CONFIG_DRIVE_MIME_multi-part
          - { get_resource: configDriveMIMEMultiPartResource }
          - { get_resource: userDataContentResource }
        user_data_format: "RAW"
nfvComputeInfo:
  value:
    str_replace:
      template: |
      {
        "computeId": "$computeId",
        "computeName": "$computeName",
        "flavourId": "$flavourId",
        "virtualCpu": {
          "numVirtualCpu": "$numVirtualCpu",
          "virtualCpuPinning": "$virtualCpuPinning"
        },
        "virtualMemory": {
          "virtualMemSize": "$virtualMemSize"
        },
        "virtualNetworkInterface": "$virtualNetworkInterface",
        "virtualDisks": [
          {
            "storageId": "$storageId",
            "typeOfStorage": "disk",
            "sizeOfStorage": "$sizeOfStorageDisk",
            "operationalState": "$storageOperationalState"
          },
          {
            "storageId": "$storageId",
            "typeOfStorage": "ephemeral",
            "sizeOfStorage": "$sizeOfStorageEphemeral",
            "operationalState": "$storageOperationalState"
          },
          {
            "storageId": "$storageId",
            "typeOfStorage": "swap",
            "sizeOfStorage": "$sizeOfStorageSwap",
            "operationalState": "$storageOperationalState"
          }
        ],
        "vcImageId": "$vcImageId",
        "zoneId": "$zoneId",
        "hostId": "$hostId",
        "operationalState": "$operationalState",
        "metaData": "$metaData"
      }
    params:
      $computeId: { get_attr: [ virtualisedComputeResource, show, id ] }
      $computeName: { get_attr: [ virtualisedComputeResource, show, name ] }
      $flavourId: { get_attr: [ forOutput-flavorResource, show, id ] }
      $numVirtualCpu: { get_attr: [ forOutput-flavorResource, show, vcpus ] }
      $virtualCpuPinning: { get_attr: [ forOutput-flavorExtraSpecs, resource.0.cpuPinning ] }
      $virtualMemSize: { get_attr: [ forOutput-flavorResource, show, ram ] }
      $virtualNetworkInterface:
        repeat:
          for_each:
            <resourceId>:
              get_attr: [ interfaceResource, show, id ]
            <$ownerId>:
              get_attr: [ interfaceResource, show, device_id ]
            <$networkId>:
              get_attr: [ interfaceResource, show, network_id ]
            <$ipAddress%>:
              get_attr: [ interfaceResource, show, fixed_ips, 0, ip_address ]
            <$typeVirtualNic%>:
              get_attr: [ interfaceResource, show, "binding:vnic_type" ]
            <$macAddress%>:
              get_attr: [ interfaceResource, show, mac_address ]
            <$operationalState%>:
              get_attr: [ forOutput-portStatusResource, status ]
          template:
            "resourceId": <$resourceId%>
            "$ownerId": <$ownerId%>
            "$networkId": <$networkId%>
            "$ipAddress%": <$ipAddress%>
            "$typeVirtualNic%": <$typeVirtualNic%>
            "$macAddress%": <$macAddress%>
            "$operationalState%": <$operationalState%>
        permutations: false
      $storageId: { get_attr: [ virtualisedComputeResource, show, id ] }
      $sizeOfStorageDisk: { get_attr: [ forOutput-flavorResource, show, disk ] }
      $sizeOfStorageEphemeral: { get_attr: [ forOutput-flavorResource, show, "OS-FLV-EXT-DATA:ephemeral" ] }
      $sizeOfStorageSwap:
        yaql:
          expression: $.data.swap_MB/1024
          data:
            swap_MB: { get_attr: [ forOutput-flavorResource, show, swap ] }
Below is an output example using template output parameters related to the allocated compute resource as provided by "Show output" in OpenStack Orchestration Service API [i.3]. 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": "c44df4f-66ef-4e42-9c41-7b3b449813d1",
      "operationalState": "disabled",
      "ownerId": "735ee7f9-92ce-4c00-8c7d-63eeeda75368",
      "resourceId": "658f0c3b-679e-49bd-9db-9d19a60f0321",
      "typeVirtualNic": "normal"
    },
    "virtualNetworkInterface":
    {
      "ipAddress": "20.20.20.15",
      "macAddress": "fa:16:3e:ab:ca:bc",
      "networkId": "f6a471d-032d-4c58-9432-c7e1e7f2873",
      "operationalState": "disabled",
      "ownerId": "735ee7f9-92ce-4c00-8c7d-63eeeda75368",
      "resourceId": "5b09065-81bc-43a8-abb-b306d1ac87c1",
      "typeVirtualNic": "normal"
    },
    "virtualDisks":
    {
      "storageId": "735ee7f9-92ce-4c00-8c7d-63eeeda75368",
      "typeOfStorage": "disk",
      "sizeOfStorage": "10",
      "operationalState": "enable"
    },
    "storageId": "735ee7f9-92ce-4c00-8c7d-63eeeda75368",
    "typeOfStorage": "ephemeral",
    "sizeOfStorage": "5",
    "operationalState": "enable"
  }
}
A.3.2 Example#2: Allocate Virtualised Network Resource operation

This is an example of "Create stack" in OpenStack Orchestration Service API [i.3] 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 [i.2].

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

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

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

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

NOTE 2: The example is prepared to highlight only an allocation of virtualised network resource. The parameters of affinityOrAntiAffinityConstraintsForNetwork and locationConstraintForNetwork are not used in this example (cardinality is 0).
Below is the corresponding example of the HOT that uses the parameters provided in the example above.

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

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

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

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

```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:

```yaml
"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:

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

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

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

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

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

```yaml
heat_template_version: 2021-04-16
description: Allocate Virtualised Network Resource operation.
parameters:
fv:
  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" ] }
  networkResourceType_is_routing-resource: { equals: [ { get_param: [ nfv, networkResourceType ] }, "routing-resource" ] }
  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" ] }
```
typeRoutingResourceData_operationalState_is_ENABLED: { equals: [ { get_param: [ nfv, typeRoutingResourceData, operationalState ] }, "ENABLED" ] }

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-routingResourceStatusResource:
    type: OS::Heat::ResourceGroup
    depends_on: routerResource
    properties:
      count: 1
      resource_def:
        type: http://controller/Allocate-Virtualised-Network-Resource-operation/getResourceStatus.yaml
        properties:
          status: [ get_attr: [ routerResource, 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 ] ]
subnetResource:
  type: OS::Heat::ResourceGroup
  properties:
  count: 1
  resource_def:
  if:
  - networkResourceType_is_subnet
    - type: OS::Neutron::Subnet
      properties:
      name: { get_param: [ nfv, networkResourceName ] }
      network: { get_param: [ nfv, typeSubnetData, networkId ] }
      ip_version: { if: [ typeSubnetData_ipVersion_is_IPv4, 4, 6 ] }
      gateway_ip: { get_param: [ nfv, typeSubnetData, gatewayIp ] }
      cidr: { get_param: [ nfv, typeSubnetData, cidr ] }
      enable_dhcp: { get_param: [ nfv, typeSubnetData, isDhcpEnabled ] }
      allocation_pools: { get_param: [ nfv, typeSubnetData, addressPool ] }
  - type: OS::Heat::None

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

routerResource:
  type: OS::Heat::ResourceGroup
  properties:
  count: 1
  resource_def:
  if:
  - networkResourceType_is_routing-resource
    - type: OS::Neutron::Router
      properties:
      name: { get_param: [ nfv, typeRoutingResourceData, name ] }
      distributed: { get_param: [ nfv, typeRoutingResourceData, distributed ] }
      admin_state_up:
        if:
        - typeRoutingResourceData_operationalState_is_ENABLED
          - true
          - false
      ha: { get_param: [ nfv, typeRoutingResourceData, ha ] }
      tags: { [ get_param: [ nfv, typeRoutingResourceData, metadata ] ] }
  - type: OS::Heat::None

routerInterfaceResources:
  type: OS::Heat::ResourceGroup
  depends_on: routerResource
  properties:
  count: 1
  index_var: "none"
  resource_def:
  if:
  - networkResourceType_is_routing-resource
    - type: OS::Heat::ResourceGroup
      properties:
      count: { get_param: [ nfv, typeRoutingResourceData, subnet, count ] }
      resource_def:
      type: http://controller/Allocate-Virtualised-Network-Resource-operation/createRouterInterface.yaml
      properties:
      subnet: { get_param: [ nfv, typeRoutingResourceData, subnet ] }
      routerId: { get_attr: [ routerResource, refs, 0 ] }
      index: "$index$"
outputs:
nfvNetworkInfo:
  value:
  if:
    - networkResourceType_is_network
      - str_replace:
        template: |
          { "networkResourceId": "$networkResourceId", "networkResourceName": "$networkResourceName", "subnet": { "resourceId": "$resourceId", "networkId": "$networkId", "ipVersion": "IPv$ipVersion", "gatewayIp": "$gatewayIp", "cidr": "$cidr", "isDhcpEnabled": "$isDhcpEnabled", "addressPool": "$addressPool" }, "networkType": "$networkType", "isShared": "$isShared", "zoneId": "$zoneId", "operationalState": "$operationalState" }
  params:
    $networkResourceId: { get_attr: [ networkResource, resource.0.show, id ] }
    $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": "IPv$ipVersion", "gatewayIp": "$gatewayIp", "cidr": "$cidr", "isDhcpEnabled": "$isDhcpEnabled", "addressPool": "$addressPool" }
  params:
    $resourceId: { get_attr: [ subnetResource, resource.0.show, id ] }
    $networkId: { get_attr: [ subnetResource, resource.0.show, network_id ] }
    $ipVersion: { get_attr: [ subnetResource, resource.0.show, ip_version ] }
    $gatewayIp: { get_attr: [ subnetResource, resource.0.show, gateway_ip ] }
    $cidr: { get_attr: [ subnetResource, resource.0.show, cidr ] }
    $isDhcpEnabled: { get_attr: [ subnetResource, resource.0.show, enable_dhcp ] }
    $addressPool: { get_attr: [ subnetResource, resource.0.show, allocation_pools ] }
    - str_replace:
      template:
      This is output of Subnet.
      Please specify output of $resourceType.
      params:
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.3]. 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.

```json
{
  "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": [
```
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.3] 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 [i.2].

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", "3f26f7ae-d5c-43bb-bace-87d6ec7b5374"]
                }
            },
            "storageData": {
                "storageAttributes": {
                    "typeOfStorage": "volume",
                    "sizeOfStorage": 1
                }
            },
            "locationConstraints": "nova",
            "metaData": {
                "test-key": "test-value"
            }
        },
        "stack_name": "storage-test-stack"
    }
}
```

Below is the corresponding example of the HOT that uses the parameters provided in the example above.
The parameters section in the template has definitions for input data to be provided when instantiating the template. In this case, parameter, nfv, is typed as JSON format.

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

JSON format is used for the structured data (e.g. affinityOrAntiAffinityConstraintsForStorage, storageData, metaData) as determined by the HOT specification [i.2]. 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:

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

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

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

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

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

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

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

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

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

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

The following is an example of a HOT for the Allocate Virtualised Storage Resource operation.
typeOfStorage_if_volume: { equals: [ { get_param: [ nfv, storageData, storageAttributes, typeOfStorage ] }, "volume" ] }
Constraints_type_is_affinity: { equals: [ { get_param: [ nfv, affinityOrAntiAffinityConstraintsForStorage, typeOfAffinityOrAntiAffinityConstraintForStorage ] }, "affinity" ] }

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

    size: { get_param: [ nfv, storageData, storageAttributes, sizeOfStorage ] }
    availability_zone: { get_param: [ nfv, locationConstraints ] }
    metadata: { get_param: [ nfv, metaData ] }
    - type: OS::Heat::None

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

outputs:
  nfvStorageInfo:
    value:
      str_replace:
        template: |
        { 
          "storageId": "$storageId",
          "storageName": "$storageName",
          "typeOfStorage": "$typeOfStorage",
          "sizeOfStorage": "$sizeOfStorage",
          "ownerId": "$ownerId",
          "zoneId": "$zoneId",
          "hostId": "$hostId",
          "operationalState": "$operationalState",
          "metadata": "$metadata"
        }
    params:
      $storageId: { get_attr: [ virtualisedStorageResource, resource.0.show, id ] }
      $storageName: { get_attr: [ virtualisedStorageResource, resource.0.show, name ] }
      $typeOfStorage: { get_param: [ nfv, storageData, storageAttributes, typeOfStorage ] }
      $sizeOfStorage: { get_attr: [ virtualisedStorageResource, resource.0.show, size ] }
      $ownerId: { get_attr: [ virtualisedStorageResource, resource.0.show, attachments, 0, server_id ] }
      $zoneId: { get_attr: [ virtualisedStorageResource, resource.0.show, availability_zone ] }
      $hostId: { get_attr: [ virtualisedStorageResource, resource.0.show, "os-vol-host-attr:host" ] }
      $operationalState: { get_attr: [ forOutput-virtualisedStorageResourceStatus, resource.0.status ] }
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.3]. 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.

```json
{
  "output": {
    "output_value": {
      "storageId": "f4e0afbe-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.3] 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 [i.2].

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",
        "zoneId": "nova",
        "hostId": "compute1@lvm#LVM",
        "operationalState": "enable",
        "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.

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; flavourid is paired with 10 of flavourId, ram is paired with 100 of virtualMemSize and vcpus is paired with 8 of numVirtualCpu.

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

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

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

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

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

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

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

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

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

    flavourId: { get_param: [ nfv, flavourId ] }

    ram: { get_param: [ nfv, virtualMemory, virtualMemorySize ] }

    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": "al12"
                    - |
                  - |
                  - |
                - |
              - |
            - |
          - |
        |

### another pattern's process(e.g. crypto).
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>
</thead>
<tbody>
<tr>
<td>nfvStorageInfo</td>
<td></td>
</tr>
<tr>
<td>&gt;storageId</td>
<td>resource/attributes/id</td>
</tr>
<tr>
<td>&gt;storageName</td>
<td>resource/attributes/name</td>
</tr>
<tr>
<td>&gt;flavourId</td>
<td>(not supported by HEAT)</td>
</tr>
<tr>
<td>&gt;sizeOfStorage</td>
<td>resource/attributes/size</td>
</tr>
<tr>
<td>&gt;rdmaEnabled</td>
<td>(not supported by HEAT)</td>
</tr>
<tr>
<td>&gt;ownerId</td>
<td>resource/attributes/attachments/server_id</td>
</tr>
<tr>
<td>&gt;zoneId</td>
<td>resource/attributes/availability_zone</td>
</tr>
<tr>
<td>&gt;hostId</td>
<td>os-vol-host-attr:host</td>
</tr>
<tr>
<td>&gt;operationalState</td>
<td>resource/attributes/status</td>
</tr>
<tr>
<td>&gt;metadata</td>
<td>resource/attributes/metadata</td>
</tr>
</tbody>
</table>

### A.3.6 Example#6: OpenStack Heat API sequence

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

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

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

Figure A.3.6-2

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

Figure A.3.6-3
Figure A.3.6-4 illustrates the sequence diagram of Scale Virtualised Compute/Storage Resource operation using "find stack", "update stack" and "show stack". In the case of Storage, only increase operation is supported.

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

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

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

This is an example of "Create stack" in OpenStack Orchestration Service API [i.3] corresponding to the Subscribe operation in the Change Notification Interface (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification [i.2].
Parameters grouped by "nfv" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters callbackUriForChangeNotify, inputFilter are given as keys with their corresponding values. This example covers the input parameter values part.

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

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

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

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

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

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

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

```yaml
heat_template_version: 2018-08-31
description: Virtualised Compute Resources Change Notification Interface Subscribe operation.
parameters:
  nfv:
    type: json
    description:
    default: {}
resources:
  maintenance:
    type: OS::Aodh::EventAlarm
    properties:
      event_type: compute.instance.create.end
      alarm_actions:
        - { get_param: [ nfv, callbackUriForChangeNotify ] }
      query:
        - field: traits.host
          op: eq
          value: { get_param: [ nfv, inputFilter, hostId ] }
        - field: traits.user_id
          op: eq
          value: c794077f19f142819716e3116724ccfe
        repeat_actions: true
```

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

```json
{"alarm_name": "change-notify-compute-maintenance-dricxhhg53iq",
 "alarm_id": "a76dd860-daad-456c-8ff3-0e7cbed12117",
 "severity": "low",
 "previous": "insufficient data",
 "current": "alarm",
 "reason": "Event <id=1cafb631-0c9a-4fdc-8d3c-d4ff9b0eba43,event_type=compute.instance.create.end> hits the query <query>[(field: traits.host, op: eq, type: string, value: ussuri-compute1), (field: traits.user_id, op: eq, type: string, value: c794077f19f142819716e3116724ccfe)]>.",
 "reason_data": {
  "type": "event",
  "message_id": "1cafb631-0c9a-4fdc-8d3c-d4ff9b0eba43",
```
"event_type": "compute.instance.create.end",
"generated": "2021-08-19T05:11:35.822867",
"traits": [
  {
    "service",
    1,
    "compute"
  },
  {
    "request_id",
    1,
    "req-462d2144-88e7-4307-bbec-cd972a07bfa0"
  },
  {
    "project_id",
    1,
    "f4453d4fab274ff4ae9cfe76a82d928"
  },
  {
    "user_id",
    1,
    "c794077f19f142819716e3116724ccfe"
  },
  {
    "tenant_id",
    1,
    "f4453d4fab274ff4ae9cfe76a82d928"
  },
  {
    "instance_id",
    1,
    "c33af9b4-7ebd-4894-944c-e16880630d5b"
  },
  {
    "display_name",
    1,
    "vm-for-maintenance"
  },
  {
    "resource_id",
    1,
    "c33af9b4-7ebd-4894-944c-e16880630d5b"
  },
  {
    "cell_name",
    1,
    ""
  },
  {
    "host",
    1,
    "ussuri-compute1"
  },
  {
    "memory_mb",
    2,
    64
  },
  {
    "disk_gb",
    2,
    15
  },
  {
    "root_gb",
    2,
    10
  },
  {
    "ephemeral_gb",
    2,
    5
  },
  {
    "vcpus",
    2,
    1
}]
Table A.3.7-1 illustrates the mapping between the input parameters for change notifications defined in the present document data model and the information in change notifications by OpenStack Aodh.

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

<table>
<thead>
<tr>
<th>Parameter in the present document</th>
<th>Notification from OpenStack Aodh</th>
</tr>
</thead>
<tbody>
<tr>
<td>changeId</td>
<td>reason_data/event/message_id</td>
</tr>
<tr>
<td>virtualisedResourceId</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>virtualisedResourceGroupId</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>endOfChange</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>changeTime</td>
<td>reason_data/event/generated</td>
</tr>
<tr>
<td>vimId</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>changeType</td>
<td>alarm_name (see note)</td>
</tr>
<tr>
<td>changedResourceData</td>
<td>(not supported by Aodh)</td>
</tr>
</tbody>
</table>

**NOTE:** Due to current specifications of OpenStack Heat and OpenStack Aodh, "alarm_name" is determined to be a concatenation of "stack_name", "resource name in HOT" and "random string generated by Heat". This is not matched to allowed value of changeType, but like changeType, "alarm_name" is used to distinguish the type of notification.

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

This is an example of "Create stack" in OpenStack Orchestration Service API [i.3] corresponding to the Subscribe operation in the Fault Management Interface (ETSI GS NFV-IFA 005 [1] and ETSI GS NFV-IFA 006 [2]).

The input data is given as an argument and starts with "parameters". The input data is expressed in JSON format, as this is determined by the HOT specification [i.2].

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

The following example illustrates the input parameters that can be passed to a HEAT API call for the Subscribe operation.
Below is the corresponding example of the HOT that uses the parameters provided in the example above.

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

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

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

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

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

```json
{
  "alarm_name": "fault-notify-compute-stoppedState-bla6fvjo5nrf",
  "alarm_id": "5429876f-c8c4-42e6-a8be-5a5daeb5c4",
  "severity": "low",
  "previous": "alarm",
  "current": "alarm",
  "reason": "Event <id=4a55319f-dc22-413d-b21a-34d3728c72c0,event_type=compute.instance.power_off.end> hits the query <query={field: traits.instance_id, op: eq, type: string, value: 3e5cb24b-044d-4c65-8488-60ebd2c797cc}>".
}
```
"reason_data": {  "type": "event",  "event": {    "message_id": "4a55319f-dc22-413d-b21a-34d3728c72c0",    "event_type": "compute.instance.power_off.end",    "generated": "2021-08-19T08:12:20.805018",    "traits": [      [        "service",        1,        "compute"      ],      [        "request_id",        1,        "req-72f8bda-9444-4e65-8b02-8485c2b8d43c"      ],      [        "project_id",        1,        "f4453d4f4ab274ff44a9cfe76a82d928"      ],      [        "user_id",        1,        "4d75edde64505878e5c59c042b70c"      ],      [        "tenant_id",        1,        "f4453d4f4ab274ff44a9cfe76a82d928"      ],      [        "instance_id",        1,        "3e5cb24b-044d-4c65-8488-60ebd2c797cc"      ],      [        "display_name",        1,        "test-vm"      ],      [        "resource_id",        1,        "3e5cb24b-044d-4c65-8488-60ebd2c797cc"      ],      [        "cell_name",        1,        ""      ],      [        "host",        1,        "ussuri-compute2"      ],      [        "memory_mb",        2,        64      ],      [        "disk_gb",        2,        1      ],      [        "root_gb",        2,        1      ],      [        "ephemeral_gb",        2,        0      ]    ]  }
}
Table A.3.8-1 illustrates the mapping between the input parameter and attributes for fault notifications defined in the present document data model and the information in fault notifications by OpenStack Aodh.

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

<table>
<thead>
<tr>
<th>Attribute in the present document</th>
<th>Notification from OpenStack Aodh</th>
</tr>
</thead>
<tbody>
<tr>
<td>alarm</td>
<td></td>
</tr>
<tr>
<td>&gt;alarmId</td>
<td>reason_data/event/message_id</td>
</tr>
<tr>
<td>&gt;managedObjectId</td>
<td>reason_data/event/traits/instance_id</td>
</tr>
<tr>
<td>&gt;alarmRaisedTime</td>
<td>reason_data/event/generated</td>
</tr>
<tr>
<td>&gt;alarmChangedTime</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;alarmClearedTime</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;state</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;perceivedSeverity</td>
<td>severity</td>
</tr>
<tr>
<td>&gt;eventTime</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;eventType</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;faultType</td>
<td>alarm_name (see note)</td>
</tr>
<tr>
<td>&gt;probableCause</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;isRootCause</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;correlatedAlarmId</td>
<td>(not supported by Aodh)</td>
</tr>
<tr>
<td>&gt;faultDetails</td>
<td>(not supported by Aodh)</td>
</tr>
</tbody>
</table>

NOTE: Due to current specifications of OpenStack Heat and OpenStack Aodh, "alarm_name" is determined to be a concatenation of "stack_name", "resource name in HOT" and "random string generated by Heat". Like faultType, "alarm_name" is used to distinguish the type of notification.

A.3.9 Example#9: Create Compute Resource Reservation operation

This is an example of "Create stack" in OpenStack Orchestration Service API [i.3] corresponding to the Create Compute Resource Reservation operation (ETSI GS NFV-IFA 005 [1]).

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 [i.2].
Parameters grouped by "nfv" are specified in the present document. Following the input parameter specifications in the present example (see further below), input parameters startTime, endTime, computePoolReservation 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 Create Compute Resource Reservation operation.

```json
{
  "parameters": {
    "nfv": {
      "startTime": "2022-03-28 06:00",
      "endTime": "2023-03-28 06:00",
      "computePoolReservation": {
        "numCpuCores": 1,
        "numVcInstances": 1,
        "virtualMemSize": 1024
      }
    }
  },
  "stack_name": "compute-reservation-test-stack"
}
```

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

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

By the function get_param, the value of the input parameters are taken from input parameters and paired with resource keys in the property section; start_date is paired with "2022-03-28 06:00" of startTime, memory_mb is paired with 1024 of virtualMemSize of computePoolReservation.

The outputs section of the template describes output data for the user, e.g. when in terms of the Create Compute Resource Reservation the nfvComputeReservationInfo 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 "stack_name" is a required parameter to generate an identifier that points to a stack of the virtualised resources, as shown in clause A.3.6.

```yaml
heat_template_version: 2018-08-31
description: Create Compute Resource Reservation operation.
parameters:
  nfv:
    type: json
    description:
    default: {}
resources:
  computeResourceReservation:
    type: OS::Blazar::Lease
    properties:
      name: "computeResourceReservation"
      start_date: { get_param: [ nfv, startTime ] }
      end_date: { get_param: [ nfv, endTime ] }
      reservations:
        "vcpus": { get_param: [ nfv, computePoolReservation, numCpuCores ] }
        "amount": { get_param: [ nfv, computePoolReservation, numVcInstances ] }
        "memory_mb": { get_param: [ nfv, computePoolReservation, virtualMemSize ] }
        "disk_gb": 0
        "resource_type": "virtual:instance"
outputs:
  nfvComputeReservationInfo:
    value:
      str_replace:
        template: |
        "reservationId": "$reservationId"
        params:
          $reservationId: { get_attr: [ computeResourceReservation, show, reservations, 0, id ] }
```
Below is an output example of the output parameters related to the compute resource reservation resource as provided by "Show output" in OpenStack Orchestration Service API [i.3]. Specified attributes defined in nfvComputeReservationInfo 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": {  
            "reservationId": "e0bd181d-0d82-466b-bd26-30dd9c750175"  
        },  
        "output_key": "nfvComputeReservationInfo",  
        "description": "No description given"  
    }  
}
```

A.3.10 Example#10: Create Compute Host Reservation operation

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

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 minAmount, maxAmount, startTime, endTime, computeHostProperties 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 Create Compute Host Reservation operation.

```

{  
    "parameters": {  
        "nfv": {  
            "minAmount": "1",  
            "maxAmount": "1",  
            "startTime": "2023-06-01 00:00",  
            "endTime": "2024-06-01 00:00",  
            "computeHostProperties": [  
                "ssd",  
                "gpu"  
            ]  
        }  
    },  
    "stack_name": "compute-host-reservation-test-stack"  
}
```

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

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

By the function get_param, the value of the input parameters are taken from input parameters and paired with resource keys in the property section; start_date is paired with "2023-06-01 00:00" of startTime, computeHostProperty0 is paired with "ssd" of the first element of computeHostProperties.

The outputs section of the template describes output data for the user, e.g. when in terms of the Create Compute Host Reservation the nfvComputeHostReservationInfo 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 "stack_name" is a required parameter to generate an identifier that points to a stack of the virtualised resources, as shown in clause A.3.6.
heat_template_version: 2021-04-16
description: Create Compute Host Reservation operation.

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

resources:
  computeHostReservation:
    type: OS::Blazar::Lease
    properties:
      name: "computeHostReservation"
      start_date: { get_param: [ nfv, startTime ] }
      end_date: { get_param: [ nfv, endTime ] }
      reservations:
        - "min": { get_param: [ nfv, minAmount ] }
        - "max": { get_param: [ nfv, maxAmount ] }
      "resource_properties":
        str_replace:
          template: '\[ "and", [ "\=", "$computeHostProperty0", "true"], ["\=",
          "$computeHostProperty1", "true"] \]
          params:
            computeHostProperty0: { get_param: [ nfv, computeHostProperties, 0 ] }
            computeHostProperty1: { get_param: [ nfv, computeHostProperties, 1 ] }
      "resource_type": "physical:host"

outputs:
  nfvComputeHostReservationInfo:
    value:
      str_replace:
        template: |
        { "reservationId": "$reservationId" }
        params:
          $reservationId: { get_attr: [ computeHostReservation, show, reservations, 0, id ] }

Below is an output example of the output parameters related to the compute host reservation resource as provided by "Show output" in OpenStack Orchestration Service API [i.2]. Specified attributes defined in nfvComputeHostReservationInfo 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": {  
      "reservationId": "d090a8af-7e0b-4432-9a54-3646e26c2eff"  
    },  
    "output_key": "nfvComputeHostReservationInfo",  
    "description": "No description given"  
  }  
}
```

A.4 Complex templates

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

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

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

Multiple levels of nesting of templates are allowed.
Annex B (informative):
Explanations of concepts

B.1 Introduction

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

B.2 Concept of descriptor-based virtualised resource management

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

The input parameter data model consists of:

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

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

The output parameter data model consists of:

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

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

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

Figure B.2-1 illustrates the concepts described above. The method for passing input data as arguments and output data as return values is out of the scope of the present document. The present document provides examples of virtualised resource descriptors, arguments and return values for each solution identified in Annex A.
Figure B.2-1: Concept of descriptor-based virtualised resource management
## Annex C (informative):
### Change history

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<tr>
<th>Date</th>
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<th>Information about changes</th>
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<td>3.0.1</td>
<td>Initial draft for SOL014ed351</td>
</tr>
<tr>
<td>March 2021</td>
<td>3.0.2</td>
<td>Implements - NFVSOL(21)000166 Improvements towards OpenAPI-based data models for general aspects - NFVSOL(21)000160r1 SOL014ed351 Improvements towards OpenAPI-based data models in virtualised storage resource data model - NFVSOL(21)000143r1 SOL014ed351 Improvements towards OpenAPI-based data models in virtualised compute resource data model - NFVSOL(21)000142 SOL014ed Improvements towards OpenAPI-based data models in common data model - NFVSOL(21)000119 SOL014ed351 Improvements towards OpenAPI-based data models in Virtualised Network Management - NFVSOL(21)000059 SOL014 networkResourceName in OpenAPI</td>
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<td>November 2021</td>
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<td>4.3.3</td>
<td>Update RFC reference according to the new format</td>
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<td>September 2023</td>
<td>4.4.3</td>
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## History

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