Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Network Service Templates Specification

__Disclaimer__

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

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

The present document specifies requirements and templates for describing Network Functions Virtualisation (NFV) Network Services (NSs) in the form of meta-data.

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 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

2.2 Informative references

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

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

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

[i.1] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".
[i.2] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV); Management and Orchestration; Os-Ma-Nfvo reference point - Interface and Information Model Specification".
[i.3] ETSI GS NFV-SWA 001: "Network Functions Virtualisation (NFV); Virtual Network Functions Architecture".
[i.5] ETSI GS NFV-REL 001: "Network Functions Virtualisation (NFV); Resiliency Requirements".
[i.6] IETF RFC 7665: "Service Function Chaining (SFC) Architecture".
[i.7] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV); Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".
3 Definition of terms, symbols and abbreviations

3.1 Terms

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

**Service Access Point (SAP):** connection point where a NS can be accessed

*NOTE:* A SAP can either provide access to an NS, e.g. to an end-user, or interconnect different NS.

3.2 Symbols

Void.

3.3 Abbreviations

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

- CDN: Content Delivery Network
- CM: Conditional Mandatory
- CO: Conditional Optional
- CP: Connection Point
- CPD: Connection Point Descriptor
- DF: Deployment Flavour
- DSL: Domain Specific Language
- E-LAN: Ethernet Local Area Network
- GS: Group Specification
- IPV4: Internet Protocol Version 4
- IPV6: Internet Protocol Version 6
- LAN: Local Area Network
- MANO: Management and Orchestration
- MPLS: MultiProtocol Label Switching
- NCT: Network Connectivity Topology
- NFP: Network Forwarding Path
- NFPD: Network Forwarding Path Descriptor
- NS: Network Service
- NSD: Network Service Descriptor
- ODU2: Optical channel Data Unit - type 2
- PM: Performance Management
- PNFD: Physical Network Function Descriptor
- SAP: Service Access Point
- SAPD: Service Access Point Descriptor
- SFC: Service Function Chaining
- UML: Unified Modelling Language
- VL: Virtual Link
- VLD: Virtual Link Descriptor
- VNFFG: VNF Forwarding Graph
- VNFFGD: VNF Forwarding Graph Descriptor
- XOR: eXclusive OR
4 Overview

4.1 Network Service Descriptions

The Network Service Descriptor (NSD) is a deployment template which consists of information used by the NFV Orchestrator (NFVO) for life cycle management of an NS.

An NS is a composition of Network Functions (NF) arranged as a set of functions with unspecified connectivity between them or according to one or more forwarding graphs. As illustrated in figure 4.1-1, the description of a NS as used by the NFV Management and Orchestration (MANO) functions to deploy an NS instance includes or references the descriptors of its constituent objects:

- zero, one or more Virtualised Network Function Descriptors (VNFD);
- zero, one or more Physical Network Function Descriptors (PNFD) used by the NFVO to determine how to connect PNFs to VLs;
- zero, one or more nested NSD;
  NOTE 1: The information contained within the PNFD is limited to the description of the connectivity requirements to integrate PNFs in an NS.
  NOTE 2: An NSD references at least either one VNFD or one nested NSD.
- zero, one or more Virtual Link Descriptors (VLD) used by the NFVO to deploy Virtual Links (VL); and
- zero, one or more VNF Forwarding Graph Descriptors (VNFFGD).

A VNF Forwarding Graph Descriptor (VNFFGD) describes a topology of the NS or a portion of the NS, by referencing a pool of connection points and service access points, the descriptors of its constituent VNFs, PNFs and of the VLs that connect them. It may also contain one or more Network Forwarding Path (NFP) descriptors.

  NOTE 3: Different VNFFGDs can be contained in a given NSD. Each VNFFGD uses subsets of the lists of VLDs, VNFDs and PNFDs included in the NSD.
  NOTE 4: For a given NS different VNFFGs can result in packets/frames traversing identical sequences of (V)NFs, depending on the NFP descriptors included in the VNFFGDs.
  NOTE 5: In a given VNFFG the connectivity topology represents how the (V)NFs among which packets/frames can be exchanged are connected to each other. A Network Connectivity Topology (NCT), as defined in ETSI GS NFV-SWA 001 [i.3] represents a higher logical level connectivity, possibly a global view of combined connectivity from different VNFFGs of a given NS.
4.2 Relation to other ETSI NFV Group Specifications

The concepts of network services and forwarding graphs are described in ETSI GS NFV 002 [i.1].

Instances of objects created according to the templates specified in the present document are exchanged at the Os-Ma-Nfvo reference point as specified in ETSI GS NFV-IFA 013 [i.2].

The format of the VNF descriptors referenced in a network service template shall comply with the specifications in ETSI GS NFV-IFA 011 [2].

4.3 Conventions

The attributes of the NSD and associated information elements are described in the tables provided in clause 6. Each table has 5 columns, with the following significance:

- The "Attribute" column provides the attribute name.
- The "Qualifier" column indicates whether the support of the attribute is mandatory, optional or conditional.
- The "Cardinality" column contains the minimum and maximum cardinality of this information element (e.g. 1, 2, 0..N, 1..N). A cardinality range starting with 0 indicates that the attribute needs not always to be included.
- The "Content" column provides information on the type of the attribute values. It can be the name of an Information Element, a primitive type (Identifier, DateTime, etc.) or a generic UML type (String, Integer, etc.). If a cell in the "Content" column is marked as "Not specified", this means that the specification of the type is left to the data model design stage.
- The "Description column" provides a brief explanatory description and additional constraints.

The following notations, defined in ISO/IEC 9646-7 [i.4], are used for the qualifier column of information elements:

- M mandatory - the attribute shall be supported.
- O optional - the attribute may, but need not, be supported.
- CM conditional mandatory - the attribute shall be supported under certain conditions. If the specified conditions are met then the attribute shall be supported. These conditions are specified in the Description column.
• CO conditional optional - the attribute may, but need not, be supported under certain conditions. If the specified conditions are met then the attribute may, but need not, be supported. These conditions are specified in the Description column.

The following notation is used for parameters that represent identifiers, and for attributes that represent identifiers in information elements and notifications:

• If parameters are referring to an identifier of an actual object, their type is "Identifier".

• If an object (information element or notification) contains an attribute that identifies the object, the type of that attribute is "Identifier" and the description states that the attribute is the identifier of that particular notification or information element.

EXAMPLE 1: Identifier "resourceId" of the "NetworkSubnet information element" has type "Identifier" and description "Identifier of this NetworkSubnet information element".

• If an object (information element or notification) contains an attribute that references another object or objects defined in an ETSI NFV Group Specification (GS), the type of the attribute is "Identifier", followed by the list of objects it references.

EXAMPLE 2: "Identifier (Reference to Vnfc)" or "Identifier (Reference to Vnfc, VirtualLink or VirtualStorage)".

4.4 Various levels of NFV entities

For NFV management and orchestration, there are four basic levels of entities:

• Descriptors - general type definitions for things such as NSs, VNFs and VLs.

• Descriptor objects - an instance of a descriptor, e.g. an instance of an NSD (not an instance of a NS instantiated according to this NSD):
  - A descriptor object may provide (among other things) value ranges and default values for the attributes in the associated NFV entity class.
  - In the present document, the creation of subclasses of generic descriptors (e.g. NSD_x as a subclass of NSD) has been avoided, since this approach would create a proliferation of descriptor classes.

• NFV entity classes - these are classes that represent various NFV entities such as NS, VNF and VL. There is one-to-one mapping between the set of descriptor objects and the set of NFV entity classes. An example of NFV entity class is CDN NS.

• NFV entity instances - these are instances of a given NFV entity class. An NFV entity instance is used to represent the current state and attribute values for a given NFV entity. Each NFV entity instance is bound by the associated descriptor object, e.g. value ranges and default values for attributes. More than one NFV entity instance can be created from the same associated descriptor object. An example of NFV entity instance is CDN NS instance.

Each level puts constraints on the subsequent levels.

Information in a lower level does not appear in a higher level, e.g. NFV entity instance information does not appear in the associated NFV entity class, descriptor object or descriptor.

5 Functional requirements

5.1 Void
# 5.2 Functional requirements for Network Service Descriptor

Table 5.2-1 specifies functional requirements applicable to the templates for NSD instances.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_NSD001</td>
<td>The NSD shall reference the VNFDs applicable to its constituent VNFs.</td>
</tr>
<tr>
<td>NST_NSD002</td>
<td>The NSD shall include the VLDs applicable to the VLs used by the NS to interconnect its constituent NFs.</td>
</tr>
<tr>
<td>NST_NSD003</td>
<td>The NSD shall reference the PNFDs applicable to its constituent PNFs.</td>
</tr>
<tr>
<td>NST_NSD004</td>
<td>The NSD shall specify the Service Access Points (SAPs) of the NS.</td>
</tr>
<tr>
<td>NST_NSD005</td>
<td>The NSD shall include the descriptors of the VNFFGs applicable to the NS. See note 1.</td>
</tr>
<tr>
<td>NST_NSD006</td>
<td>The NSD shall support the capability to include or reference NS life cycle management scripts describing how to react upon specific life cycle events, fault detection, performance threshold crossing detection and other events that can occur at the NFVO reference points.</td>
</tr>
<tr>
<td>NST_NSD007</td>
<td>The NSD shall support the capability to provide monitoring parameters to be tracked during the lifetime of a NS instance. See note 2.</td>
</tr>
<tr>
<td>NST_NSD008</td>
<td>The NSD shall support the capability to describe one or more NS DF(s).</td>
</tr>
<tr>
<td>NST_NSD009</td>
<td>The NSD shall support the capability to describe auto scale rules, associating criteria to scaling actions (e.g. removing existing VNF instances from an NS instance).</td>
</tr>
<tr>
<td>NST_NSD010</td>
<td>The NSD shall include security information enabling validating its authenticity and integrity.</td>
</tr>
<tr>
<td>NST_NSD011</td>
<td>The NSD shall support the capability to reference NSDs used to instantiate nested or appended NSs. See note 3.</td>
</tr>
<tr>
<td>NST_NSD012</td>
<td>The NSD shall include a globally unique identifier for identifying each descriptor instance.</td>
</tr>
</tbody>
</table>

**NOTE 1:** A NS might have multiple graphs, for example, for:
1. Control plane traffic.
2. Management plane traffic.
3. User plane traffic.

**NOTE 2:** These can be used for specifying different Deployment Flavours (DF) for the NS in the NSD or in determining the need to scale-out.

**NOTE 3:** NSs are composable, i.e. they can include other NSs (a.k.a. nested NS) or other NSs can be appended to them.

# 5.3 Functional requirements for Network Service Deployment Flavour

Table 5.3-1 specifies functional requirements applicable to the templates for describing NS DF.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_NSF001</td>
<td>An NS DF description shall describe how many instances of each constituent VNF are required.</td>
</tr>
<tr>
<td>NST_NSF002</td>
<td>An NS DF description shall reference a VNF flavour to be used for each constituent VNF.</td>
</tr>
<tr>
<td>NST_NSF003</td>
<td>An NS DF description shall enable describing affinity and anti-affinity rules between the different instances of a constituent VNF.</td>
</tr>
<tr>
<td>NST_NSF004</td>
<td>An NS DF description shall enable describing affinity and anti-affinity rules between the constituent VNFs.</td>
</tr>
<tr>
<td>NST_NSF005</td>
<td>An NS DF description shall enable referencing a VL flavour to be used for each VL connected to its constituent VNFs.</td>
</tr>
<tr>
<td>NST_NSF006</td>
<td>An NS DF description shall enable describing affinity and anti-affinity rules between the different instances of a constituent VL.</td>
</tr>
<tr>
<td>NST_NSF007</td>
<td>An NS DF description shall enable describing affinity and anti-affinity rules between the constituent VLs.</td>
</tr>
<tr>
<td>NST_NSF008</td>
<td>An NS DF description shall support the capability to describe dependencies between VNF and/or nested NS instances in terms of primary and secondary entities. See note.</td>
</tr>
</tbody>
</table>

**NOTE:** This information is used, for example, to define the sequence in which various numbered VNF and/or nested NS should be instantiated by the NFVO.
5.4 Functional requirements for VNF Forwarding Graph Descriptor

Table 5.4-1 specifies functional requirements applicable to a VNFFGD.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_FGD001</td>
<td>A VNFFGD shall enable associating multiple network forwarding paths to a forwarding graph.</td>
</tr>
<tr>
<td>NST_FGD002</td>
<td>Within a VNFFGD, an NFP description shall enable associating a set of conditions captured in a rule to a sequence of connection points to be traversed by packets or frames matching these conditions. See note.</td>
</tr>
<tr>
<td>NST_FGD003</td>
<td>A VNFFGD shall reference the VNFDs and PNFDs of its constituent VNFs and PNFs.</td>
</tr>
<tr>
<td>NST_FGD004</td>
<td>A VNFFGD shall reference the VLDs applicable to instantiate VLS between the VNFs and PNFs that are part of the VNFFG.</td>
</tr>
<tr>
<td>NST_FGD005</td>
<td>A VNFFGD shall enable referencing a pool of descriptors of connection points attached to constituent VNFs and PNFs and/or of SAPs of the parent NS or of a nested NS.</td>
</tr>
</tbody>
</table>

NOTE: Annex A provides an overview of the mapping between NFV terminology and the IETF terminology for Service Function Chaining (SFC) and NFP management.

5.5 Functional requirements for Virtual Link Descriptor

Table 5.5-1 specifies functional requirements applicable to a VLD.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_VLD001</td>
<td>A VLD shall enable specifying the type of connectivity provided by the link (e.g. Layer 2 E-Line, E-LAN or E-Tree, or Layer 3).</td>
</tr>
<tr>
<td>NST_VLD002</td>
<td>A VLD shall enable specifying one or more VL DFs. See note.</td>
</tr>
</tbody>
</table>

NOTE: Different VL DFs may be used for different flavours of the same NS.

Table 5.5-2 specifies functional requirements for VL DF descriptions.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_VLDF001</td>
<td>A VL DF description shall enable specifying requirements on performance characteristics of the link for inter-VNF communication as well as communication with external entities and PNFs (e.g. round trip delay, jitter, packet loss ratio, etc.).</td>
</tr>
<tr>
<td>NST_VLDF002</td>
<td>A VL DF description shall enable specifying requirements on the throughput of the link (e.g. bandwidth of E-Line, root bandwidth of E-Tree, and aggregate capacity of E-LAN).</td>
</tr>
<tr>
<td>NST_VLDF003</td>
<td>A VL DF description shall enable specifying the throughput of leaf connections to the link (e.g. for E-Tree and E-LAN branches), where applicable for the connectivity topology being used.</td>
</tr>
<tr>
<td>NST_VLDF004</td>
<td>A VL DF description shall enable specifying service availability levels.</td>
</tr>
</tbody>
</table>

5.6 Functional requirements for Physical Network Function Descriptor

Table 5.6-1 specifies functional requirements applicable to a PNFD.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_PNF001</td>
<td>A PNFD shall enable specifying the characteristics of the connection points exposed by a PNF.</td>
</tr>
</tbody>
</table>
5.7 Functional requirements for PNFD archive

Table 5.7-1 specifies functional requirements applicable to the structure of a PNFD archive.

<table>
<thead>
<tr>
<th>Numbering</th>
<th>Requirement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST_PNFDA001</td>
<td>The PNFD contents shall be assembled as one single file, the PNFD archive.</td>
</tr>
<tr>
<td>NST_PNFDA002</td>
<td>The PNFD archive contents, including the PNF descriptor as well as manifest file, checksum, etc. constitutes a single delivery unit from a distribution perspective. Any changes to the constituency of this unit shall be considered as a change to the whole and therefore shall be versioned, tracked and inventoried as one.</td>
</tr>
<tr>
<td>NST_PNFDA003</td>
<td>The PNFD archive shall contain a change log. The change log captures the changes from one version to another.</td>
</tr>
<tr>
<td>NST_PNFDA004</td>
<td>The PNFD archive shall allow to store in the archive sets of related artifacts for use by functional blocks beyond NFV-MANO, and to assign a globally unique identifier to each set in an SDO-independent and vendor-independent manner.</td>
</tr>
<tr>
<td>NST_PNFDA005</td>
<td>The PNFD archive and each of its constituents shall be digitally signed by the creator of the PNFD archive or the creator of the specific constituent respectively. See note.</td>
</tr>
<tr>
<td>NST_PNFDA006</td>
<td>The digest and the public key of the entity signing the PNFD archive shall be included in the archive along with the corresponding certificate.</td>
</tr>
<tr>
<td>NST_PNFDA007</td>
<td>For each signed artifact, corresponding public key, algorithm and certificate used shall be stored in a well-known location within the PNFD archive.</td>
</tr>
<tr>
<td>NST_PNFDA008</td>
<td>Security sensitive artifacts shall be encrypted. Encryption keys for these artifacts should be different than the PNFD archive key to allow for better access control within the provider environment.</td>
</tr>
</tbody>
</table>

NOTE: The present document does not make any assumption on which organization or entity creates the PNFD archive.

6 Descriptors formats and contents

6.1 Void

6.2 Information elements related to the Network Service Descriptor

6.2.1 Introduction

Clauses 6.2.2 to 6.2.9.2 define the information elements related to the NSD.

The UML information diagram of the NSD is provided in figure 6.2.1-1.
6.2.2 Network Service Descriptor information element

6.2.2.1 Description

The NSD information element is a deployment template whose instances are used by the NFVO for the lifecycle management of NSs.

6.2.2.2 Attributes

The attributes of the NSD information element shall follow the indications provided in table 6.2.2.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsdIdentifier</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this NSD information element. It globally uniquely identifies an instance of the NSD.</td>
</tr>
<tr>
<td>designer</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Specifies the designer of the NSD.</td>
</tr>
<tr>
<td>version</td>
<td>M</td>
<td>1</td>
<td>Version</td>
<td>Provides the version of the NSD.</td>
</tr>
<tr>
<td>nsdName</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Provides the human readable name of the NSD.</td>
</tr>
<tr>
<td>nsdInvariantId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies an NSD in a version independent manner. This attribute is invariant across versions of NSD.</td>
</tr>
<tr>
<td>nestedNsId</td>
<td>M</td>
<td>0..N</td>
<td>(Reference to Nsd)</td>
<td>References the NSD of a constituent nested NS. See note 1.</td>
</tr>
<tr>
<td>vnfdId</td>
<td>M</td>
<td>0..N</td>
<td>Identifier (Reference to Vnfd)</td>
<td>References the VNFD of a constituent VNF. See note 1.</td>
</tr>
<tr>
<td>pnfdId</td>
<td>M</td>
<td>0..N</td>
<td>Identifier (Reference to Pnfd)</td>
<td>References the PNFD of a constituent PNF. See note 1.</td>
</tr>
<tr>
<td>sapd</td>
<td>M</td>
<td>0..N</td>
<td>Sapd</td>
<td>Provides the descriptor of a service access point of the network service.</td>
</tr>
<tr>
<td>virtualLinkDesc</td>
<td>M</td>
<td>0..N</td>
<td>NsVirtualLinkDesc</td>
<td>Provides the constituent VLDs.</td>
</tr>
</tbody>
</table>

Figure 6.2.1-1: UML information diagram of NSD
### 6.2.3 Sapd information element

#### 6.2.3.1 Description

The Sapd information element specifies the information used to instantiate the service access points of an NS. A Sapd inherits from the corresponding Cpd Class (see clause 6.6.3). All attributes of the Cpd are also attributes of the Sapd.

#### 6.2.3.2 Attributes

The attributes of the Sapd information element shall follow the indications provided in table 6.2.3.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsVirtualLinkDescId</td>
<td>M</td>
<td>0..1</td>
<td>Identifier</td>
<td>References the descriptor of the NS VL instance to which the SAP instantiated from this SAPD connects to. See note.</td>
</tr>
<tr>
<td>associatedCpdId</td>
<td>M</td>
<td>0..1</td>
<td>Identifier</td>
<td>References the descriptor of VNF external connection points (defined in clause 7.1.3 of ETSI GS NFV-IFA 011 [2]) or the descriptor of PNF external connection points (defined in clause 6.6.4) or the descriptor of the SAP of a nested NS of this NS, which the SAPs instantiated from this SAPD are mapped to. See note.</td>
</tr>
</tbody>
</table>

(inherited attributes) All attributes inherited from corresponding Cpd.

NOTE: At most one of the two attributes associatedCpdId and nsVirtualLinkDescId shall be included.

### 6.2.4 Void

### 6.2.5 SecurityParameters information element

#### 6.2.5.1 Description

The SecurityParameters information element contains the signature of an NSD instance together with information required to validate the signature.
6.2.5.2 Attributes

The attributes of the SecurityParameters information element shall follow the indications provided in table 6.2.5.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>signature</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Provides the signature of the signed part of the descriptor.</td>
</tr>
<tr>
<td>algorithm</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Specifies the algorithm used to compute the signature.</td>
</tr>
<tr>
<td>certificate</td>
<td>M</td>
<td>0..1</td>
<td>Not specified</td>
<td>Provides a certificate or a reference to a certificate to validate the signature. See note.</td>
</tr>
</tbody>
</table>

NOTE: Cardinality of 0 corresponds to the case where the certificate is provided by means outside the NSD.

6.2.6 MonitoredData Information element

6.2.6.1 Description

The MonitoredData information element identifies information to be monitored during the lifetime of a network service instance.

6.2.6.2 Attributes

The attributes of the MonitoredData information element shall follow the indications provided in table 6.2.6.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vnfIndicatorInfo</td>
<td>M</td>
<td>0..1</td>
<td>VnfIndicatorData</td>
<td>Provides information on a VNF Indicator to be monitored. See note.</td>
</tr>
<tr>
<td>monitoringParameter</td>
<td>M</td>
<td>0..1</td>
<td>MonitoringParameter</td>
<td>Specifies the virtualised resource related performance metric to be monitored on an NS level or VNF level. See note.</td>
</tr>
</tbody>
</table>

NOTE: One and only one of the attributes shall be included (i.e. there is a XOR relationship between the attributes).

6.2.7 VnfIndicatorData Information element

6.2.7.1 Description

The VnfIndicatorData information element identifies a VNF indicator in a VNFD.

6.2.7.2 Attributes

The attributes of the VnfIndicatorData information element shall follow the indications provided in table 6.2.7.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vnfId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to Vnf)</td>
<td>Identifies a VNF.</td>
</tr>
<tr>
<td>vnfIdIndicator</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to VnfIndicator)</td>
<td>Identifies a VNF indicator within the VNFD.</td>
</tr>
</tbody>
</table>
6.2.8 MonitoringParameter Information element

6.2.8.1 Description
The MonitoringParameter information element specifies a virtualised resource related performance metric to be monitored.

6.2.8.2 Attributes
The attributes of the MonitoringParameter information element shall follow the indications provided in table 6.2.8.2-1.

Table 6.2.8.2-1: Attributes of the MonitoringParameter information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>monitoringParameterId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Unique identifier of this monitoring parameter information element.</td>
</tr>
<tr>
<td>name</td>
<td>M</td>
<td>0..1</td>
<td>String</td>
<td>Human readable name of the monitoring parameter.</td>
</tr>
<tr>
<td>performanceMetric</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Defines the virtualised resource-related performance metric. See note.</td>
</tr>
<tr>
<td>collectionPeriod</td>
<td>M</td>
<td>0..1</td>
<td>Not specified</td>
<td>An attribute that describes the periodicity at which to collect the performance information.</td>
</tr>
</tbody>
</table>

NOTE: The NFVO collects the performance reports corresponding to metric defined in this attribute from the VIMs and VNFM using one or more PM Jobs.

6.2.9 LifeCycleManagementScript Information element

6.2.9.1 Description
The LifeCycleManagementScript information element specifies a script for the NS.

6.2.9.2 Attributes
The attributes of the LifeCycleManagementScript information element shall follow the indications provided in table 6.2.9.2-1.

Table 6.2.9.2-1: Attributes of the LifeCycleManagementScript information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>event</td>
<td>M</td>
<td>1..N</td>
<td>String</td>
<td>Describes NS lifecycle event(s) or an external stimulus detected on an NFVO reference point. See notes 1 and 2.</td>
</tr>
<tr>
<td>script</td>
<td>M</td>
<td>1</td>
<td>Not specified</td>
<td>Includes an NS LCM script (e.g. written in a DSL) triggered to react to one of the events listed in the event attribute.</td>
</tr>
</tbody>
</table>

NOTE 1: A minimum set of NS lifecycle events triggered internally by the NFVO includes: start instantiation, end instantiation, start scaling, end scaling, start healing, end healing, start termination, end termination, start update, end update.

NOTE 2: A minimum set of external stimulus includes: the receipt of request message of instantiation, scaling, healing, termination, update of NS.

6.2.10 Information elements related to NS lifecycle management operations

6.2.10.1 Introduction
This clause defines information elements which represent additional parameters for lifecycle management operations of NS, as specified in ETSI GS NFV-IFA 013 [i.2].
6.2.10.2 NsLcmAdditionalParams information element

6.2.10.2.1 Description

This information element is a container for all additional parameters that affect the invocation of NS Lifecycle Management operations, structured by operation.

6.2.10.2.2 Attributes

The attributes of NsLcmAdditionalParams information element shall follow the indications provided in table 6.2.10.2.2-1.

Table 6.2.10.2.2-1: Attributes of NsLcmAdditionalParams information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>instantiateNsAdditionalParams</td>
<td>M</td>
<td>0..1</td>
<td>InstantiateNsAdditionalParams</td>
<td>Additional parameters for the Instantiate NS operation.</td>
</tr>
<tr>
<td>scaleNsAdditionalParams</td>
<td>M</td>
<td>0..1</td>
<td>ScaleNsAdditionalParams</td>
<td>Additional parameters for the Scale NS operation.</td>
</tr>
<tr>
<td>healNSAdditionalParams</td>
<td>M</td>
<td>0..1</td>
<td>HealNsAdditionalParams</td>
<td>Additional parameters for the Heal NS operation.</td>
</tr>
</tbody>
</table>

6.2.10.3 InstantiateNsAdditionalParams information element

6.2.10.3.1 Description

This information element defines attributes that represent additional parameters for invocation of the Instantiate NS operation.

6.2.10.3.2 Attributes

The attributes of InstantiateNsAdditionalParams information element shall follow the indications provided in table 6.2.10.3.2-1.

Table 6.2.10.3.2-1: Attributes of InstantiateNsAdditionalParams information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsAdditionalParam</td>
<td>M</td>
<td>0..N</td>
<td>Not specified</td>
<td>Array of KVP requirements for additional parameters of NS to be passed when invoking the Instantiate NS operation. See note.</td>
</tr>
</tbody>
</table>

NOTE: It is assumed that the KVP requirements will be implicitly used to define the value type.

6.2.10.4 ScaleNsAdditionalParams information element

6.2.10.4.1 Description

This information element defines attributes that represent additional parameters for invocation of the Scale NS operation.

6.2.10.4.2 Attributes

The attributes of the ScaleNsAdditionalParams information element shall follow the indications provided in table 6.2.10.4.2-1.
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsAdditionalParam</td>
<td>M</td>
<td>0..N</td>
<td>Not specified</td>
<td>Array of KVP requirements for additional parameters of NS to be passed when invoking the Scale Ns operation. See note.</td>
</tr>
</tbody>
</table>

**NOTE:** It is assumed that the KVP requirements will be implicitly used to define the value type.

6.2.10.5 HealNsAdditionalParams information element

6.2.10.5.1 Description

This information element defines attributes that represent additional parameters for invocation of the Heal Ns operation.

6.2.10.5.2 Attributes

The attributes of the HealNsAdditionalParams information element shall follow the indications provided in table 6.2.10.5.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsAdditionalParam</td>
<td>M</td>
<td>0..N</td>
<td>Not specified</td>
<td>Array of KVP requirements for additional parameters of NS when invoking the Heal Ns operation. See note.</td>
</tr>
</tbody>
</table>

**NOTE:** It is assumed that the KVP requirements will be implicitly used to define the value type.

6.3 Information elements related to the Network Service Deployment Flavour

6.3.1 Introduction

Clauses 6.3.2 to 6.3.12.2 define the information elements related to the NsDf.

6.3.2 NsDf information element

6.3.2.1 Description

The NsDf information element specifies the properties of a variant of an NS.
6.3.2.2 Attributes

The attributes of the NsDf information element shall follow the indications provided in table 6.3.2.2-1.

Table 6.3.2.2-1: Attributes of the NsDf information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsDfId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies this NsDf information element. It identifies a NS DF within the NSD.</td>
</tr>
<tr>
<td>flavourKey</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Assurance parameter against which this flavour is being described. The key can be a combination of multiple assurance parameters with a logical relationship between them. The parameters should be present as a monitoredInfo attribute in this NsDf.</td>
</tr>
<tr>
<td>vnfProfile</td>
<td>M</td>
<td>0..N</td>
<td>VnfProfile</td>
<td>VNF profile to be used for the NS flavour.</td>
</tr>
<tr>
<td>pnfProfile</td>
<td>M</td>
<td>0..N</td>
<td>PnfProfile</td>
<td>PNF profile to be used for the NS flavour.</td>
</tr>
<tr>
<td>virtualLinkProfile</td>
<td>M</td>
<td>0..N</td>
<td>VirtualLinkProfile</td>
<td>VL profile to be used for the NS flavour.</td>
</tr>
<tr>
<td>scalingAspect</td>
<td>M</td>
<td>0..N</td>
<td>NsScalingAspect</td>
<td>The scaling aspects supported by this DF of the NS.</td>
</tr>
<tr>
<td>affinityOrAntiAffinityGroup</td>
<td>M</td>
<td>0..N</td>
<td>AffinityOrAntiAffinityGroup</td>
<td>Specifies affinity or anti-affinity relationship applicable between the VNF instances created using different VNFDs, the Virtual Link instances created using different NsVirtualLinkDescs or the nested NS instances created using different NSDs in the same affinity or anti-affinity group. See clause 6.3.5.</td>
</tr>
<tr>
<td>nsInstantiationLevel</td>
<td>M</td>
<td>1..N</td>
<td>NsLevel</td>
<td>Describes the details of an NS level. See clause 6.3.9. See note.</td>
</tr>
<tr>
<td>defaultNsInstantationLevelId</td>
<td>M</td>
<td>0..1</td>
<td>Identifier</td>
<td>Identifies the NS level which represents the default NS instantiation level for this DF. It shall be present if there are multiple &quot;nsInstantiationLevel&quot; entries.</td>
</tr>
<tr>
<td>nsLcmAdditionalParams</td>
<td>M</td>
<td>0..1</td>
<td>NsLcmAdditionalParams</td>
<td>Additional parameters for NS Lifecycle Management operations.</td>
</tr>
<tr>
<td>nsProfile</td>
<td>M</td>
<td>0..N</td>
<td>NsProfile</td>
<td>Specifies a NS Profile supported by this NS DF.</td>
</tr>
<tr>
<td>dependencies</td>
<td>M</td>
<td>0..N</td>
<td>Dependencies</td>
<td>Specifies the order in which instances of the VNFs and/or nested NSs have to be created.</td>
</tr>
<tr>
<td>monitoredInfo</td>
<td>M</td>
<td>0..N</td>
<td>MonitoredData</td>
<td>Specifies either a virtualised resource-related performance metric or a VNF Indicator to be monitored.</td>
</tr>
</tbody>
</table>

NOTE: Every VNF, VL and nested NS whose descriptor is referenced by the NS DF shall be involved in an NS instantiation level of the parent NS. If no instances of a given VNF/nested NS have to be deployed at NS instantiation time, the numberOfInstances attribute in the corresponding VnfToLevelMapping/NsToLevelMapping information element shall be set to 0.

6.3.3 VnfProfile information element

6.3.3.1 Description

The VnfProfile information element specifies a profile for instantiating VNFs of a particular NS DF according to a specific VNFD and VNF DF.

6.3.3.2 Attributes

The attributes of the VnfProfile information element shall follow the indications provided in table 6.3.3.2-1.
Table 6.3.3.2-1: Attributes of the VnfProfile information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vnfProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this vnfProfile information element. It uniquely identifies a VnfProfile.</td>
</tr>
<tr>
<td>vnfId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to Vnf)</td>
<td>References a VNFD.</td>
</tr>
<tr>
<td>flavourId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to VnfDf)</td>
<td>Identifies a flavour within the VNFD. See note 1.</td>
</tr>
<tr>
<td>instantiationLevel</td>
<td>M</td>
<td>0..1</td>
<td>Identifier</td>
<td>Identifier of the instantiation level of the VNF DF to be used for instantiation. If not present, the default instantiation level as declared in the VNFD shall be used.</td>
</tr>
<tr>
<td>minNumberOfInstances</td>
<td>M</td>
<td>1</td>
<td>Integer</td>
<td>Minimum number of instances of the VNF based on this VNFD that is permitted to exist for this VnfProfile.</td>
</tr>
<tr>
<td>maxNumberOfInstances</td>
<td>M</td>
<td>1</td>
<td>Integer</td>
<td>Maximum number of instances of the VNF based on this VNFD that is permitted to exist for this VnfProfile.</td>
</tr>
<tr>
<td>localAffinityOrAntiAffinityRule</td>
<td>M</td>
<td>0..N</td>
<td>LocalAffinityOrAntiAffinityRule</td>
<td>Specifies affinity and anti-affinity rules applicable between VNF instances created from this profile. See clause 6.3.8.</td>
</tr>
<tr>
<td>affinityOrAntiAffinityGroupId</td>
<td>M</td>
<td>0..N</td>
<td>Identifier</td>
<td>Identifier(s) of the affinity or anti-affinity group(s) the VnfProfile belongs to. See note 2.</td>
</tr>
<tr>
<td>nsVirtualLinkConnectivity</td>
<td>M</td>
<td>1..N</td>
<td>NsVirtualLinkConnectivity</td>
<td>Defines the connection information of the VNF, it contains connection relationship between a VNF connection point and a NS Virtual Link.</td>
</tr>
</tbody>
</table>

NOTE 1: The VnfDf information element is defined in ETSI GS NFV-IFA 011 [2], clause 7.1.8.2.
NOTE 2: Each identifier references an affinity or anti-affinity group which expresses affinity or anti-affinity relationships between the VNF instance(s) created using this VnfProfile and the VNF instance(s) created using other VnfProfile(s) in the same group.

6.3.4 VirtualLinkProfile information element

6.3.4.1 Description

The VirtualLinkProfile information element specifies a profile for instantiating VLs of a particular NS DF according to a specific VLD and VL DF.

6.3.4.2 Attributes

The attributes of the VirtualLinkProfile information element shall follow the indications provided in table 6.3.4.2-1.
### Table 6.3.4.2-1: Attributes of the VirtualLinkProfile information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>virtualLinkProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Uniquely identifies this VirtualLinkProfile information element.</td>
</tr>
<tr>
<td>virtualLinkDescId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to NsVirtualLinkDesc)</td>
<td>Uniquely references a VLD.</td>
</tr>
<tr>
<td>flavourId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to VirtualLinkDf)</td>
<td>Identifies a flavour within the VLD.</td>
</tr>
<tr>
<td>localAffinityOrAntiAffinityRule</td>
<td>M</td>
<td>0..N</td>
<td>LocalAffinityOrAntiAffinityRule</td>
<td>Specifies affinity and anti-affinity rules applicable between VLs instantiated from the referenced VLD. See clause 6.3.8.</td>
</tr>
<tr>
<td>affinityOrAntiAffinityGroupId</td>
<td>M</td>
<td>0..N</td>
<td>Identifier (Reference to AffinityOrAntiAffinityGroup)</td>
<td>References an affinity or anti-affinity group the VLs instantiated according to the VlProfile belong to. See note 1.</td>
</tr>
<tr>
<td>maxBitrateRequirements</td>
<td>M</td>
<td>1</td>
<td>LinkBitrateRequirements</td>
<td>Specifies the maximum bitrate requirements for a VL instantiated according to this profile. See clause 6.5.5. See note 2.</td>
</tr>
<tr>
<td>minBitrateRequirements</td>
<td>M</td>
<td>1</td>
<td>LinkBitrateRequirements</td>
<td>Specifies the minimum bitrate requirements for a VL instantiated according to this profile. See clause 6.5.5. See note 2.</td>
</tr>
</tbody>
</table>

**NOTE 1:** Each identifier references an affinity or anti-affinity group which expresses affinity or anti-affinity relationship between the VL(s) using this VirtualLinkProfile and the VL(s) using other VirtualLinkProfile(s) in the same group.

**NOTE 2:** These attributes are used to control scaling boundaries.

### 6.3.5 AffinityOrAntiAffinityGroup information element

#### 6.3.5.1 Description

The AffinityOrAntiAffinityGroup information element describes the affinity or anti-affinity relationship applicable between the VNF instances created using different VnfProfiles, the Virtual Link instances created using different VlProfiles or the nested NS instances created using different NsProfiles.

#### 6.3.5.2 Attributes

The attributes of the AffinityOrAntiAffinityGroup information element shall follow the indications provided in table 6.3.5.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>groupId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of Identifier of this AffinityOrAntiAffinityGroup information element.</td>
</tr>
<tr>
<td>affinityOrAntiAffinity</td>
<td>M</td>
<td>1</td>
<td>Enum</td>
<td>Specifies the type of relationship that the members of the group have: &quot;affinity&quot; or &quot;anti-affinity&quot;.</td>
</tr>
<tr>
<td>scope</td>
<td>M</td>
<td>1</td>
<td>Enum</td>
<td>Specifies the scope of the affinity or anti-affinity relationship e.g. a NFVI node, an NFVI PoP, etc.</td>
</tr>
</tbody>
</table>
6.3.6 PnfProfile information element

6.3.6.1 Description

The PnfProfile information element describes additional data for a given PNF instance used in a DF.

6.3.6.2 Attributes

The attributes of the PnfProfile information element shall follow the indications provided in table 6.3.6.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pnfProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this PnfProfile information element. It uniquely identifies a PnfProfile.</td>
</tr>
<tr>
<td>pnfld</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>References a PNFD.</td>
</tr>
<tr>
<td>pnfVirtualLinkConnectivity</td>
<td>M</td>
<td>1..N</td>
<td>NsVirtualLinkConnectivity</td>
<td>Defines the connection information of the PNF, it contains connection relationship between a PNF connection point and a NS Virtual Link.</td>
</tr>
</tbody>
</table>

6.3.7 NsVirtualLinkConnectivity information element

6.3.7.1 Description

The NsVirtualLinkConnectivity information element describes connection information between a connection point and a NS Virtual Link.

6.3.7.2 Attributes

The attributes of the NsVirtualLinkConnectivity information element shall follow the indications provided in table 6.3.7.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>virtualLinkProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>References an NS VL profile.</td>
</tr>
<tr>
<td>constituentCpdlId</td>
<td>M</td>
<td>1..N</td>
<td>CpdInConstituentElement</td>
<td>Describes a connection point on a VNF/PNF or a SAP which connects to virtual links instantiated from the profile identified in the virtualLinkProfileId attribute.</td>
</tr>
</tbody>
</table>

6.3.8 LocalAffinityOrAntiAffinityRule information element

6.3.8.1 Description

The LocalAffinityOrAntiAffinityRule information element specifies affinity or anti-affinity rules applicable to VNFs or VLS instantiated from the same VNFD or VLD.
6.3.8.2 Attributes

The attributes of the LocalAffinityOrAntiAffinityRule information element shall follow the indications provided in table 6.3.8.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>M</td>
<td>1</td>
<td>Enum</td>
<td>Specifies whether the rule is an affinity rule or an anti-affinity rule.</td>
</tr>
<tr>
<td>scope</td>
<td>M</td>
<td>1</td>
<td>Enum</td>
<td>Specifies the scope of the rule: possible values are &quot;NFVI-PoP&quot;, &quot;Zone&quot;,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;ZoneGroup&quot;, &quot;NFVI-node&quot;.</td>
</tr>
</tbody>
</table>

6.3.9 NsLevel information element

6.3.9.1 Description

The NsLevel information element describes the details of an NS level. An NS level consists of a list of involved entities, i.e. VNFs, VLs and/or nested NSs. For each involved VNF/nested NS, the number of instances required by the NS level is specified. For each involved VL, the bitrate requirements corresponding to the NS level are specified.

NS levels shall be used in the context of NS instantiation and in this case they are referred to as NS instantiation levels. Every VNF, VL and nested NS whose descriptor is referenced by the NS DF shall be involved in an NS instantiation level of the parent NS. If no instances of a given VNF/nested NS have to be deployed at NS instantiation time, the numberOfInstances attribute in the corresponding VnfToLevelMapping/NsToLevelMapping information element shall be set to 0.

NS levels may be used in the context of NS scaling and in this case they are referred to as NS scale levels. Only a subset of the VNFs, VLs and nested NSs whose descriptor is referenced by the NS DF may be involved in an NS scale level of the parent NS.

6.3.9.2 Attributes

The attributes of the NsLevel information element shall follow the indications provided in table 6.3.9.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsLevelId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this NsLevel information element. It uniquely identifies an NS level within the DF.</td>
</tr>
<tr>
<td>description</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Human readable description of the NS level.</td>
</tr>
<tr>
<td>vnfToLevelMapping</td>
<td>M</td>
<td>0..N</td>
<td>VnfToLevelMapping</td>
<td>Specifies the profile of the VNFs involved in this NS level and, for each of them, the required number of instances. See note.</td>
</tr>
<tr>
<td>virtualLinkToLevelMapping</td>
<td>M</td>
<td>0..N</td>
<td>VirtualLinkToLevelMapping</td>
<td>Specifies the profile of the VLs involved in this NS level and, for each of them, the needed bandwidth. See note.</td>
</tr>
<tr>
<td>nsToLevelMapping</td>
<td>M</td>
<td>0..N</td>
<td>NsToLevelMapping</td>
<td>Specifies the profile of the nested NSs involved in this NS level and, for each of them, the required number of instances. See note.</td>
</tr>
</tbody>
</table>

NOTE: At least one attribute between vnfToLevelMapping, virtualLinkToLevelMapping and nsToLevelMapping shall be present.
6.3.10  NsScaleInfo information element

6.3.10.1  Description
The NsScaleInfo information element represents a scale level for a particular scaling aspect.

6.3.10.2  Attributes
The attributes of the NsScaleInfo information element shall follow the indications provided in table 6.3.10.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsScalingAspectId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of the NS scaling aspect.</td>
</tr>
<tr>
<td>nsScaleLevelId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of the NS scale level.</td>
</tr>
</tbody>
</table>

6.3.11  NsProfile information element

6.3.11.1  Description
The NsProfile information element specifies the profile to be used for a nested NS.

6.3.11.2  Attributes
The attributes of the NsProfile information element shall follow the indications provided in table 6.3.11.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies an NS profile.</td>
</tr>
<tr>
<td>nsdId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies the NSD applicable to NS instantiated according to this profile.</td>
</tr>
<tr>
<td>nsDfId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies the applicable NS DF within the scope of the NSD.</td>
</tr>
<tr>
<td>nsInstantiationLevelId</td>
<td>M</td>
<td>1..1</td>
<td>Identifier</td>
<td>Identifies the NS level within the referenced NS DF to be used in the context of the parent NS instantiation. If not present, the default NS instantiation level as declared in the referenced NSD shall be used.</td>
</tr>
<tr>
<td>minNumberOfInstances</td>
<td>M</td>
<td>1</td>
<td>Integer</td>
<td>Minimum number of nested NS instances based on the referenced NSD that is permitted to exist for this NsProfile.</td>
</tr>
<tr>
<td>maxNumberOfInstances</td>
<td>M</td>
<td>1</td>
<td>Integer</td>
<td>Maximum number of nested NS instances based on the referenced NSD that is permitted to exist for this NsProfile.</td>
</tr>
<tr>
<td>affinityOrAntiAffinityGroupId</td>
<td>M</td>
<td>1..N</td>
<td>Identifier</td>
<td>Identifies an affinity or anti-affinity group the NSs created according to this NsProfile belongs to.</td>
</tr>
<tr>
<td>nsVirtualLinkConnectivity</td>
<td>M</td>
<td>1..N</td>
<td>nsVirtualLinkConnectivity</td>
<td>Defines the connection information of the NS, it contains connection relationship between an NS SAP and a NS virtual Link of the composite NS.</td>
</tr>
</tbody>
</table>

NOTE: Each identifier references an affinity or anti-affinity group which expresses affinity or anti-affinity relationships between the NS instance(s) created using this NsProfile and the NS instance(s) created using other NsProfile(s) in the same group.
6.3.12 Dependencies information element

6.3.12.1 Description

The Dependencies information element provides indications on the order in which VNFs associated to different VNF Profiles and/or nested NSs associated to different NS Profiles are to be instantiated.

6.3.12.2 Attributes

The attributes of the Dependencies information element shall follow the indications provided in table 6.3.12.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>primaryId</td>
<td>M</td>
<td>1..N</td>
<td>Identifier (Reference to VnfProfile or NsProfile)</td>
<td>References a VnfProfile or NsProfile. See note.</td>
</tr>
<tr>
<td>secondaryId</td>
<td>M</td>
<td>1..N</td>
<td>Identifier (Reference to VnfProfile or NsProfile)</td>
<td>References a VnfProfile or NsProfile. See note.</td>
</tr>
</tbody>
</table>

NOTE: NFV Management and Orchestration functions shall instantiate VNFs from the VnfProfile and/or nested NSs from the NsProfile referenced in the primary attribute before instantiating VNFs from the VnfProfile and/or nested NSs from the NsProfile referenced in the secondary attribute.

6.4 Information elements related to the VNF Forwarding Graph Descriptor

6.4.1 Introduction

Clauses 6.4.2 to 6.4.5.2 define the information elements related to the VNFFGD.

6.4.2 Vnffgd information element

6.4.2.1 Description

The Vnffgd information element specifies a topology of connectivity of a NS and optionally forwarding rules applicable to the traffic conveyed over this topology.

6.4.2.2 Attributes

The attributes of the Vnffgd information element shall follow the indications provided in table 6.4.2.2-1.
Table 6.4.2.2-1: Attributes of the Vnffgd information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vnffgdId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this Vnffgd information element. It uniquely identifies a VNFFGD.</td>
</tr>
<tr>
<td>vnfProfileId</td>
<td>M</td>
<td>1..N</td>
<td>Identifier (Reference to VnfProfile)</td>
<td>References the VnfProfile of a constituent VNF. See notes 1 and 2.</td>
</tr>
<tr>
<td>pnfProfileId</td>
<td>M</td>
<td>0..N</td>
<td>Identifier (Reference to PnfProfile)</td>
<td>References the PnfProfile of a constituent PNF. See notes 1 and 2.</td>
</tr>
<tr>
<td>nestedNsProfileId</td>
<td>M</td>
<td>0..N</td>
<td>Identifier (Reference to NsProfile)</td>
<td>References the NsProfile of a nestedNS. See notes 1 and 2.</td>
</tr>
<tr>
<td>virtualLinkProfileId</td>
<td>M</td>
<td>1..N</td>
<td>Identifier (Reference to NsVirtualLinkProfile)</td>
<td>References the Virtual Link Profile of a constituent VL. See note 3.</td>
</tr>
<tr>
<td>nfpPositionElement</td>
<td>M</td>
<td>1..N</td>
<td>NfpPositionElement</td>
<td>NfpPositionElement associated with one of the constituent VNF Profile, PNF Profile or NS Profile of a nested NS.</td>
</tr>
<tr>
<td>nfpd</td>
<td>M</td>
<td>0..N</td>
<td>Nfpd</td>
<td>The network forwarding path associated to the VNFFG. See clause 6.4.3.</td>
</tr>
</tbody>
</table>

NOTE 1: The list of constituent VNFs, PNFs, and nested NSs of a VNFFG can be identical to the list of constituent VNFs, PNFs and nested NSs of the parent NSD, or can be a subset of it.

NOTE 2: The presence of a VnfProfile or PnfProfile identifier in a VNFFGD does not imply that all connection points instantiated from all related CPDs are connected to the VNFFG instantiated using the VNFFGD.

NOTE 3: The presence of a VL profile identifier in a VNFFGD does not imply that all connection points connected to the VLs instantiated using this profile are also connected to the VNFFG instantiated using the VNFFGD.

6.4.3 Nfpd information element

6.4.3.1 Description

The Nfpd information element associates traffic flow criteria to a list of descriptors associated to the connection points and service access points to be visited by traffic flows matching these criteria.

6.4.3.2 Attributes

The attributes of the Nfpd information element shall follow the indications provided in table 6.4.3.2-1.

Table 6.4.3.2-1: Attributes of the Nfpd information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfpdId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies this nfpd information element within a VNFFG.</td>
</tr>
<tr>
<td>nfpRule</td>
<td>M</td>
<td>0..1</td>
<td>Rule</td>
<td>Provides an NFP classification and selection rule. The rule may be expressed as a criteria constructed out of atomic assertions linked by Boolean operators AND, OR and NOT. See note 1.</td>
</tr>
<tr>
<td>nfpPositionDesc</td>
<td>M</td>
<td>1..N</td>
<td>NfpPositionDesc</td>
<td>Describes a position in the NFP in terms of one or more CPDs and SAPDs and rules for distributing the traffic among CP and SAP instances created from these CPDs and SAPDs. See note 2.</td>
</tr>
</tbody>
</table>

NOTE 1: Examples of atomic assertions are assertions on packet header fields' values, date and time ranges, etc.

NOTE 2: When multiple values are provided, the order is significant and specifies the sequence of connection points (or group of connection points) to be traversed by traffic flows.
6.4.4 Void

6.4.5 NfpPositionDesc information element

6.4.5.1 Description

The NfpPositionDesc information element references one or more CPDs or SAPDs and provides rules on how to route traffic flows among CP or SAP instances instantiated from these descriptors.

6.4.5.2 Attributes

The attributes of the NfpPositionDesc information element shall follow the indications provided in table 6.4.5.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfpPositionDescId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this NfpPositionDesc element.</td>
</tr>
<tr>
<td>nfpPositionElementId</td>
<td>M</td>
<td>1..N</td>
<td>Identifier (Reference to NfpPositionElement)</td>
<td>References one or a pair of CPDs or SAPDs.</td>
</tr>
</tbody>
</table>
| forwardingBehaviour      | M         | 0..1        | Enum                              | Specifies a rule to apply to forward traffic to CP or SAP instances corresponding to the referenced CPD(s) and SAPD(s). The minimum list of rules to be supported shall include:  
  • ALL = Traffic flows shall be forwarded simultaneously to all CP or SAP instances created from the referenced CP profile(s).  
  • LB = Traffic flows shall be forwarded to one CP or SAP instance created from the referenced CP profile(s) selected based on a load-balancing algorithm.  
  See note 1.                                                                 |
| forwardingBehaviourInPutParameters | M         | 0..1        | Not Specified                     | Provides input parameters to configure the forwarding behaviour (e.g. identifies a load balancing algorithm). |

**NOTE 1:** When no rules are provided and there are multiple CP or SAP instances corresponding to the referenced CPD(s) and SAPD(s), the VIM and/or the NFVI are expected to apply NFP-independent rules determined by means outside the scope of the present document.

**NOTE 2:** An NFP position corresponds to one or more instances of the same Service Function (SF) in a given Service Function Chain, as defined in IETF RFC 7665 [i.6]. An NfpPositionElement describes the ingress and egress connection points corresponding to an instance of this SF. As illustrated in Annex A, these connection points may - but need not - be attached to the same VNF, PNF or nested NS instance.

6.4.6 NfpPositionElement information element

6.4.6.1 Description

The NfpPositionElement information element references one or two CPD(s) or SAPD(s) for a given VnfProfile, PnfProfile or NsProfile. The usage of profiles enables differentiating the CPDs or SAPDs specified in the same VNFD/PNFD/NSD that are applicable to different VNF/PNF/NS instances derived from the same VNFD/PNFD/NSD.
6.4.6.2 Attributes

The attributes of the NfpPositionElement information element shall follow the indications provided in table 6.4.6.2-1.

Table 6.4.6.2-1: Attributes of the NfpPositionElement information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nfpPositionElementId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this NfpPositionElement information element. It uniquely identifies an NfpPositionElement.</td>
</tr>
<tr>
<td>nfpPositionElementDesc</td>
<td>M</td>
<td>1..2</td>
<td>CpdInConstituentElement</td>
<td>Specifies a CPD or SAPD in the context of a profile of an NS constituent element. See note 5.</td>
</tr>
</tbody>
</table>

NOTE 1: Void.
NOTE 2: Void.
NOTE 3: Void.
NOTE 4: Void.
NOTE 5: When only one value is provided, the ingress and egress traffic is associated to a single CPD or SAPD. When two values are provided, the ingress CP/SAP is associated to the first value and the egress CP/SAP is associated to the second value.

6.4.7 ConstituentProfileElements information element - DEPRECATED

6.4.7.1 Description

The ConstituentProfileElements information element references a CPD or a SAPD for a given VnfProfile, PnfProfile or NsProfile. This information element was deprecated in ETSI GS NFV-IFA 014 ed. 2.7.1.

6.4.7.2 Attributes

The attributes of the ConstituentProfileElements information element shall follow the indications provided in table 6.4.7.2-1.

Table 6.4.7.2-1: Attributes of the ConstituentProfileElements information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>constituentBaseElementId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>References the constituents of the CpProfile.</td>
</tr>
<tr>
<td>constituentCpdlId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>References the VNF external CPD for a given VnfProfile, or the PNF external CPD for a given PnfProfile, or a NS SAPD for a give NsProfile identified by the constituentBasedElementId.</td>
</tr>
</tbody>
</table>

6.4.8 CpdInConstituentElement information element

6.4.8.1 Description

The CpdInConstituentElement information element enables identifying a CPD or SAPD in the context of an NS constituent.

6.4.8.2 Attributes

The attributes of the CpdInConstituentElement information element shall follow the indications provided in table 6.4.8.2-1.
### 6.5 Information elements related to the Network Service Virtual Link Descriptor

#### 6.5.1 Introduction

Clauses 6.5.2 up to 6.5.6.2 define the information elements related to the NS VLD.

#### 6.5.2 NsVirtualLinkDesc information element

##### 6.5.2.1 Description

The NsVirtualLinkDesc information element provides general information enabling the instantiation of virtual links.

##### 6.5.2.2 Attributes

The attributes of the NsVirtualLinkDesc information element shall follow the indications provided in table 6.5.2.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>virtualLinkDescId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of the NsVirtualLinkDesc information element. It uniquely identifies a VLD.</td>
</tr>
<tr>
<td>connectivityType</td>
<td>M</td>
<td>1</td>
<td>ConnectivityType</td>
<td>See clause 6.5.3.</td>
</tr>
<tr>
<td>virtualLinkDf</td>
<td>M</td>
<td>1..N</td>
<td>VirtualLinkDf</td>
<td>See clause 6.5.4.</td>
</tr>
<tr>
<td>testAccess</td>
<td>M</td>
<td>0..N</td>
<td>String</td>
<td>Specifies test access facilities expected on the VL (e.g. none, passive monitoring, or active (intrusive) loopbacks at endpoints).</td>
</tr>
<tr>
<td>description</td>
<td>M</td>
<td>0..1</td>
<td>String</td>
<td>Provides human-readable information on the purpose of the virtual link (e.g. VL for control plane traffic).</td>
</tr>
</tbody>
</table>

#### 6.5.3 ConnectivityType information element

##### 6.5.3.1 Description

The ConnectivityType information element specifies the protocol exposed by a VL and the flow pattern supported by the VL.

##### 6.5.3.2 Attributes

The attributes of the ConnectivityType information element shall follow the indications provided in table 6.5.3.2-1.
Table 6.5.3.2-1: Attributes of the ConnectivityType information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>layerProtocol</td>
<td>M</td>
<td>1..N</td>
<td>Enum</td>
<td>Specifies the protocols that the VL uses (Ethernet, MPLS, ODU2, IPV4, IPV6, Pseudo-Wire). See note.</td>
</tr>
<tr>
<td>flowPattern</td>
<td>M</td>
<td>0..1</td>
<td>String</td>
<td>Specifies the flow pattern of the connectivity (Line, Tree, Mesh, etc.).</td>
</tr>
</tbody>
</table>

NOTE: The top layer protocol of the VL protocol stack shall always be provided. The lower layer protocols may be included when there are specific requirements on these layers.

6.5.4 VirtualLinkDf information element

6.5.4.1 Description

The VirtualLinkDf information element specifies properties for instantiating a VL according to a specific flavour.

6.5.4.2 Attributes

The attributes of the VirtualLinkDf information element shall follow the indications provided in table 6.5.4.2-1.

Table 6.5.4.2-1: Attributes of the VirtualLinkDf information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>flavourId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies this VirtualLinkDf information element within a VLD.</td>
</tr>
<tr>
<td>qos</td>
<td>M</td>
<td>0..1</td>
<td>NsQoS</td>
<td>See clause 6.5.6.</td>
</tr>
</tbody>
</table>
| serviceAvailabilityLevel | M | 0..1 | Enum | Specifies one of the three levels defined in ETSI GS NFV-REL 001 [i.5]:  
  • Level 1.  
  • Level 2.  
  • Level 3. |

6.5.5 LinkBitrateRequirements information element

6.5.5.1 Description

The LinkBitrateRequirements information element describes the requirements in terms of bitrate for a VL.

6.5.5.2 Attributes

The attributes of the LinkBitrateRequirements information element shall follow the indications provided in table 6.5.5.2-1.

Table 6.5.5.2-1: Attributes of the LinkBitrateRequirements information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>root</td>
<td>M</td>
<td>1</td>
<td>Number</td>
<td>Specifies the throughput requirement of the link (e.g. bitrate of E-Line, root bitrate of E-Tree, aggregate capacity of E-LAN).</td>
</tr>
<tr>
<td>leaf</td>
<td>M</td>
<td>0..1</td>
<td>Number</td>
<td>Specifies the throughput requirement of leaf connections to the link when applicable to the connectivity type (e.g. for E-Tree and E-LAN branches). See note.</td>
</tr>
</tbody>
</table>

NOTE: The present document does not specify the means to declare different bitrate requirements for leaf connections (e.g. E-LAN leaves).
6.5.6  **NsQoS information element**

6.5.6.1  **Description**

The NsQoS information element specifies quality of service parameters applicable to a NS VL.

6.5.6.2  **Attributes**

The attributes of the NsQoS information element shall follow the indications provided in table 6.5.6.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>latency</td>
<td>M</td>
<td>1</td>
<td>Number</td>
<td>Specifies the maximum latency in ms.</td>
</tr>
<tr>
<td>packetDelayVariation</td>
<td>M</td>
<td>1</td>
<td>Number</td>
<td>Specifies the maximum jitter in ms.</td>
</tr>
<tr>
<td>packetLossRatio</td>
<td>M</td>
<td>0..1</td>
<td>Number</td>
<td>Specifies the maximum packet loss ratio.</td>
</tr>
<tr>
<td>priority</td>
<td>M</td>
<td>0..1</td>
<td>Integer</td>
<td>Specifies the priority level in case of congestion on the underlying physical links.</td>
</tr>
</tbody>
</table>

6.6  **Information elements related to the PNFD**

6.6.1  **Introduction**

Clauses 6.6.2 up to 6.6.4.2 define the information elements related to the PNFD.

6.6.2  **Pnfd information element**

6.6.2.1  **Description**

The Pnfd information element is a deployment template enabling on-boarding PNFs and referencing them from an NSD. It focuses on connectivity aspects only.

6.6.2.2  **Attributes**

The attributes of the Pnfd information element shall follow the indications provided in table 6.6.2.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pnfdId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this Pnf information element. It uniquely identifies the PNFD.</td>
</tr>
<tr>
<td>functionDescription</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Describes the PNF function</td>
</tr>
<tr>
<td>provider</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Specifies the provider of the PNFD.</td>
</tr>
<tr>
<td>version</td>
<td>M</td>
<td>1</td>
<td>Version</td>
<td>Specifies the version of the PNFD.</td>
</tr>
<tr>
<td>pnfdInvariantId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifies a PNFD in a version independent manner. This attribute is invariant across versions of PNFD.</td>
</tr>
<tr>
<td>name</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Provides the human readable name of the PNFD.</td>
</tr>
<tr>
<td>pnfExtCp</td>
<td>M</td>
<td>1..N</td>
<td>PnfExtCpd</td>
<td>Specifies the characteristics of one or more connection points where to connect the PNF to a VL. See clause 6.6.4.</td>
</tr>
<tr>
<td>geographicalLocationInfo</td>
<td>M</td>
<td>0..1</td>
<td>Not specified</td>
<td>It provides information about the geographical location (e.g. geographic coordinates or address of the building, etc.) of the PNF. The cardinality 0 is used when the location is unknown.</td>
</tr>
</tbody>
</table>

NOTE: The provider of the PNFD might be different from the provider of the PNF.
6.6.3 Cpd information element

6.6.3.1 Description
The Cpd information element is defined in clause 7.1.6.3 of ETSI GS NFV-IFA 011 [2]. This is an abstract class used as parent for the various Cpd classes.

6.6.3.2 Attributes
The attributes of the Cpd information element are defined in clause 7.1.6.3 of ETSI GS NFV-IFA 011 [2].

6.6.4 PnfExtCpd information element

6.6.4.1 Description
A PnfExtCpd is a type of Cpd and describes the characteristics of an external interface, a.k.a. an external CP, where to connect the PNF to a VL. A PnfExtCpd inherits from the Cpd Class (see clause 6.6.3). All attributes of the Cpd are also attributes of the PnfExtCpd.

6.6.4.2 Attributes
The attributes of the PnfExtCpd information element shall follow the indications provided in table 6.6.4.2-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(inherited attributes)</td>
<td></td>
<td></td>
<td></td>
<td>All attributes inherited from Cpd.</td>
</tr>
</tbody>
</table>

6.7 Information elements related to scaling

6.7.1 Introduction
Clauses 6.7.2 to 6.7.6.2 define the information elements related to scaling.

6.7.2 NsScalingAspect information element

6.7.2.1 Description
The NsScalingAspect information element describes the details of an NS scaling aspect. An NS scaling aspect is an abstraction representing a particular "dimension" or "property" along which a given NS can be scaled. Defining NS levels, in this context also known as NS scale levels, within an NS scaling aspect allows to scale NS instances "by steps", i.e. to increase/decrease their capacity in a discrete manner moving from one NS scale level to another. Scaling by a single step does not imply that exactly one instance of each entity involved in the NS scale level is created or removed.

6.7.2.2 Attributes
The attributes of the NsScalingAspect information element shall follow the indications provided in table 6.7.2.2-1.
Table 6.7.2.2-1: Attributes of the NsScalingAspect information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsScalingAspectId</td>
<td>M</td>
<td>1</td>
<td>Identifier</td>
<td>Identifier of this NsScalingAspect information element. It uniquely identifies the NS scaling aspect in an NSD.</td>
</tr>
<tr>
<td>name</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Provides a human readable name of the NS scaling aspect.</td>
</tr>
<tr>
<td>description</td>
<td>M</td>
<td>1</td>
<td>String</td>
<td>Provides a human readable description of the NS scaling aspect.</td>
</tr>
<tr>
<td>nsScaleLevel</td>
<td>M</td>
<td>1..N</td>
<td>NsLevel</td>
<td>Describes the details of an NS level. See clause 6.3.9. See note.</td>
</tr>
</tbody>
</table>

NOTE: Only a subset of the VNFs, VLs and nested NSs whose descriptor is referenced by the NS DF may be involved in an NS scale level of the parent NS.

6.7.3 Void

6.7.4 VnfToLevelMapping information element

6.7.4.1 Description

The VnfToLevelMapping information element specifies the profile to be used for a VNF involved in a given NS level and the required number of instances.

6.7.4.2 Attributes

The attributes of the VnfToLevelMapping information element shall follow the indications provided in table 6.7.4.2-1.

Table 6.7.4.2-1: Attributes of the VnfToLevelMapping information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vnfProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to VnfProfile)</td>
<td>Identifies the profile to be used for a VNF involved in an NS level.</td>
</tr>
<tr>
<td>numberOfInstances</td>
<td>M</td>
<td>1</td>
<td>Integer</td>
<td>Specifies the number of VNF instances required for an NS level. See notes 1 to 3.</td>
</tr>
</tbody>
</table>

NOTE 1: It shall be in the range of minNumberOfInstances-maxNumberOfInstances, as specified in the referenced VnfProfile.
NOTE 2: When the corresponding NS level is used in the context of NS instantiation, the numberOfInstances attribute specifies the number of VNF instances to be deployed.
NOTE 3: When the corresponding NS level is used in the context of NS scaling, the numberOfInstances attribute does not specify the number of VNF instances to be added/removed when reaching that NS scale level. The actual number of VNF instances to be added/removed can be derived by subtracting the numberOfInstances declared in the source NS scale level from the numberOfInstances declared in the target NS level of the scaling request.

6.7.5 VirtualLinkToLevelMapping information element

6.7.5.1 Description

The VirtualLinkToLevelMapping information element specifies the profile to be used for a VL involved in a given NS level and bitrate requirements.

6.7.5.2 Attributes

The attributes of the VirtualLinkToLevelMapping information element shall follow the indications provided in table 6.7.5.2-1.
Table 6.7.5.2-1: Attributes of the VirtualLinkToLevelMapping information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>virtualLinkProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to VirtualLinkProfile)</td>
<td>Identifies the profile to be used for a VL involved in an NS level.</td>
</tr>
<tr>
<td>bitRateRequirements</td>
<td>M</td>
<td>1</td>
<td>LinkBitrateRequirements</td>
<td>Specifies the bit rate requirements for the NS level. See note.</td>
</tr>
</tbody>
</table>

NOTE: It shall be in the range of minBitrateRequirements-maxBitrateRequirements, as specified in the referenced VirtualLinkProfile.

6.7.6 NsToLevelMapping information element

6.7.6.1 Description

The NsToLevelMapping information element specifies the profile to be used for a nested NS involved in a given NS level and the required number of instances.

6.7.6.2 Attributes

The attributes of the NsToLevelMapping information element shall follow the indications provided in table 6.7.6.2-1.

Table 6.7.6.2-1: Attributes of the NsToLevelMapping information element

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Qualifier</th>
<th>Cardinality</th>
<th>Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nsProfileId</td>
<td>M</td>
<td>1</td>
<td>Identifier (Reference to NsProfile)</td>
<td>Identifies the profile to be used for a nested NS involved in the NS level.</td>
</tr>
<tr>
<td>numberOfInstances</td>
<td>M</td>
<td>1</td>
<td>Integer</td>
<td>Specifies the number of nested NS instances required for the NS scale level. See notes 1 to 3.</td>
</tr>
</tbody>
</table>

NOTE 1: It shall be in the range of minNumberOfInstances-maxNumberOfInstances, as specified in the referenced NsProfile.
NOTE 2: When the corresponding NS level is used in the context of NS instantiation, the numberOfInstances attribute specifies the number of nested NS instances to be deployed.
NOTE 3: When the corresponding NS level is used in the context of NS scaling, the numberOfInstances attribute does not specify the number of nested NS instances to be added/removed when reaching that NS scale level. The actual number of nested NS instances to be added/removed can be derived by subtracting the numberOfInstances declared in the source NS scale level from the numberOfInstances declared in the target NS level of the scaling request.
Annex A (informative): Support of service function chaining

A.1 Introduction

Within an NSD, the NFPD information element is intended to serve as the main input for supporting Service Function Chaining (SFC) as specified in IETF RFC 7665 [i.6] in an NFV environment, by leveraging the NFV-MANO and NFVI capabilities.

NOTE: Scenarios where service chaining is realized in the tenant domain (i.e. classification and forwarding occurs in VNF instances) rather than the NFVI are outside the scope of the present annex, as in such cases service chaining does not rely on the contents of the NSD and is not visible to NFV-MANO.

To take advantage of the service function chaining capabilities supported by NFV-MANO, NS designers are expected to include one or more NFPDs in one or more VNFFGDs within the NSD.

The NSD management interface specified in ETSI GS NFV-IFA 013 [i.2] enables on-boarding a set of NFPDs as part of the NSD. The Update NS operation of the NS lifecycle management interface specified in ETSI GS NFV-IFA 013 [i.2] enables adding or removing NFP instances from an existing NS instance.

A.2 IETF SFC concepts

Table A.2-1 provides an overview of the mapping of SFC concepts as described in IETF RFC 7665 [i.6] and NFV constructs.

NOTE: In some cases, when embedding examples and additional explanations, the IETF definition has been truncated.

<table>
<thead>
<tr>
<th>IETF RFC 7665 [i.6] term</th>
<th>IETF RFC 7665 [i.6] (simplified) definition</th>
<th>Equivalent NFV constructs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Service</td>
<td>An offering provided by an operator that is delivered using one or more service functions. This may also be referred to as a &quot;composite service&quot;. The term &quot;service&quot; is used to denote a &quot;network service&quot; in the context of this document.</td>
<td>A Network Service as defined in IETF RFC 7665 [i.6] can be deployed as one or more VNF combined to form an NFV NS as defined in ETSI GS NFV 003 [1].</td>
</tr>
<tr>
<td>Classification</td>
<td>Locally instantiated matching of traffic flows against policy for subsequent application of the required set of network service functions. The policy may be customer/network/service specific.</td>
<td>The nfpRule attribute of the Nfpd information element provides the input to the Classification.</td>
</tr>
<tr>
<td>Classifier</td>
<td>An element that performs Classification.</td>
<td>This functionality is provided by the NFVI network domain.</td>
</tr>
<tr>
<td>Service Function Chain</td>
<td>A service function chain defines an ordered set of abstract service functions and ordering constraints that must be applied to packets and/or frames and/or flows selected as a result of classification.</td>
<td>A service function chain is described by an Nfpd information element.</td>
</tr>
<tr>
<td><strong>IETF RFC 7665 [i.6] term</strong></td>
<td><strong>IETF RFC 7665 [i.6] (simplified) definition</strong></td>
<td><strong>Equivalent NFV constructs</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Service Function (SF)</td>
<td>A function that is responsible for specific</td>
<td>An SF can be deployed as one or several VNFs or PNFs. In the latter case, the group of network functions can be represented as a nested NS. Multiple SFs can map to one VNF or PNF, as long as an external connection point provides access to this SF within the VNF or PNF.</td>
</tr>
<tr>
<td></td>
<td>treatment of received packets. A Service Function</td>
<td>Within an Nfpd information element, an NfpPositionDesc corresponds to one or more instances of the same SF in a given Service Function Chain, as defined in IETF RFC 7665 [i.6]. Within an NfpPositionDesc information element, an NfpPositionElement describes the ingress and egress connection points corresponding to an instance of this SF. These connection points may - but need not - be attached to the same VNF, PNF or nested NS instance.</td>
</tr>
<tr>
<td></td>
<td>can act at various layers of a protocol stack (e.g.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>at the network layer or other OSI layers). As a logical component, a service function can be realized as a virtual element or be embedded in a physical network element. [...] Multiple occurrences of the service function can exist in the same administrative domain.</td>
<td></td>
</tr>
<tr>
<td>Service Function Forwarder (SFF)</td>
<td>A service function forwarder is responsible for forwarding traffic to one or more connected service functions according to information carried in the SFC encapsulation, as well as handling traffic coming back from the SF.</td>
<td>This functionality is provided by the NFVI network domain.</td>
</tr>
<tr>
<td>Service Function Path (SFP)</td>
<td>The service function path is a constrained</td>
<td>An SFP is derived from an NFP created by the NFVO from an NFPD.</td>
</tr>
<tr>
<td></td>
<td>specification of where packets assigned to a certain service function path must go. While it may be so constrained as to identify the exact locations, it can also be less specific. The SFP provides a level of indirection between the fully abstract notion of service chain as a sequence of abstract service functions to be delivered, and the fully specified notion of exactly which SFF/SFs the packet will visit when it actually traverses the network.</td>
<td>See note.</td>
</tr>
<tr>
<td>SFC Encapsulation</td>
<td>The SFC encapsulation provides, at a minimum, SFP identification, and is used by the SFC-aware functions, such as the SFF and SFC-aware SFs. The SFC encapsulation is not used for network packet forwarding. In addition to SFP identification, the SFC encapsulation carries metadata including data-plane context information.</td>
<td>This functionality is provided by the NFVI network domain.</td>
</tr>
<tr>
<td>Rendered Service Path (RSP)</td>
<td>Within an SFP, packets themselves are of course transmitted from and to specific places in the network, visiting a specific sequence of SFFs and SFs. This sequence of actual visits by a packet to specific SFFs and SFs in the network is known as the Rendered Service Path (RSP).</td>
<td>The RSP for a given packet is determined by the NFVI by applying runtime decisions, in particular those resulting from load balancing.</td>
</tr>
<tr>
<td>SFC-Enabled Domain</td>
<td>A network or region of a network that implements SFC. An SFC-enabled domain is limited to a single network administrative domain.</td>
<td>An infrastructure domain supporting NFP management is an SFC-enabled domain.</td>
</tr>
<tr>
<td>SFC Proxy</td>
<td>Removes and inserts SFC encapsulation on behalf of an SFC-unaware service function. SFC proxies are logical elements.</td>
<td>This functionality is provided by the NFVI network domain.</td>
</tr>
</tbody>
</table>

**NOTE:** An Nfpd is always embedded in a VNFFGD. However, a VNFFGD is not a forwarding path descriptor and has no direct mapping to SFC concepts.
A.3 Use of the NFP Management interface

The NFVO requests the creation of NFP instances using the Create NFP operation from the NFP management interface specified in ETSI GS NFV-IFA 005 [i.7].

A.4 Mapping

An SF can be deployed as one or several VNFs. Multiple SFs can map to one VNF, as long as an external connection point provides access to this SF within the VNF.

Figure A.4-1 illustrates the case where there is a one-to-one mapping between 3 SFs and 3 VNFs.

![Figure A.4-1: One-to-one mapping](image1)

Figure A.4-2 illustrates the case where two SFs are implemented as two VNFCs within the same VNF.

![Figure A.4-2: Many-to-one mapping](image2)
Figure A.4-3 illustrates the case where one SF is implemented as two VNFs.

Figure A.4-4 illustrates the case where one SF is implemented as two VNFs grouped as a nested NS. In that case only the SAPs of the nested NS are visible in the NFPD of the parent NS.
Annex B (informative): Authors & contributors

The following people have contributed to the present document:

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# Annex C (informative):
## Change History

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Information about changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-06-2017</td>
<td>2.1.2</td>
<td>Update with CRs NFVIFA(17)000487, NFVIFA(17)000575.</td>
</tr>
<tr>
<td>08-12-2017</td>
<td>2.3.2</td>
<td>Update with CRs: NFVIFA(17)000658r10, NFVIFA(17)000761, NFVIFA(17)000818r2, NFVIFA(17)000937r4, NFVIFA(17)000942, NFVIFA(17)000950, NFVIFA(17)000955, NFVIFA(17)000963, NFVIFA(17)000979, NFVIFA(17)010106, NFVIFA(17)010411, NFVIFA(17)01099r2, NFVIFA(17)011143.</td>
</tr>
<tr>
<td>12-04-2018</td>
<td>2.4.2</td>
<td>NFVIFA(18)000304.</td>
</tr>
<tr>
<td>08-05-2018</td>
<td>2.4.3</td>
<td>NFVIFA(18)000192r1, NFVIFA(18)000193.</td>
</tr>
<tr>
<td>22-06-2018</td>
<td>2.4.4</td>
<td>Rapporteur action: Bug Tracker 7727, editorial review NFVIFA(18)000373r3, NFVIFA(18)000503, NFVIFA(18)000379r3.</td>
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<td>12-09-2018</td>
<td>2.5.2</td>
<td>Creation of first draft version for 2018H2 maintenance.</td>
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<td>25-09-2018</td>
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<td>Update with CRs: NFVIFA(18)000778r2_IFA014ed261_deleting_Cpd_and_reference_the_Cpd_in_IFA011</td>
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<td>12-11-2018</td>
<td>2.5.3</td>
<td>Update with CRs: NFVIFA(18)000829r3, NFVIFA(18)000884r1, NFVIFA(18)000966, NFVIFA(18)000972 (supersedes NFVIFA(18)000828r3).</td>
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<td>Update with CRs: NFVIFA(18)0001025, NFVIFA(18)0001050, NFVIFA(18)0001094.</td>
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<td>25-01-2019</td>
<td>2.5.5</td>
<td>Rapporteur action: correct editorial omission in Table 6.4.2.2-1.</td>
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<td>02-04-2019</td>
<td>2.6.2</td>
<td>Creation of first draft version for 2019H1 maintenance. Update with CRs: NFVIFA(19)000132r3 (Changes in the text are marked as done by user NFVIFA(19)000132r2, but reflect content of NFVIFA(19)000132r3).</td>
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<td>27-05-2019</td>
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<td>Update with CRs: NFVIFA(19)000346r4_IFA014Ed271_-_<em>Improving_consistency_in_NFP_data_types, NFVIFA(19)000431r5_IFA014Ed271</em>-CpPool_in_VNFG.</td>
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<td>Rapporteur action: correction of metadata for v262. Update with CRs: NFVIFA(19)000513r2_IFA014_NfpPositionDesc_and_NfpPositionElement, NFVIFA(19)000548_IFA014ed271.ONAP alignment__Class_VirtualLinkDf, NFVIFA(19)000597r2_IFA014ed271_Additional_Parameters_NSD, NFVIFA(19)000627_IFA014ed271_6_5_5_LinkBitrateRequirements_IE, NFVIFA(19)000629_IFA014ed271_6_3_8_LocalAffinityOrAntiAffinityRule_IE (Rapporteur action: remove word &quot;whether&quot; from description of attribute scope in Table 6.3.8.2-1), NFVIFA(19)00695r1_IFA014ed271v264_editorial_review.</td>
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## History

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