



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.

Reference

RGS/NFV-IFA014ed251

Keywords

MANO, network, NFV, service, virtualisation

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

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

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:

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

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

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

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

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

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

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

Copyright Notification

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

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

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

© ETSI 2018.

All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members.

3GPP™ and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

oneM2M logo is protected for the benefit of its Members.

GSM® and the GSM logo are trademarks registered and owned by the GSM Association.

Contents

Intellectual Property Rights	6
Foreword.....	6
Modal verbs terminology.....	6
1 Scope	7
2 References	7
2.1 Normative references	7
2.2 Informative references.....	7
3 Definitions and abbreviations.....	8
3.1 Definitions	8
3.2 Abbreviations	8
4 Overview	8
4.1 Network Service Descriptions.....	8
4.2 Relation to other ETSI NFV Group Specifications	10
4.3 Conventions.....	10
5 Functional requirements	11
5.1 Void.....	11
5.2 Network Service Descriptor	11
5.3 Network Service Deployment Flavour	12
5.4 VNF Forwarding Graph Descriptor.....	12
5.5 Virtual Link Descriptor	13
5.6 Physical Network Function Descriptor.....	13
6 Descriptors formats and contents	14
6.1 Void.....	14
6.2 Information elements related to the Network Service Descriptor	14
6.2.1 Introduction.....	14
6.2.2 Network Service Descriptor information element	14
6.2.2.1 Description	14
6.2.2.2 Attributes.....	14
6.2.3 Sapid information element.....	15
6.2.3.1 Description	15
6.2.3.2 Attributes.....	15
6.2.4 Void.....	16
6.2.5 SecurityParameters information element	16
6.2.5.1 Description	16
6.2.5.2 Attributes.....	16
6.2.6 MonitoredData.....	16
6.2.6.1 Description	16
6.2.6.2 Attributes.....	17
6.2.7 VnfIndicatorData	17
6.2.7.1 Description	17
6.2.7.2 Attributes.....	17
6.2.8 MonitoringParameter	17
6.2.8.1 Description	17
6.2.8.2 Attributes.....	17
6.2.9 LifeCycleManagementScript	18
6.2.9.1 Description	18
6.2.9.2 Attributes.....	18
6.3 Information elements related to the Network Service Deployment Flavour	18
6.3.1 Introduction.....	18
6.3.2 NsDf information element	18
6.3.2.1 Description	18
6.3.2.2 Attributes.....	19
6.3.3 VnfProfile information element.....	19

6.3.3.1	Description	19
6.3.3.2	Attributes.....	20
6.3.4	VirtualLinkProfile information element	20
6.3.4.1	Description	20
6.3.4.2	Attributes.....	20
6.3.5	AffinityOrAntiAffinityGroup information element	21
6.3.5.1	Description	21
6.3.5.2	Attributes.....	21
6.3.6	PnfProfile information element.....	22
6.3.6.1	Description	22
6.3.6.2	Attributes.....	22
6.3.7	NsVirtualLinkConnectivity information element	22
6.3.7.1	Description	22
6.3.7.2	Attributes.....	22
6.3.8	LocalAffinityOrAntiAffinityRule information element.....	23
6.3.8.1	Description	23
6.3.8.2	Attributes.....	23
6.3.9	NsLevel information element	23
6.3.9.1	Description	23
6.3.9.2	Attributes.....	23
6.3.10	NsScaleInfo information element	24
6.3.10.1	Description	24
6.3.10.2	Attributes.....	24
6.3.11	NsProfile information element.....	24
6.3.11.1	Description	24
6.3.11.2	Attributes.....	24
6.3.12	Dependencies information element.....	25
6.3.12.1	Description	25
6.3.12.2	Attributes.....	25
6.4	Information elements related to the VNF Forwarding Graph Descriptor.....	26
6.4.1	Introduction.....	26
6.4.2	Vnffgd information element	26
6.4.2.1	Description	26
6.4.2.2	Attributes.....	26
6.4.3	Nfpd information element.....	26
6.4.3.1	Description	26
6.4.3.2	Attributes.....	26
6.4.4	CpdPool information element	27
6.4.4.1	Description	27
6.4.4.2	Attributes.....	27
6.4.5	NfpPositionDesc information element.....	27
6.4.5.1	Description	27
6.4.5.2	Attributes.....	27
6.4.6	CpProfile information element	28
6.4.6.1	Description	28
6.4.6.2	Attributes.....	28
6.5	Information elements related to the Network Service Virtual Link Descriptor.....	29
6.5.1	Introduction.....	29
6.5.2	NsVirtualLinkDesc information element.....	29
6.5.2.1	Description	29
6.5.2.2	Attributes.....	29
6.5.3	ConnectivityType information element	30
6.5.3.1	Description	30
6.5.3.2	Attributes.....	30
6.5.4	VirtualLinkDf information element.....	30
6.5.4.1	Description	30
6.5.4.2	Attributes.....	30
6.5.5	LinkBitrateRequirements information element.....	31
6.5.5.1	Description	31
6.5.5.2	Attributes.....	31
6.5.6	QoS information element.....	31
6.5.6.1	Description	31

6.5.6.2	Attributes.....	31
6.6	Information elements related to the PNFD.....	32
6.6.1	Introduction.....	32
6.6.2	Pnfd information element	32
6.6.2.1	Description.....	32
6.6.2.2	Attributes.....	32
6.6.3	Cpd information element	32
6.6.3.1	Description.....	32
6.6.3.2	Attributes.....	32
6.6.4	PnfExtCpd information element	33
6.6.4.1	Description.....	33
6.6.4.2	Attributes.....	33
6.7	Information elements related to scaling.....	33
6.7.1	Introduction.....	33
6.7.2	NsScalingAspect information element.....	34
6.7.2.1	Description.....	34
6.7.2.2	Attributes.....	34
6.7.3	Void	34
6.7.4	VnfToLevelMapping information element.....	34
6.7.4.1	Description.....	34
6.7.4.2	Attributes.....	34
6.7.5	VirtualLinkToLevelMapping information element	35
6.7.5.1	Description.....	35
6.7.5.2	Attributes.....	35
6.7.6	NsToLevelMapping information element.....	35
6.7.6.1	Description.....	35
6.7.6.2	Attributes.....	36
Annex A (informative): Support of service function chaining.....		37
A.1	Introduction	37
A.2	IETF SFC concepts	37
A.3	Use of the NFP Management interface	38
A.4	Mapping	38
Annex B (informative): Authors & contributors.....		41
Annex C (informative): Change History		43
History		44

Intellectual Property Rights

Essential patents

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

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

Trademarks

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

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

2.2 Informative references

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

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

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

- [i.1] ETSI 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.4] ISO/IEC 9646-7: "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 7: Implementation Conformance Statements".
- [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 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions 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 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 VNFFGDs 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 VNFFGD 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 VNFFGDs of a given NS.

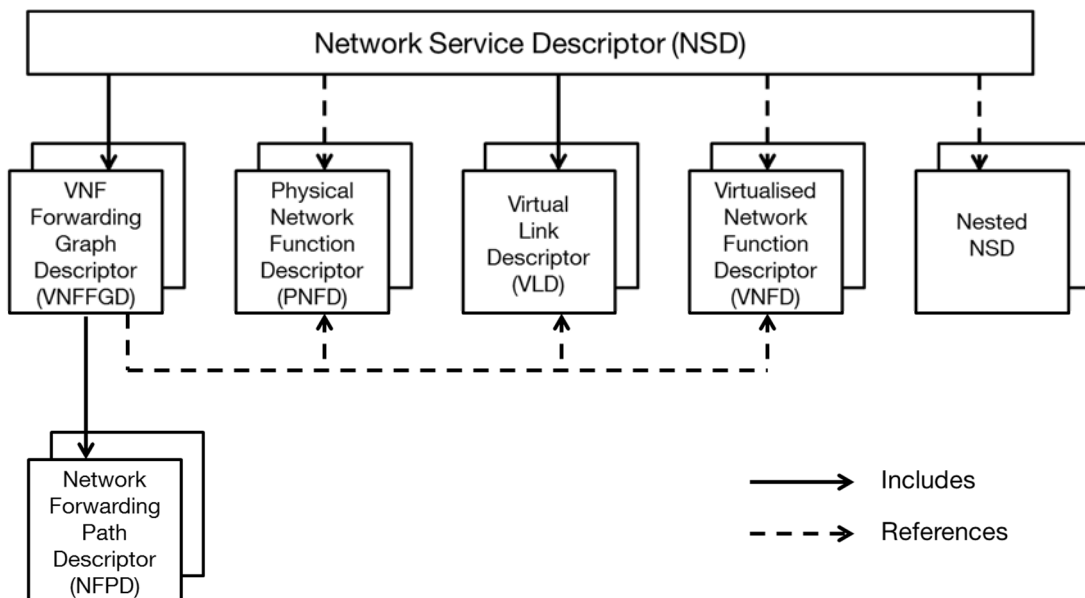


Figure 4.1-1: NSD overview

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 a 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 Network Service Descriptor

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

Table 5.2-1: NSD requirements

Numbering	Requirement description
NST_NSD001	The NSD shall reference the VNFDs applicable to its constituent VNFs.
NST_NSD002	The NSD shall include the VLDs applicable to the VLs used by the NS to interconnect its constituent NFs.
NST_NSD003	The NSD shall reference the PNFDs applicable to its constituent PNFs.
NST_NSD004	The NSD shall specify the Service Access Points (SAPs) of the NS.
NST_NSD005	The NSD shall include the descriptors of the VNFFGs applicable to the NS. See note 1.
NST_NSD006	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.
NST_NSD007	The NSD shall support the capability to provide monitoring parameters to be tracked during the lifetime of a NS instance. See note 2.
NST_NSD008	The NSD shall support the capability to describe one or more NS DF(s).
NST_NSD009	The NSD shall support the capability to describe auto scale rules, associating criteria to scaling actions (e.g. a change of flavour).
NST_NSD010	The NSD shall include security information enabling validating its authenticity and integrity.
NST_NSD011	The NSD shall support the capability to reference NSDs used to instantiate nested or appended NSs. See note 3.
NST_NSD012	The NSD shall include a globally unique identifier for identifying each descriptor instance.
<p>NOTE 1: A NS might have multiple graphs, for example, for:</p> <ol style="list-style-type: none"> 1) Control plane traffic. 2) Management plane traffic. 3) User plane traffic. <p>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.</p> <p>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.</p>	

5.3 Network Service Deployment Flavour

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

Table 5.3-1: NS DF description requirements

Numbering	Requirement description
NST_NSF001	An NS DF description shall describe how many instances of each constituent VNF are required.
NST_NSF002	An NS DF description shall reference a VNF flavour to be used for each constituent VNF.
NST_NSF003	An NS DF description shall enable describing affinity and anti-affinity rules between the different instances of a constituent VNF.
NST_NSF004	An NS DF description shall enable describing affinity and anti-affinity rules between the constituent VNFs.
NST_NSF005	An NS DF description shall enable referencing a VL flavour to be used for each VL connected to its constituent VNFs.
NST_NSF006	An NS DF description shall enable describing affinity and anti-affinity rules between the different instances of a constituent VL.
NST_NSF007	An NS DF description shall enable describing affinity and anti-affinity rules between the constituent VLs.
NST_NSF008	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.
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 VNF Forwarding Graph Descriptor

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

Table 5.4-1: VNFFGD requirements

Numbering	Requirement description
NST_FGD001	A VNFFGD shall enable associating multiple network forwarding paths to a forwarding graph.
NST_FGD002	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.
NST_FGD003	A VNFFGD shall reference the VNFDs and PNFDs of its constituent VNFs and PNFs.
NST_FGD004	A VNFFGD shall reference the VLDs applicable to instantiate VLs between the VNFs and PNFs that are part of the VNFFGD.
NST_FGD005	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.
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 Virtual Link Descriptor

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

Table 5.5-1: VLD requirements

Numbering	Requirement description
NST_VLD001	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).
NST_VLD002	A VLD shall enable specifying one or more VL DFs. See note.
NOTE:	Different VL DFs may be used for different flavours of the same NS.

Table 5.5-2 specifies requirements for VL DF descriptions.

Table 5.5-2: VL DF description requirements

Numbering	Requirement description
NST_VLDF001	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.).
NST_VLDF002	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).
NST_VLDF003	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.
NST_VLDF004	A VL DF description shall enable specifying service availability levels.

5.6 Physical Network Function Descriptor

Table 5.6-1 specifies requirements applicable to a PNFD.

Table 5.6-1: PNFD requirements

Numbering	Requirement description
NST_PNFD001	A PNFD shall enable specifying the characteristics of the connection points exposed by a PNF.

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.

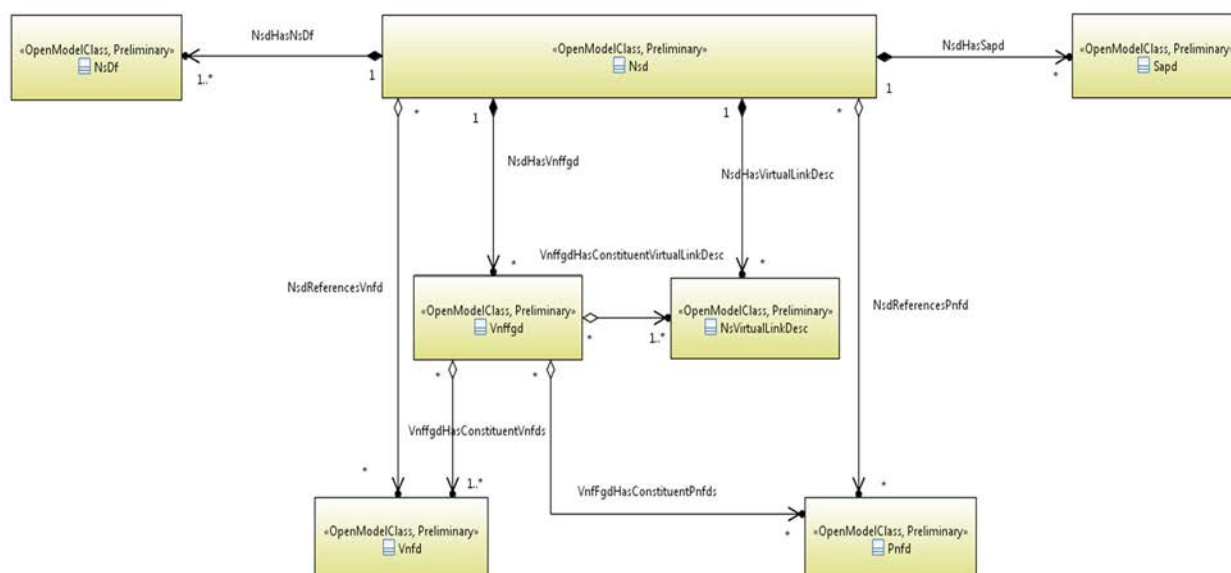


Figure 6.2.1-1: UML information diagram of NSD

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 6.2.2.2-1: Attributes of the NSD information element

Attribute	Qualifier	Cardinality	Content	Description
nsdIdentifier	M	1	Identifier	Identifier of this NSD information element. It Globally uniquely identifies an instance of the NSD.
designer	M	1	String	Identifies the designer of the NSD.
version	M	1	Version	Identifies the version of the NSD.
nsdName	M	1	String	Provides the human readable name of the NSD.
nsdInvariantId	M	1	Identifier	Identifies an NSD in a version independent manner. This attribute is invariant across versions of NSD.
nestedNsdId	M	0..N	Identifier (Reference to Nsd)	References the NSD of a constituent nested NS. See note 1.
vnfdId	M	0..N	Identifier (Reference to Vnfd)	References the VNFD of a constituent VNF. See note 1.
pnfdId	M	0..N	Identifier (Reference to Pnfd)	References the PNFD of a constituent PNF. See note 1.
sapd	M	0..N	Sapd	Provides the descriptor of a service access point of the network service.
virtualLinkDesc	M	0..N	NsVirtualLinkDesc	Provides the constituent VLDs. See note 2.
vnffgd	M	0..N	Vnffgd	Provides the descriptors of the applicable forwarding graphs. See note 2.
autoScalingRule	M	0..N	Rule	Specifies a rule to trigger a scaling action on a NS instantiated according to the NSD. See notes 3 and 4.
lifeCycleManagementScript	M	0..N	LifeCycleManagementScript	Provides a life cycle management script written in a Domain Specific Language (DSL).
nsDf	M	1..N	NsDf	Identifies a DF within the scope of an NSD.
security	M	1	SecurityParameters	Provides a signature to prevent tampering.
NOTE 1: At least one between nestedNsd and vnfdId attributes shall be present.				
NOTE 2: Cardinality of 0 means that the NS is a NF set with unspecified connectivity.				
NOTE 3: The rule is based on a combination of assertions on the values of virtualised resource-related performance metrics and VNF Indicators identified by the monitoredInfo attribute.				
NOTE 4: There may be multiple data sources (each identified as monitoredInfo) per rule.				

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 or clause 7.1.3 of ETSI GS NFV-IFA 011 [2]). All attributes of the Cpd are also attributes of the Sapd.

6.2.3.2 Attributes

The attributes of the service access point descriptor (Sapd) information element shall follow the indications provided in table 6.2.3.2-1.

Table 6.2.3.2-1: Attributes of the Sapd information element

Attribute	Qualifier	Cardinality	Content	Description
sapAddressAssignment	M	1	Boolean	Specify whether the SAP address assignment is under the responsibility of management and orchestration functions or not. If it is set to True, management and orchestration functions are responsible for assigning addresses to the access points instantiated from this SAPD.
nsVirtualLinkId	M	0..1	Identifier (Reference to NsVirtualLinkDesc)	References the descriptor of the NS VL instance to which the SAP instantiated from this SAPD connects to. See note.
associatedCpdId	M	0..1	Identifier (Reference to VnfExtCpd or to PnfExtCpd or Sapd)	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.
(inherited attributes)				All attributes inherited from corresponding Cpd.

NOTE: At most one of the two attributes associatedCpdId and nsVirtualLinkId 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 a NSD, VLD, PNFD or VNFFGD 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 6.2.5.2-1: Attributes of the SecurityParameters information element

Attribute	Qualifier	Cardinality	Content	Description
signature	M	1	String	Provides the signature of the signed part of the descriptor.
algorithm	M	1	String	Identifies the algorithm used to compute the signature.
certificate	M	0..1	Not specified	Provides a certificate or a reference to a certificate to validate the signature. See note.

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

6.2.6 MonitoredData

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 6.2.6.2-1: Attributes of the MonitoredData information element

Attribute	Qualifier	Cardinality	Content	Description
vnfIndicatorInfo	M	0..1	VnfIndicatorData	Uniquely identifies this VNF Indicator information element. See note.
monitoringParameter	M	0..1	MonitoringParameter	Specifies the virtualised resource related performance metric to be monitored on an NS level or VNF level. See note.

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

6.2.7.1 Description

The VnfIndicatorData information 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 6.2.7.2-1: Attributes of the VnfIndicatorData information element

Attribute	Qualifier	Cardinality	Content	Description
vnfdId	M	1	Identifier (Reference to Vnfd)	Identifies a VNFD.
vnfIndicator	M	1	Identifier (Reference to VnfIndicator)	Identifies a VNF indicator within the VNFD.

6.2.8 MonitoringParameter

6.2.8.1 Description

The MonitoringParameter information 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

Attribute	Qualifier	Cardinality	Content	Description
monitoringParameterId	M	1	Identifier	Unique identifier of this monitoring parameter information element.
name	M	0..1	String	Human readable name of the monitoring parameter.
performanceMetric	M	1	String	Defines the virtualised resource-related performance metric.

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

6.2.9 LifeCycleManagementScript

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

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

6.3 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

Attribute	Qualifier	Cardinality	Content	Description
nsDfId	M	1	Identifier	Identifies this NsDf information element. It identifies a NS DF within the NSD.
flavourKey	M	1	String	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 the NSD.
vnfProfile	M	0..N	VnfProfile	VNF profile to be used for the NS flavour.
pnfProfile	M	0..N	PnfProfile	PNF profile to be used for the NS flavour.
virtualLinkProfile	M	0..N	VirtualLinkProfile	VL profile to be used for the NS flavour.
scalingAspect	M	0..N	NsScalingAspect	The scaling aspects supported by this DF of the NS.
affinityOrAntiAffinityGroup	M	0..N	AffinityOrAntiAffinityGroup	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.
nsInstantiationLevel	M	1..N	NsLevel	Describes the details of an NS level. See clause 6.3.9. See note.
defaultNsInstantiationLevelId	M	0..1	Identifier (Reference to NsLevel)	Identifies the NS level which represents the default NS instantiation level for this DF. It shall be present if there are multiple "nsInstantiationLevel" entries.
nsProfile	M	0..N	NsProfile	Specifies a NS Profile supported by this NS DF.
dependencies	M	0..N	Dependencies	Specifies the order in which instances of the VNFs and/or nested NSs have to be created.
monitoredInfo	M	0..N	MonitoredData	Identifies either a virtualised resource-related performance metric or a VNF Indicator.
<p>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.</p>				

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

Attribute	Qualifier	Cardinality	Content	Description
vnfProfileId	M	1	Identifier	Identifier of this vnfProfile information element. It uniquely identifies a VnfProfile.
vnfdId	M	1	Identifier (Reference to Vnfd)	References a VNFD.
flavourId	M	1	Identifier (Reference to VnfDf)	Identifies a flavour within the VNFD. See note 1.
instantiationLevel	M	0..1	Identifier	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.
minNumberOfInstances	M	1	Integer	Minimum number of instances of the VNF based on this VNFD that is permitted to exist for this VnfProfile.
maxNumberOfInstances	M	1	Integer	Maximum number of instances of the VNF based on this VNFD that is permitted to exist for this VnfProfile.
localAffinityOrAntiAffinityRule	M	0..N	LocalAffinityOrAntiAffinityRule	Specifies affinity and anti-affinity rules applicable between VNF instances created from this profile. See clause 6.3.8.
affinityOrAntiAffinityGroupId	M	0..N	Identifier	Identifier(s) of the affinity or anti-affinity group(s) the VnfProfile belongs to. See note 2.
nsVirtualLinkConnectivity	M	1..N	NsVirtualLinkConnectivity	Defines the connection information of the VNF, it contains connection relationship between a VNF connection point and a NS Virtual Link.
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

Attribute	Qualifier	Cardinality	Content	Description
virtualLinkProfileId	M	1	Identifier	Uniquely identifies this VirtualLinkProfile information element.
virtualLinkDescId	M	1	Identifier (Reference to NsVirtualLinkDesc)	Uniquely references a VLD.
flavourId	M	1	Identifier (Reference to VrtualLinkDf)	Identifies a flavour within the VLD.
localAffinityOrAntiAffinityRule	M	0..N	LocalAffinityOrAntiAffinityRule	Specifies affinity and anti-affinity rules applicable between VLS instantiated from the referenced VLD. See clause 6.3.8.
affinityOrAntiAffinityGroupId	M	0..N	Identifier (Reference to AffinityOrAntiAffinityGroup)	Identifies an affinity or anti-affinity group the VLS instantiated according to the VProfile belong to. See note 1.
maxBitrateRequirements	M	1	LinkBitrateRequirements	Specifies the maximum bitrate requirements for a VL instantiated according to this profile. See clause 6.5.5. See note 2.
minBitrateRequirements	M	1	LinkBitrateRequirements	Specifies the minimum bitrate requirements for a VL instantiated according to this profile. See clause 6.5.5. See note 2.
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 describes the affinity or anti-affinity relationship applicable between the VNF instances created using different VnfProfiles, the Virtual Link instances created using different VProfiles 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 6.3.5.2-1: Attributes of the AffinityOrAntiAffinityGroup information element

Attribute	Qualifier	Cardinality	Content	Description
groupId	M	1	Identifier	Identifier of Identifier of this AffinityOrAntiAffinityGroup information element.
affinityOrAntiAffinity	M	1	Enum	Specifies the type of relationship that the members of the group have: "affinity" or "anti-affinity".
scope	M	1	Enum	Specifies the scope of the affinity or anti-affinity relationship e.g. a NFVI node, an NFVI PoP, etc.

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 6.3.6.2-1: Attributes of the PnfProfile information element

Attribute	Qualifier	Cardinality	Content	Description
pnfProfileId	M	1	Identifier	Identifier of this PnfProfile information element. It uniquely identifies a PnfProfile.
pnfdId	M	1	Identifier (Reference to Pnfd)	References a PNFD.
pnfVirtualLinkConnectivity	M	1..N	NsVirtualLinkConnectivity	Defines the connection information of the PNF, it contains connection relationship between a PNF connection point and a NS Virtual Link.

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 6.3.7.2-1: Attributes of the NsVirtualLinkConnectivity information element

Attribute	Qualifier	Cardinality	Content	Description
virtualLinkProfileId	M	1	Identifier (Reference to VirtualLinkProfile)	Reference an NS VL profile.
cpId	M	1..N	Identifier (Reference to Cpd)	References the descriptor of a connection point on a VNF/PNF or a SAP which connects to virtual links instantiated from the profile identified in the virtualLinkProfileId attribute.

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 6.3.8.2-1: Attributes of the LocalAffinityOrAntiAffinityRule information element

Attribute	Qualifier	Cardinality	Content	Description
affinityOrAntiAffinity	M	1	Enum	Specifies the type of the rule: "affinity" or "anti-affinity".
scope	M	1	Enum	Specifies whether the scope of the rule is an NFVI-node, an NFVI-PoP, etc.

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 6.3.9.2-1: Attributes of the NsLevel information element

Attribute	Qualifier	Cardinality	Content	Description
nsLevelId	M	1	Identifier	Identifier of this NsLevel information element. It uniquely identifies an NS level within the DF.
description	M	1	String	Human readable description of the NS level.
vnfToLevelMapping	M	0..N	VnfToLevelMapping	Specifies the profile of the VNFs involved in this NS level and, for each of them, the required number of instances. See note.
virtualLinkToLevelMapping	M	0..N	VirtualLinkToLevelMapping	Specifies the profile of the VFs involved in this NS level and, for each of them, the needed bandwidth. See note.
nsToLevelMapping	M	0..N	NsToLevelMapping	Specifies the profile of the nested NSs involved in this NS level and, for each of them, the required number of instances. See note.
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 6.3.10.2-1: Attributes of the NsScaleInfo information element

Attribute	Qualifier	Cardinality	Content	Description
nsScalingAspectId	M	1	Identifier (Reference to NsScalingAspect)	Identifier of the NS scaling aspect.
nsScaleLevelId	M	1	Identifier (Reference to NsLevel)	Identifier of the NS scale level.

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 6.3.11.2-1: Attributes of the NsProfile information element

Attribute	Qualifier	Cardinality	Content	Description
nsProfileId	M	1	Identifier	Identifies an NS profile.
nsdId	M	1	Identifier (Reference to Nsd)	Identifies the NSD applicable to NS instantiated according to this profile.
nsDfId	M	1	Identifier (Reference to NsDf)	Identifies the applicable network service DF within the scope of the NSD.
nsInstantiationLevelId	M	0..1	Identifier (Reference to NsLevel)	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.
minNumberOfInstances	M	1	Integer	Minimum number of nested NS instances based on the referenced NSD that is permitted to exist for this NsProfile.
maxNumberOfInstances	M	1	Integer	Maximum number of nested NS instances based on the referenced NSD that is permitted to exist for this NsProfile.
affinityOrAntiAffinityGroupId	M	0..N	Identifier (Reference to AffinityOrAntiAffinityGroup)	Identifies an affinity or anti-affinity group the NSs created according to this NsProfile belongs to.
nsVirtualLinkConnectivity	M	1..N	NsVirtualLinkConnectivity	Defines the connection information of the NS, it contains connection relationship between an NS SAP and a NS virtual Link of the composite NS.
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 6.3.12.2-1: Attributes of the Dependencies information element

Attribute	Qualifier	Cardinality	Content	Description
primaryId	M	1..N	Identifier (Reference to VnfProfile or NsProfile)	References a VnfProfile or NsProfile. See note.
secondaryId	M	1..N	Identifier (Reference to VnfProfile or NsProfile)	References a VnfProfile or NsProfile. See note.
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 6.4.4.2 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

Attribute	Qualifier	Cardinality	Content	Description
vnffgdId	M	1	Identifier	Identifier of this Vnffgd information element. It uniquely identifies a VNFFGD.
vnfProfileId	M	1..N	Identifier (Reference to VnfProfile)	References the VnfProfile of a constituent VNF. See notes 1 and 2.
pnfProfileId	M	0..N	Identifier (Reference to PnfProfile)	References the PnfProfile of a constituent PNF. See notes 1 and 2.
nestedNsProfileId	M	0..N	Identifier (Reference to NsProfile)	References the NsProfile of a nestedNS. See notes 1 and 2.
virtualLinkProfileId	M	1..N	Identifier (Reference to NsVirtualLinkProfile)	References the Virtual Link Profile of a constituent VL. See note 3.
cpdPoolId	M	1..N	Identifier (Reference to CpdPool)	A reference to a pool of descriptors of connection points attached to one of the constituent VNFs and PNFs and/or one of the SAPs of the parent NS or of a nested NS.
nfpd	M	0..N	Nfpd	The network forwarding path associated to the VNFFG. See clause 6.4.3.
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 VNs 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

Attribute	Qualifier	Cardinality	Content	Description
nfpdId	M	1	Identifier	Identifies this nfpd information element within a VNFFGD.
nfpRule	M	0..1	Rule	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.
nfpPositionDescId	M	1..N	Identifier (Reference to NfpPositionDesc)	Describes a position in the NFP in terms of one or more CP profiles and rules for distributing the traffic among CP and SAP instances created from the CPD or SAPD associated to these profiles. This shall be a connection point profile, which is either a CPD associated with the VnfProfile of a constituent VNF, or a CPD associated with the PnfProfile of a constituent PNF, or a SAPD associated with the NsProfile of a nested NS. The related VnfProfile, PnfProfile and NsProfile shall be included in the parent VNFFGD. See note 2.
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 CpdPool information element

6.4.4.1 Description

The CpdPool information element specifies a pool of descriptors of connection points and service access points.

6.4.4.2 Attributes

The attributes of the CpdPool information element shall follow the indications provided in table 6.4.4.2-1.

Table 6.4.4.2-1: Attributes of the CpdPool information element

Attribute	Qualifier	Cardinality	Content	Description
cpdPoolId	M	1	Identifier	Identifier of this CpdPool information element. It identifies a pool of descriptors of connection points and NS SAPs.
cpdId	M	1..N	Identifier (Reference to Cpd)	A reference to the descriptor of a connection point attached to one of the constituent VNFs and PNFs or to the descriptor of a NS SAP.

6.4.5 NfpPositionDesc information element

6.4.5.1 Description

The NfpPositionDesc information element references one or more Cp profiles and provides rules on how to route traffic flows among CP or SAP instances corresponding to these profiles.

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 6.4.5.2-1: Attributes of the NfpPositionDesc information element

Attribute	Qualifier	Cardinality	Content	Description
nfpPositionDescId	M	1	Identifier	Identifier of this NfpPositionDesc element.
cpProfileId	M	1..N	Identifier (Reference to CpProfile)	References the profile of a connection point to be traversed by the traffic flows matching the criteria. This shall be a connection point attached to one of the constituent VNFs and PNFs of the parent VNFFG, or a SAP of one of the constituent nested NSs of the parent VNFFG.
forwardingBehaviour	M	0..1	Enum	Identifies a rule to apply to forward traffic to CP or SAP instances corresponding to the referenced CP profile(s). The minimum list of rules to be supported shall include: <ul style="list-style-type: none"> • 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.
forwardingBehaviourInputParameters	M	0..1	Not Specified	Provides input parameters to configure the forwarding behaviour (e.g. identifies a load balancing algorithm).
NOTE: When no rules are provided and there are multiple CP or SAP instances corresponding to the referenced CP profile(s), the VIM and/or the NFVI are expected to apply NFP-independent rules determined by means outside the scope of the present document.				

6.4.6 CpProfile information element

6.4.6.1 Description

The CpProfile 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 CpProfile information element shall follow the indications provided in table 6.4.6.2-1.

Table 6.4.6.2-1: Attributes of the CpProfile information element

Attribute	Qualifier	Cardinality	Content	Description
cpProfileId	M	1	Identifier	Identifier of this CpProfile information element. It uniquely identifies a CpProfile.
constituentProfileElements	M	1..2	ConstituentProfileElements	Specifies the constituents of the CpProfile. See note 5.
NOTE 1: Void.				
NOTE 2: Void.				
NOTE 3: Void.				
NOTE 4: Void.				
NOTE 5: When only one constituentProfileElements value is provided, the ingress and egress traffic is associated to a single VNF, or PNF, or nested NS. When two values of constituentProfileElements attribute are provided, the ingress CP/SAP is associated to the first constituent profile element and the egress CP/SAP is associated to the second constituent profile element.				

6.4.7 ConstituentProfileElements information element

6.4.7.1 Description

The ConstituentProfileElements information element references a CPD or a SAPD for a given VnfProfile, PnfProfile or NsProfile.

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

Attribute	Qualifier	Cardinality	Content	Description
constituentBaseElementId	M	1	Identifier (Reference to VnfProfile or PnfProfile or NsProfile)	Specifies the constituents of the CpProfile.
constituentCpdId	M	1	Identifier (Reference to VnfExtCpd or PnfExtCpd or Sapd)	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.

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 6.5.2.2-1: Attributes of the NsVirtualLinkDesc information element

Attribute	Qualifier	Cardinality	Content	Description
virtualLinkDescId	M	1	Identifier	Identifier of the NsVirtualLinkDesc information element. It uniquely identifies a VLD.
virtualLinkDescProvider	M	0..1	String	Defines the organization generating the VLD.
virtualLinkDescVersion	M	1	Version	Specifies the version of the VLD.
connectivityType	M	1	ConnectivityType	See clause 6.5.3.
virtualLinkDf	M	1..N	VirtualLinkDf	See clause 6.5.4.
testAccess	M	0..N	String	Specifies test access facilities expected on the VL (e.g. none, passive monitoring, or active (intrusive) loopbacks at endpoints).
description	M	0..1	String	Provides human-readable information on the purpose of the virtual link (e.g. VL for control plane traffic).
security	M	0..1	SecurityParameters	Provides a signature to prevent tampering.

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

Attribute	Qualifier	Cardinality	Content	Description
layerProtocol	M	1..N	Enum	Identifies the protocols that the VL uses (Ethernet, MPLS, ODU2, IPV4, IPV6, Pseudo-Wire). See note.
flowPattern	M	0..1	String	Identifies the flow pattern of the connectivity (Line, Tree, Mesh, etc.).
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

Attribute	Qualifier	Cardinality	Content	Description
flavourId	M	1	Identifier	Identifies this VirtualLinkDf information element within a VLD.
qos	M	0..1	QoS	See clause 6.5.6.
serviceAvailabilityLevel	M	0..1	Enum	Specifies one of the three levels defined in ETSI GS NFV-REL 001 [i.5]: <ul style="list-style-type: none"> • 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 LinkBitRequirements information element

Attribute	Qualifier	Cardinality	Content	Description
root	M	1	Number	Specifies the throughput requirement of the link (e.g. bitrate of E-Line, root bitrate of E-Tree, aggregate capacity of E-LAN).
leaf	M	0..1	Number	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.

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 QoS information element

6.5.6.1 Description

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

6.5.6.2 Attributes

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

Table 6.5.6.2-1: Attributes of the QoS information element

Attribute	Qualifier	Cardinality	Content	Description
latency	M	1	Number	Specifies the maximum latency in ms.
packetDelayVariation	M	1	Number	Specifies the maximum jitter in ms.
packetLossRatio	M	0..1	Number	Specifies the maximum packet loss ratio.
priority	M	0..1	Integer	Specifies the priority level in case of congestion on the underlying physical links.

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 6.6.2.2-1: Attributes of the Pnfd information element

Attribute	Qualifier	Cardinality	Content	Description
pnfdId	M	1	Identifier	Identifier of this Pnfd information element. It uniquely identifies the PNFD.
functionDescription	M	1	String	Describes the PNF function
provider	M	1	String	Identifies the provider of the PNFD.
version	M	1	Version	Identifies the version of the PNFD.
pnfdInvariantId	M	1	Identifier	Identifies a PNFD in a version independent manner. This attribute is invariant across versions of PNFD.
name	M	1	String	Provides the human readable name of the PNFD.
pnfExtCpd	M	1..N	PnfExtCpd	Specifies the characteristics of one or more connection points where to connect the PNF to a VL. See clause 6.6.4.
security	M	0..1	SecurityParameters	Provides a signature to prevent tampering.
geographicalLocationInfo	M	0..1	Not specified	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.

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 specifies the characteristics of connection points attached to NFs and NSs. This is an abstract class used as parent for the various Cpd classes. It has an attribute "trunkMode" which enables the NFVO to identify whether the Cp instantiated from the Cpd is in trunk mode or not.

6.6.3.2 Attributes

The attributes of the Cpd information element shall follow the indications provided in table 6.6.3.2-1.

Table 6.6.3.2-1: Attributes of the Cpd information element

Attribute	Qualifier	Cardinality	Content	Description
cpdId	M	1	Identifier	Identifier of this Cpd information element.
layerProtocol	M	1..N	Enum	Identifies a protocol that the connection points corresponding to the CPD support for connectivity purposes (e.g. Ethernet, MPLS, ODU2, IPV4, IPV6, Pseudo-Wire, etc.). See note.
cpRole	M	0..1	String	Identifies the role of the connection points corresponding to the CPD in the context of the traffic flow patterns in the VNF, PNF or NS. For example an NS with a tree flow pattern within the NS will have legal cpRoles of ROOT and LEAF.
description	M	0..1	String	Provides human-readable information on the purpose of the connection point (e.g. connection point for control plane traffic).
trunkMode	M	0..1	Boolean	Information about whether the Cp instantiated from this CPD is in Trunk mode (802.1Q or other). When operating in "trunk mode", the Cp is capable of carrying traffic for several VLANs. A cardinality of 0 implies that trunkMode is not configured for the Cp i.e. It is equivalent to Boolean value "false".
NOTE: This information determines, amongst other things, which type of address to assign to the connection point at instantiation time.				

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 6.6.4.2-1: Attributes of the PnfExtCpd information element

Attribute	Qualifier	Cardinality	Content	Description
(inherited attributes)				All attributes inherited from Cpd.

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

Attribute	Qualifier	Cardinality	Content	Description
nsScalingAspectId	M	1	Identifier	Identifier of this NsScalingAspect information element. It Uniquely identifies the NS scaling aspect in an NSD.
name	M	1	String	Provides a human readable name of the NS scaling aspect.
description	M	1	String	Provides a human readable description of the NS scaling aspect.
nsScaleLevel	M	1..N	NsLevel	Describes the details of an NS level. See clause 6.3.9. See note.
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

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

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

Attribute	Qualifier	Cardinality	Content	Description
nsProfileId	M	1	Identifier (Reference to NsProfile)	Identifies the profile to be used for a nested NS involved in the NS level.
numberOfInstances	M	1	Integer	Specifies the number of nested NS instances required for the NS scale level. See notes 1 to 3.
<p>NOTE 1: It shall be in the range of minNumberOfInstances-maxNumberOfInstances, as specified in the referenced NsProfile.</p> <p>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.</p> <p>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.</p>				

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 A.2-1: SFC concepts to NFV constructs mapping

IETF RFC 7665 [i.6] term	IETF RFC 7665 [i.6] (simplified) definition	Equivalent NFV constructs
Network Service	<i>An offering provided by an operator that is delivered using one or more service functions. This may also be referred to as a "composite service". The term "service" is used to denote a "network service" in the context of this document.</i>	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].
Classification	<i>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.</i>	The nfpRule attribute of the Nfpd information element provides the input to the Classification.
Classifier	<i>An element that performs Classification.</i>	This functionality is provided by the NFVI network domain.
Service Function Chain	<i>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.</i>	A service function chain is described by an Nfpd information element.
Service Function (SF)	<i>A function that is responsible for specific treatment of received packets. A Service Function can act at various layers of a protocol stack (e.g., 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.</i>	An SF can be deployed as one or several VNFs. In the latter case, the group of VNFs can be represented as a nested NS. Multiple SFs can map to one VNF, as long as an external connection point provides access to this SF within the VNF.

IETF RFC 7665 [i.6] term	IETF RFC 7665 [i.6] (simplified) definition	Equivalent NFV constructs
Service Function Forwarder (SFF)	<i>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.</i>	This functionality is provided by the NFVI network domain.
Service Function Path (SFP)	<i>The service function path is a constrained 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.</i>	An SFP is derived from an NFP created by the NFVO from an NFPD. See note.
SFC Encapsulation	<i>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.</i>	This functionality is provided by the NFVI network domain.
Rendered Service Path (RSP)	<i>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).</i>	The RSP for a given packet is determined by the NFVI by applying runtime decisions, in particular those resulting from load balancing.
SFC-Enabled Domain	<i>A network or region of a network that implements SFC. An SFC-enabled domain is limited to a single network administrative domain.</i>	An infrastructure domain supporting NFP management is an SFC-enabled domain.
SFC Proxy	<i>Removes and inserts SFC encapsulation on behalf of an SFC-unaware service function. SFC proxies are logical elements.</i>	This functionality is provided by the NFVI network domain.
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.

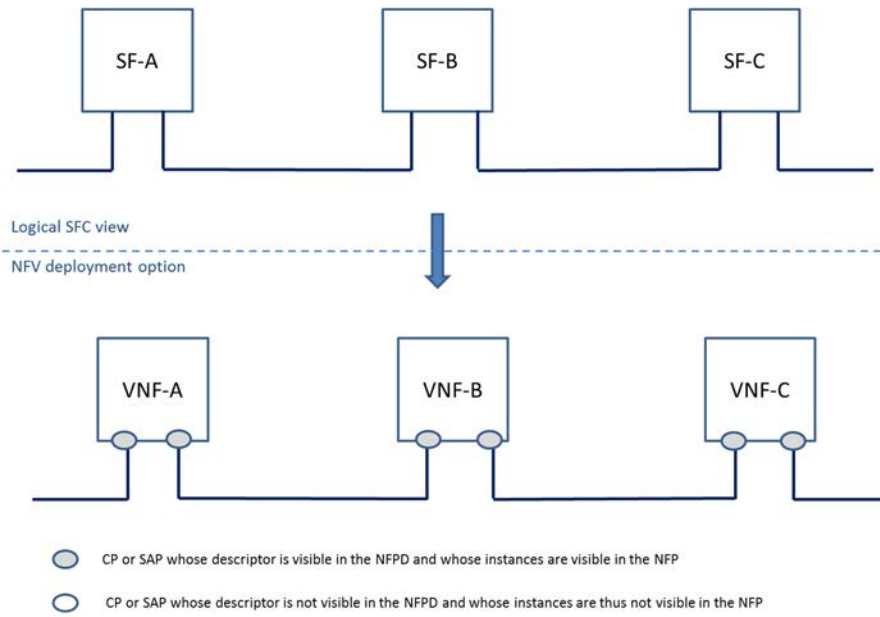


Figure A.4-1: One-to-one mapping

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

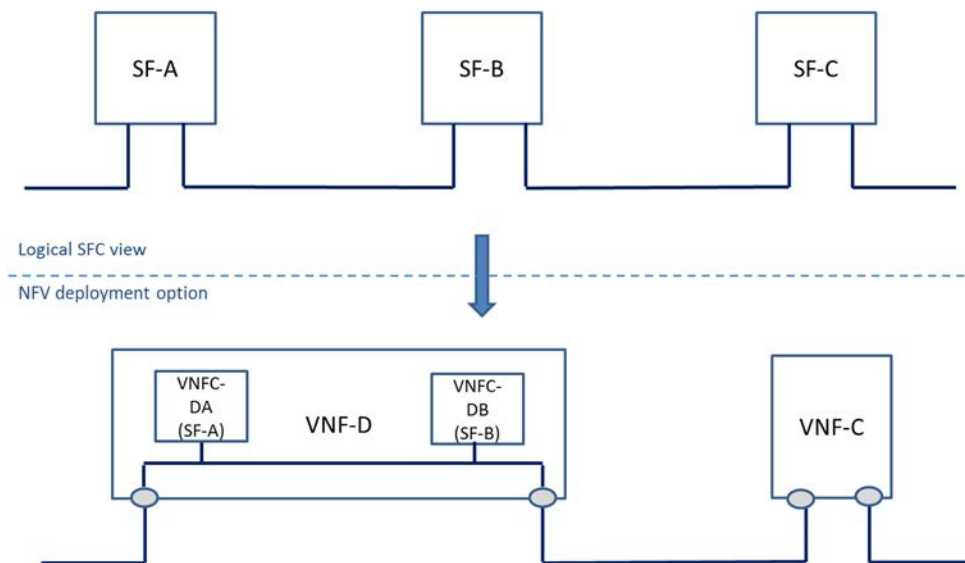


Figure A.4-2: Many-to-one mapping

Figure A.4-3 illustrates the case where one SF is implemented as two VNFs.

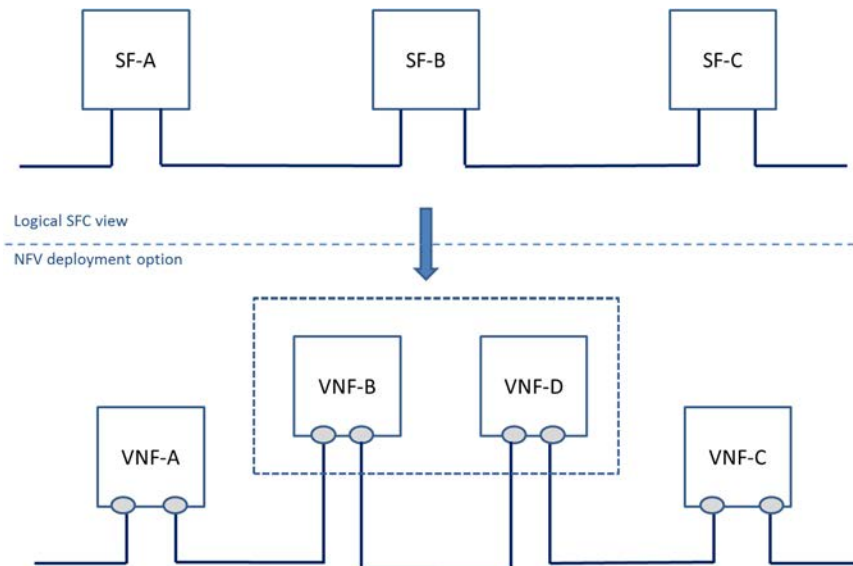


Figure A.4-3: One-to-many mapping

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.

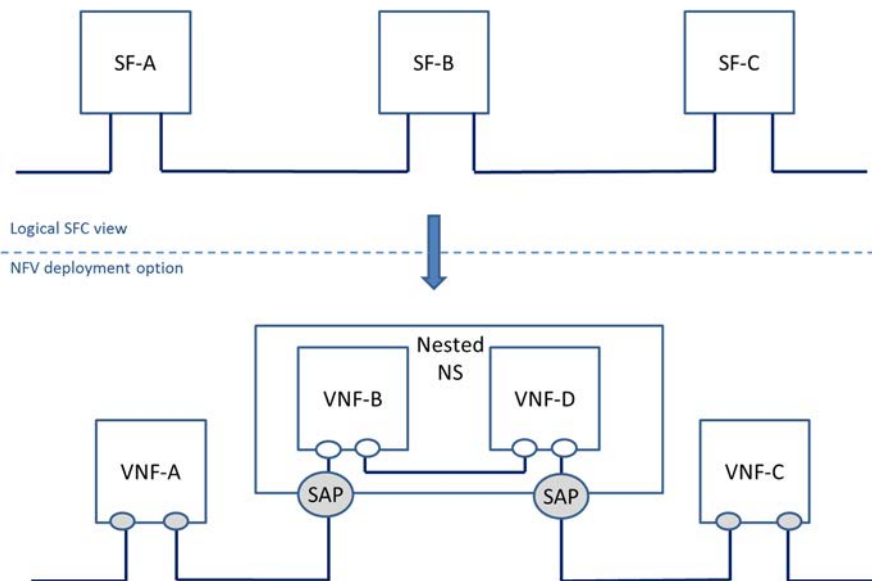


Figure A.4-4: SF as a nested NS mapping

Annex B (informative): Authors & contributors

The following people have contributed to the present document:

Rapporteur:

Janusz Pieczerak, Orange

Previous Rapporteur:

Bruno Chatras, Orange, from version 0.0.1 to version 2.1.1

Other contributors:

Bruno Chatras, Orange

Dmytro Gassanov, NetCracker

Andrew Veitch, NetCracker

Shuang Zhang, KPN

Frank den Hartog, KPN

Amanda Xiang, Huawei

Michael Klotz, Deutsche Telekom AG

Zarrar Yousaf, NEC Europe

Marc Flauw, Hewlett-Packard Enterprise

Stephen Fratini, Ericsson LM

Jeongyun Kim, ETRI

Zhou Yan, Huawei

Xu Ruiyue, Huawei

Yu Fang, Huawei

Nigel Davis, Ciena

Anatoly Andrianov, Nokia

Shitao Li, Huawei

Jie Miao, China Unicom

Gang He, China Unicom

Junjie Tong, China Unicom

Nicola Santinelli, Telecom Italia

Joan Triay, DOCOMO

Kazuaki Obana, DOCOMO

Ashiq Khan, DOCOMO

Gerald Kunzmann, DOCOMO

Bertrand Souville, DOCOMO

Drew Jordan, Sigma Systems Canada Inc.

Arturo Martin de Nicolas, Ericsson LM

Haibin Chu, Ericsson LM

Xiang Li, China Mobile US Research Centre

Rongwei Ren, China Mobile US Research Centre

Yuan Yannan, China Mobile US Research Centre

Priya TG, NetCracker

Ernie Bayha, Ericsson LM

Janusz Pieczerak, Orange

Annex C (informative): Change History

Date	Version	Information about changes
27-06-2017	2.1.2	Update with CRs NFVIFA(17)000487, NFVIFA(17)000575.
08-12-2017	2.3.2	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)001006 NFVIFA(17)001041r1 NFVIFA(17)001099r2 NFVIFA(17)001143
12-04-2018	2.4.2	NFVIFA(18)000304
08-05-2018	2.4.3	NFVIFA(18)000192r1 NFVIFA(18)000193
22-06-2018	2.4.4	Rapporteur action: Bug Tracker 7727, editorial review NFVIFA(18)000373r3 NFVIFA(18)000503 NFVIFA(18)000379r3

History

Document history		
V2.1.1	October 2016	Publication
V2.3.1	August 2017	Publication
V2.4.1	February 2018	Publication
V2.5.1	August 2018	Publication