ETSI GS NFV-SOL 001 V3.7.1 (2022-12)

Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; NFV descriptors based on TOSCA 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-SOL001ed371

Keywords
data, information model, model, NFV

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 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are 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 Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, 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.

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 a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

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 a data model for NFV descriptors, using the TOSCA-Simple-Profile-YAML-v1.3 [20], fulfilling the requirements specified in ETSI GS NFV-IFA 011 [1] and ETSI GS NFV-IFA 014 [2] for a Virtualised Network Function Descriptor (VNFD), a Network Service Descriptor (NSD) and a Physical Network Function Descriptor (PNFD). The present document also specifies requirements on the VNFM and NFVO specific to the handling of NFV descriptors based on the TOSCA-Simple-Profile-YAML-v1.3 [20].

2 References

2.1 Normative references

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

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

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

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

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

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

[3] Void.

[4] Void.

[5] Private Enterprise Numbers registry at IANA.

NOTE: Available at https://www.iana.org/assignments/enterprise-numbers/enterprise-numbers.

[6] IETF RFC 5234: "Augmented BNF for Syntax Specifications: ABNF".

[7] ETSI GS NFV-IFA 027: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Performance Measurements Specification".

[8] IETF RFC 3986: "Uniform Resource Identifier (URI): Generic Syntax".

[9] IETF RFC 4122: "A Universally Unique IDentifier (UUID) URN Namespace".

[10] ISO 3166 (all parts): "Codes for the representation of names of countries and their subdivisions".

[11] IETF RFC 4776: "Dynamic Host Configuration Protocol (DHCPv4 and DHCPv6) Option for Civic Addresses Configuration Information".

NOTE: Available at https://www.rfc-editor.org/info/rfc4776.

[12] IETF RFC 7230: "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing".

[13] IETF RFC 5646: "Tags for Identifying Languages".

[14] Hash Function Textual Names registry at IANA.

NOTE: Available at https://www.iana.org/assignments/hash-function-text-names.

[15] The Open Group Base Specifications Issue 7, 2018 edition IEEE™ Std 1003.1-2017 (Revision of IEEE Std 1003.1™-2008).

NOTE: Available at http://pubs.opengroup.org/onlinepubs/9699919799/basedefs/V1_chap09.html.

[16] IEEE 802.1Q™-2014: "IEEE Standard for Local and metropolitan area networks - Bridges and Bridged Networks".

[17] IETF RFC 791: "Internet Protocol".

NOTE: Available at https://www.rfc-editor.org/info/rfc791.

[18] IETF RFC 8200: "Internet Protocol, Version 6 (IPv6) Specification".

NOTE: Available at https://www.rfc-editor.org/info/rfc8200.

[19] IANA: "Assigned Internet Protocol Numbers".

NOTE: Available at https://www.iana.org/assignments/protocol-numbers/protocol-numbers.xhtml.

[20] TOSCA-Simple-Profile-yaml-v1.3: "TOSCA Simple Profile in YAML Version 1.3".

[21] IETF RFC 6225: "Dynamic Host Configuration Protocol Options for Coordinate-Based Location Configuration Information".

NOTE: Available at https://www.rfc-editor.org/info/rfc6225.

[22] ETSI GS NFV-SOL 002: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point".

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-IFA 007: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".

[i.2] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.3] Void.

[i.4] Void.

[i.5] Void.

[i.6] ETSI GS NFV-SOL 004: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; VNF Package and PNFD Archive specification".

[i.7] Mistral Workflow Language v2 specification.

NOTE 1: Available at https://docs.openstack.org/mistral/latest/user/wf_lang_v2.html.

NOTE 2: The OpenStack® Word Mark and OpenStack Logo are either registered trademarks/service marks or trademarks/service marks of the OpenStack Foundation, in the United States and other countries and are used with the OpenStack Foundation's permission. ETSI is not affiliated with, endorsed or sponsored by the OpenStack Foundation, or the OpenStack community.

[i.8] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Os-Ma-Nfvo reference point - Interface and Information Model Specification".

[i.9] ETSI GS NFV-SOL 003: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point".

[i.10] ETSI GS NFV-SOL 005: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; RESTful protocols specification for the Os-Ma-nfvo Reference Point".

[i.11] ETSI GS NFV-SOL 007: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; Network Service Descriptor File Structure Specification".

[i.12] OpenStack® documentation: "Disk and container formats for images".

NOTE: Available at https://docs.openstack.org/glance/pike/user/formats.html.

[i.13] Openstack® Metadata service.

NOTE: Available at https://docs.openstack.org/nova/rocky/user/metadata-service.html.

[i.14] Openstack® User-data service.

NOTE: Available at https://docs.openstack.org/nova/rocky/user/user-data.html.

[i.15] Openstack® Personality service.

NOTE: Available at http://www.openstacknetsdk.org/docs/html/T_net_openstack_Core_Domain_Personality.htm.

[i.16] ETSI NFV registry of VimConnectionInfo information.

NOTE: Available at http://register.etsi.org/NFV.

[i.17] IETF RFC 4090: "Fast Reroute Extensions to RSVP-TE for LSP Tunnels".

[i.18] TOSCA-Simple-Profile-yaml-v1.2: "TOSCA Simple Profile in YAML Version 1.2".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GS NFV 003 [i.2] and the following apply:

TOSCA interface type: reusable entity that describes a set of TOSCA operations that can be included as part of a Node type or Relationship Type definition

NOTE: See TOSCA-Simple-Profile-YAML-v1.3 [20].

TOSCA operation: behavioural lifecycle procedure in a TOSCA node or relationship definition that can be invoked by an orchestration engine, whose implementation definition can be provided in the service template as part of a node template definition or a relationship template definition, or rely on an implementation of the operation built in the orchestration engine

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 003 [i.2] apply.

4 Overview of TOSCA model

TOSCA (Topology and Orchestration Specification for Cloud Applications) is a modelling language for describing the components of a cloud application and their relationships. TOSCA uses the concept of service templates to describe cloud workloads. TOSCA further provides means of associating standard or user-defined lifecycle operations to a cloud application component or to a relationship between components. The present document is based on TOSCA-Simple-Profile-YAML-v1.3 [20], which describes a YAML rendering for TOSCA.

5 General concept of using TOSCA to model NFV descriptors

5.1 Introduction

An NFV deployment template is modelled by using one or more TOSCA service template as defined in TOSCA-Simple-Profile-YAML-v1.3 [20].

Three main deployment templates are identified in the present document:

- The Virtualised Network Function Descriptor (VNFD).
- The Network Service Descriptor (NSD).
- The Physical Network Function Descriptor (PNFD).

When processing TOSCA service templates modelling all or part of an NFV descriptor, the consumer of the NFV descriptor shall comply with and implement the semantics of any of the keynames defined in clause 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20] and used in clauses 5, 6, 7 and 8 of the present document. The presence of other keynames defined in clause 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20] shall not cause the NFV descriptor to be rejected and the consumer of the NFV descriptor may choose to ignore them and their associated contents, unless they are part of the type definitions files referred to in annex B of the present document.

5.2 Network Service Descriptor

The Network Service Descriptor (NSD) is a deployment template which consists of information used by the NFVO for lifecycle management of an NS as defined in ETSI GS NFV-IFA 014 [2]. The NSD:

- References zero, one or more Virtualised Network Function Descriptors (VNFD).
- References zero, one or more Physical Network Functions Descriptors (PNFD).
- References zero, one or more nested NSD.
- Includes zero, one or more Virtual Link Descriptors (VLD).
- Includes zero, one or more VNF Forwarding Graph Descriptors (VNFFGD).

A VNFFGD describes a topology of the Network Service or a portion of the Network Service.

A VLD describes the resource for deploying and managing the lifecycle of virtual links between the constituents of an NS.

A PNFD describes the connectivity requirements to integrate PNFs in an NS.

A nested NSD is an NSD from which a nested NS can be instantiated within a parent NS instance.

5.3 Virtualised Network Function Descriptor

The VNFD is a component of a VNF package. It is used by both the NFVO and the VNFM.

A VNFD is a deployment template which describes a VNF in terms of deployment and operational behaviour requirements. It also contains Virtualised Deployment Units (VDUs), internal virtual link descriptors, external connection point descriptors, software image descriptors, and deployment flavour descriptors, as defined in ETSI GS NFV-IFA 011 [1].

A VNFD contains the following main pieces of information, as shown in figure 5.3-1:

- Virtualisation Deployment Unit (VDU) is a construct supporting the description of the deployment and operational behaviour of a VNF Component (VNFC). A VNFC instance created based on the VDU maps to a single virtualisation container (e.g. a VM). AVDU describes the resources needed to deploy and manage the lifecycle of a VNFC. A VDU includes internal Connection Point Descriptors (CPDs) that describe internal connection points that can either be used to connect a VNFC to an internal virtual link or be re-exposed outside the VNF as external connection points.
- External CPD: describes an external connection point of a VNF, where either an internal connection point of a VDU is exposed as external connection point or the external connection point is directly connected to an internal virtual link.
- Internal VLD: describes the resource requirements for deploying and managing the lifecycle of virtual links between one or more VNFC instances created based on one or more VDUs.

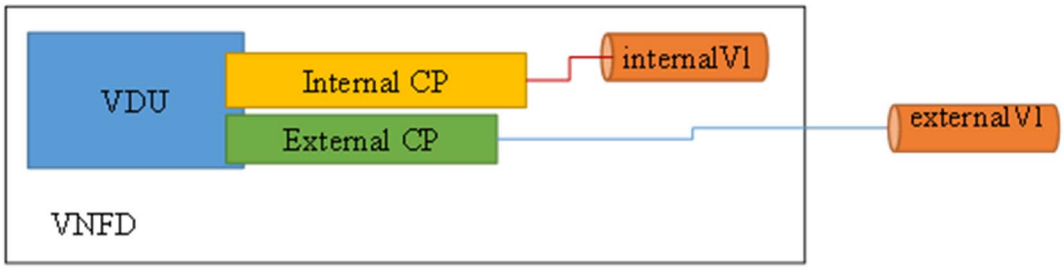


Figure 5.3-1: Overview of VNF descriptor

The information within a VNFD is structured according to one or more VNF deployment flavours (VnfDf) that specify different deployment configuration of a VNF, in terms of its internal topology and resource needs.

5.4 Physical Network Function Descriptor

The Physical Network Function Descriptor (PNFD) information element is a deployment template enabling on-boarding PNFs and referencing them from an NSD. It focuses on connectivity aspects only.

5.5 tosca_definitions_version and Namespace prefix

The "tosca_definitions_version" keyword when used in the present document shall comply with the definition as specified in section 3.1.2 of TOSCA-Simple-Profile-YAML-v1.3 [20] with the associated Namespace Alias value defined in the TOSCA-Simple-Profile-YAML-v1.3 [20].

NOTE 1: This implies that service templates complying to the present document can only import service templates that reference the same version - and thus use the same grammar - as the importing service template. This is a restriction compared to the TOSCA-Simple-Profile-YAML-v1.3 specification [20].

NOTE 2: As specified in TOSCA-Simple-Profile-YAML-v1.3 [20], the grammar used in TOSCA-Simple-Profile-YAML-v1.2 [i.18] is still supported with deprecation. The present document indicates the cases in which support with deprecation is applicable.

Table 5.5-1 defines the TOSCA Namespace prefix that shall be used to declare the namespace of all the TOSCA types as specified in the present document.

Table 5.5-1

Namespace Prefix	Specification Description
toscanfv	The TOSCA namespace prefix of all the TOSCA types as specified in the present document.

5.6 Imports statement

5.6.1 VNFD TOSCA service template

A VNFD TOSCA service template as specified in clause 6.11 shall include a TOSCA import definition referencing the following files:

- The file defined in clause B.2 that includes all the type definitions from clause 6 of the present document.
- Others, as described in clause 6.11.

As specified in TOSCA-Simple-Profile-YAML-v1.3 [20], the import statement can use a single-line or multi-line grammar.

The single-line grammar supports the import of single or multiple uniquely named VNFD types and other template definition files.

EXAMPLE 1:

```
imports:
  - https://forge.etsi.org/rep/nfv/SOL001/raw/v2.6.1/etsi_nfv_sol001_vnfd_types.yaml
  - any_other_files.yaml
  - custom_vnfd_datatypes_extension.yaml
```

The multi-line grammar also supports the import of single or multiple uniquely named VNFD types and other template definition files. The "file" keyword is a mandatory parameter in this grammar.

EXAMPLE 2:

```
imports:
  - file: https://forge.etsi.org/rep/nfv/SOL001/raw/v2.6.1/etsi_nfv_sol001_vnfd_types.yaml
  - file: any_other_files.yaml
  - file: custom_vnfd_datatypes_extension.yaml
```

5.6.2 NSD TOSCA service template

An NSD TOSCA service template as specified in clause 7.11 shall include a TOSCA import definition referencing the following files:

- The file defined in clause B.3 that includes all the type definitions from clause 7 of the present document.
- Others, as described in clause 7.11.

As specified in TOSCA-Simple-Profile-YAML-v1.3 [20], the import statement can use a single-line or multi-line grammar.

The single-line grammar supports the import of single or multiple uniquely named NSD types and other template definition files.

EXAMPLE 1:

```
imports:
  - https://forge.etsi.org/rep/nfv/SOL001/raw/v2.6.1/etsi_nfv_sol001_nsd_types.yaml
  - any_other_files.yaml
  - custom_nsd_node_types_extension.yaml
```

The multi-line grammar also supports the import of single or multiple uniquely named NSD types and other template definition files. The "file" keyword is a mandatory parameter in this grammar.

EXAMPLE 2:

```
imports:
  - file: https://forge.etsi.org/rep/nfv/SOL001/raw/v2.6.1/etsi_nfv_sol001_nsd_types.yaml
  - file: any_other_files.yaml
  - file: custom_nsd_node_types_extension.yaml
```

5.6.3 PNFD TOSCA service template

A PNFD TOSCA service template as specified in clause 8.11 shall include a TOSCA import definition referencing the following files:

- The file defined in clause B.4 that includes all the type definitions from clause 8 of the present document.
- Others, as described in clause 8.11.

As specified in TOSCA-Simple-Profile-YAML-v1.3 [20], the import statement can use a single-line or multi-line grammar.

The single-line grammar supports the import of single or multiple uniquely named PNFD types and other template definition files.

EXAMPLE 1:

```
imports:
  - https://forge.etsi.org/rep/nfv/SOL001/raw/v2.6.1/etsi_nfv_sol001_pnfd_types.yaml
  - any_other_files.yaml
  - custom_pnfd_node_types_extension.yaml
```

The multi-line grammar also supports the import of single or multiple uniquely named PNFD types and other template definition files. The "file" keyword is a mandatory parameter in this grammar.

EXAMPLE 2:

```
imports:
  - file: https://forge.etsi.org/rep/nfv/SOL001/raw/v2.6.1/etsi_nfv_sol001_pnfd_types.yaml
  - file: any_other_files.yaml
  - file: custom_pnfd_node_types_extension.yaml
```

5.7 Type extension

5.7.1 Introduction

Type extension is used when VNF-specific type information is introduced in the VNFD (e.g. modifiable attributes, configurable properties and additional parameters to LCM operations) or NSD (e.g. additional parameters to LCM operations).

5.7.2 Rules

Type extension may be applied to NFV types defined in the present document within the limits specified in table 5.7.3-1 and table 5.7.4-1, adhering to the following rule.

A derived type shall extend the base type in such a way that it remains substitutable for the base type with the following requirements:

- New properties and attributes may be introduced with no restriction within the limits specified in table 5.7.3-1 and table 5.7.4-1.
- Existing properties may be extended according to the following rules:

a) A scalar property shall not be extended to another type (e.g. a string property shall not be replaced with an integer property or with a complex property of the same name).

b) A complex property of data type "X" may only be extended to a property of type "Y" where "Y" is derived from "X" according to the present rules (recursive rule: present rules applied to each property of the derived data type.

c) A property of type list with entry schema "X" may only be extended to a list with entry schema "Y" where "Y" is an extension of "X" according to the present rules (recursive rule: present rules applied to the elements of the list).

d) A property of type map with entry schema "X" may only be extended to a map with entry schema "Y" where "Y" is an extension of "X" according to the present rules (recursive rule: present rules applied to the values of the map).

In general, the above rules apply to introducing/extending other elements beyond properties such as capabilities, requirements, interfaces, operations, inputs, etc. as well.

5.7.3 VNFD Types

Table 5.7.3-1 specifies the extension point where VNFD author may extend the pre-defined types.

Table 5.7.3-1: VNFD type extension points

Type	Keyname	Property name
tosca.nodes.nfv.VNF	properties	modifiable_attributes (as a new property) configurable_properties (as a new property). See note 4 and note 5.
	requirements	New requirements with capability type VirtualLinkable (as new requirements).
	interfaces	Vnflcm.{operation_name}.inputs.additional_parameters (as a new property) Vnflcm.{operation_name}.inputs (as new properties). VnfIndicator.notifications (as new notifications). See note 4.
	attributes	One attribute of primitive type per VNF indicator may be added. One attribute of type integer per scaling aspect may be added. It holds the value of the current scale level.
tosca.nodes.nfv.Vdu.Compute	properties	configurable_properties (as a new property). See notes 1 and 4.
tosca.datatypes.nfv.VnfInfoModifiableAttributes	properties	extensions (as a new property) metadata (as a new property). See note 2 and note 4.
tosca.datatypes.nfv.VnfConfigurableProperties	properties	additional_configurable_properties (as a new property). See notes 2 and 4.
tosca.datatypes.nfv.VnfcConfigurableProperties	properties	additional_vnfc_configurable_properties (as a new property). See notes 2 and 4.
tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions	properties	(new properties). See notes 2 and 4.
tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata	properties	(new properties). See notes 2 and 4.
tosca.datatypes.nfv.VnfAdditionalConfigurableProperties	properties	(new properties). See notes 2 and 4.
tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties	properties	(new properties). See notes 2 and 4.
tosca.datatypes.nfv.VnfOperationAdditionalParameters	properties	(new properties). See notes 2 and 4.
tosca.datatypes.nfv.InputOpCoordParams	properties	(new properties). See notes 2 and 4.
tosca.datatypes.nfv.OutputOpCoordParams	properties	(new properties). See notes 2 and 4.
tosca.interfaces.nfv.VnfIndicator	notifications	one notification may be added per Vnf indicator. See note 3.
tosca.interfaces.nfv.ChangeCurrentVnfPackage	operations	{change_current_package_script} (as new operation). {change_current_package_script}.inputs.additional_parameters (as new property).

Type	Keyname	Property name
tosca.policies.nfv.LcmCoordinationAction	policies	See clause 6.10.16.4.

NOTE 1: VNF specific Vdu.Compute node types should be given names starting by the provider name followed by a dot (".") in order to avoid collisions if these node types are imported in an NSD service template. The provider name may, but need not, be identical to the value of the provider property of the VNF node type. Furthermore, it is the VNF provider's responsibility to ensure the uniqueness of the names of its Vdu.Compute node types, i.e. the Vdu.Compute node type names starting with its provider name.
NOTE 2: VNF specific extension datatypes should be given names starting by the provider name followed by a dot (".") in order to avoid collisions when importing these datatypes in an NSD service template. The provider name may, but need not, be identical to the value of the provider property of the VNF node type. Furthermore, it is the VNF provider's responsibility to ensure the uniqueness of the names of its datatypes, i.e. the datatype names starting with its provider name.
NOTE 3: VNF specific interface types should be given names starting by the provider name followed by a dot (".") in order to avoid collisions when importing these types in an NSD service template. The provider name may, but need not, be identical to the value of the provider property of the VNF node type. Furthermore, it is the VNF provider's responsibility to ensure the uniqueness of the names of its interface types, i.e. the interface type names starting with its provider name.
NOTE 4: If a property is defined with a required value equal to false, the default value shall not be present in VNFD. This also applies to any new datatypes introduced in the VNFD.
NOTE 5: Additional properties when introduced in the VNF specific node type definition may be ignored by NFV-MANO.

5.7.4 NSD types

Table 5.7.4-1 specifies the extension points where NSD author may extend the pre-defined types.

Table 5.7.4-1: NSD type extension points

Type	Keyname	Property name
tosca.nodes.nfv.NS	requirements	New requirements with capability type VirtualLinkable (as new requirements).
	interfaces	Nslcm.{operation_name}.inputs.additional_parameters (as a new property).
tosca.datatypes.nfv.NsOperationAdditionalParameters	properties	(new properties). See note.
tosca.policies.nfv.NsAutoScale	policies	See clause 7.10.15.

NOTE: If a property is defined with a required value equal to false, the default value shall not be present in NSD. This also applies to any new datatypes introduced in the NSD.

5.7.5 Security-sensitive properties in extended data types

The definition of the properties of some of the data types derived from the data types specified in the present document may include the following metadata:

- sensitive: "true"

NOTE: Double quotes are needed to avoid that the parser interprets it as the Boolean value true.

This metadata indicates that the property holds security-sensitive information (e.g. passwords).

It is out of the scope of the present document to specify the exact behaviour of a functional block handling security-sensitive properties. The intent of this metadata is to signal not to expose the value of the property by means such as user interfaces, logging files, programmatic interfaces, etc.

Specific handling of these properties when they are used as parameters in the APIs is defined in the affected specifications, e.g. ETSI GS NFV-SOL 003 [i.9].

Extension of the types listed in table 5.7.5-1 may include properties with this metadata.

Table 5.7.5-1: VNFD and NSD extensible data types

Data type
tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
tosca.datatypes.nfv.VnfAdditionalConfigurableProperties
tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
tosca.datatypes.nfv.VnfOperationAdditionalParameters
tosca.datatypes.nfv.NsOperationAdditionalParameters

In this version of the present document the use of the security-sensitive tagging is limited to properties defined in the extended types. The use of the security-sensitive tagging in properties defined in the present document is not supported.

The security-sensitive tagging is foreseen for properties whose values are expected to be dynamically set from the APIs. Tagging a property that has a value assigned in the VNFD as security-sensitive does not prevent its exposure when the complete VNFD is exposed. Therefore, assigning a value in the VNFD should be avoided.

5.8 Non-Backward Compatible changes

Annex F provides the list of non-backward compatible changes during the development of the present document.

5.9 Use of TOSCA functions

The TOSCA service templates complying with the present document may use the TOSCA functions listed in table 5.9-1. Use of these TOSCA functions shall comply with the provisions in section 4 of TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 5.9-1: Supported TOSCA functions

TOSCA function
get_property
get_artifact (see note 1)
get_input (see note 2)
get_attribute (see note 3)
TOSCA intrinsic functions (see note 4)
NOTE 1: Service templates complying with the present document may only use the get_artifact function in a VNFD service template. NOTE 2: The get_input function is used to retrieve the values of parameters declared in the input section of a service template and assign them properties. Service templates complying with the present document may only the use of the get_input function to assigning values to the properties listed in table 5-9-2. NOTE 3: Service templates complying with the present document may only use the get_attribute function to retrieve the value of the following attributes: a) In a VNF node template: scale_status attribute. b) In an NS node template: scale_status attribute and any VNF node attribute holding the value of a VNF indicator. NOTE 4: TOSCA intrinsic functions (concat, join and token) are defined in section 4.3 of TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 5.9-2: Applicable properties for get_input

Type	Property
tosca.nodes.nfv.VNF	flavour_id modifiable_attributes configurable_properties
tosca.nodes.nfv.Vdu.Compute	configurable_properties
tosca.nodes.nfv.NS	flavour_id
NOTE: Input values are either assigned in the service templates or received from the APIs. The mapping between TOSCA properties and API attributes is described in Annex D of the present document.	

6 VNFD TOSCA model

6.1 Introduction

The VNFD information model specified by ETSI GS NFV-IFA 011 [1] is mapped to the TOSCA concepts. The VNFD is represented as one or more TOSCA service templates to be used by the VNFM for deploying and managing the lifecycle of a VNF instance.

Table 6.1-1 describes the mapping of the main information elements defined in ETSI GS NFV-IFA 011 [1] applicable to a VNFD and the corresponding NFV-specific TOSCA Types, as well the basic TOSCA types defined in TOSCA-Simple-Profile-YAML-v1.3 [20] from which they are derived from. The full definition of all types can be found in the following clauses.

NOTE: The autoScale rule with use of VNF monitoring parameters specified in ETSI GS NFV-IFA 011 [1] is not supported in this version of the present document.

Table 6.1-1: Mapping of ETSI GS NFV-IFA 011 [1] information elements with TOSCA types

ETSI GS NFV-IFA 011 [1] Elements	VNFD TOSCA types	Derived from
VNFD	tosca.nodes.nfv.VNF	tosca.nodes.Root
Vdu	n/a (see note 1)	n/a
Cpd (Connection Point)	tosca.nodes.nfv.Cp	tosca.nodes.Root
VduCpd (internal connection point)	tosca.nodes.nfv.VduCp	tosca.nodes.nfv.Cp
VipCpd	tosca.nodes.nfv.VipCp	tosca.nodes.nfv.Cp
VnfVirtualLinkDesc (Virtual Link)	tosca.nodes.nfv.VnfVirtualLink	tosca.nodes.Root
VnfExtCpd (External Connection Point)	tosca.nodes.nfv.VnfExtCp tosca.nodes.nfv.VduCp	tosca.nodes.nfv.Cp
VirtualStorageDesc	tosca.nodes.nfv.Vdu.VirtualBlockStorage tosca.nodes.nfv.Vdu.VirtualObjectStorage tosca.nodes.nfv.Vdu.VirtualFileStorage	tosca.nodes.Root
VirtualComputeDesc	tosca.nodes.nfv.Vdu.Compute	tosca.nodes.Root
SwImageDesc	tosca.artifacts.nfv.SwImage	tosca.artifacts.Deployment.Image
VnfDf	n/a (see note 2)	n/a
SecurityGroupRule	tosca.policies.nfv.SecurityGroupRule	tosca.policies.Root
VnfConfigurableProperties	tosca.datatypes.nfv.VnfConfigurableProperties	tosca.datatypes.Root
VnfInfoModifiableAttributes	tosca.datatypes.nfv.VnfInfoModifiableAttributes	tosca.datatypes.Root
NOTE 1: The Vdu information element is represented as a collection of tosca.nodes.nfv.VduCp, tosca.nodes.nfv.Vdu.Compute, tosca.nodes.nfv.Vdu.VirtualBlockStorage, tosca.nodes.nfv.Vdu.VirtualObjectStorage and tosca.nodes.nfv.Vdu.VirtualFileStorage types. NOTE 2: The VnfDf information element is represented as a TOSCA service template.		

Figure 6.1-1 provides an overview of the TOSCA node types used to build a service template representing a VNFD for a specific deployment flavour, and of the relationship between them for VNF when all its virtualization containers are realized as VMs. The figure shows one of the three types of virtual storage. A detailed description is provided in clause 6.11.

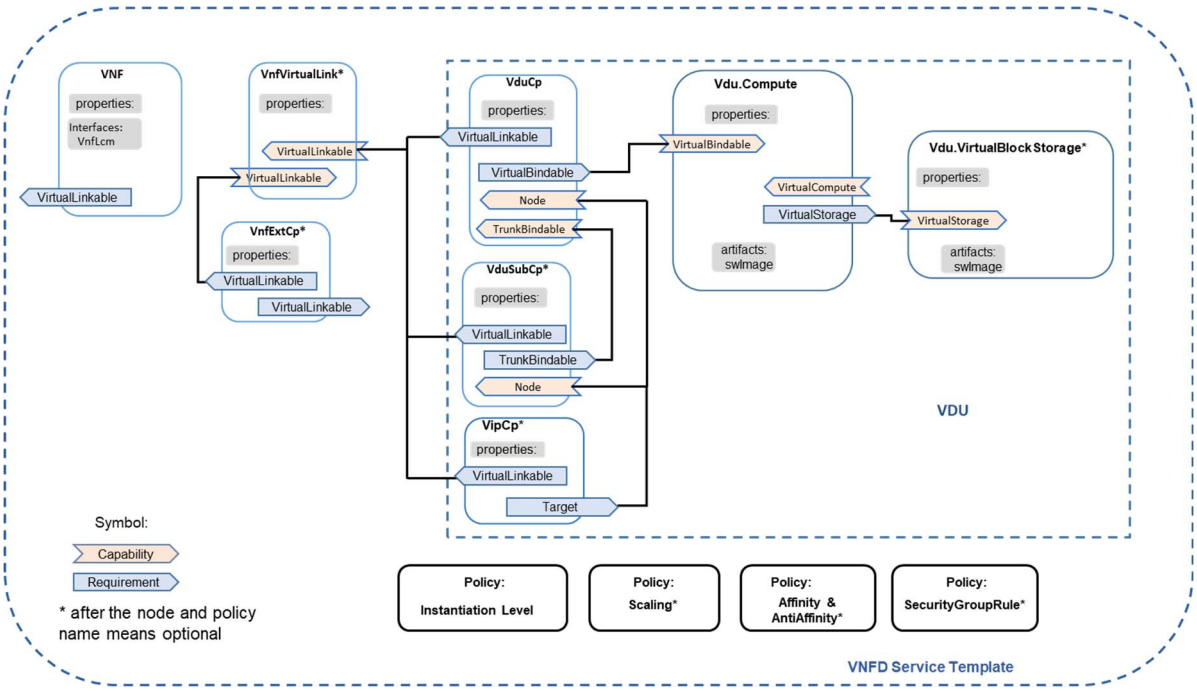


Figure 6.1-1: Service template VNFD overview when all the virtualization containers of the VNF are realized as VMs

6.2 Data Types

6.2.1 tosca.datatypes.nfv.CpProtocolData

6.2.1.1 Description

The CpProtocolData data type is defined in clause 9.2.6 of the present document.

6.2.2 tosca.datatypes.nfv.AddressData

6.2.2.1 Description

The AddressData data type is defined in clause 9.2.3 of the present document.

6.2.3 tosca.datatypes.nfv.L2AddressData

6.2.3.1 Description

The L2AddressData data type is defined in clause 9.2.1 of the present document.

6.2.4 tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements

6.2.4.1 Description

The VirtualNetworkInterfaceRequirements data type describes requirements on a virtual network interface, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.4.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.4.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualNetworkInterfaceRequirements
Type Qualified Name	toscanfv:VirtualNetworkInterfaceRequirements
Type URI	tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements

6.2.4.2 Properties

The properties of the VirtualNetworkInterfaceRequirements data type shall comply with the provisions set out in table 6.2.4.2-1.

Table 6.2.4.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Provides a human readable name for the requirement.
description	no	string		Provides a human readable description of the requirement.
network_interface_requirements	yes	map of string		The network interface requirements. A single-element map of strings where the string contains a set of key-value pairs that describes hardware platform specific network interface deployment requirements. More information regarding the usage of this property is available at: https://register.etsi.org.
nic_io_requirements	no	tosca.datatypes.nfv.LogicalNodeData		This references (couples) the CP with any logical node I/O requirements (for network devices) that may have been created. Linking these attributes is necessary so that so that I/O requirements that need to be articulated at the logical node level can be associated with the network interface requirements associated with the CP.

6.2.4.3 Definition

The syntax of the VirtualNetworkInterfaceRequirements data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements:
    derived_from: tosca.datatypes.Root
    description: Describes requirements on a virtual network interface
    properties:
      name:
        type: string
        description: Provides a human readable name for the requirement.
        required: false
      description:
        type: string
        description: Provides a human readable description of the requirement.
        required: false
      network_interface_requirements:
        type: map
        description: The network interface requirements. A single-element map of strings where the
string contains a set of key-value pairs that describes hardware platform specific network
interface deployment requirements.
        required: true
        entry_schema:
          type: string
        constraints:
          - max_length: 1
      nic_io_requirements:
        type: tosca.datatypes.nfv.LogicalNodeData
```

```
        description: references (couples) the CP with any logical node I/O requirements (for
network devices) that may have been created. Linking these attributes is necessary so that so that
I/O requirements that need to be articulated at the logical node level can be associated with the
network interface requirements associated with the CP.
        required: false
```

6.2.4.4 Examples

None.

6.2.4.5 Additional Requirements

None.

6.2.5 tosca.datatypes.nfv.L3AddressData

6.2.5.1 Description

The L3AddressData data type is defined in clause 9.2.2 of the present document.

6.2.6 tosca.datatypes.nfv.RequestedAdditionalCapability

6.2.6.1 Description

The RequestedAdditionalCapability data type describes requested additional capability for a particular VDU, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.6.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.6.1-1: Type name, shorthand, and URI

Shorthand Name	RequestedAdditionalCapability
Type Qualified Name	toscanfv:RequestedAdditionalCapability
Type URI	tosca.datatypes.nfv.RequestedAdditionalCapability

6.2.6.2 Properties

The properties of the RequestedAdditionalCapability data type shall comply with the provisions set out in table 6.2.6.2-1.

Table 6.2.6.2-1: Properties

Name	Required	Type	Constraints	Description
requested_additional_capability_name	yes	string		Identifies a requested additional capability for the VDU.
support_mandatory	yes	boolean		Indicates whether the requested additional capability is mandatory for successful operation.
min_requested_additional_capability_version	no	string		Identifies the minimum version of the requested additional capability.
preferred_requested_additional_capability_version	no	string		Identifies the preferred version of the requested additional capability.
target_performance_parameters	yes	map of string		Identifies specific attributes, dependent on the requested additional capability type.

6.2.6.3 Definition

The syntax of the RequestedAdditionalCapability data type shall comply with the following definition:

```
  tosca.datatypes.nfv.RequestedAdditionalCapability:
    derived_from: tosca.datatypes.Root
    description: describes requested additional capability for a particular VDU
    properties:
      requested_additional_capability_name:
        type: string
        description: Identifies a requested additional capability for the VDU.
        required: true
      support_mandatory:
        type: boolean
        description: Indicates whether the requested additional capability is mandatory for
successful operation.
        required: true
      min_requested_additional_capability_version:
        type: string
        description: Identifies the minimum version of the requested additional capability.
        required: false
      preferred_requested_additional_capability_version:
        type: string
        description: Identifies the preferred version of the requested additional capability.
        required: false
      target_performance_parameters:
        type: map
        description: Identifies specific attributes, dependent on the requested additional
capability type.
        required: true
        entry_schema:
          type: string
```

6.2.6.4 Examples

None.

6.2.6.5 Additional Requirements

None.

6.2.7 tosca.datatypes.nfv.VirtualMemory

6.2.7.1 Description

The VirtualMemory data type supports the specification of requirements related to virtual memory of a virtual compute resource, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.7.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.7.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualMemory
Type Qualified Name	toscanfv:VirtualMemory
Type URI	tosca.datatypes.nfv.VirtualMemory

6.2.7.2 Properties

The properties of the VirtualMemory data type shall comply with the provisions set out in table 6.2.7.2-1.

Table 6.2.7.2-1: Properties

Name	Required	Type	Constraints	Description
virtual_mem_size	yes	scalar-unit.size		Amount of virtual memory.
virtual_mem_oversubscription_policy	no	string		The memory core oversubscription policy in terms of virtual memory to physical memory on the platform.

Name	Required	Type	Constraints	Description
vdu_mem_requirements	no	map of string		The hardware platform specific VDU memory requirements. A map of strings where each string contains a set of key-value pairs that describes hardware platform specific VDU memory requirements. More information regarding the usage of this property is available at: https://register.etsi.org.
numa_enabled	yes	boolean	default: false	It specifies the memory allocation to be cognisant of the relevant process/core allocation.

6.2.7.3 Definitions

The syntax of the VirtualMemory data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualMemory:
    derived_from: tosca.datatypes.Root
    description: supports the specification of requirements related to virtual memory of a virtual
compute resource
    properties:
      virtual_mem_size:
        type: scalar-unit.size
        description: Amount of virtual memory.
        required: true
      virtual_mem_oversubscription_policy:
        type: string
        description: The memory core oversubscription policy in terms of virtual memory to
physical memory on the platform.
        required: false
      vdu_mem_requirements:
        type: map
        description: The hardware platform specific VDU memory requirements. A map of strings
where each string contains a set of key-value pairs that describes hardware platform specific VDU
memory requirements.
        required: false
        entry_schema:
          type: string
      numa_enabled:
        type: boolean
        description: It specifies the memory allocation to be cognisant of the relevant
process/core allocation.
        required: true
        default: false
```

6.2.7.4 Examples

None.

6.2.7.5 Additional Requirements

None.

6.2.8 tosca.datatypes.nfv.VirtualCpu

6.2.8.1 Description

The VirtualCpu data type supports the specification of requirements related to virtual CPU(s) of a virtual compute resource, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.8.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.8.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualCpu

Type Qualified Name	toscanfv:VirtualCpu
Type URI	tosca.datatypes.nfv.VirtualCpu

6.2.8.2 Properties

The properties of the VirtualCpu data type shall comply with the provisions set out in table 6.2.8.2-1.

Table 6.2.8.2-1: Properties

Name	Required	Type	Constraints	Description
cpu_architecture	no	string		CPU architecture type. Examples are x86, ARM.
num_virtual_cpu	yes	integer	greater_than: 0	Number of virtual CPUs.
virtual_cpu_clock	no	scalar-unit.frequency		Minimum virtual CPU clock rate.
virtual_cpu_oversubscription_policy	no	string		CPU core oversubscription policy e.g. the relation of virtual CPU cores to physical CPU cores/threads.
vdu_cpu_requirements	no	map of string		The hardware platform specific VDU CPU requirements. A map of strings where each string contains a set of key-value pairs describing VDU CPU specific hardware platform requirements. More information regarding the usage of this property is available at: https://register.etsi.org.
virtual_cpu_pinning	no	tosca.datatypes.nfv.VirtualCpuPinning		The virtual CPU pinning configuration for the virtualised compute resource.

6.2.8.3 Definition

The syntax of the VirtualCpu data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualCpu:
    derived_from: tosca.datatypes.Root
    description: Supports the specification of requirements related to virtual CPU(s) of a virtual
compute resource
    properties:
      cpu_architecture:
        type: string
        description: CPU architecture type. Examples are x86, ARM
        required: false
      num_virtual_cpu:
        type: integer
        description: Number of virtual CPUs
        required: true
        constraints:
          - greater_than: 0
      virtual_cpu_clock:
        type: scalar-unit.frequency
        description: Minimum virtual CPU clock rate
        required: false
      virtual_cpu_oversubscription_policy:
        type: string
        description: CPU core oversubscription policy e.g. the relation of virtual CPU cores to
physical CPU cores/threads.
        required: false
      vdu_cpu_requirements:
        type: map
        description: The hardware platform specific VDU CPU requirements. A map of strings where
each string contains a set of key-value pairs describing VDU CPU specific hardware platform
requirements.
        required: false
        entry_schema:
          type: string
      virtual_cpu_pinning:
```

```
        type: tosca.datatypes.nfv.VirtualCpuPinning
        description: The virtual CPU pinning configuration for the virtualised compute resource.
        required: false
```

6.2.8.4 Examples

None.

6.2.8.5 Additional Requirements

None.

6.2.9 tosca.datatypes.nfv.VirtualCpuPinning

6.2.9.1 Description

The VirtualCpuPinning data type supports the specification of requirements related to the virtual CPU pinning configuration of a virtual compute resource, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.9.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.9.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualCpuPinning
Type Qualified Name	toscanfv:VirtualCpuPinning
Type URI	tosca.datatypes.nfv.VirtualCpuPinning

6.2.9.2 Properties

The properties of the VirtualCpuPinning data type shall comply with the provisions set out in table 6.2.9.2-1.

Table 6.2.9.2-1: Properties

Name	Required	Type	Constraints	Description
virtual_cpu_pinning_policy	no	string	Valid values: See YAML definition constraints	Indicates the policy for CPU pinning. The policy can take values of "static" or "dynamic". In case of "dynamic" the allocation of virtual CPU cores to logical CPU cores is decided by the VIM. (e.g. SMT (Simultaneous Multi-Threading) requirements). In case of "static" the allocation is requested to be according to the virtual_cpu_pinning_rule.
virtual_cpu_pinning_rule	no	list of string		Provides the list of rules for allocating virtual CPU cores to logical CPU cores/threads.

6.2.9.3 Definition

The syntax of the virtualCpuPinning data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualCpuPinning:
    derived_from: tosca.datatypes.Root
    description: Supports the specification of requirements related to the virtual CPU pinning
configuration of a virtual compute resource
    properties:
      virtual_cpu_pinning_policy:
        type: string
        description: Indicates the policy for CPU pinning. The policy can take values of "static"
or "dynamic". In case of "dynamic" the allocation of virtual CPU cores to logical CPU cores is
decided by the VIM. (e.g. SMT (Simultaneous Multi-Threading) requirements). In case of "static"
the allocation is requested to be according to the virtual_cpu_pinning_rule.
        required: false
        constraints:
          - valid_values: [ static, dynamic ]
      virtual_cpu_pinning_rule:
        type: list
        description: Provides the list of rules for allocating virtual CPU cores to logical  CPU
cores/threads
        required: false
        entry_schema:
          type: string
```

6.2.9.4 Examples

None.

6.2.9.5 Additional Requirements

The virtual_cpu_pinning_rule shall be included if the virtual_cpu_pinning_policy property is set to "static" and shall be absent otherwise.

6.2.10 tosca.datatypes.nfv.VnfcConfigurableProperties

6.2.10.1 Description

The VnfcConfigurableProperties data type defines the configurable properties of a VNFC, as defined in ETSI GS NFV-IFA 011 [1].

Table 6.2.10.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.10.1-1: Type name, shorthand, and URI

Shorthand Name	VnfcConfigurableProperties
Type Qualified Name	toscanfv:VnfcConfigurableProperties
Type URI	tosca.datatypes.nfv.VnfcConfigurableProperties

6.2.10.2 Properties

The properties of the VnfcconfigurableProperties shall comply with the provisions set out in table 6.2.10.2-1.

Table 6.2.10.2-1: Properties

Name	Required	Type	Constraints	Description
additional_vnfc_configurable_properties	no	tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties		Describes additional configuration for VNFC that can be modified using the ModifyVnfInfo operation.

6.2.10.3 Definition

The syntax of the VnfcConfigurableProperties data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfcConfigurableProperties:
    derived_from: tosca.datatypes.Root
    description: Defines the configurable properties of a VNFC
    properties:
      additional_vnfc_configurable_properties:
        type: tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
        description: Describes additional configuration for VNFC that can be modified using the
ModifyVnfInfo operation
        required: false
      # derived types are expected to introduce
      # additional_vnfc_configurable_properties with its type derived from
      # tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
```

6.2.10.4 Examples

Example definition of configurable properties without properties assignment value.

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
  MyCompany.nodes.nfv.Vdu.Aux:
    derived_from: tosca.nodes.nfv.Vdu.Compute
    properties:
      configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties

data_types:
  MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcConfigurableProperties
    properties:
      additional_vnfc_configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties
        required: true

  MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
    properties:
      name_prefix_in_vim:
        type: string
        required: false
      dns_server:
        type: string
        required: true

topology_template:
  ..

  node_templates:
    aux:
      type: MyCompany.nodes.nfv.Vdu.Aux
      properties:
        ..
```

Example definition of configurable properties with properties assignment value.

```
tosca_definitions_version: tosca_simple_yaml_1_3

...

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      ...
    interfaces:
      Vnflcm:
        type: tosca.interfaces.nfv.Vnflcm

  MyCompany.nodes.nfv.Vdu.Aux:
```

```
    derived_from: tosca.nodes.nfv.Vdu.Compute
    properties:
      configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties
        required: false


data_types:
  MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcConfigurableProperties
    properties:
      additional_vnfc_configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties
        required: true

  MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
    properties:
      name_prefix_in_vim:
        type: string
        required: true
        default: "MyCustomer"
      dns_server:
        type: string
        required: true
        default: "90.200.250.57"

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
    requirements:
      virtual_link: [ dbBackendIpv4, virtual_link ] # IPv4 for SQL

  inputs:
    name_prefix_in_vim:
      type: string
    dns_server:
      type: string

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0

    dbBackend:
      type: MyCompany.nodes.nfv.Vdu.Aux
      properties:
        ...
        configurable_properties:
          additional_vnfc_configurable_properties:
            name_prefix_in_vim: { get_input: name_prefix_in_vim }
            dns_server: { get_input: dns_server }
```

In the above example, default values are provided in the node type definition, properties assignment by using TOSCA get_input function is described in the node template. The properties values from the API will override the default values.

6.2.10.5 Additional Requirements

None.

6.2.11 tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties

6.2.11.1 Description

The VnfcAdditionalConfigurableProperties type is an empty base type for deriving data types for describing additional configurable properties for a given VNFC. Table 6.2.11.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.11.1-1: Type name, shorthand, and URI

Shorthand Name	VnfcAdditionalConfigurableProperties
Type Qualified Name	toscanfv:VnfcAdditionalConfigurableProperties
Type URI	tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties

6.2.11.2 Properties

None.

6.2.11.3 Definition

The syntax of the VnfcAdditionalConfigurableProperties data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.Root
    description: VnfcAdditionalConfigurableProperties type is an empty base type for deriving
data types for describing additional configurable properties for a given VNFC.
```

6.2.11.4 Examples

See clause 6.2.10.4.

6.2.12 tosca.datatypes.nfv.VduProfile

6.2.12.1 Description

The VduProfile data type describes additional instantiation data for a given Vdu.Compute used in a specific deployment flavour. Table 6.2.12.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.12.1-1: Type name, shorthand, and URI

Shorthand Name	VduProfile
Type Qualified Name	toscanfv:VduProfile
Type URI	tosca.datatypes.nfv.VduProfile

6.2.12.2 Properties

The properties of the VduProfile data type shall comply with the provisions set out in table 6.2.12.2-1.

Table 6.2.12.2-1: Properties

Name	Required	Type	Constraints	Description
min_number_of_instances	yes	integer	greater_or_equal: 0	Minimum number of instances of the VNFC based on this Vdu.Compute that is permitted to exist for a particular VNF deployment flavour.
max_number_of_instances	yes	integer	greater_or_equal: 0	Maximum number of instances of the VNFC based on this Vdu.Compute that is permitted to exist for a particular VNF deployment flavour.
nfvi_maintenance_info	no	tosca.datatypes.nfv.NfviMaintenanceInfo		Provides information on the impact tolerance and rules to be observed when instance(s) of the Vdu.Compute are impacted during NFVI operation and maintenance (e.g. NFVI resource upgrades). See notes 2 and 3.

NOTE 1: A vduId property, which exists in ETSI GS NFV-IFA 011 [1] is not needed, as the VduProfile is contained in the Vdu.Compute node.
NOTE 2: The impact tolerance and rules also apply to the VirtualBlockStorage, VirtualObjectStorage and VirtualFileStorage nodes connected to the Vdu.Compute via one particular occurrence of the virtual_storage requirement and to each VduCp node connected to the Vdu.Compute via one particular occurrence of the virtual_binding capability.
NOTE 3: An NFVI level operation (e.g. restart of a virtual machine) can impact a VNF and the VNF may be able to tolerate only a limited number of such impacts simultaneously. The nfvi_maintenance_info provides constraints related to detection and tolerance so that negative impact on VNF functionality can be avoided during NFVI maintenance operations.

6.2.12.3 Definition

The syntax of the VduProfile data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VduProfile:
    derived_from: tosca.datatypes.Root
    description: describes additional instantiation data for a given Vdu.Compute used in a
specific deployment flavour.
    properties:
      min_number_of_instances:
        type: integer
        description: Minimum number of instances of the VNFC based on this Vdu.Compute that is
permitted to exist for a particular VNF deployment flavour.
        required: true
        constraints:
          - greater_or_equal: 0
      max_number_of_instances:
        type: integer
        description: Maximum number of instances of the VNFC based on this Vdu.Compute that is
permitted to exist for a particular VNF deployment flavour.
        required: true
        constraints:
          - greater_or_equal: 0
      nfvi_maintenance_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the impact tolerance and rules to be observed when
instance(s) of the Vdu.Compute are impacted during NFVI operation and maintenance (e.g. NFVI
resource upgrades).
        required: false
```

6.2.12.4 Examples

```
tosca_definitions_version: tosca_simple_yaml_1_3

topology template:
…

  node_templates:
    VDU_A:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        vdu_profile:
          min_number_of_instances: 2
          max_number_of_instances: 6
      # other properties omitted for brevity
      requirements:
        - virtual_storage: VirtualStorage_A1
        - virtual_storage: VirtualStorage_A2
      capabilities:
          virtual_binding:



    VirtualStorage_A1:
      type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
      properties:
        # omitted for brevity
      capabilities:
          virtual_storage

    VirtualStorage_A2:
      type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
      properties:
        # omitted for brevity
      capabilities:
          virtual_storage

    VduCp_A1:
      type: tosca.nodes.nfv.VduCp
      properties:
        # omitted for brevity
      requirements:
        - virtual_binding: VDU_A
        - virtual_link

     VduCp_A2:
      type: tosca.nodes.nfv.VduCp
      properties:
        # omitted for brevity
      requirements:
        - virtual_binding: VDU_A
        - virtual_link
```

Above snippet shows part of a topology template. The VDU_A node template is a Vdu.Compute node that is connected to two VirtualBlockStorage nodes: VirtualStorage_A1 and VirtualStorage_A2. It also has two VduCps: VduCp_A1 and Vdu_CpA2.

The minimum number of instances of VDU_A that are permitted to exist is 2. Likewise, the minimum number of instances of VirtualStorage_A1, VirtualStorage_A2, VduCp_A1 and VduCp_A2 that are permitted to exist is 2.

The maximum number of instances of VDU_A that are permitted to exist is 6. Likewise, the maximum number of instances of VirtualStorage_A1, VirtualStorage_A2, VduCp_A1 and VduCp_A2 that are permitted to exist is 6.

6.2.12.5 Additional requirements

The properties of the vdu_profile indicate the maximum and minimum number of Vdu.Compute instances that are permitted to exist, created from a given Vdu.Compute node template during its lifecycle, as well as:

- The maximum and minimum number of instances of each VirtualBlockStorage, VirtualObjectStorage and VirtualFileStorage nodes connected to the Vdu.Compute via one particular occurrence of the virtual_storage requirement.

- The maximum and minimum number instances of each VduCp node connected to the Vdu.Compute via one particular occurrence of the virtual_binding capability.

6.2.13 tosca.datatypes.nfv.VlProfile

6.2.13.1 Description

The VlProfile data type describes additional instantiation data for a given VL used in a specific VNF deployment flavour. Table 6.2.13.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.13.1-1: Type name, shorthand, and URI

Shorthand Name	VlProfile
Type Qualified Name	toscanfv:VlProfile
Type URI	tosca.datatypes.nfv.VlProfile

6.2.13.2 Properties

The properties of the VlProfile data type shall comply with the provisions set out in table 6.2.13.2-1.

Table 6.2.13.2-1: Properties

Name	Required	Type	Constraints	Description
max_bitrate_requirements	yes	tosca.datatypes.nfv.LinkBitrateRequirements		Specifies the maximum bitrate requirements for a VL instantiated according to this profile.
min_bitrate_requirements	yes	tosca.datatypes.nfv.LinkBitrateRequirements		Specifies the minimum bitrate requirements for a VL instantiated according to this profile.
qos	no	tosca.datatypes.nfv.Qos		Specifies the QoS requirements of a VL instantiated according to this profile.
virtual_link_protocol_data	no	list of tosca.datatypes.nfv.VirtualLinkProtocolData		Specifies the protocol data for a virtual link. If more than 1 values are present, the order shall be the same as the order of the layer_protocols occurrences in the connectivity_type property of the same VnfVirtualLink node, i.e. the first occurrence of the virtual_link_protocol_data represents the highest layer protocol data, and the last occurrence represents the lowest layer protocol data.
NOTE: A vnfVirtualLinkDescId property, which exists in ETSI GS NFV-IFA 011 [1] is not needed, as the VLProfile is contained in the VL node.				

6.2.13.3 Definition

The syntax of the VlProfile data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VlProfile:
    derived_from: tosca.datatypes.Root
    description: Describes additional instantiation data for a given VL used in a specific VNF
deployment flavour.
    properties:
      max_bitrate_requirements:
        type: tosca.datatypes.nfv.LinkBitrateRequirements
        description: Specifies the maximum bitrate requirements for a VL instantiated according to
this profile.
        required: true
      min_bitrate_requirements:
        type: tosca.datatypes.nfv.LinkBitrateRequirements
        description: Specifies the minimum bitrate requirements for a VL instantiated according to
this profile.
        required: true
      qos:
        type: tosca.datatypes.nfv.Qos
        description: Specifies the QoS requirements of a VL instantiated according to this
profile.
        required: false
      virtual_link_protocol_data:
        type: list
        description: Specifies the protocol data for a virtual link.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.VirtualLinkProtocolData
```

6.2.13.4 Examples

None.

6.2.13.5 Additional Requirements

None.

6.2.14 tosca.datatypes.nfv.VirtualLinkProtocolData

6.2.14.1 Description

The VirtualLinkProtocolData data type describes one protocol layer and associated protocol data for a given virtual link used in a specific VNF deployment flavour. Table 6.2.14.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.14.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkProtocolData
Type Qualified Name	toscanfv:VirtualLinkProtocolData
Type URI	tosca.datatypes.nfv.VirtualLinkProtocolData

6.2.14.2 Properties

The properties of the VirtualLinkProtocolData data type shall comply with the provisions set out in table 6.2.14.2-1.

Table 6.2.14.2-1: Properties

Name	Required	Type	Constraints	Description
associated_layer_protocol	yes	string	Valid values: See YAML definition constraints	Identifies one of the protocols a virtualLink gives access to (ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire) as specified by the connectivity_type property.

Name	Required	Type	Constraints	Description
l2_protocol_data	no	tosca.datatypes.nfv.L2ProtocolData		Specifies the L2 protocol data for a virtual link. Shall be present when the associatedLayerProtocol attribute indicates a L2 protocol and shall be absent otherwise.
l3_protocol_data	no	tosca.datatypes.nfv.L3ProtocolData		Specifies the L3 protocol data for this virtual link. Shall be present when the associatedLayerProtocol attribute indicates a L3 protocol and shall be absent otherwise.

6.2.14.3 Definition

The syntax of the VirtualLinkProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualLinkProtocolData:
    derived_from: tosca.datatypes.Root
    description: describes one protocol layer and associated protocol data for a given virtual
link used in a specific VNF deployment flavour
    properties:
      associated_layer_protocol:
         type: string
         description: Identifies one of the protocols a virtualLink gives access to (ethernet,
mpls, odu2, ipv4, ipv6, pseudo-wire) as specified by the connectivity_type property.
         required: true
         constraints:
           - valid_values: [ ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire ]
      l2_protocol_data:
         type: tosca.datatypes.nfv.L2ProtocolData
         description: Specifies the L2 protocol data for a virtual link. Shall be present when
the associatedLayerProtocol attribute indicates a L2 protocol and shall be absent otherwise.
         required: false
      l3_protocol_data:
         type: tosca.datatypes.nfv.L3ProtocolData
         description: Specifies the L3 protocol data for this virtual link.  Shall be present
when the associatedLayerProtocol attribute indicates a L3 protocol and shall be absent
otherwise.
         required: false
```

6.2.14.4 Examples

None.

6.2.14.5 Additional Requirements

None.

6.2.15 tosca.datatypes.nfv.L2ProtocolData

6.2.15.1 Description

The L2ProtocolData data type escribes L2 protocol data for a given virtual link used in a specific VNF deployment flavour. Table 6.2.15.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.15.1-1: Type name, shorthand, and URI

Shorthand Name	L2ProtocolData
Type Qualified Name	toscanfv:L2ProtocolData
Type URI	tosca.datatypes.nfv.L2ProtocolData

6.2.15.2 Properties

The properties of the L2ProtocolData data type shall comply with the provisions set out in table 6.2.15.2-1.

Table 6.2.15.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Identifies the network name associated with this L2 protocol.
network_type	no	string	Valid values: See YAML definition constraints	Specifies the network type for this L2 protocol. The value may be overridden at run-time.
vlan_transparent	yes	boolean	default: false	Specifies whether to support VLAN transparency for this L2 protocol or not.
mtu	no	integer	greater_than : 0	Specifies the Maximum Transmission Unit (MTU) value for this L2 protocol.
segmentation_id	no	string		If present, specifies a specific virtualised network segment, which depends on the network type. For e.g. VLAN ID for VLAN network type and tunnel ID for GRE/VXLAN network types. See note.
NOTE: If this property is included in the VNFD, the property value shall be provided at run-time, unless a default value is provided at design time in the VNFD. If a default value is provided at design-time, this value may be overridden at run-time.				

6.2.15.3 Definition

The syntax of the L2ProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.L2ProtocolData:
    derived_from: tosca.datatypes.Root
    description: describes L2 protocol data for a given virtual link used in a specific VNF
deployment flavour.
    properties:
      name:
        type: string
        description: Identifies the network name associated with this L2 protocol.
        required: false
      network_type:
        type: string
        description: Specifies the network type for this L2 protocol. The value may be
overridden at run-time.
        required: false
        constraints:
          - valid_values: [ flat, vlan, vxlan, gre ]
      vlan_transparent:
        type: boolean
        description: Specifies whether to support VLAN transparency for this L2 protocol or
not.
        required: true
        default: false
      mtu:
        type: integer
        description: Specifies the maximum transmission unit (MTU) value for this L2 protocol.
        required: false
        constraints:
          - greater_than: 0
      segmentation_id:
        type: string
        description: Specifies a specific virtualised network segment, which depends on the
network type. For e.g. VLAN ID for VLAN network type and tunnel ID for GRE/VXLAN network types
        required: false
```

6.2.15.4 Examples

See example in clause A.5.

6.2.15.5 Additional Requirements

None.

6.2.16 tosca.datatypes.nfv.L3ProtocolData

6.2.16.1 Description

The L3ProtocolData data type describes L3 protocol data for a given virtual link used in a specific VNF deployment flavour. Table 6.2.16.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.16.1-1: Type name, shorthand, and URI

Shorthand Name	L3ProtocolData
Type Qualified Name	toscanfv:L3ProtocolData
Type URI	tosca.datatypes.nfv.L3ProtocolData

6.2.16.2 Properties

The properties of the L3ProtocolData data type shall comply with the provisions set out in table 6.2.16.2-1.

Table 6.2.16.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Identifies the network name associated with this L3 protocol.
ip_version	yes	string	Valid values: See YAML definition constraints	Specifies IP version of this L3 protocol. The value of the ip_version property shall be consistent with the value of the layer_protocol in the connectivity_type property of the virtual link node.
cidr	yes	string		Specifies the CIDR (Classless Inter-Domain Routing) of this L3 protocol. The value may be overridden at run-time.
ip_allocation_pools	no	list of tosca.datatypes.nfv.IpAllocationPool		Specifies the allocation pools with start and end IP addresses for this L3 protocol. The value may be overridden at run-time.
gateway_ip	no	string		Specifies the gateway IP address for this L3 protocol. The value may be overridden at run-time.
dhcp_enabled	no	boolean		Indicates whether DHCP (Dynamic Host Configuration Protocol) is enabled or disabled for this L3 protocol. The value may be overridden at run-time.
ipv6_address_mode	no	string	Valid values: See YAML definition constraints	Specifies IPv6 address mode. May be present when the value of the ipVersion attribute is "ipv6" and shall be absent otherwise. The value may be overridden at run-time.

6.2.16.3 Definition

The syntax of the L3ProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.L3ProtocolData:
    derived_from: tosca.datatypes.Root
    description: describes L3 protocol data for a given virtual link used in a specific VNF
deployment flavour.
    properties:
      name:
        type: string
        description: Identifies the network name associated with this L3 protocol.
        required: false
      ip_version:
```

```
        type: string
        description: Specifies IP version of this L3 protocol. The value of the ip_version
property shall be consistent with the value of the layer_protocol in the connectivity_type
property of the virtual link node.
        required: true
        constraints:
          - valid_values: [ ipv4, ipv6 ]
      cidr:
        type: string
        description: Specifies the CIDR (Classless Inter-Domain Routing) of this L3 protocol.
The value may be overridden at run-time.
        required: true
      ip_allocation_pools:
        type: list
        description: Specifies the allocation pools with start and end IP addresses for this
L3 protocol. The value may be overridden at run-time.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.IpAllocationPool
      gateway_ip:
        type: string
        description: Specifies the gateway IP address for this L3 protocol. The value may be
overridden at run-time.
        required: false
      dhcp_enabled:
        type: boolean
        description: Indicates whether DHCP (Dynamic Host Configuration Protocol) is enabled
or disabled for this L3 protocol. The value may be overridden at run-time.
        required: false
      ipv6_address_mode:
        type: string
        description: Specifies IPv6 address mode. May be present when the value of the
ipVersion attribute is "ipv6" and shall be absent otherwise. The value may be overridden at
run-time.
        required: false
        constraints:
          - valid_values: [ slaac, dhcpv6-stateful, dhcpv6-stateless ]
```

6.2.16.4 Examples

None.

6.2.16.5 Additional Requirements

None.

6.2.17 tosca.datatypes.nfv.IpAllocationPool

6.2.17.1 Description

The IpAllocationPool data type specifies a range of IP addresses. Table 6.2.17.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.17.1-1: Type name, shorthand, and URI

Shorthand Name	IpAllocationPool
Type Qualified Name	toscanfv:IpAllocationPool
Type URI	tosca.datatypes.nfv.IpAllocationPool

6.2.17.2 Properties

The properties of the IpAllocationPool data type shall comply with the provisions set out in table 6.2.17.2-1.

Table 6.2.17.2-1: Properties

Name	Required	Type	Constraints	Description
start_ip_address	yes	string		The IP address to be used as the first one in a pool of addresses derived from the cidr block full IP range
end_ip_address	yes	string		The IP address to be used as the last one in a pool of addresses derived from the cidr block full IP range

6.2.17.3 Definition

The syntax of the IpAllocationPool data type shall comply with the following definition:

```
  tosca.datatypes.nfv.IpAllocationPool:
    derived_from: tosca.datatypes.Root
    description: Specifies a range of IP addresses
    properties:
      start_ip_address:
        type: string
        description: The IP address to be used as the first one in a pool of addresses derived
from the cidr block full IP range
        required: true
      end_ip_address:
        type: string
        description: The IP address to be used as the last one in a pool of addresses derived
from the cidr block full IP range
        required: true
```

6.2.17.4 Examples

None.

6.2.17.5 Additional Requirements

None.

6.2.18 tosca.datatypes.nfv.InstantiationLevel

6.2.18.1 Description

The InstantiationLevel data type describes the scale level for each aspect that corresponds to a given level of resources to be instantiated within a deployment flavour in term of the number VNFC instances . Table 6.2.18.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.18.1-1: Type name, shorthand, and URI

Shorthand Name	InstantiationLevel
Type Qualified Name	toscanfv:InstantiationLevel
Type URI	tosca.datatypes.nfv.InstantiationLevel

6.2.18.2 Properties

The properties of the InstantiationLevel data type shall comply with the provisions set out in table 6.2.18.2-1.

Table 6.2.18.2-1: Properties

Name	Required	Type	Constraints	Description
description	yes	string		Human readable description of the level.
scale_info	no	map of tosca.datatypes.nfv .ScaleInfo		Represents for each aspect the scale level that corresponds to this instantiation level. scale_info shall be present if the VNF supports scaling.

6.2.18.3 Definition

The syntax of the InstantiationLevel data type shall comply with the following definition:

```
  tosca.datatypes.nfv.InstantiationLevel:
    derived_from: tosca.datatypes.Root
    description: Describes the scale level for each aspect that corresponds to a given level of
resources to be instantiated within a deployment flavour in term of the number VNFC instances
    properties:
      description:
        type: string
        description: Human readable description of the level
        required: true
      scale_info:
        type: map # key: aspectId
        description: Represents for each aspect the scale level that corresponds to this
instantiation level. scale_info shall be present if the VNF supports scaling.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.ScaleInfo
```

6.2.18.4 Examples

See clause A.6.

6.2.18.5 Additional Requirements

None.

6.2.19 tosca.datatypes.nfv.VduLevel

6.2.19.1 Description

The VduLevel data type indicates for a given Vdu.Compute in a given level the number of instances to deploy. Table 6.2.19.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.19.1-1: Type name, shorthand, and URI

Shorthand Name	VduLevel
Type Qualified Name	toscanfv:VduLevel
Type URI	tosca.datatypes.nfv.VduLevel

6.2.19.2 Properties

The properties of the VduLevel data type shall comply with the provisions set out in table 6.2.19.2-1.

Table 6.2.19.2-1: Properties

Name	Required	Type	Constraints	Description
number_of_instances	yes	integer	greater_or_equal : 0	Number of instances of VNFC based on this VDU to deploy for this level.

6.2.19.3 Definition

The syntax of the VduLevel data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VduLevel:
    derived_from: tosca.datatypes.Root
    description: Indicates for a given Vdu.Compute in a given level the number of instances to
deploy
    properties:
```

```
      number_of_instances:
        type: integer
        description: Number of instances of VNFC based on this VDU to deploy for this level.
        required: true
        constraints:
          - greater_or_equal: 0
```

6.2.19.4 Examples

See clause A.6.

6.2.19.5 Additional Requirements

None.

6.2.20 tosca.datatypes.nfv.VnfLcmOperationsConfiguration

6.2.20.1 Description

The VnfLcmOperationsConfiguration data type represents information to configure lifecycle management operations as specified in ETSI GS NFV-IFA 007 [i.1]. Each VNF LCM operations configuration property represents a container for all attributes that affect the invocation of the corresponding VNF Lifecycle Management operation. Table 6.2.20.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.20.1-1: Type name, shorthand, and URI

Shorthand Name	VnfLcmOperationsConfiguration
Type Qualified Name	toscanfv:VnfLcmOperationsConfiguration
Type URI	tosca.datatypes.nfv.VnfLcmOperationsConfiguration

6.2.20.2 Properties

The properties of the VnfLcmOperationsConfiguration data type shall comply with the provisions set out in table 6.2.20.2-1.

Table 6.2.20.2-1: Properties

Name	Required	Type	Constraints	Description
instantiate	no	tosca.datatypes.nfv.VnfInstantiateOperationConfiguration		Configuration parameters for the InstantiateVnf operation.
scale	no	tosca.datatypes.nfv.VnfScaleOperationConfiguration		Configuration parameters for the ScaleVnf operation.
scale_to_level	no	tosca.datatypes.nfv.VnfScaleToLevelOperationConfiguration		Configuration parameters for the ScaleVnfToLevel operation.
change_flavour	no	tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration		Configuration parameters for the changeVnfFlavourOpConfig operation.
heal	no	tosca.datatypes.nfv.VnfHealOperationConfiguration		Configuration parameters for the HealVnf operation.

Name	Required	Type	Constraints	Description
terminate	no	tosca.datatypes.nfv.VnfTerminateOperationConfiguration		Configuration parameters for the TerminateVnf operation.
operate	no	tosca.datatypes.nfv.VnfOperateOperationConfiguration		Configuration parameters for the OperateVnf operation.
change_ext_connectivity	no	tosca.datatypes.nfv.VnfChangeExtConnectivityOperationConfiguration		Configuration parameters for the changeExtVnfConnectivityOpConfig operation.
change_current_package	no	tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration		Configuration parameters for the ChangeCurrentVnfPackage operation.
create_snapshot	no	tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration		Configuration parameters for the CreateVnfSnapshot operation.
revert_to_snapshot	no	tosca.datatypes.nfv.VnfRevertToSnapshotOperationConfiguration		Configuration parameters for the RevertToVnfSnapshot operation.

6.2.20.3 Definition

The syntax of the VnfLcmOperationsConfiguration data type shall comply with the following definition:

```
tosca.datatypes.nfv.VnfLcmOperationsConfiguration:
  derived_from: tosca.datatypes.Root
  description: Represents information to configure lifecycle management operations
  properties:
    instantiate:
      type: tosca.datatypes.nfv.VnfInstantiateOperationConfiguration
      description: Configuration parameters for the InstantiateVnf operation
      required: false
    scale:
      type: tosca.datatypes.nfv.VnfScaleOperationConfiguration
      description: Configuration parameters for the ScaleVnf operation
      required: false
    scale_to_level:
      type: tosca.datatypes.nfv.VnfScaleToLevelOperationConfiguration
      description: Configuration parameters for the ScaleVnfToLevel operation
      required: false
    change_flavour:
      type: tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration
      description: Configuration parameters for the changeVnfFlavourOpConfig operation
      required: false
    heal:
      type: tosca.datatypes.nfv.VnfHealOperationConfiguration
      description: Configuration parameters for the HealVnf operation
      required: false
    terminate:
      type: tosca.datatypes.nfv.VnfTerminateOperationConfiguration
      description: Configuration parameters for the TerminateVnf operation
      required: false
    operate:
      type: tosca.datatypes.nfv.VnfOperateOperationConfiguration
      description: Configuration parameters for the OperateVnf operation
      required: false
    change_ext_connectivity:
      type:   tosca.datatypes.nfv.VnfChangeExtConnectivityOperationConfiguration
      description: Configuration parameters for the changeExtVnfConnectivityOpConfig operation
      required: false
    change_current_package:
      type: tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration
      description: Configuration parameters for the ChangeCurrentVnfPackage operation
```

```
        required: false
        # derived types are expected to introduce new properties, with their type derived from
        # tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration,
        # with the same name as the operation designated to the ChangeCurrentVnfPackage request
      create_snapshot:
        type: tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration
        description: Configuration parameters for the CreateVnfSnapshot operation
        required: false
      revert_to_snapshot:
        type: tosca.datatypes.nfv.VnfRevertToSnapshotOperationConfiguration
        description: Configuration parameters for the RevertToVnfSnapshot operation
        required: false
```

6.2.20.4 Examples

None.

6.2.20.5 Additional Requirements

None.

6.2.21 tosca.datatypes.nfv.VnfInstantiateOperationConfiguration

6.2.21.1 Description

The VnfInstantiateOperationConfiguration data type represents information that affect the invocation of the InstantiateVnf operation, as specified in ETSI GS NFV-IFA 011 [1]. This data type definition is reserved for future use in the present document. Table 6.2.21.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.21.1-1: Type name, shorthand, and URI

Shorthand Name	VnfInstantiateOperationConfiguration
Type Qualified Name	toscanfv:VnfInstantiateOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfInstantiateOperationConfiguration

6.2.21.2 Properties

None.

6.2.21.3 Definition

The syntax of the VnfInstantiateOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfInstantiateOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the InstantiateVnf
operation.
    # This data type definition is reserved for future use in the present document.
    # properties:
```

6.2.21.4 Examples

None.

6.2.21.5 Additional Requirements

None.

6.2.22 tosca.datatypes.nfv.VnfScaleOperationConfiguration

6.2.22.1 Description

VnfScaleOperationConfiguration represents information that affect the invocation of the ScaleVnf operation, as specified in ETSI GS NFV-IFA 011 [1]. Table 6.2.22.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.22.1-1: Type name, shorthand, and URI

Shorthand Name	VnfScaleOperationConfiguration
Type Qualified Name	toscanfv:VnfScaleOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfScaleOperationConfiguration

6.2.22.2 Properties

The properties of the VnfScaleOperationConfiguration data type shall comply with the provisions set out in table 6.2.22.2-1.

Table 6.2.22.2-1: Properties

Name	Required	Type	Constraints	Description
scaling_by_more_than_one_step_supported	yes	boolean		Signals whether passing a value larger than one in the numScalingSteps parameter of the ScaleVnf operation is supported by this VNF. Default is FALSE, i.e. "not supported".

6.2.22.3 Definition

The syntax of the VnfScaleOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfScaleOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: Represents information that affect the invocation of the ScaleVnf operation
    properties:
      scaling_by_more_than_one_step_supported:
        type: boolean
        description: Signals whether passing a value larger than one in the numScalingSteps
parameter of the ScaleVnf operation is supported by this VNF.
        required: true
        default: false
```

6.2.22.4 Examples

See clause 6.8.1.9.

6.2.22.5 Additional Requirements

None.

6.2.23 tosca.datatypes.nfv.VnfScaleToLevelOperationConfiguration

6.2.23.1 Description

The VnfScaleToLevelOperationConfiguration data type represents information that affect the invocation of the ScaleVnfToLevel operation, as specified in ETSI GS NFV-IFA 011 [1]. Table 6.2.23.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.23.1-1: Type name, shorthand, and URI

Shorthand Name	VnfScaleToLevelOperationConfiguration
Type Qualified Name	toscanfv:VnfScaleToLevelOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfScaleToLevelOperationConfiguration

6.2.23.2 Properties

The properties of the VnfScaleToLevelOperationConfiguration data type shall comply with the provisions set out in table 6.2.23.2-1.

Table 6.2.23.2-1: Properties

Name	Required	Type	Constraints	Description
arbitrary_target_levels_supported	yes	boolean		Signals whether scaling according to the parameter "scaleInfo" is supported by this VNF.

6.2.23.3 Definition

The syntax of the VnfScaleToLevelOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfScaleToLevelOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the ScaleVnfToLevel
operation
    properties:
      arbitrary_target_levels_supported:
        type: boolean
        description: Signals whether scaling according to the parameter "scaleInfo" is supported
by this VNF
        required: true
```

6.2.23.4 Examples

See clause 6.8.1.9.

6.2.23.5 Additional Requirements

None.

6.2.24 tosca.datatypes.nfv.VnfHealOperationConfiguration

6.2.24.1 Description

The VnfHealOperationConfiguration data type represents information that affect the invocation of the HealVnf operation, as specified in ETSI GS NFV-IFA 011 [1]. Table 6.2.24.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.24.1-1: Type name, shorthand, and URI

Shorthand Name	VnfHealOperationConfiguration
Type Qualified Name	toscanfv:VnfHealOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfHealOperationConfiguration

6.2.24.2 Properties

The properties of the VnfHealOperationConfiguration data type shall comply with the provisions set out in table 6.2.24.2-1.

Table 6.2.24.2-1: Properties

Name	Required	Type	Constraints	Description
causes	no	list of string		Supported "cause" parameter values.

6.2.24.3 Definition

The syntax of the VnfHealOperationConfiguration data type shall comply with the following definition:

```
tosca.datatypes.nfv.VnfHealOperationConfiguration:
  derived_from: tosca.datatypes.Root
  description: represents information that affect the invocation of the HealVnf operation
  properties:
    causes:
      type: list
      description: Supported "cause" parameter values
      required: false
      entry_schema:
        type: string
```

6.2.24.4 Examples

See clause 6.8.1.9.

6.2.24.5 Additional Requirements

None.

6.2.25 tosca.datatypes.nfv.VnfTerminateOperationConfiguration

6.2.25.1 Description

The VnfTerminateOperationConfiguration data type represents information that affect the invocation of the TerminateVnf, as specified in ETSI GS NFV-IFA 011 [1]. Table 6.2.25.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.25.1-1: Type name, shorthand, and URI

Shorthand Name	VnfTerminateOperationConfiguration
Type Qualified Name	toscanfv:VnfTerminateOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfTerminateOperationConfiguration

6.2.25.2 Properties

The properties of the VnfTerminateOperationConfiguration data type shall comply with the provisions set out in table 6.2.25.2-1.

Table 6.2.25.2-1: Properties

Name	Required	Type	Constraints	Description
min_graceful_termination_timeout	yes	scalar-unit.time		Minimum timeout value for graceful termination of a VNF instance.
max_recommended_graceful_termination_timeout	no	scalar-unit.time		Maximum recommended timeout value that can be needed to gracefully terminate a VNF instance of a particular type under certain conditions, such as maximum load condition. This is provided by VNF provider as information for the operator facilitating the selection of optimal timeout value. This value is not used as constraint.

6.2.25.3 Definition

The syntax of the VnfTerminateOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfTerminateOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the TerminateVnf
    properties:
      min_graceful_termination_timeout:
        type: scalar-unit.time
        description: Minimum timeout value for graceful termination of a VNF instance
        required: true
      max_recommended_graceful_termination_timeout:
        type: scalar-unit.time
        description: Maximum recommended timeout value that can be needed to gracefully terminate
a VNF instance of a particular type under certain conditions, such as maximum load condition. This
is provided by VNF provider as information for the operator facilitating the selection of optimal
timeout value. This value is not used as constraint
        required: false
```

6.2.25.4 Examples

None.

6.2.25.5 Additional Requirements

None.

6.2.26 tosca.datatypes.nfv.VnfOperateOperationConfiguration

6.2.26.1 Description

The VnfOperateOperationConfiguration data type represents information that affect the invocation of the OperateVnf operation, as specified in ETSI GS NFV-IFA 011 [1]. Table 6.2.26.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.26.1-1: Type name, shorthand, and URI

Shorthand Name	VnfOperateOperationConfiguration
Type Qualified Name	toscanfv:VnfOperateOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfOperateOperationConfiguration

6.2.26.2 Properties

The properties of the VnfOperateOperationConfiguration data type shall comply with the provisions set out in table 6.2.26.2-1.

Table 6.2.26.2-1: Properties

Name	Required	Type	Constraints	Description
min_graceful_stop_timeout	yes	scalar-unit.time		Minimum timeout value for graceful stop of a VNF instance.
max_recommended_graceful_stop_timeout	no	scalar-unit.time		Maximum recommended timeout value that can be needed to gracefully stop a VNF instance of a particular type under certain conditions, such as maximum load condition. This is provided by VNF provider as information for the operator facilitating the selection of optimal timeout value. This value is not used as constraint.

6.2.26.3 Definition

The syntax of the VnfOperateOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfOperateOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the OperateVnf operation
    properties:
      min_graceful_stop_timeout:
        type: scalar-unit.time
        description: Minimum timeout value for graceful stop of a VNF instance
        required: true
      max_recommended_graceful_stop_timeout:
        type: scalar-unit.time
        description: Maximum recommended timeout value that can be needed to gracefully stop a VNF
instance of a particular type under certain conditions, such as maximum load condition. This is
provided by VNF provider as information for the operator facilitating the selection of optimal
timeout value. This value is not used as constraint
        required: false
```

6.2.26.4 Examples

None.

6.2.26.5 Additional Requirements

None.

6.2.27 tosca.datatypes.nfv.ScaleInfo

6.2.27.1 Description

The scaleInfo data type indicates for a given scaleAspect the corresponding scaleLevel. Table 6.2.27.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.27.1-1: Type name, shorthand, and URI

Shorthand Name	ScaleInfo
Type Qualified Name	toscanfv:ScaleInfo
Type URI	tosca.datatypes.nfv.ScaleInfo

6.2.27.2 Properties

The properties of the ScaleInfo data type shall comply with the provisions set out in table 6.2.27.2-1.

Table 6.2.27.2-1: Properties

Name	Required	Type	Constraints	Description
scale_level	yes	integer	greater_or_equal : 0	The scale level for a particular aspect.

6.2.27.3 Definition

The syntax of the ScaleInfo data type shall comply with the following definition:

```
  tosca.datatypes.nfv.ScaleInfo:
    derived_from: tosca.datatypes.Root
    description: Indicates for a given scaleAspect the corresponding scaleLevel
    properties:
      scale_level:
        type: integer
        description: The scale level for a particular aspect
```

```
      required: true
      constraints:
        - greater_or_equal: 0
```

6.2.27.4 Examples

See clause 6.8.1.9.

6.2.27.5 Additional Requirements

None.

6.2.28 tosca.datatypes.nfv.ScalingAspect

6.2.28.1 Description

The ScalingAspect data type describes the details of an aspect used for horizontal scaling. Table 6.2.28.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.28.1-1: Type name, shorthand, and URI

Shorthand Name	ScalingAspect
Type Qualified Name	toscanfv:ScalingAspect
Type URI	tosca.datatypes.nfv.ScalingAspect

6.2.28.2 Properties

The properties of the ScalingAspect data type shall comply with the provisions set out in table 6.2.28.2-1.

Table 6.2.28.2-1: Properties

Name	Required	Type	Constraints	Description
name	yes	string		Human readable name of the aspect.
description	yes	string		Human readable description of the aspect.
max_scale_level	yes	integer	positiveInteger	Total number of scaling steps that can be applied with regards to this aspect. The value of this property corresponds to the number of scaling steps can be applied to this aspect when scaling it from the minimum scale level (i.e. 0) to the maximum scale level defined by this property.
step_deltas	no	list of string		List of scaling deltas to be applied for the different subsequent scaling steps of this aspect. The first entry in the array shall correspond to the first scaling step (between scale levels 0 to 1) and the last entry in the array shall correspond to the last scaling step (between maxScaleLevel-1 and maxScaleLevel).

6.2.28.3 Definition

The syntax of the ScalingAspect data type shall comply with the following definition:

```
tosca.datatypes.nfv.ScalingAspect:
  derived_from: tosca.datatypes.Root
  description: describes the details of an aspect used for horizontal scaling
  properties:
    name:
      type: string
      description: Human readable name of the aspect
      required: true
    description:
      type: string
```

```
        description: Human readable description of the aspect
        required: true
      max_scale_level:
        type: integer # positiveInteger
        description: Total number of scaling steps that can be applied w.r.t. this aspect. The
value of this property corresponds to the number of scaling steps can be applied to this aspect
when scaling it from the minimum scale level (i.e. 0) to the maximum scale level defined by this
property
        required: true
        constraints:
          - greater_or_equal: 0
      step_deltas:
        type: list
        description: List of scaling deltas to be applied for the different subsequent scaling
steps of this aspect. The first entry in the array shall correspond to the first scaling step
(between scale levels 0 to 1) and the last entry in the array shall correspond to the last scaling
step (between maxScaleLevel-1 and maxScaleLevel)
        required: false
        entry_schema:
          type: string # Identifier
```

6.2.28.4 Examples

See clause A.6.

6.2.28.5 Additional Requirements

None.

6.2.29 tosca.datatypes.nfv.LinkBitrateRequirements

6.2.29.1 Description

The LinkBitrateRequirements data type is defined in clause 9.2.5 of the present document.

6.2.30 tosca.datatypes.nfv.ConnectivityType

6.2.30.1 Description

The ConnectivityType data type is defined in clause 9.2.4 of the present document.

6.2.31 tosca.datatypes.nfv.VnfConfigurableProperties

6.2.31.1 Description

The VnfConfigurableProperties data type describes configurable properties for a given VNF. Configurable properties can be standardized as listed below (e.g. related to auto scaling, auto healing and interface configuration) or can be VNF-specific as defined by the VNF provider.

The value of all VNF configurable properties listed in table 6.2.31.2-1 shall be modifiable anytime (including after instantiation of the VNF) via the Modify VNF information operation, unless stated otherwise in the description of the specific VNF configurable property.

Table 6.2.31.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.31.1-1: Type name, shorthand, and URI

Shorthand Name	VnfConfigurableProperties
Type Qualified Name	toscanfv:VnfConfigurableProperties
Type URI	tosca.datatypes.nfv.VnfConfigurableProperties

6.2.31.2 Properties

The properties of the VnfConfigurableProperties data type shall comply with the provisions set out in table 6.2.31.2-1.

Table 6.2.31.2-1: Properties

Name	Required	Type	Constraints	Description
is_autoscale_enabled	no	boolean		It permits to enable (TRUE)/disable (FALSE) the auto-scaling functionality. If the property is not present , then configuring this VNF property is not supported.
is_autoheal_enabled	no	boolean		It permits to enable (TRUE)/disable (FALSE) the auto-healing functionality. If the property is not present, then configuring this VNF property is not supported.
vnfm_interface_info	no	list of tosca.datatypes .nfv.VnfmInterfaceInfo		Contains information enabling the VNF instance to access to the NFV-MANO interfaces produced by the VNFM (e.g. URIs and credentials). If the property is not present, then configuring this VNF property is not supported. If this attribute is declared for a VNF, its initial value shall be set prior to or at instantiation time (as initial value in the VNFD or via the VNF LCM interface). Its value shall be further modifiable after instantiation via the Modify VNF information operation.
vnfm_oauth_server_info	no	tosca.datatypes .nfv.OauthServerInfo		Contains information to enable discovery of the authorization server protecting access to VNFM interfaces. If the property is not present, then configuring this VNF property is not supported. If this attribute is declared for a VNF, its initial value shall be set prior to or at instantiation time (as initial value in the VNFD or via the VNF LCM interface). Its value shall be further modifiable after instantiation via the Modify VNF information operation.
vnf_oauth_server_info	no	tosca.datatypes .nfv.OauthServerInfo		Contains information to enable discovery of the authorization server to validate the access tokens provided by the VNFM when the VNFM accesses the VNF interfaces, if that functionality (token introspection) is supported by the authorization server. If the property is not present, then configuring this VNF property is not supported. If this attribute is declared for a VNF, its initial value shall be set prior to or at instantiation time (as initial value in the VNFD or via the VNF LCM interface). Its value shall be further modifiable after instantiation via the Modify VNF information operation.
additional_configurable_property	no	tosca.datatypes .nfv.VnfAddition		It provides VNF specific configurable properties that can be modified using the ModifyVnfInfo operation.

Name	Required	Type	Constraints	Description
		alConfigurable Properties		If some of these properties are declared as required, their values shall be set prior to or at instantiation time (as initial value in the VNFD or via the VNF LCM interface). Their values may be modifiable after instantiation via the Modify VNF information operation if such modification of individual attributes is supported by the VNF and declared per attribute in the VNFD.

6.2.31.3 Definition

The syntax of the VnfConfigurableProperties data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfConfigurableProperties:
    derived_from: tosca.datatypes.Root
    description: indicates configuration properties for a given VNF (e.g. related to auto scaling
and auto healing).
    properties:
      is_autoscale_enabled:
        type: boolean
        description: It permits to enable (TRUE)/disable (FALSE) the auto-scaling functionality.
If the property is not present, then configuring this VNF property is not supported.
        required: false
      is_autoheal_enabled:
        type: boolean
        description: It permits to enable (TRUE)/disable (FALSE) the auto-healing functionality.
If the property is not present, then configuring this VNF property is not supported.
        required: false
      vnfm_interface_info:
        type: list
        description: Contains information enabling access to the NFV-MANO interfaces produced by
the VNFM (e.g. URIs and credentials). If the property is not present, then configuring this VNF
property is not supported.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.VnfmInterfaceInfo
      vnfm_oauth_server_info:
        type: tosca.datatypes.nfv.OauthServerInfo
        description: Contains information to enable discovery of the authorization server
protecting access to VNFM interfaces. If the property is not present, then configuring this VNF
property is not supported.
        required: false
      vnf_oauth_server_info:
        type: tosca.datatypes.nfv.OauthServerInfo
        description: Contains information to enable discovery of the authorization server to
validate the access tokens provided by the VNFM when  the VNFM accesses the VNF interfaces, if
that functionality (token introspection) is supported by the authorization server. If the property
is not present, then configuring this VNF property is not supported.
        required: false
      additional_configurable_properties:
        description: It provides VNF specific configurable properties that can be modified using
the ModifyVnfInfo operation
        required: false
        type: tosca.datatypes.nfv.VnfAdditionalConfigurableProperties
      # derived types are expected to introduce
      # additional_configurable_properties with its type derived from
      # tosca.datatypes.nfv.VnfAdditionalConfigurableProperties
```

6.2.31.4 Examples

Example definition of configurable properties without properties assignment value.

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      flavour_id:
        constraints:
          - valid_values: [ simple, complex ]
      configurable_properties:
        type: MyCompany.datatypes.nfv.VnfConfigurableProperties


data_types:
  Mycompany.datatypes.nfv.VnfConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfConfigurableProperties
    properties:
      additional_configurable_properties:
        type: MyCompany.datatypes.nfv.VnfAdditionalConfigurableProperties

  MyCompany.datatypes.nfv.VnfAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfAdditionalConfigurableProperties
    properties:
      name_prefix_in_vim:
        type: string
        required: false
      dns_server:
        type: string
        required: true
```

In the above example, properties definitions are provided and properties assignment values are not necessary. The properties values are available in the API.

6.2.31.5 Additional Requirements

None.

6.2.32 tosca.datatypes.nfv.VnfAdditionalConfigurableProperties

6.2.32.1 Description

The VnfAdditionalConfigurableProperties data type is an empty base type for deriving data types for describing additional configurable properties for a given VNF. Table 6.2.32.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.32.1-1: Type name, shorthand, and URI

Shorthand Name	VnfAdditionalConfigurableProperties
Type Qualified Name	toscanfv:VnfAdditionalConfigurableProperties
Type URI	tosca.datatypes.nfv.VnfAdditionalConfigurableProperties

6.2.32.2 Properties

The properties of the VnfAdditionalConfigurableProperties data type shall comply with the provisions set out in table 6.2.32.2-1.

Table 6.2.32.2-1: Properties

Name	Required	Type	Constraints	Description
is_writable_anytime	yes	boolean		It specifies whether these additional configurable properties are writeable (TRUE) at anytime (i.e. prior to / at instantiation time as well as after instantiation) or (FALSE) only prior to / at instantiation time. If this property is not present, the additional configurable properties are writable anytime.

6.2.32.3 Definition

The syntax of the VnfAdditionalConfigurableProperties data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.Root
    description: is an empty base type for deriving data types for describing additional
configurable properties for a given VNF
    properties:
      is_writable_anytime:
        type: boolean
        description: It specifies whether these additional configurable properties are writeable
(TRUE) at any time (i.e. prior to / at instantiation time as well as after instantiation).or
(FALSE) only prior to / at instantiation time. If this property is not present, the additional
configurable properties are writable anytime.
        required: true
        default: true
```

6.2.32.4 Examples

See clause 6.2.31.4.

6.2.32.5 Additional Requirements

None.

6.2.33 tosca.datatypes.nfv.VnfInfoModifiableAttributes

6.2.33.1 Description

The VnfInfoModifiableAttributes data type describes VNF-specific extension and metadata for a given VNF. Table 6.2.33.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.33.1-1: Type name, shorthand, and URI

Shorthand Name	VnfInfoModifiableAttributes
Type Qualified Name	toscanfv:VnfInfoModifiableAttributes
Type URI	tosca.datatypes.nfv.VnfInfoModifiableAttributes

6.2.33.2 Properties

The properties of the VnfInfoModifiableAttributes data type shall comply with the provisions set out in table 6.2.33.2-1.

Table 6.2.33.2-1: Properties

Name	Required	Type	Constraints	Description
extensions	no	tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions		"Extension" properties of VnfInfo that are writeable.
metadata	no	tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata		"Metadata" properties of VnfInfo that are writeable.

6.2.33.3 Definition

The syntax of the VnfInfoModifiableAttributes data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfInfoModifiableAttributes:
    derived_from: tosca.datatypes.Root
    description: Describes VNF-specific extension and metadata for a given VNF
    properties:
      extensions:
        type: tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
        description: Extension properties of VnfInfo that are writeable
        required: false
        # derived types are expected to introduce
        # extensions with its type derived from
        # tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
      metadata:
        type: tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata
        description: Metadata properties of VnfInfo that are writeable
        required: false
        # derived types are expected to introduce
        # metadata with its type derived from
        # tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata
```

6.2.33.4 Examples

The following example shows an example of a derived VnfInfoModifiableAttributesExtensions data type that contains one security-sensitive property.

```
tosca_definitions_version: tosca_simple_yaml_1_3

data_types:
  MyCompany.datatypes.nfv.VnfInfoModifiableAttributes:
    derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributes
    properties:
      extensions:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions

  mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
    derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
    properties:
      password:
        type: string
        metadata:
          sensitive: "true"
```

See clause 6.8.1.9 for other examples.

6.2.33.5 Additional Requirements

None.

6.2.34 tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions

6.2.34.1 Description

The VnfInfoModifiableAttributesExtensions data type is an empty base type for deriving data types for describing VNF-specific extension. Table 6.2.34.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.34.1-1: Type name, shorthand, and URI

Shorthand Name	VnfInfoModifiableAttributesExtensions
Type Qualified Name	toscanfv:VnfInfoModifiableAttributesExtensions
Type URI	tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions

6.2.34.2 Properties

None.

6.2.34.3 Definition

The syntax of the VnfInfoModifiableAttributesExtensions data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
    derived_from: tosca.datatypes.Root
    description: is an empty base type for deriving data types for describing VNF-specific
extension
```

6.2.34.4 Examples

See clause 6.8.1.9.

6.2.34.5 Additional Requirements

None.

6.2.35 tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata

6.2.35.1 Description

The VnfInfoModifiableAttributesMetadata data type is an empty base type for deriving data types for describing VNF-specific metadata. Table 6.2.35.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.35.1-1: Type name, shorthand, and URI

Shorthand Name	VnfInfoModifiableAttributesMetadata
Type Qualified Name	toscanfv:VnfInfoModifiableAttributesMetadata
Type URI	tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata

6.2.35.2 Properties

None.

6.2.35.3 Definition

The syntax of the VnfInfoModifiableAttributesMetadata data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata:
    derived_from: tosca.datatypes.Root
    description: is an empty base type for deriving data types for describing VNF-specific
metadata
```

6.2.35.4 Examples

Example metadata definition:

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      flavour_id:
        constraints:
          - valid_values: [ simple, complex ]
      modifiable_attributes:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes

data_types:
  mycompany.datatypes.nfv.VnfInfoModifiableAttributes:
    derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributes
    properties:
      metadata:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesMetadata

  mycompany.datatypes.nfv.VnfInfoModifiableAttributesMetadata:
    derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata
    properties:
      metadata_key_1:
        type: string
        required: false
      metadata_key_2:
        type: string
        required: false
```

6.2.35.5 Additional Requirements

None.

6.2.36 tosca.datatypes.nfv.Qos

6.2.36.1 Description

The Qos data type is defined in clause 9.2.7 of the present document.

6.2.37 tosca.datatypes.nfv.LogicalNodeData

6.2.37.1 Description

The LogicalNodeData data type describes compute, memory and I/O requirements associated with a particular VDU. Table 6.2.37.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.37.1-1: Type name, shorthand, and URI

Shorthand Name	LogicalNodeData
Type Qualified Name	toscanfv:LogicalNodeData
Type URI	tosca.datatypes.nfv.LogicalNodeData

6.2.37.2 Properties

The properties of the LogicalNodeData data type shall comply with the provisions set out in table 6.2.37.2-1.

Table 6.2.37.2-1: Properties

Name	Required	Type	Constraints	Description
logical_node_requirements	no	map of string		The logical node-level compute, memory and I/O requirements. A map of strings where each string contains a set of key-value pairs that describes hardware platform specific deployment requirements, including the number of CPU cores on this logical node, a memory configuration specific to a logical node or a requirement related to the association of an I/O device with the logical node. More information regarding the usage of this property is available at: https://register.etsi.org.

6.2.37.3 Definition

The syntax of the LogicalNodeData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.LogicalNodeData:
    derived_from: tosca.datatypes.Root
    description: Describes compute, memory and I/O requirements associated with a particular VDU.
    properties:
      logical_node_requirements:
        type: map
        description: The logical node-level compute, memory and I/O requirements. A map of strings
where each string contains a set of key-value pairs that describes hardware platform specific
deployment requirements, including the number of CPU cores on this logical node, a memory
configuration specific to a logical node  or a requirement related to the association of an I/O
device with the logical node.
        required: false
        entry_schema:
          type: string
```

6.2.37.4 Examples

None.

6.2.37.5 Additional Requirements

None.

6.2.38 Void

6.2.39 tosca.datatypes.nfv.VirtualBlockStorageData

6.2.39.1 Description

The VirtualBlockStorageData data type describes block storage requirements associated with compute resources in a particular VDU, either as a local disk or as virtual attached storage. Table 6.2.39.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.39.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualBlockStorageData
Type Qualified Name	toscanfv:VirtualBlockStorageData
Type URI	tosca.datatypes.nfv.VirtualBlockStorageData

6.2.39.2 Properties

The properties of the VirtualBlockStorageData data type shall comply with the provisions set out in table 6.2.39.2-1.

Table 6.2.39.2-1: Properties

Name	Required	Type	Constraints	Description
size_of_storage	yes	scalar-unit.size	greater_or_equal:0 B	Size of virtualised storage resource.
vdu_storage_requirements	no	map of string		The hardware platform specific storage requirements. A map of strings where each string contains a set of key-value pairs that represents the hardware platform specific storage deployment requirements. More information regarding the usage of this property is available at: https://register.etsi.org.
rdma_enabled	yes	boolean	default: false	Indicate if the storage support RDMA.

6.2.39.3 Definition

The syntax of the VirtualBlockStorageData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualBlockStorageData:
    derived_from: tosca.datatypes.Root
    description: VirtualBlockStorageData describes block storage requirements associated with
compute resources in a particular VDU, either as a local disk or as virtual attached storage
    properties:
      size_of_storage:
        type: scalar-unit.size
        description: Size of virtualised storage resource
        required: true
        constraints:
          - greater_or_equal: 0 B
      vdu_storage_requirements:
        type: map
        description: The hardware platform specific storage requirements. A map of strings where
each string contains a set of key-value pairs that represents the hardware platform specific
storage deployment requirements
        required: false
        entry_schema:
          type: string
      rdma_enabled:
        type: boolean
        description: Indicates if the storage support RDMA
        required: true
        default: false
```

6.2.39.4 Examples

None.

6.2.39.5 Additional Requirements

None.

6.2.40 tosca.datatypes.nfv.VirtualObjectStorageData

6.2.40.1 Description

The VirtualObjectStorageData data type describes object storage requirements associated with compute resources in a particular VDU. Table 6.2.40.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.40.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualObjectStorageData
Type Qualified Name	toscanfv:VirtualObjectStorageData
Type URI	tosca.datatypes.nfv.VirtualObjectStorageData

6.2.40.2 Properties

The properties of the VirtualObjectStorageData data type shall comply with the provisions set out in table 6.2.40.2-1.

Table 6.2.40.2-1: Properties

Name	Required	Type	Constraints	Description
max_size_of_storage	no	scalar-unit.size	greater_or_equal:0 B	Maximum size of virtualised storage resource.

6.2.40.3 Definition

The syntax of the VirtualObjectStorageData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualObjectStorageData:
    derived_from: tosca.datatypes.Root
    description: VirtualObjectStorageData describes object storage requirements associated
with compute resources in a particular VDU
    properties:
      max_size_of_storage:
        type: scalar-unit.size
        description: Maximum size of virtualised storage resource
        required: false
        constraints:
          - greater_or_equal: 0 B
```

6.2.40.4 Examples

None.

6.2.40.5 Additional Requirements

None.

6.2.41 tosca.datatypes.nfv.VirtualFileStorageData

6.2.41.1 Description

The VirtualFileStorageData data type describes file storage requirements associated with compute resources in a particular VDU. Table 6.2.41.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.41.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualFileStorageData
Type Qualified Name	toscanfv:VirtualFileStorageData
Type URI	tosca.datatypes.nfv.VirtualFileStorageData

6.2.41.2 Properties

The properties of the VirtualFileStorageData data type shall comply with the provisions set out in table 6.2.41.2-1.

Table 6.2.41.2-1: Properties

Name	Required	Type	Constraints	Description
size_of_storage	yes	scalar-unit.size	greater_or_equal:0 B	Size of virtualised storage resource.
file_system_protocol	yes	string	Valid values: See YAML definition constraints	The shared file system protocol.

6.2.41.3 Definition

The syntax of the VirtualFileStorageData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualFileStorageData:
    derived_from: tosca.datatypes.Root
    description: VirtualFileStorageData describes file storage requirements associated with
compute resources in a particular VDU
    properties:
      size_of_storage:
        type: scalar-unit.size
        description: Size of virtualised storage resource
        required: true
        constraints:
          - greater_or_equal: 0 B
      file_system_protocol:
        type: string
        description: The shared file system protocol (e.g. NFS, CIFS)
        required: true
        constraints:
          - valid_values: [ nfs, cifs ]
```

6.2.41.4 Examples

None.

6.2.41.5 Additional Requirements

None.

6.2.42 tosca.datatypes.nfv.VirtualLinkBitrateLevel

6.2.42.1 Description

The VirtualLinkBitrateLevel data type describes bitrate requirements applicable to the virtual link instantiated from a particular VnfVirtualLink. Table 6.2.42.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.42.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkBitrateLevel
Type Qualified Name	toscanfv:VirtualLinkBitrateLevel
Type URI	tosca.datatypes.nfv.VirtualLinkBitrateLevel

6.2.42.2 Properties

The properties of the VirtualLinkBitrateLevel data type shall comply with the provisions set out in table 6.2.42.2-1.

Table 6.2.42.2-1: Properties

Name	Required	Type	Constraints	Description
bitrate_requirements	yes	tosca.datatypes.nfv.LinkBitrateRequirements		Virtual link bitrate requirements for an instantiation level or bitrate delta for a scaling step.

6.2.42.3 Definition

The syntax of the VirtualLinkBitrateLevel data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualLinkBitrateLevel:
    derived_from: tosca.datatypes.Root
    description: Describes bitrate requirements applicable to the virtual link instantiated from a
particular VnfVirtualLink
    properties:
      bitrate_requirements:
        type: tosca.datatypes.nfv.LinkBitrateRequirements
        description: Virtual link bitrate requirements for an instantiation level or bitrate delta
for a scaling step
        required: true
```

6.2.42.4 Examples

See clause A.6.

6.2.42.5 Additional Requirements

None.

6.2.43 tosca.datatypes.nfv.VnfOperationAdditionalParameters

6.2.43.1 Description

The VnfOperationAdditionalParameters data type is an empty base type for deriving data type for describing VNF-specific parameters to be passed when invoking lifecycle management operations as specified in ETSI GS NFV-IFA 011 [1]. Table 6.2.43.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.43.1-1: Type name, shorthand, and URI

Shorthand Name	VnfOperationAdditionalParameters
Type Qualified Name	toscanfv:VnfOperationAdditionalParameters
Type URI	tosca.datatypes.nfv.VnfOperationAdditionalParameters

6.2.43.2 Properties

None.

6.2.43.3 Definition

The syntax of the VnfOperationAdditionalParameters data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfOperationAdditionalParameters:
    derived_from: tosca.datatypes.Root
    description: Is an empty base type for deriving data type for describing VNF-specific
parameters to be passed when invoking lifecycle management operations
    #properties:
```

6.2.43.4 Examples

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
  MyCompany.nodes.nfv.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
   ..
    interfaces:
      Vnflcm:
        operations:
          instantiate:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters

data_types:
  MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
      properties:
        parameter_1:
          type: string
          required: true
        parameter_2:
          type: string
          required: true
          default: value_2
```

The following example shows the declaration of an additional parameter to receive a password in the instantiate operation. The metadata sensitive: "true" indicates that this property holds security-sensitive information.

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
  MyCompany.nodes.nfv.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
    ..
    interfaces:
      Vnflcm:
        operations:
          instantiate:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters

data_types:
  MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      inst_password:
        type: string
        required: true
        metadata:
           sensitive: "true"
```

6.2.43.5 Additional Requirements

None.

6.2.44 tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration

6.2.44.1 Description

The VnfChangeFlavourOperationConfiguration data type represents information that affect the invocation of the ChangeVnfFlavour operation, as specified in ETSI GS NFV-IFA 011 [1]. This data type definition is reserved for future use in the present document. Table 6.2.44.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.44.1-1: Type name, shorthand, and URI

Shorthand Name	VnfChangeFlavourOperationConfiguration
Type Qualified Name	toscanfv:VnfChangeFlavourOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration

6.2.44.2 Properties

None.

6.2.44.3 Definition

The syntax of the VnfChangeFlavourOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the ChangeVnfFlavour
operation
  # This data type definition is reserved for future use in the present document.
  # properties:
```

6.2.44.4 Examples

None.

6.2.44.5 Additional Requirements

None.

6.2.45 tosca.datatypes.nfv.VnfChangeExtConnectivityOperation Configuration

6.2.45.1 Description

The VnfChangeExtConnectivityOperationConfiguration data type represents information that affect the invocation of the ChangeExtVnfConnectivity operation, as specified in ETSI GS NFV-IFA 011 [1]. This data type definition is reserved for future use in the present document. Table 6.2.45.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.45.1-1: Type name, shorthand, and URI

Shorthand Name	VnfChangeExtConnectivityOperationConfiguration
Type Qualified Name	toscanfv:VnfChangeExtConnectivityOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfChangeExtConnectivityOperationConfiguration

6.2.45.2 Properties

None.

6.2.45.3 Definition

The syntax of the VnfChangeExtConnectivityOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfChangeExtConnectivityOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the ChangeExtVnfConnectivity
operation
  # This data type definition is reserved for future use in the present document.
  # properties:
```

6.2.45.4 Examples

None.

6.2.45.5 Additional Requirements

None.

6.2.46 tosca.datatypes.nfv.VnfMonitoringParameter

The VnfMonitoringParameter data type is defined in clause 9.2.9 of the present document.

6.2.47 tosca.datatypes.nfv.VnfcMonitoringParameter

6.2.47.1 Description

This data type provides information on virtualised resource related performance metrics applicable to a VNFC. Table 6.2.47.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.47.1-1: Type name, shorthand, and URI

Shorthand Name	VnfcMonitoringParameter
Type Qualified Name	toscanfv:VnfcMonitoringParameter
Type URI	tosca.datatypes.nfv.VnfcMonitoringParameter

6.2.47.2 Properties

The properties of the VnfcMonitoringParameter data type shall comply with the provisions set out in table 6.2.47.2-1.

Table 6.2.47.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Human readable name of the monitoring parameter.
performance_metric	yes	string	valid values: See YAML definition constraintse	Identifies a performance metric to be monitored. Performance metric values shall be either set to: • A corresponding measurement name defined in clause 7.2 of ETSI GS NFV-IFA 027 [7], without appending a sub-counter. In this case the VNFM computes these measurements from lower-level metrics collected from the VIM. See note. • A corresponding measurement name defined in clause 7.1 of ETSI GS NFV-IFA 027 [7], without appending a sub-counter. In this case the VNFM collects these metrics from the VIM for all compute, storage and network resources allocated to the VNFC instance.
collection_period	no	scalar-unit.time		Describes the periodicity at which to collect the performance information.
NOTE: The measured object type for _cpu_usage_mean_vnf, v_cpu_usage_peak_vnf, v_memory_usage_mean_vnf, v_memory_usage_peak_vnf, v_disk_usage_mean_vnf and v_disk_usage_peak_vnf is the VNFC.				

6.2.47.3 Definition

The syntax of the VnfcMonitoringParameter data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfcMonitoringParameter:
    derived_from: tosca.datatypes.Root
    description: Represents information on virtualised resource related performance metrics
applicable to the VNF.
    properties:
      name:
        type: string
        description: Human readable name of the monitoring parameter
        required: true
      performance_metric:
        type: string
        description: Identifies a performance metric to be monitored, according to ETSI GS NFV-IFA
027.
        required: true
        constraints:
          - valid_values: [ v_cpu_usage_mean_vnf, v_cpu_usage_peak_vnf, v_memory_usage_mean_vnf,
v_memory_usage_peak_vnf, v_disk_usage_mean_vnf, v_disk_usage_peak_vnf, byte_incoming_vnf_int_cp,
byte_outgoing_vnf_int_cp,
packet_incoming_vnf_int_cp, packet_outgoing_vnf_int_cp, v_cpu_usage_mean,
v_cpu_usage_peak,v_memory_usage_mean,v_memory_usage_peak, v_disk_usage_mean, v_disk_usage_peak,
v_net_byte_incoming, v_net_byte_outgoing, v_net_packet_incoming, v_net_packet_outgoing,
usage_mean_vStorage, usage_peak_vStorage ]
      collection_period:
        type: scalar-unit.time
        description: Describes the  periodicity at which to collect the performance information.
        required: false
        constraints:
          - greater_than: 0 s
```

6.2.47.4 Examples

None.

6.2.47.5 Additional Requirements

None.

6.2.48 tosca.datatypes.nfv.VirtualLinkMonitoringParameter

6.2.48.1 Description

This data type provides information on virtualised resource related performance metrics. Table 6.2.48.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.48.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkMonitoringParameter
Type Qualified Name	toscanfv: VirtualLinkMonitoringParameter
Type URI	tosca.datatypes.nfv.VirtualLinkMonitoringParameter

6.2.48.2 Properties

The properties of the VirtualLinkMonitoringParameter data type shall comply with the provisions set out in table 6.2.48.2-1.

Table 6.2.48.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Human readable name of the monitoring parameter.
performance_metric	yes	string	valid values: See YAML definition constraints	Identifies a performance metric to be monitored. Performance metric values shall be set to following measurement names defined in clause 7.1 of ETSI GS NFV-IFA 027 [7] ,without appending a sub-counter: • ByteIncoming • ByteOutgoing • PacketIncoming • PacketOutgoing The VNFM collects these metrics from the VIM by aggregating the sub-counters of all virtual link ports attached to the virtual link to which the metrics apply.
collection_period	no	scalar-unit.time		Describes the periodicity at which to collect the performance information.

6.2.48.3 Definition

The syntax of the VirtualLinkMonitoringParameter data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VirtualLinkMonitoringParameter:
    derived_from: tosca.datatypes.Root
    description: Represents information on virtualised resource related performance metrics
applicable to the VNF.
    properties:
      name:
        type: string
        description: Human readable name of the monitoring parameter
        required: true
      performance_metric:
        type: string
        description: Identifies a performance metric to be monitored.
        required: true
        constraints:
          - valid_values: [ byte_incoming, byte_outgoing, packet_incoming, packet_outgoing ]
      collection_period:
        type: scalar-unit.time
        description: Describes the periodicity at which to collect the performance information.
```

```
        required: false
        constraints:
          - greater_than: 0 s
```

6.2.48.4 Examples

None.

6.2.48.5 Additional Requirements

None.

6.2.49 tosca.datatypes.nfv.InterfaceDetails

6.2.49.1 Description

The InterfaceDetails data type describes information used to access an interface exposed by a VNF. It corresponds to the interfaceDetails attribute of the VnfInterfaceDetails information element defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.49.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.49.1-1: Type name, shorthand, and URI

Shorthand Name	InterfaceDetails
Type Qualified Name	toscanfv:InterfaceDetails
Type URI	tosca.datatypes.nfv.InterfaceDetails

6.2.49.2 Properties

The properties of the InterfaceDetails data type shall comply with the provisions set out in table 6.2.49.2-1.

Table 6.2.49.2-1: Properties

Name	Required	Type	Constraints	Description
uri_components	no	tosca.datatypes.nfv .UriComponents		Provides components to build a Uniform Resource Identifier (URI) where to access the interface end point.
interface_specific_ data	no	map of string		Provides additional details that are specific to the type of interface considered.

6.2.49.3 Definition

The syntax of the InterfaceDetails data type shall comply with the following definition:

```
  tosca.datatypes.nfv.InterfaceDetails:
    derived_from: tosca.datatypes.Root
    description: information used to access an interface exposed by a VNF
    properties:
      uri_components:
        type: tosca.datatypes.nfv.UriComponents
        description: Provides components to build a Uniform Resource Identifier (URI) where to
access the interface end point.
        required: false
      interface_specific_data:
        type: map
        description: Provides additional details that are specific to the type of interface
considered.
        required: false
        entry_schema:
          type: string
```

6.2.49.4 Examples

See clause 6.10.12.

6.2.49.5 Additional Requirements

None.

6.2.50 tosca.datatypes.nfv.UriComponents

6.2.50.1 Description

The UriComponents data type describes information used to build a URI that complies with IETF RFC 3986 [8]. Table 6.2.50.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.50.1-1: Type name, shorthand, and URI

Shorthand Name	UriComponents
Type Qualified Name	toscanfv:UriComponents
Type URI	tosca.datatypes.nfv.UriComponents

6.2.50.2 Properties

The properties of the UriComponents data type shall comply with the provisions set out in table 6.2.50.2-1.

Table 6.2.50.2-1: Properties

Name	Required	Type	Constraints	Description
scheme	yes	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the scheme component of a URI, as per IETF RFC 3986 [8].
authority	no	tosca.datatypes.nfv.UriAuthority		Corresponds to the authority component of a URI, as per IETF RFC 3986 [8]. See note.
path	no	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the path component of a URI, as per IETF RFC 3986 [8].
query	no	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the query component of a URI, as per IETF RFC 3986 [8].
fragment	no	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the fragment component of a URI, as per IETF RFC 3986 [8].
NOTE: If this property is not included while the URI scheme requires it, the VNFM is expected to generate it, based on knowledge of the network configuration of the external CP instance that provides the connectivity for this interface.				

6.2.50.3 Definition

The syntax of the UriComponents data type shall comply with the following definition:

```
tosca.datatypes.nfv.UriComponents:
  derived_from: tosca.datatypes.Root
  description: information used to build a URI that complies with IETF RFC 3986.
  properties:
    scheme:
      type: string # shall comply with IETF RFC 3986
      description: scheme component of a URI.
      required: true
    authority:
      type: tosca.datatypes.nfv.UriAuthority
      description: Authority component of a URI
      required: false
    path:
      type: string # shall comply with IETF RFC 3986
      description: path component of a URI.
      required: false
    query:
      type: string # shall comply with IETF RFC 3986
      description: query component of a URI.
      required: false
    fragment:
      type: string # shall comply with IETF RFC 3986
      description: fragment component of a URI.
      required: false
```

6.2.50.4 Examples

See clause 6.10.12.

6.2.50.5 Additional Requirements

When this datatype is used to provide information for accessing APIs defined in ETSI GS NFV-SOL 002 [22], the path property may be included and the query and fragment properties shall be absent. The values of the scheme, authority and path properties form the {apiRoot} of the URI prefix.

6.2.51 tosca.datatypes.nfv.UriAuthority

6.2.51.1 Description

The UriAuthority data type corresponds to the authority component of a URI as specified in IETF RFC 3986 [8]. Table 6.2.51.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.51.1-1: Type name, shorthand, and URI

Shorthand Name	UriAuthority
Type Qualified Name	toscanfv:UriAuthority
Type URI	tosca.datatypes.nfv.UriAuthority

6.2.51.2 Properties

The properties of the UriAuthority data type shall comply with the provisions set out in table 6.2.51.2-1.

Table 6.2.51.2-1: Properties

Name	Required	Type	Constraints	Description
user_info	no	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the user_info field of the authority component of a URI, as per IETF RFC 3986 [8]. For HTTP and HTTPS URIs, the provisions in sections 2.7.1 and 2.7.2 of IETF RFC 7230 [12] apply, respectively.
host	no	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the host field of the authority component of a URI, as per IETF RFC 3986 [8]. See note 1.
port	no	string	String values shall comply with IETF RFC 3986 [8]	Corresponds to the port field of the authority component of a URI, as per IETF RFC 3986 [8]. See note 2.

NOTE 1: If this property is not included the VNFM is expected to generate it, based on knowledge of the network configuration of the external CP instance that provides the connectivity for this interface.

NOTE 2: If this property is not included the default port for the protocol declared by the scheme property of the parent UriComponents structure shall be used unless there are configuration mechanisms applied that are outside the scope of the present document. If no default port exists for the URI scheme, the port property shall be included unless there are configuration mechanisms applied that are outside the scope of the present document.

6.2.51.3 Definition

The syntax of the UriAuthority data type shall comply with the following definition:

```
  tosca.datatypes.nfv.UriAuthority:
    derived_from: tosca.datatypes.Root
    description: information that corresponds to the authority component of a URI as specified in
IETF RFC 3986
    properties:
      user_info:
        type: string # shall comply with IETF RFC 3986
        description: user_info field of the authority component of a URI
        required: false
      host:
        type: string # shall comply with IETF RFC 3986
        description: host field of the authority component of a URI
        required: false
      port:
        type: string # shall comply with IETF RFC 3986
        description: port field of the authority component of a URI
        required: false
```

6.2.51.4 Examples

See clause 6.10.12.

6.2.51.5 Additional Requirements

When this datatype is used to provide information for accessing APIs defined in ETSI GS NFV-SOL 002 [22], the host property and port properties may be included and the user_info property shall not be included. If the host property is included and the value is a registered name, it is assumed that means are in place to resolve the host name to the correct IP address. If the host property is not included, it is assumed that the VNFM will use the IP address associated to one of the connection point instances created from the VnfExpCp and VduCp node types declared as a target of the SupportedVnfInterface policy.

NOTE: This means that if multiple CP instances exist that were created from a particular VnfExtCp or VduCp node template, the VNFM may use any of them to attempt accessing the interface. If no reply is received because the selected CP instance if out of service or is not reachable, the VNFM is expected to try reaching the interface through another CP instance.

6.2.52 tosca.datatypes.nfv.VnfProfile

6.2.52.1 Description

The VnfProfile data type is defined in clause 9.2.8 of the present document.

6.2.53 tosca.datatypes.nfv.ChecksumData

6.2.53.1 Description

The ChecksumData data type describes information about the result of performing a checksum operation over some arbitrary data. Table 6.2.53.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.53.1-1: Type name, shorthand, and URI

Shorthand Name	ChecksumData
Type Qualified Name	toscanfv:ChecksumData
Type URI	tosca.datatypes.nfv.ChecksumData

6.2.53.2 Properties

The properties of the ChecksumData data type shall comply with the provisions set out in table 6.2.53.2-1.

Table 6.2.53.2-1: Properties

Name	Required	Type	Constraints	Description
algorithm	yes	string	Valid values: See YAML definition constraints	Describes the algorithm used to obtain the checksum value, as described in [14].
hash	yes	string		Contains the result of applying the algorithm indicated by the algorithm property to the data to which this ChecksumData refers.

6.2.53.3 Definition

The syntax of the ChecksumData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.ChecksumData:
    derived_from: tosca.datatypes.Root
    description: Describes information about the result of performing a checksum operation over
some arbitrary data
    properties:
      algorithm:
        type: string
        description: Describes the algorithm used to obtain the checksum value
        required: true
        constraints:
          - valid_values: [sha-224, sha-256, sha-384, sha-512 ]
      hash:
        type: string
        description: Contains the result of applying the algorithm indicated by the algorithm
property to the data to which this ChecksumData refers
        required: true
```

6.2.53.4 Examples

```
<some_tosca_entity>:
  properties:
   checksum:
    algorithm: sha-256
    hash: b9c3036539fd7a5f87a1bf38eb05fdde8b556a1a7e664dbeda90ed3cd74b4f9d
```

6.2.53.5 Additional Requirements

None.

6.2.54 tosca.datatypes.nfv.VnfmInterfaceInfo

6.2.54.1 Description

The VnfmInterfaceInfo data type describes information enabling the VNF instance to access the NFV-MANO interfaces produced by the VNFM (e.g. URIs and credentials). Table 6.2.54.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.54.1-1: Type name, shorthand, and URI

Shorthand Name	VnfmInterfaceInfo
Type Qualified Name	toscanfv:VnfmInterfaceInfo
Type URI	tosca.datatypes.nfv.VnfmInterfaceInfo

6.2.54.2 Properties

The properties of the VnfmInterfaceInfo data type shall comply with the provisions set out in table 6.2.54.2-1.

Table 6.2.54.2-1: Properties

Name	Required	Type	Constraints	Description
interface_name	yes	string	Valid values: See YAML definition constraints	Identifies an interface produced by the VNFM.
details	no	tosca.datatypes.nfv.InterfaceDetails		Provide additional data to access the interface endpoint (e.g. API URI prefix).
credentials	no	map of string		Provides credential enabling access to the interface. This property is reserved for future use in the present document.

6.2.54.3 Definition

The syntax of the VnfmInterfaceInfo data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfmInterfaceInfo:
    derived_from: tosca.datatypes.Root
    description: Describes information enabling the VNF instance to access the NFV-MANO interfaces
produced by the VNFM
    properties:
      interface_name:
        type: string
        description: Identifies an interface produced by the VNFM.
        required: true
        constraints:
          - valid_values: [ vnf_lcm, vnf_pm, vnf_fm ]
      details:
```

```
      type: tosca.datatypes.nfv.InterfaceDetails
      description: Provide additional data to access the interface endpoint
      required: false
    credentials:
      type: map
      description: Provides credential enabling access to the interface
      required: false
      entry_schema:
        type: string
```

6.2.54.4 Examples

None.

6.2.54.5 Additional Requirements

None.

6.2.55 tosca.datatypes.nfv.OauthServerInfo

6.2.55.1 Description

The OauthServerInfo data type describes information to enable discovery of the authorization server. This data type definition is reserved for future use in the present document. Table 6.2.55.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.55.1-1: Type name, shorthand, and URI

Shorthand Name	OauthServerInfo
Type Qualified Name	toscanfv:OauthServerInfo
Type URI	tosca.datatypes.nfv.OauthServerInfo

6.2.55.2 Properties

None.

6.2.55.3 Definition

The syntax of the OauthServerInfo data type shall comply with the following definition:

```
tosca.datatypes.nfv.OauthServerInfo:
  derived_from: tosca.datatypes.Root
  description: information to enable discovery of the authorization server
  #properties:
  #This data type definition is reserved for future use in the present document
```

6.2.55.4 Examples

None.

6.2.55.5 Additional Requirements

None.

6.2.56 tosca.datatypes.nfv.BootData

6.2.56.1 Description

The BootData data type describes the information used to customize a virtualised compute resource at boot time. Table 6.2.56.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.56.1-1: Type name, shorthand, and URI

Shorthand Name	BootData
Type Qualified Name	toscanfv:BootData
Type URI	tosca.datatypes.nfv.BootData

6.2.56.2 Properties

The properties of the BootData data type shall comply with the provisions set out in table 6.2.56.2-1.

Table 6.2.56.2-1: Properties

Name	Required	Type	Constraints	Description
vim_specific_properties	no	tosca.datatypes.nfv.BootDataVimSpecificProperties		Properties used for selecting VIM specific capabilities when setting the boot data.
kvp_data	no	tosca.datatypes.nfv.KvpData		A set of key-value pairs for configuring a virtual compute resource. The mechanisms for conveying these key-value pairs to the virtual compute resource are out of the scope of the present document. An example of such mechanisms is the OpenStack metadata service defined in [i.13].
content_or_file_data	no	tosca.datatypes.nfv.ContentOrFileData		A string content or a file for configuring a virtual compute resource. The mechanisms for conveying the string content or the file to the virtual compute resource are out of the scope of the present document. An example of such mechanisms is the OpenStack User-data service defined in [i.14].

6.2.56.3 Definition

The syntax of the BootData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.BootData:
    derived_from: tosca.datatypes.Root
    description: describes the information used to customize a virtualised compute resource at
boot time.
    properties:
      vim_specific_properties:
        type: tosca.datatypes.nfv.BootDataVimSpecificProperties
        description: Properties used for selecting VIM specific capabilities when setting the
boot data.
        required: false
      kvp_data:
        type: tosca.datatypes.nfv.KvpData
        description: A set of key-value pairs for configuring a virtual compute resource.
        required: false
      content_or_file_data:
```

```
        type: tosca.datatypes.nfv.ContentOrFileData
        description: A string content or a file for configuring a virtual compute resource.
        required: false
```

6.2.56.4 Examples

See clause 6.8.3.8.

6.2.56.5 Additional Requirements

None.

6.2.57 tosca.datatypes.nfv.KvpData

6.2.57.1 Description

The KvpData data type describes a set of key-value pairs information used to customize a virtualised compute resource by using only key-value pairs data. Table 6.2.57.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.57.1-1: Type name, shorthand, and URI

Shorthand Name	KvpData
Type Qualified Name	toscanfv:KvpData
Type URI	tosca.datatypes.nfv.KvpData

6.2.57.2 Properties

The properties of the MetaData data type shall comply with the provisions set out in table 6.2.57.2-1.

Table 6.2.57.2-1: Properties

Name	Required	Type	Constraints	Description
data	no	map of string		A map of strings that contains a set of key-value pairs that describes the information for configuring the virtualised compute resource.

6.2.57.3 Definition

The syntax of the KvpData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.KvpData:
    derived_from: tosca.datatypes.Root
    description: describes a set of key-value pairs information used to customize a
virtualised compute resource at boot time by using only key-value pairs data.
    properties:
      data:
        type: map
        description: A map of strings that contains a set of key-value pairs that describes
the information for configuring the virtualised compute resource.
        required: false
        entry_schema:
          type: string
```

6.2.57.4 Examples

See clause 6.8.3.8.

6.2.57.5 Additional Requirements

None.

6.2.58 tosca.datatypes.nfv.ContentOrFileData

6.2.58.1 Description

The ContentOrFileData data type describes a string content or a file information used to customize a virtualised compute resource by using string content or file. Table 6.2.58.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.58.1-1: Type name, shorthand, and URI

Shorthand Name	ContentOrFileData
Type Qualified Name	toscanfv:ContentOrFileData
Type URI	tosca.datatypes.nfv.ContentOrFileData

6.2.58.2 Properties

The properties of the ContentOrFileData data type shall comply with the provisions set out in table 6.2.58.2-1.

Table 6.2.58.2-1: Properties

Name	Required	Type	Constraints	Description
data	no	map of string		A map of strings that contains a set of key-value pairs that carries the dynamic deployment values which used to replace the corresponding variable parts in the file as identify by a URL as described in source_path. Shall be present if "source_path" is present and shall be absent otherwise. See note 1.
content	no	string		The string information used to customize a virtualised compute resource at boot time. See note 2.
source_path	no	string		The URL to a file contained in the VNF package used to customize a virtualised compute resource. The content shall comply with IETF RFC 3986 [8]. See note 2.
destination_path	no	string		The URL where to inject a file indicated by the source_path property into the virtualised compute resource. The content shall comply with IETF RFC 3986 [8]. See note 3.
NOTE 1: It is the file processor (e.g. in the VNFM) responsibility to replace the corresponding variable parts in the file with the value carried in the data property, the variable parts in the file are start with $ and end with $, its content is the same character with one of the keys in the data property, for example, if one of the keys in 'data' is "https_proxy", somewhere in the file content there is $https_proxy$.				
NOTE 2: One and only one of the following properties shall be present: contents or source_path.				
NOTE 3: It is only present when a particular method is used for transferring boot information into a virtualised compute resource and source_path is also present. For example, such method can be the personality method as described in [i.15], and it has been deprecated since Openstack 12.0.0 (Stein).				

6.2.58.3 Definition

The syntax of the ContentOrFileData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.ContentOrFileData:
    derived_from: tosca.datatypes.Root
    description: describes a string content or a file information used to customize a
virtualised compute resource at boot time by using string content or file.
    properties:
      data:
        type: map
        description: A map of strings that contains a set of key-value pairs that carries the
dynamic deployment values which used to replace the corresponding variable parts in the file
as identify by a URL as described in source_path. Shall be present if "source_path" is present
and shall be absent otherwise..
        required: false
        entry_schema:
          type: string
      content:
        type: string
        description: The string information used to customize a virtualised compute resource
at boot time.
        required: false
      source_path:
        type: string
        description: The URL to a file contained in the VNF package used to customize a
virtualised compute resource. The content shall comply with IETF RFC 3986.
        required: false
      destination_path:
        type: string
        description: The URL address when inject a file into the virtualised compute resource.
The content shall comply with IETF RFC 3986.
        required: false
```

6.2.58.4 Examples

See clause 6.8.3.8.

6.2.58.5 Additional Requirements

None.

6.2.59 tosca.datatypes.nfv.BootDataVimSpecificProperties

6.2.59.1 Description

The BootDataVimSpecificProperties data type describes the VIM related information used for selecting VIM specific capabilities when setting the boot data when setting the boot data. Table 6.2.59.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.59.1-1: Type name, shorthand, and URI

Shorthand Name	BootDataVimSpecificProperties
Type Qualified Name	toscanfv: BootDataVimSpecificProperties
Type URI	tosca.datatypes.nfv.BootDataVimSpecificProperties

6.2.59.2 Properties

The properties of the BootDataVimSpecificProperties data type shall comply with the provisions set out in table 6.2.59.2-1.

Table 6.2.59.2-1: Properties

Name	Required	Type	Constraints	Description
vim_type	no	string		Discriminator for the different types of the VIM information. The set of permitted values is expected to change over time as new types or versions of VIMs become available. The ETSI NFV registry of VIM-related information [i.16] provides access to information about various VIM types.
properties	yes	map of string		Properties used for selecting VIM specific capabilities when setting the boot data. For example, it can set whether config_drive functionality is selected in case VIM support it. This property is reserved for future use in the present document.

6.2.59.3 Definition

The syntax of the BootDataVimSpecificProperties data type shall comply with the following definition:

```
  tosca.datatypes.nfv.BootDataVimSpecificProperties:
    derived_from: tosca.datatypes.Root
    description: describes the VIM specific information used for selecting VIM specific
capabilities when setting the boot data.
    properties:
      vim_type:
        type: string
        description: Discriminator for the different types of the VIM information.
        required: true
      properties:
        type: map
        description: Properties used for selecting VIM specific capabilities when setting the
boot data
        entry_schema:
          type: string
        required: true
```

6.2.59.4 Examples

None.

6.2.59.5 Additional Requirements

None.

6.2.60 tosca.datatypes.nfv.VnfPackageChangeSelector

6.2.60.1 Description

The VnfPackageChangeSelector data type describes the source and destination VNFDs as well as source deployment flavour for a change current VNF Package. Table 6.2.60.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.60.1-1: Type name, shorthand, and URI

Shorthand Name	VnfPackageChangeSelector
Type Qualified Name	toscanfv: VnfPackageChangeSelector
Type URI	tosca.datatypes.nfv.VnfPackageChangeSelector

6.2.60.2 Properties

The properties of the VnfPackageChangeSelector data type shall comply with the provisions set out in table 6.2.60.2-1.

Table 6.2.60.2-1: Properties

Name	Required	Type	Constraints	Description
source_descriptor_id	yes	string		Identifier of the source VNFD and the source VNF package.
destination_descriptor_id	yes	string		Identifier of the destination VNFD and the destination VNF package.
source_flavour_id	yes	string		Identifier of the deployment flavour in the source VNF package for which this data type applies.

6.2.60.3 Definition

The syntax of the VnfPackageChangeSelector data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfPackageChangeSelector:
    derived_from: tosca.datatypes.Root
    description: data type describes the source and destination VNFDs as well as source
deployment flavour for a change current VNF Package.
    properties:
      source_descriptor_id:
        type: string
        description: Identifier of the source VNFD and the source VNF package.
        required: true
      destination_descriptor_id:
        type: string
        description: Identifier of the destination VNFD and the destination VNF package.
        required: true
      source_flavour_id:
        type: string
        description: Identifier of the deployment flavour in the source VNF package for which
this data type applies.
        required: true
```

6.2.60.4 Examples

See clause 6.10.15.5.

6.2.60.5 Additional Requirements

Either the source_descriptor_id or the destination_descriptor_id shall be equal to the vnfdId of the VNFD containing this version VnfPackageChangeSelector.

6.2.61 tosca.datatypes.nfv.VnfPackageChangeComponentMapping

6.2.61.1 Description

The VnfPackageChangeComponentMapping data type describes a mapping between the identifier of a components or property in the source VNFD and the identifier of the corresponding component or property in the destination VNFD. Table 6.2.61.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.61.1-1: Type name, shorthand, and URI

Shorthand Name	VnfPackageChangeComponentMapping
Type Qualified Name	toscanfv: VnfPackageChangeComponentMapping
Type URI	tosca.datatypes.nfv.VnfPackageChangeComponentMapping

6.2.61.2 Properties

The properties of the VnfPackageChangeComponentMapping data type shall comply with the provisions set out in table 6.2.61.2-1.

Table 6.2.61.2-1: Properties

Name	Required	Type	Constraints	Description
component_type	yes	string	Valid values: See YAML definition constraints	The type of component or property. Possible values differentiate whether changes concern to some VNF component (e.g. VDU, internal VLD, etc.) or property (e.g. a Scaling Aspect, etc.).
source_id	yes	string		Identifier of the component or property in the source VNFD.
destination_id	yes	string		Identifier of the component or property in the destination VNFD.
description	no	string		Human readable description of the component changes.

6.2.61.3 Definition

The syntax of the VnfPackageChangeComponentMapping data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfPackageChangeComponentMapping:
    derived_from: tosca.datatypes.Root
    description: A mapping between the identifier of a components or property in the source VNFD
and the identifier of the corresponding component or property in the destination VNFD.
    properties:
      component_type:
        type: string
        description: The type of component or property. Possible values differentiate whether
changes concern to some VNF component (e.g. VDU, internal VLD, etc.) or property (e.g. a Scaling
Aspect, etc.).
        constraints:
          - valid_values: [ vdu, cp, virtual_link, virtual_storage, deployment_flavour,
instantiation_level, scaling_aspect ]
        required: true
      source_id:
        type: string
        description: Identifier of the component or property in the source VNFD.
        required: true
      destination_id:
        type: string
        description: Identifier of the component or property in the destination VNFD.
        required: true
      description:
        type: string
        description: Human readable description of the component changes.
        required: false
```

6.2.61.4 Examples

See clause 6.10.15.5.

6.2.61.5 Additional Requirements

None.

6.2.62 tosca.datatypes.nfv.VnfChangeCurrentPackageOperation Configuration

6.2.62.1 Description

The VnfChangeCurrentPackageOperationConfiguration data type represents information that affect the invocation of the change current VNF Package operation, as specified in ETSI GS NFV-IFA 011 [1]. This data type definition is reserved for future use in the present document. Table 6.2.62.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.62.1-1: Type name, shorthand, and URI

Shorthand Name	VnfChangeCurrentPackageOperationConfiguration
Type Qualified Name	toscanfv:VnfChangeCurrentPackageOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration

6.2.62.2 Properties

None.

6.2.62.3 Definition

The syntax of the VnfChangeCurrentPackageOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the change current VNF
Package operation.
    # This data type definition is reserved for future use in the present document.
    # properties:
        # derived types are expected to introduce new properties, with their type derived from
tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration, with the same name as the
operation designated to the ChangeCurrentVnfPackage request
```

6.2.62.4 Examples

None.

6.2.62.5 Additional Requirements

None.

6.2.63 tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration

6.2.63.1 Description

The VnfCreateSnapshotOperationConfiguration data type represents information that affect the invocation of the CreateVnfSnapshot operation, as specified in ETSI GS NFV-IFA 011 [1]. This data type definition is reserved for future use in the present document. Table 6.2.63.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.63.1-1: Type name, shorthand, and URI

Shorthand Name	VnfCreateSnapshotOperationConfiguration
Type Qualified Name	toscanfv:VnfCreateSnapshotOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration

6.2.63.2 Properties

None.

6.2.63.3 Definition

The syntax of the VnfCreateSnapshotOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the CreateVnfSnapshot
operation
  # This data type definition is reserved for future use in the present document.
  # properties:
```

6.2.63.4 Examples

None.

6.2.63.5 Additional Requirements

None.

6.2.64 tosca.datatypes.nfv.VnfRevertToSnapshotOperationConfiguration

6.2.64.1 Description

The VnfRevertToSnapshotOperationConfiguration data type represents information that affect the invocation of the RevertToVnfSnapshot operation, as specified in ETSI GS NFV-IFA 011 [1]. This data type definition is reserved for future use in the present document. Table 6.2.64.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.64.1-1: Type name, shorthand, and URI

Shorthand Name	VnfRevertToSnapshotOperationConfiguration
Type Qualified Name	toscanfv:VnfRevertToSnapshotOperationConfiguration
Type URI	tosca.datatypes.nfv.VnfRevertToSnapshotOperationConfiguration

6.2.64.2 Properties

None.

6.2.64.3 Definition

The syntax of the VnfRevertToSnapshotOperationConfiguration data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfRevertToSnapshotOperationConfiguration:
    derived_from: tosca.datatypes.Root
    description: represents information that affect the invocation of the RevertToVnfSnapshot
operation
  # This data type definition is reserved for future use in the present document.
  # properties:
```

6.2.64.4 Examples

None.

6.2.64.5 Additional Requirements

None.

6.2.65 tosca.datatypes.nfv.VnfLcmOpCoord

6.2.65.1 Description

The VnfLcmOpCoord data type describes a set of information used for a coordination action in a VNF lifecycle management operation for a given VNF.

Table 6.2.65.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.65.1-1: Type name, shorthand, and URI

Shorthand Name	VnfLcmOpCoord
Type Qualified Name	toscanfv:VnfLcmOpCoord
Type URI	tosca.datatypes.nfv.VnfLcmOpCoord

6.2.65.2 Properties

The properties of the VnfLcmOpCoord data type shall comply with the provisions set out in table 6.2.65.2-1.

Table 6.2.65.2-1: Properties

Name	Required	Type	Constraints	Description
description	no	string		Human readable description of the coordination action.
endpoint_type	no	string	Valid values: mgmt, vnf	Specifies the type of the endpoint exposing the LCM operation coordination such as operations supporting management systems (e.g. EM) or the VNF instance. valid values: • mgmt: coordination with other operations supporting management systems • vnf: coordination with the VNF instance If the VNF produces the LCM coordination interface, this property may be omitted or may have the value "vnf". If this attribute is omitted, the type of endpoint that provides the interface is determined at deployment time. If the VNF does not produce the LCM coordination interface but coordination via this interface is needed, it is expected that a management entity such as the EM exposes the coordination interface, and consequently, this attribute shall be present and shall have the value "mgmt".

Name	Required	Type	Constraints	Description
coordination_stage	no	string	Valid values: start, end	Indicates whether the coordination action is invoked before or after all other changes performed by the VNF LCM operation. See note. Valid values: • start: the coordination action is invoked after receiving the grant and before the LCM operation performs any other changes. • end: the coordination action is invoked after the LCM operation has performed all other changes. coordination_stage property shall be omitted if the coordination action is intended to be invoked at an intermediate stage of the LCM operation, i.e. neither at the start nor at the end. In this case, the time at which to invoke the coordination during the execution of the LCM operation is determined by means outside the scope of the present document such as VNFM-internal logic or LCM script.
input_parameters	no	tosca.datatypes.nfv.InputOpCoordParams		Input parameters to be provided in the LCM coordination request.
output_parameters	no	tosca.datatypes.nfv.OutputOpCoordParams		Output parameters provided in the LCM coordination response.
NOTE: The changes mentioned include changes to the VNF instance, its resources or its snapshots.				

6.2.65.3 Definition

The syntax of the VnfLcmOpCoord data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfLcmOpCoord:
    derived_from: tosca.datatypes.Root
    description: describes a set of information used for a coordination action in a VNF lifecycle
management operation for a given VNF.
    properties:
      description:
        type: string
        description: Human readable description of the coordination action.
        required: false
      endpoint_type:
        type: string
        description: Specifies the type of the endpoint exposing the LCM operation coordination
such as other operations supporting or management systems (e.g. an EM) or the VNF instance. If the
VNF produces the LCM coordination interface, this property may be omitted or may have the value
"vnf". If this attribute is omitted, the type of endpoint that provides the interface is
determined at deployment time. If the VNF does not produce the LCM coordination interface but
coordination via this interface is needed, it is expected that a management entity such as the EM
exposes the coordination interface, and consequently, this attribute shall be present and shall
have the value "mgmt".
        required: false
        constraints:
          - valid_values: [ mgmt, vnf ]
      coordination_stage:
        type: string
        description: Indicates whether the coordination action is invoked before or after all
other changes performed by the VNF LCM operation. coordination_stage property shall be omitted if
the coordination action is intended to be invoked at an intermediate stage of the LCM operation,
i.e. neither at the start nor at the end. In this case, the time at which to invoke  the
coordination during the execution of  the LCM operation is determined by means outside the scope
of the present document such as VNFM-internal logic or LCM script.
        required: false
        constraints:
          - valid_values: [ start, end  ]
      input_parameters:
```

```
        type: tosca.datatypes.nfv.InputOpCoordParams
        description: Input parameters to be provided in the LCM coordination request.
        required: false
      output_parameters:
        type: tosca.datatypes.nfv.OutputOpCoordParams
        description: Output parameters provided in the LCM coordination response.
        required: false
```

6.2.65.4 Examples

See clause 6.10.15.

6.2.65.5 Additional Requirements

None.

6.2.66 tosca.datatypes.nfv.InputOpCoordParams

6.2.66.1 Description

The InputOpCoordParams data type is an empty base type for deriving data types for describing additional input operation coordination parameters for a given coordination action. Table 6.2.66.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.66.1-1: Type name, shorthand, and URI

Shorthand Name	InputOpCoordParams
Type Qualified Name	toscanfv:InputOpCoordParams
Type URI	tosca.datatypes.nfv.InputOpCoordParams

6.2.66.2 Properties

None.

6.2.66.3 Definition

The syntax of the InputOpCoordParams data type shall comply with the following definition:

```
  tosca.datatypes.nfv.InputOpCoordParams:
    derived_from: tosca.datatypes.Root
    description: is an empty base type for deriving data types for describing additional input
operation coordination parameters for a given coordination action
```

6.2.67 tosca.datatypes.nfv.OutputOpCoordParams

6.2.67.1 Description

The OutputOpCoordParams data type is an empty base type for deriving data types for describing additional Output operation coordination parameters for a given coordination action. Table 6.2.67.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.67.1-1: Type name, shorthand, and URI

Shorthand Name	OutputOpCoordParams
Type Qualified Name	toscanfv:OutputOpCoordParams
Type URI	tosca.datatypes.nfv.OutputOpCoordParams

6.2.67.2 Properties

None.

6.2.67.3 Definition

The syntax of the OutputOpCoordParams data type shall comply with the following definition:

```
  tosca.datatypes.nfv.OutputOpCoordParams:
    derived_from: tosca.datatypes.Root
    description: is an empty base type for deriving data types for describing additional Output
operation coordination parameters for a given coordination action
```

6.2.68 tosca.datatypes.nfv.MaxNumberOfImpactedInstances

6.2.68.1 Description

The MaxNumberOfImpactedInstances data type specifies the maximum number of instances of a given Vdu.Compute node or VnfVirtualLink node that may be impacted simultaneously without impacting the functionality of the group of a given size. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.68.1-1: Type name, shorthand, and URI

Shorthand Name	MaxNumberOfImpactedInstances
Type Qualified Name	toscanfv:MaxNumberOfImpactedInstances
Type URI	tosca.datatypes.nfv.MaxNumberOfImpactedInstances

6.2.68.2 Properties

The properties of the MaxNumberOfImpactedInstances data type shall comply with the provisions set out in table 6.2.68.2-1.

Table 6.2.68.2-1: Properties

Name	Required	Type	Constraints	Description
group_size	no	integer	greater_than: 0	Determines the size of the group for which the max_number_of_impacted_instances is specified. If not present the size is not limited. See notes 1 and 2.
max_number_of_impacted_instances	yes	integer	greater_than: 0	The maximum number of instances that can be impacted simultaneously within the group of the specified size. See notes 1 and 2.
NOTE 1: Each group_size value specified for a group of virtual resources shall be unique, and it shall be possible to form an ascending ordered list of group sizes. NOTE 2: The number of instances in the group for which the max_number_of_impacted_instances is specified may be equal to group_size or less. When the number of instances is less than group_size, it shall be at least 1 if this is the first group size in the ordered list of group sizes, or it shall be greater by at least 1 than the previous group size in the ordered list of group sizes.				

6.2.68.3 Definition

The syntax of the MaxNumberOfImpactedInstances data type shall comply with the following definition:

```
  tosca.datatypes.nfv.MaxNumberOfImpactedInstances:
    derived_from: tosca.datatypes.Root
    description: Specifies the maximum number of instances of a given Vdu.Compute node or
VnfVirtualLink node that may be impacted simultaneously without impacting the functionality of the
group of a given size.
    properties:
      group_size:
        type: integer
        description: Determines the size of the group for which the
max_number_of_impacted_instances is specified. If not present the size is not limited.
```

```
        required: false
        constraints:
          - greater_than: 0
      max_number_of_impacted_instances:
        type: integer
        description: The maximum number of instances that can be impacted simultaneously within
the group of the specified size.
        required: true
        constraints:
          - greater_than: 0
```

6.2.68.4 Examples

Node.

6.2.68.5 Additional Requirements

None.

6.2.69 tosca.datatypes.nfv.NfviMaintenanceInfo

6.2.69.1 Description

The NfviMaintenanceInfo data type provides information related to the constraints and rules applicable to virtualised resources and their groups impacted due to NFVI maintenance operations, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.2.69.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.69.1-1: Type name, shorthand, and URI

Shorthand Name	NfviMaintenanceInfo
Type Qualified Name	toscanfv:NfviMaintenanceInfo
Type URI	tosca.datatypes.nfv.NfviMaintenanceInfo

6.2.69.2 Properties

The properties of the NfviMaintenanceInfo data type shall comply with the provisions set out in table 6.2.69.2-1.

Table 6.2.69.2-1: Properties

Name	Required	Type	Constraints	Description
impact_notification_lead_time	yes	scalar-unit.time		Specifies the minimum notification lead time requested for upcoming impact of the virtualised resource or their group (i.e. between the notification and the action causing the impact).
is_impact_mitigation_requested	yes	boolean	default: false	Indicates whether it is requested that at the time of the notification of an upcoming change that is expected to have an impact on the VNF, virtualised resource(s) of the same characteristics as the impacted ones is/are provided to compensate for the impact (TRUE) or not (FALSE).
supported_migration_type	no	list of string	valid values: no_migration offline_migration live_migration	Specifies the allowed migration types in the order of preference in case of an impact starting with the most preferred type. It is applicable to the Vdu.Compute node and to the VirtualBlockStorage, VirtualObjectStorage and VirtualFileStorage nodes. See note 1.

Name	Required	Type	Constraints	Description
max_undetectable_interruption_time	no	scalar-unit.time		Specifies the maximum interruption time that can go undetected at the VNF level and therefore which will not trigger VNF-internal recovery during live migration. It is applicable to the Vdu.Compute node and to the VirtualBlockStorage, VirtualObjectStorage and VirtualFileStorage nodes. See note 1.
min_recovery_time_between_impacts	no	scalar-unit.time		Specifies the time required by the group to recover from an impact, thus, the minimum time requested between consecutive impacts of the group. See note 2.
max_number_of_impacted_instances	no	list of tosca.datatypes.nfv.MaxNumberOfImpactedInstances		Specifies for different group sizes the maximum number of instances that can be impacted simultaneously within the group of virtualised resources without losing functionality. See notes 2 and 3.
min_number_of_preserved_instances	no	list of tosca.datatype.nfv.MinNumberOfPreservedInstances		Specifies for different group sizes the minimum number of instances which need to be preserved simultaneously within the group of virtualised resources. See notes 2 and 3.

NOTE 1: When the max_undetectable_interruption_time is specified it constrains the live migration. If it cannot be guaranteed on an NFVI that the interruption caused by the live migration will be less than the indicated maximum undetectable interruption time, then life migration should be downgraded according to the order of preference.
NOTE 2: Impacts to instances of the group happening within the min_recovery_time_between_impacts are considered simultaneous impacts.
NOTE 3: Either "max_number_of_impacted_instances" or "min_number_of_preserved_instances" may be provided, but not both.

6.2.69.3 Definition

The syntax of the NfviMaintenanceInfo data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NfviMaintenanceInfo:
    derived_from: tosca.datatypes.Root
    description: Provides information related to the constraints and rules applicable to
virtualised resources and their groups impacted due to NFVI maintenance operations
    properties:
      impact_notification_lead_time:
        type: scalar-unit.time
        description: Specifies the minimum notification lead time requested for upcoming impact of
the virtualised resource or their group (i.e. between the notification and the action causing the
impact).
        required: true
      is_impact_mitigation_requested:
        type: boolean
        description: Indicates whether it is requested that at the time of the notification of an
upcoming change that is expected to have an impact on the VNF, virtualised resource(s) of the same
characteristics as the impacted ones is/are provided to compensate for the impact (TRUE) or not
(FALSE).
        required: true
        default: false
      supported_migration_type:
        type: list
        description: Specifies the allowed migration types in the order of preference in case of
an impact starting with the most preferred type. It is applicable to the Vdu.Compute node and to
the VirtualBlockStorage, VirtualObjectStorage and VirtualFileStorage nodes.
        required: false
        entry_schema:
          type: string
          constraints:
            - valid_values: [ no_migration, offline_migration, live_migration ]
      max_undetectable_interruption_time:
        type: scalar-unit.time
        description: Specifies the maximum interruption time that can go undetected at the VNF
level and therefore which will not trigger VNF-internal recovery during live migration. It is
applicable to the Vdu.Compute node and to the VirtualBlockStorage, VirtualObjectStorage and
VirtualFileStorage nodes.
```

```
        required: false
      min_recovery_time_between_impacts:
        type: scalar-unit.time
        description: Specifies the time required by the group to recover from an impact, thus, the
minimum time requested between consecutive impacts of the group..
        required: false
      max_number_of_impacted_instances:
        type: list
        description: Specifies for different group sizes the maximum number of instances that can
be impacted simultaneously within the group of virtualised resources without losing functionality.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.MaxNumberOfImpactedInstances
      min_number_of_preserved_instances:
        type: list
        description: Specifies for different group sizes the minimum number of instances which
need to be preserved simultaneously within the group of virtualised resources.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.MinNumberOfPreservedInstances
```

6.2.69.4 Examples

None.

6.2.69.5 Additional Requirements

None.

6.2.70 tosca.datatypes.nfv.MinNumberOPreservedInstances

6.2.70.1 Description

The MinNumberOfPreservedInstances data type specifies the minimum number of instances of a given Vdu.Compute node or VnfVirtualLink node which need to be preserved simultaneously. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.70.1-1: Type name, shorthand, and URI

Shorthand Name	MinNumberOfPreservedInstances
Type Qualified Name	toscanfv:MinNumberOfPreservedInstances
Type URI	tosca.datatypes.nfv.MinNumberOfPreservedInstances

6.2.70.2 Properties

The properties of the MinNumberOPreservedInstances data type shall comply with the provisions set out in table 6.2.70.2-1.

Table 6.2.70.2-1: Properties

Name	Required	Type	Constraints	Description
group_size	no	integer	greater_than: 0	Determines the size of the group for which the min_number_of_preserved_instances is specified. If not present the size is not limited. See notes 1 and 2.

Name	Required	Type	Constraints	Description
min_number_of_preserved_instances	yes	integer	greater_or_equal: 0	The minimum number of instances which need to be preserved simultaneously within the group of the specified size. See notes 1 and 2.
NOTE 1: Each group_size value specified for a group of virtual resources shall be unique, and it shall be possible to form an ascending ordered list of group sizes. NOTE 2: The number of instances in the group for which the min_number_of_preserved_instances is specified may be equal to group_size or less. When the number of instances is less than group_size.				

6.2.70.3 Definition

The syntax of the MinNumberOfPreservedInstances data type shall comply with the following definition:

```
  tosca.datatypes.nfv.MinNumberOfPreservedInstances:
    derived_from: tosca.datatypes.Root
    description: Specifies the minimum number of instances of a given Vdu.Compute node or
VnfVirtualLink node which need to be preserved simultaneously.
    properties:
      group_size:
        type: integer
        description: Determines the size of the group for which the
min_number_of_preserved_instances is specified. If not present the size is not limited.
        required: false
        constraints:
          - greater_than: 0
      min_number_of_preserved_instances:
        type: integer
        description: The minimum number of instances which need to be preserved simultaneously
within the group of the specified size.
        required: true
        constraints:
          - greater_than: 0
```

6.2.70.4 Examples

None.

6.2.70.5 Additional Requirements

None.

6.2.71 tosca.datatypes.nfv.VipCpLevel

6.2.71.1 Description

The VipCpLevel data type indicates for a given VipCp in a given level the number of instances to deploy. Table 6.2.71.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.71.1-1: Type name, shorthand, and URI

Shorthand Name	VipCpLevel
Type Qualified Name	toscanfv:VipCpLevel
Type URI	tosca.datatypes.nfv.VipCpLevel

6.2.71.2 Properties

The properties of the VipCpLevel data type shall comply with the provisions set out in table 6.2.71.2-1.

Table 6.2.71.2-1: Properties

Name	Required	Type	Constraints	Description
number_of_instances	yes	integer	greater_or_equal: 0	Number of instances of VipCp based on the referenced VipCp node template to deploy for an instantiation level or for a scaling delta.

6.2.71.3 Definition

The syntax of the VipCpLevel data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VipCpLevel:
    derived_from: tosca.datatypes.Root
    description: Indicates for a given VipCp in a given level the number of instances to deploy
    properties:
      number_of_instances:
        type: integer
        description: Number of instances of VipCp based on the referenced VipCp node template to
deploy for an instantiation level or for a scaling delta.
        required: true
        constraints:
          - greater_or_equal: 0
```

6.2.71.4 Examples

None.

6.2.71.5 Additional Requirements

None.

6.3 Artifact Types

6.3.1 tosca.artifacts.nfv.SwImage

6.3.1.1 Description

The SwImage artifact describes the software image which is directly loaded on the virtualisation container realizing of the VDU or is to be loaded on a virtual storage resource, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.3.1.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.3.1.1-1: Type name, shorthand, and URI

Shorthand Name	SwImage
Type Qualified Name	toscanfv:SwImage
Type URI	tosca.artifacts.nfv.SwImage

6.3.1.2 Properties

The properties of the SwImage artifacts type shall comply with the provisions set out in table 6.3.1.2-1.

Table 6.3.1.2-1: Properties

Name	Required	Type	Constraints	Description
name	yes	string		Name of this software image.
version	yes	string		Version of this software image.
provider	no	string		Provider of this software image.

Name	Required	Type	Constraints	Description
checksum	yes	tosca.datatypes.nfv.ChecksumData		Checksum of the software image file.
container_format	yes	string	Valid values: See YAML definition constraints	The container format describes the container file format in which software image is provided. Description of valid values: aki: a kernel image ami: a machine image ari: a ramdisk image bare: the image does not have a container or metadata envelope docker: docker container format ova: OVF package in a tarfile ovf: OVF container format Future versions of the present document may extend the list of possible values. See note 1.
disk_format	yes	string	Valid values: See YAML definition constraints	The disk format of a software image is the format of the underlying disk image. Description of valid values: aki: a kernel image ami: a machine image ari: a ramdisk image iso: an archive format for the data contents of an optical disc, such as CD-ROM qcow2: a common disk image format, which can expand dynamically and supports copy on write raw: an unstructured disk image format vdi: a common disk image format vhd: a common disk image format vhdx: enhanced version of VHD format vmdk: a common disk image format Future versions of the present document may extend the list of possible values. See note 2.
min_disk	yes	scalar-unit.size	greater_or_equal: 0 B	The minimal disk size requirement for this software image.
min_ram	no	scalar-unit.size	greater_or_equal: 0 B	The minimal RAM requirement for this software image.
size	yes	scalar-unit.size		The size of this software image.
operating_system	no	string		Identifies the operating system used in the software image.
supported_virtualisation_environments	no	list of string		Identifies the virtualisation environments (e.g. hypervisor) compatible with this software image.
NOTE 1: The list of permitted values was taken from "Container formats" in [i.12]. NOTE 2: The list of permitted values was adapted from "Disk formats" in [i.12].				

6.3.1.3 Description

```
  tosca.artifacts.nfv.SwImage:
    derived_from: tosca.artifacts.Deployment.Image
    description: describes the software image which is directly loaded on the virtualisation
container realizing of the VDU or is to be loaded on a virtual storage resource
    properties:
      name:
        type: string
        description: Name of this software image
        required: true
      version:
        type: string
        description: Version of this software image
        required: true
      provider:
        type: string
        description: Provider of this software image
        required: false
      checksum:
        type: tosca.datatypes.nfv.ChecksumData
        description:  Checksum of the software image file
        required: true
      container_format:
        type: string
        description: The container format describes the container file format in which software
image is provided
        required: true
        constraints:
          - valid_values: [ aki, ami, ari, bare, docker, ova, ovf ]
      disk_format:
        type: string
        description: The disk format of a software image is the format of the underlying disk
image
        required: true
        constraints:
          - valid_values: [ aki, ami, ari, iso, qcow2, raw, vdi, vhd, vhdx, vmdk ]
      min_disk:
        type: scalar-unit.size # Number
        description:  The minimal disk size requirement for this software image
        required: true
        constraints:
          - greater_or_equal: 0 B
      min_ram:
        type: scalar-unit.size # Number
        description: The minimal RAM requirement for this software image
        required: false
        constraints:
          - greater_or_equal: 0 B
      size:
        type: scalar-unit.size # Number
        description: The size of this software image
        required: true
      operating_system:
        type: string
        description: Identifies the operating system used in the software image
        required: false
      supported_virtualisation_environments:
        type: list
        description: Identifies the virtualisation environments (e.g. hypervisor) compatible with
this software image
        required: false
        entry_schema:
          type: string
```

6.3.2 tosca.artifacts.Implementation.nfv.Mistral

6.3.2.1 Description

This artifact type represents a Mistral file that contains Mistral language [i.7] constructs that can be executed within a Mistral workbook. Support of this type is optional.

Table 6.3.2.1-1: Type name, shorthand, and URI

Shorthand Name	Mistral
Type Qualified Name	toscanfv:Mistral
Type URI	tosca.artifacts.Implementation.nfv.Mistral
derived_from	tosca.artifacts.Implementation

6.3.2.2 Definition

The syntax of the Mistral artifact type shall comply with the following definition:

```
  tosca.artifacts.Implementation.nfv.Mistral:
    derived_from: tosca.artifacts.Implementation
    description: artifacts for Mistral workflows
    mime_type: application/x-yaml
    file_ext: [ yaml ]
```

6.4 Capability Types

6.4.1 tosca.capabilities.nfv.VirtualBindable

6.4.1.1 Description

The VirtualBindable capability indicates that the node that includes it can be pointed by a tosca.relationships.nfv.VirtualBindsTo relationship type which is used to model the VduHasCpd association illustrated in ETSI GS NFV-IFA 011 [1]. Table 6.4.1.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.4.1.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualBindable
Type Qualified Name	toscanfv:VirtualBindable
Type URI	tosca.capabilities.nfv.VirtualBindable

6.4.1.2 Properties

None.

6.4.1.3 Definition

The syntax of the VirtualBindable capability type shall comply with the following definition:

```
  tosca.capabilities.nfv.VirtualBindable:
    derived_from: tosca.capabilities.Node
    description: Indicates that the node that includes it can be pointed by a
tosca.relationships.nfv.VirtualBindsTo relationship type which is used to model the VduHasCpd
association
```

6.4.2 tosca.capabilities.nfv.VirtualLinkable

6.4.2.1 Description

The VirtualLinkable capability type is defined in clause 9.4.1 of the present document.

6.4.3 tosca.capabilities.nfv.VirtualCompute

6.4.3.1 Description

The VirtualCompute capability type describes the capabilities related to virtual compute resources, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.4.3.1-1 specifies the declared names for this capability type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.4.3.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualCompute
Type Qualified Name	toscanfv:VirtualCompute
Type URI	tosca.capabilities.nfv.VirtualCompute

6.4.3.2 Properties

The properties of the VirtualCompute capability type shall comply with the provisions set out in table 6.4.3.2-1.

Table 6.4.3.2-1: Properties

Name	Required	Type	Constraints	Description
logical_node	no	map of tosca.datatypes.nfv.LogicalNodeData		The Logical Node requirements.
request_additional_capabilities	no	map of tosca.datatypes.nfv.RequestedAdditionalCapability		Describes additional capability for a particular VDU.
compute_requirements	no	map of string		Describes compute requirements.
virtual_memory	yes	tosca.datatypes.nfv.VirtualMemory		Describes virtual memory of the virtualised compute.
virtual_cpu	yes	tosca.datatypes.nfv.VirtualCpu		Describes virtual CPU(s) of the virtualised compute.
virtual_local_storage	no	list of tosca.datatypes.nfv.VirtualBlockStorageData		A list of virtual system disks created and destroyed as part of the VM lifecycle.

6.4.3.3 Definition

The syntax of the VirtualCompute capability type shall comply with the following definition:

```
tosca.capabilities.nfv.VirtualCompute:
  derived_from: tosca.capabilities.Node
  description: Describes the capabilities related to virtual compute resources
  properties:
    logical_node:
      type: map
      description: Describes the Logical Node requirements
      required: false
      entry_schema:
        type: tosca.datatypes.nfv.LogicalNodeData
    requested_additional_capabilities:
      type: map
      description: Describes additional capability for a particular VDU
      required: false
      entry_schema:
        type: tosca.datatypes.nfv.RequestedAdditionalCapability
    compute_requirements:
      type: map
```

```
        required: false
        entry_schema:
          type: string
      virtual_memory:
        type: tosca.datatypes.nfv.VirtualMemory
        description: Describes virtual memory of the virtualised compute
        required: true
      virtual_cpu:
        type: tosca.datatypes.nfv.VirtualCpu
        description: Describes virtual CPU(s) of the virtualised compute
        required: true
      virtual_local_storage:
        type: list
        description: A list of virtual system disks created and destroyed as part of the VM
lifecycle
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.VirtualBlockStorageData
          description: virtual system disk definition
```

6.4.4 tosca.capabilities.nfv.VirtualStorage

6.4.4.1 Description

The VirtualStorage capability indicates that the node that includes it can be pointed by a tosca.relationships.nfv.AttachesTo relationship type which is used to model the VduHasVirtualStorageDesc association illustrated in ETSI GS NFV-IFA 011 [1]. Table 6.4.4.1-1 specifies the declared names for this capability type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.4.4.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualStorage
Type Qualified Name	toscanfv:VirtualStorage
Type URI	tosca.capabilities.nfv.VirtualStorage

6.4.4.2 Definition

The syntax of the VirtualStorage capability type shall comply with the following definition:

```
  tosca.capabilities.nfv.VirtualStorage:
    derived_from: tosca.capabilities.Root
    description: Describes the attachment capabilities related to Vdu.Storage
```

6.4.5 tosca.capabilities.nfv.TrunkBindable

6.4.5.1 Description

The TrunkBindable capability indicates that the VduCp node that includes it can be pointed by a tosca.relationships.nfv.TrunkBindsTo relationship type which is used to model the trunkPortTopology illustrated in ETSI GS NFV-IFA 011 [1]. Table 6.4.5.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.4.5.1-1: Type name, shorthand, and URI

Shorthand Name	TrunkBindable
Type Qualified Name	toscanfv:TrunkBindable
Type URI	tosca.capabilities.nfv.TrunkBindable

6.4.5.2 Properties

None.

6.4.5.3 Definition

The syntax of the TrunkBindable capability type shall comply with the following definition:

```
  tosca.capabilities.nfv.TrunkBindable:
    derived_from: tosca.capabilities.Node
    description: Indicates that the node that includes it can be pointed by a
tosca.relationships.nfv.TrunkBindsTo relationship type which is used to model the
trunkPortTopology.
```

6.5 Requirements Types

None.

6.6 Relationship Types

6.6.1 tosca.relationships.nfv.VirtualBindsTo

6.6.1.1 Description

This relationship type represents an association between Vdu.Compute and VduCp node types. Table 6.6.1.1-1 specifies the declared names for this relationship type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.6.1.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualBindsTo
Type Qualified Name	toscanfv:VirtualBindsTo
Type URI	tosca.relationships.nfv.VirtualBindsTo

6.6.1.2 Properties

None.

6.6.1.3 Definition

The syntax of the VirtualBindsTo relationship type shall comply with the following definition:

```
  tosca.relationships.nfv.VirtualBindsTo:
    derived_from: tosca.relationships.DependsOn
    description: Represents an association relationship between Vdu.Compute and VduCp node types
    valid_target_types: [ tosca.capabilities.nfv.VirtualBindable ]
```

6.6.2 tosca.relationships.nfv.VirtualLinksTo

6.6.2.1 Description

The VirtualLinksTo relationship type is defined in clause 9.6.1 of the present document representing an association relationship between a VduCp and a VnfVirtualLink node type or a VnfExtCp and a VnfVirtualLink node type.

6.6.3 tosca.relationships.nfv.AttachesTo

6.6.3.1 Description

This relationship type represents an association between the Vdu.Compute and one of the following node types: Vdu.VirtualBlockStorage, Vdu.VirtualObjectStorage or Vdu.VirtualFileStorage. Table 6.6.3.1-1 specifies the declared names for this relationship type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.6.3.1-1: Type name, shorthand, and URI

Shorthand Name	AttachesTo
Type Qualified Name	toscanfv:AttachesTo
Type URI	tosca.relationships.nfv.AttachesTo

6.6.3.2 Properties

None.

6.6.3.3 Definition

The syntax of the AttachesTo relationship type shall comply with the following definition:

```
  tosca.relationships.nfv.AttachesTo:
    derived_from: tosca.relationships.Root
    description: Represents an association relationship between the Vdu.Compute and one of the
node types, Vdu.VirtualBlockStorage, Vdu.VirtualObjectStorage or Vdu.VirtualFileStorage
    valid_target_types: [ tosca.capabilities.nfv.VirtualStorage ]
```

6.6.4 tosca.relationships.nfv.TrunkBindsTo

6.6.4.1 Description

This relationship type represents an association between a VduCp node used as a trunk port and other VduSubCp nodes used as subports of the same trunk. Table 6.6.4.1-1 specifies the declared names for this relationship type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.6.4.1-1: Type name, shorthand, and URI

Shorthand Name	TrunkBindsTo
Type Qualified Name	toscanfv: TrunkBindsTo
Type URI	tosca.relationships.nfv.TrunkBindsTo

6.6.4.2 Properties

None.

6.6.4.3 Definition

The syntax of the TrunkBindsTo relationship type shall comply with the following definition:

```
  tosca.relationships.nfv.TrunkBindsTo:
    derived_from: tosca.relationships.DependsOn
    description: Represents the association relationship between a VduCp node used as a trunk port
and other VduSubCp nodes used as subports of the same trunk.
    valid_target_types: [ tosca.capabilities.nfv.TrunkBindable ]
```

6.7 Interface Types

6.7.1 tosca.interfaces.nfv.Vnflcm

6.7.1.1 Description

The tosca.interfaces.nfv.Vnflcm contains a set of TOSCA operations corresponding to the following VNF LCM operations defined in ETSI GS NFV-IFA 007 [i.1]:

- Instantiate VNF
- Terminate VNF
- Modify VNF information
- Change VNF Flavour
- Change External VNF Connectivity
- Operate VNF
- Heal VNF
- Scale VNF
- Scale VNF To Level
- Create VNF Snapshot
- Revert to VNF Snapshot
- Change VNF current package

In addition, the VNFM shall also support TOSCA operations corresponding to preamble and postamble to the execution of the base operation. The name of these operations is constructed according to the following pattern:

- <base_operation_name>_start for a preamble
- <base_operation_name>_end for a postamble

The designations ("_start", "_end") in the name of TOSCA operations are postfixes so that related operations are adjacent in an alphabetical listing.

The tosca.interfaces.nfv.Vnflcm also contains a set of TOSCA notifications corresponding to the following VNF LCM operations defined in ETSI GS NFV-IFA 007 [i.1]:

- Change VNF current package

In addition, the VNFM shall also support TOSCA notifications corresponding to preamble and postamble to the base notification. The name of these notifications is constructed according to the following pattern:

- <base_notification_name>_start for a preamble
- <base_notification_name>_end for a postamble

Table 6.7.1.1-1 specifies the declared names for this interface type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.7.1.1-1: Type name, shorthand, and URI

Shorthand Name	Vnflcm
Type Qualified Name	toscanfv:Vnflcm
Type URI	tosca.interfaces.nfv.Vnflcm

6.7.1.2 Definition

The syntax of the Vnflcm interface type shall comply with the following definition:

```
  tosca.interfaces.nfv.Vnflcm:
    derived_from: tosca.interfaces.Root
    description: This interface encompasses a set of TOSCA operations corresponding to the VNF LCM
operations defined in ETSI GS NFV-IFA 007 as well as to preamble and postamble procedures to the
execution of the VNF LCM operations.
    operations:
      instantiate:
        description: Invoked upon receipt of an Instantiate VNF request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
           # derived types are expected to introduce additional_parameters with its
           # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
      instantiate_start:
        description: Invoked before instantiate
      instantiate_end:
        description: Invoked after instantiate
      terminate:
        description: Invoked upon receipt Terminate VNF request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
           # derived types are expected to introduce additional_parameters with its
           # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
      terminate_start:
        description: Invoked before terminate
      terminate_end:
        description: Invoked after terminate
      modify_information:
        description: Invoked upon receipt of a Modify VNF Information request
      modify_information_start:
        description: Invoked before modify_information
      modify_information_end:
        description: Invoked after modify_information
      change_flavour:
        description: Invoked upon receipt of a Change VNF Flavour request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
           # derived types are expected to introduce additional_parameters with its
           # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
      change_flavour_start:
        description: Invoked before change_flavour
      change_flavour_end:
        description: Invoked after change_flavour
      change_external_connectivity:
        description: Invoked upon receipt of a Change External VNF Connectivity  request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
           # derived types are expected to introduce additional_parameters with its
           # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
      change_external_connectivity_start:
        description: Invoked before change_external_connectivity
      change_external_connectivity_end:
        description: Invoked after change_external_connectivity
      operate:
        description: Invoked upon receipt of an Operate VNF request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
           # derived types are expected to introduce additional_parameters with its
           # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
      operate_start:
        description: Invoked before operate
      operate_end:
        description: Invoked after operate
      heal:
        description: Invoked upon receipt of a Heal VNF request
```

```
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
            # derived types are expected to introduce additional_parameters with its
            # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
          cause:
            type: string
            description: Indicates the reason why a healing procedure is required.
            required: false
          vnfc_instance_ids:
            type: list
            entry_schema:
              type: string
            description: List of VNFC instances requiring a healing action.
            required: false
      heal_start:
        description: Invoked before heal
      heal_end:
        description: Invoked after heal
      scale:
        description: Invoked upon receipt of a Scale VNF request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
            # derived types are expected to introduce additional_parameters with its
            # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
          type:
            type: string
            description: Indicates the type of the scale operation requested.
            required: false
            constraints:
              - valid_values: [ scale_out, scale_in ]
          aspect:
            type: string
            description: Identifier of the scaling aspect.
            required: false
          number_of_steps:
            type: integer
            description: Number of scaling steps to be executed.
            required: true
            constraints:
              - greater_than: 0
            default: 1
      scale_start:
        description: Invoked before scale
      scale_end:
        description: Invoked after scale
      scale_to_level:
        description: Invoked upon receipt of a Scale VNF to Level request
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
            required: false
            # derived types are expected to introduce additional_parameters with its
            # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
          instantiation_level:
            type: string
            description: Identifier of the target instantiation level of the current deployment
flavour to which the VNF is requested to be scaled. Either instantiation_level or scale_info shall
be provided.
            required: false
          scale_info:
            type: map # key: aspectId
            description: For each scaling aspect of the current deployment flavour, indicates the
target scale level to which the VNF is to be scaled. Either instantiation_level or scale_info
shall be provided.
            required: false
            entry_schema:
              type: tosca.datatypes.nfv.ScaleInfo
      scale_to_level_start:
        description: Invoked before scale_to_level
      scale_to_level_end:
        description: Invoked after scale_to_level
      create_snapshot:
        description: Invoked upon receipt of a Create VNF snapshot request
        inputs:
```

```
        additional_parameters:
          type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
          required: false
          # derived types are expected to introduce additional_parameters with its
          # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
    create_snapshot_start:
      description: Invoked before create_snapshot
    create_snapshot_end:
      description: Invoked after create_snapshot
    revert_to_snapshot:
      description: Invoked upon receipt of a Revert to VNF snapshot request
      inputs:
        additional_parameters:
          type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
          required: false
          # derived types are expected to introduce additional_parameters with its
          # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
    revert_to_snapshot_start:
      description: Invoked before revert_to_snapshot
    revert_to_snapshot_end:
      description: Invoked after revert_to_snapshot
    change_current_package:
      description: Invoked by tosca.policies.nfv.VnfPackageChange
      inputs:
        additional_parameters:
          type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
          required: false
          # derived types are expected to introduce additional_parameters with its
          # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
    change_current_package_start:
      description: Invoked by tosca.policies.nfv.VnfPackageChange
    change_current_package_end:
      description: Invoked by tosca.policies.nfv.VnfPackageChange
  notifications:
    change_current_package_notification:
      description: Invoked upon receipt of a ChangeCurrentVnfPackage request
    change_current_package_start_notification:
      description: Invoked before the operation designated to changing the current VNF package
    change_current_package_end_notification:
      description: Invoked after the operation designated to changing the current VNF package
```

6.7.1.3 Additional Requirements

All VNF supported LCM operations shall be listed in the service template, except "instantiate" and "terminate" that may be omitted, as specified in ETSI GS NFV-IFA 011 [1] for the supportedOperation attribute of a deployment flavour.

The implementation and inputs keynames specified in TOSCA-Simple-Profile-YAML-v1.3 [20] for an operation definition may be included for each operation listed in the Vnflcm interface definition.

If a TOSCA operation representing a VNF LCM operation is listed in the service template without an associated implementation, then it means that:

- the VNF LCM operation is supported (i.e. this is the manifestation of the supportedOperation attribute as per ETSI GS NFV-IFA 011 [1]); and
- the processing logic associated with the LCM operation is the default implementation provided by the VNFM.

If an implementation is associated to a TOSCA operation that represents a preamble or a postamble to a VNF LCM operation, the implementation logic is executed before or after the execution of the VNF LCM operation implementation, respectively.

The VNFM shall make available all parameters from the message invoking the VNF LCM operation as inputs to the corresponding TOSCA interface operations.

In the operation definitions on the Vnflcm interface, the additional_parameters (VNF-specific extension of the tosca.datatypes.nfv.VnfOperationAdditionalParameters) of the inputs section describes the name and type of the additional parameters (additionalParams) that can be submitted in the VNF LCM operation request. See an example in clause 6.2.43 (tosca.datatypes.nfv.VnfOperationAdditionalParameters).

The inputs keyname can also be used to specify additional input parameters for executing the TOSCA operation, beyond those received in the VNF LCM operation request. To distinguish them from the latter ones, such input parameters shall not be named "additional_parameters".

The implementation of the operation corresponding to preamble and postamble TOSCA operations (instantiate_start, instantiate_end, scale_start, scale_end, etc.), if present, shall be invoked with the same parameters as the corresponding base operations ones (instantiate, scale, etc.). The inputs of the operations corresponding to the postamble and preamble operations shall not be defined in the VNFD.

Starting with version 3.3.1 of the present document, the Vnflcm interface type definition grammar was changed to support notifications and operations. For backward compatibility, TOSCA-Simple-Profile-YAML-v1.3 [20], clause 3.7.5.5 specifies the provisions for handling the previous grammar. Support of the Release 2 Vnflcm interface type definition grammar can be removed in subsequent versions of the present document.

6.7.1.4 Support of LCM scripts

In ETSI GS NFV-IFA 011 [1], the definition of the "LifeCycleManagementScript" information element of the VNFD associates scripts with events, where an event can be an external or an internal stimulus. These events are mapped to TOSCA operations of the VNF node type in the following way:

- external stimuli are mapped to TOSCA operations corresponding to the VNF LCM operations defined in ETSI GS NFV-IFA 007 [i.1];
- internal stimuli are mapped to preamble and postamble of these TOSCA operations;
- events that cannot be mapped to these TOSCA operations (lcmTransitionEvent as described in ETSI GS NFV-IFA 011 [1], clause 7.1.13) can be mapped to further TOSCA operations by extending the TOSCA interface.

The LCM scripts can be regarded as artifacts that provide a VNF-specific implementation of the TOSCA operation corresponding to the stimulus. The script input parameters shall be provided to the script according to the declaration in the inputs field of the operation definition. The artifact type definition shall enable identifying the DSL used by the script. The artifact type definition for Python is provided in section 5.4.4.1 of TOSCA-Simple-Profile-YAML-v1.3 [20]. The artifact definition for Mistral is provided in clause 6.3.2 of the present document.

NOTE: As all input parameters needed for operations corresponding to external and internal stimuli are defined in the "input parameters of the external stimuli operations", the VNF Designer is expected to make the list of parameters as complete as needed to handle not only the external stimuli but also the internal stimuli.

6.7.1.5 Examples

The following example template fragments illustrate the concepts.

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
 - ..

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
  ..

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
  ..

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
   ..
      interfaces:
        Vnflcm:
          operations:
            instantiate: {}
     ..
```

In the above example, as there is no implementation and inputs specified to the operations, the built-in implementation of the operation is invoked when the Instantiate VNF request is received on the LCM interface of the Or-Vnfm reference point. The received parameters (flavourId, instantiationLevelId, etc.) are passed to the built-in implementation (as flavour_id, instantiation_level_id).

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
 - ..

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
 ..

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
  ..

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
   ..
      interfaces:
        Vnflcm:
          operations:
            instantiate:
              implementation: instantiate-script
      ..
```

In the above example, the instantiate-script is invoked when the Instantiate VNF request is received, passing the received parameters to it similarly to the previous example. This example does not imply a one-to-one mapping between operations and script names.

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
 - ..

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
  ..

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
  ..

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
   ..
      interfaces:
        Vnflcm:
          operations:
    ..
            scale_start: pre-scale-script
            scale_end: post-scale-script
    ..
```

In the above example, LCM scripts are associated with the "scale start" and "scale end" internal stimuli. As no script is associated to the `scale` operation, its default implementation runs (after running the `pre-scale-script`, and before running the `post-scale-script`).

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
 - ..

node_types:
  MyCompany.SunshineDB.1_0.1_0:
```

```
    derived_from: tosca.nodes.nfv.VNF
  ..

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
  ..

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
   ..
      interfaces:
        Vnflcm:
          operations:
            instantiate:
              implementation: instantiate-script
                inputs:
                  script_input_1: value_1
                  script_input_2: value_2

      artifacts:
        instantiate-script:
        description: Instantiate workflow script
        type: tosca.artifacts.Implementation.Python
        file: instantiate.py
        #repository: ..
        #deploy_path: ..
    ..
```

In the above example:

- The inputs section provides additional input values to the instantiate-script (i.e. the manifestation of the scriptInput attribute of LifeCycleManagementScript as defined in ETSI GS NFV-IFA 011 [1]).

NOTE: There is another kind of input called `additional_parameters` dedicated to the additional parameters (additionalParams) received in the message invoking the VNF LCM operation; this input is not illustrated by the above examples; see clause 6.2.43.4 on how to declare `additional_parameters` in the derived VNF node type.

- TOSCA artifacts definition is used to convey the type of DSL used as a scripting language that is associated with an operation (i.e. the manifestation of the scriptDsl attribute of LifeCycleManagementScript as per ETSI GS NFV-IFA 011 [1]).

6.7.2 tosca.interfaces.nfv.VnfIndicator

6.7.2.1 Description

The tosca.interfaces.nfv.VnfIndictor is an empty base interface type for deriving VNF specific interface types that include VNF indicator specific notifications.

Table 6.7.2.1-1 specifies the declared names for this interface type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.7.2.1-1: Type name, shorthand, and URI

Shorthand Name	VnfIndicator
Type Qualified Name	toscanfv:VnfIndicator
Type URI	tosca.interfaces.nfv.VnfIndicator

6.7.2.2 Definition

The syntax of the VnfIndicator interface type shall comply with the following definition:

```
  tosca.interfaces.nfv.VnfIndicator:
    derived_from: tosca.interfaces.Root
```

```
    description: This interface is an empty base interface type for deriving VNF specific
interface types that include VNF indicator specific notifications.
```

6.7.2.3 Examples

See clause 6.8.1.9.

6.7.3 tosca.interfaces.nfv.ChangeCurrentVnfPackage

6.7.3.1 Description

The tosca.interfaces.nfv.ChangeCurrentVnfPackage is an empty base interface type for deriving VNF specific interface types that include VNF Change Current VNF Package specific operation.

Table 6.7.3.1-1 specifies the declared names for this interface type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.7.3.1-1: Type name, shorthand, and URI

Shorthand Name	ChangeCurrentVnfPackage
Type Qualified Name	toscanfv:ChangeCurrentVnfPackage
Type URI	tosca.interfaces.nfv.ChangeCurrentVnfPackage

6.7.3.2 Definition

The syntax of the ChangeCurrentVnfPackage interface type shall comply with the following definition:

```
  tosca.interfaces.nfv.ChangeCurrentVnfPackage:
    derived_from: tosca.interfaces.Root
    description: This interface is an empty base interface type for deriving VNF specific
interface types that include VNF Change Current VNF Package specific operation.
  # operations:
      # operation_name: name of a VNF-specific operation serving the Change current VNF Package
request.
        # description: Invoked by tosca.policies.nfv.VnfPackageChange
        # inputs:
          # additional_parameters:
          #   type: tosca.datatypes.nfv.VnfOperationAdditionalParameters
          #   required: false
      # derived types are expected to introduce additional_parameters with its
      # type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters
```

6.7.3.3 Examples

See clause 6.10.15.5.

6.8 Node Types

6.8.1 tosca.nodes.nfv.VNF

6.8.1.1 Description

The VNF node type is the generic abstract type from which all VNF specific node types shall be derived to form, together with other node types, the TOSCA service template(s) representing the VNFD information element as defined in ETSI GS NFV-IFA 011 [1]. Table 6.8.1.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.1.1-1: Type name, shorthand, and URI

Shorthand Name	VNF
Type Qualified Name	toscanfv:VNF
Type URI	tosca.nodes.nfv.VNF

6.8.1.2 Properties

The properties of the VNF node type shall comply with the provisions set out in table 6.8.1.2-1.

Table 6.8.1.2-1: Properties

Name	Required	Type	Constraints	Description
descriptor_id	yes	string		Identifier of this VNFD information element. This attribute shall be globally unique. See note 3. The VNFD Identifier shall be used as the unique identifier of the VNF Package that contains this VNFD. Any modification of the content of the VNFD or the VNF Package shall result in a new VNFD Identifier.
descriptor_version	yes	string		Identifies the version of the VNFD.
provider	yes	string		Provider of the VNF and of the VNFD.
product_name	yes	string		Name to identify the VNF Product. Invariant for the VNF Product lifetime.
software_version	yes	string		Software version of the VNF. This is changed when there is any change to the software that is included in the VNF Package.
product_info_name	no	string		Human readable name for the VNF Product. Can change during the VNF Product lifetime.
product_info_description	no	string		Human readable description of the VNF Product. Can change during the VNF Product lifetime.
vnfm_info	yes	list of string		Identifies VNFM(s) compatible with the VNF described in this version of the VNFD. To indicate that a VNF can be managed by any ETSI NFV compliant VNFM, the string value shall be the concatenation of the string "etsivnfm" and the minimum version of ETSI GS NFV-SOL 002 [22] to be supported by this VNFM (e.g. etsivnfm:v2.3.1). If the VNF is compatible with multiple versions, multiple values may be included. See note 1. To indicate a specific VNFM product, the string value shall be the concatenation of the IANA enterprise number of the VNFM provider [5], followed by a product-specific string.
localization_languages	no	list of string	Valid values: string values that comply with IETF RFC 5646 [13]	Information about localization languages of the VNF (includes e.g. strings in the VNFD). This allows to provide one or more localization languages to support selecting a specific localization language at VNF instantiation time.

Name	Required	Type	Constraints	Description
default_localization_language	no	string	Valid values: string values that comply with IETF RFC 5646 [13]	Default localization language that is instantiated if no information about selected localization language is available. Shall be present if "localizationLanguage" is present and shall be absent otherwise.
configurable_properties	no	tosca.datatypes.nfv.VnfConfigurableProperties		Describes the configurable properties of the VNF (e.g. related to auto scaling and auto healing).
modifiable_attributes	no	tosca.datatypes.nfv.VnfInfoModifiableAttributes		Describes the modifiable attributes of the VNF.
lcm_operations_configuration	no	tosca.datatypes.nfv.VnfLcmOperationsConfiguration		Describes the configuration parameters for the VNF LCM operations.
monitoring_parameters	no	map of tosca.datatypes.nfv.VnfMonitoringParameter		Describes monitoring parameters applicable to the VNF. See note 4.
flavour_id	yes	string		Identifier of this DF within the VNFD.
flavour_description	yes	string		Human readable description of the DF.
vnf_profile	no	tosca.datatypes.nfv.VnfProfile		Describes a profile for instantiating VNFs of a particular NS DF according to a specific VNFD and VNF DF. See note 2.

NOTE 1: When LCM scripts are used, the support of this minimum version might not be sufficient to ensure that the VNF can be managed by a VNFM. The support of the domain specific language(s) used by these LCM scripts is another criterion for determining the compatibility of the VNF with a VNFM.
NOTE 2: This property is only used in an NSD service template when describing a VNF node template with the corresponding VnfProfile information.
NOTE 3: The value of the descriptor_id string shall comply with an UUID format as specified in section 3 of [9].
NOTE 4: This property is only used in a VNFD service template when describing a VNF node template with the corresponding monitoring information.

The syntax of the vnfm_info string values shall comply with the following ABNF [6] snippet:

```
value = any_etsi_nfv_compliant_product| product_specific

any_etsi_nfv_compliant_product = "etsivnfm" SEP "version"

version = "v" version_identifier
version_identifier = 1*2DIGIT DOT 1*2DIGIT DOT 1*2DIGIT
; the version identifier is encoded as a sequence of items of 1 or 2 digits separated by dots
representing the 3 fields (major, technical and editorial) of the version of an ETSI deliverable.

product_specific = enterprise_number SEP product_specific_string
enterprise_number = 1*DIGIT
product_specific_string = *(ALPHA / DIGIT / "-" / ".")

SEP = ":"
DOT = "."
```

This implies that vnfm_info string values shall also comply with the pattern defined by the following regular expression [15]: `(^etsivnfm:v[0-9]?[0-9]\.[0-9]?[0-9]\.[0-9]?[0-9]$)|(^[0-9]+:[a-zA-Z0-9.-]+$)`

6.8.1.3 Attributes

The attribute of the VNF node type shall comply with the provisions set out in table 6.8.1.3-1.

Table 6.8.1.3-1: Attributes

Name	Required	Type	Constraints	Description
scale_status	no	map of tosca.datatypes.nfv.ScaleInfo		Scale status of the VNF, one entry per aspect. Represents for every scaling aspect how "big" the VNF has been scaled w.r.t. that aspect.

If the VNF supports VNF indicators, the VNF node type definition shall include one TOSCA attribute of a primitive type for each supported VNF indicator.

NOTE 1: In this version of the present document, the type of VNF indicators is constrained to primitive types. This is due to the limitations in the TOSCA-Simple-Profile-YAML-v1.3 [20] to define conditions on attributes of complex types.

If the scale_status attribute is used in a VNF indicator policy, e.g. an auto-scale policy, the VNF specific node type definitions may include additional attribute definitions of type integer, one for each scaling aspect. See example in clause A.15.

NOTE 2: As the scale_status attribute is complex, the scale_level property of the individual scaling aspects can be retrieved by passing a path to the get_attribute function: { get_attribute: [SELF, scale_status, {scaling_aspect}, scale_level] }. If the value of the scale_level property is needed in a constraint (tosca.policies.nfv.VnfIndicator), then the value can be retrieved in an indirect way by accessing the aforementioned additional attributes. This is due to the limitation mentioned in the previous note.

VNF indicators may be defined in the VNFD to allow for the asynchronous notification of VNF specific information to the VNFM.

An attribute defined in the VNF node type for a VNF indicator holds the value for that indicator during the lifecycle of the VNF. A notification defined in the derived interface for VNF indicators (see clause 6.7.2) produces an output value which is assigned to the attribute, as per TOSCA-Simple-Profile-YAML-v1.3 [20] syntax. Examples of such assignments are shown in clause 6.8.1.9. Thus, the value of the VNF indicator may change every time a notification is received.

6.8.1.4 Requirements

The requirements of the VNF node type shall comply with the provisions set out in table 6.8.1.4-1.

Table 6.8.1.4-1: Requirements

Name	Required	Capability type	Constraints	Description
virtual_link	no	tosca.capabilities.nfv.VirtualLinkable		Describes the requirements for linking to virtual link

6.8.1.5 Capabilities

None.

6.8.1.6 Definition

The syntax of the VNF node type shall comply with the following definition:

```
  tosca.nodes.nfv.VNF:
    derived_from: tosca.nodes.Root
    description: The generic abstract type from which all VNF specific node types shall be derived
to form, together with other node types, the TOSCA service template(s) representing the VNFD
    properties:
      descriptor_id: # instead of vnfd_id
        type: string # UUID
        description: Identifier of this VNFD information element. This attribute shall be globally
unique
        required: true
      descriptor_version: # instead of vnfd_version
        type: string
```

```
        description: Identifies the version of the VNFD
        required: true
      provider: # instead of vnf_provider
        type: string
        description: Provider of the VNF and of the VNFD
        required: true
      product_name: # instead of vnf_product_name
        type: string
        description: Human readable name for the VNF Product
        required: true
      software_version: # instead of vnf_software_version
        type: string
        description: Software version of the VNF
        required: true
      product_info_name: # instead of vnf_product_info_name
        type: string
        description: Human readable name for the VNF Product
        required: false
      product_info_description: # instead of vnf_product_info_description
        type: string
        description: Human readable description of the VNF Product
        required: false
      vnfm_info:
        type: list
        required: true
        description: Identifies VNFM(s) compatible with the VNF
        entry_schema:
          type: string
          constraints:
            - pattern: (^etsivnfm:v[0-9]?[0-9]\.[0-9]?[0-9]\.[0-9]?[0-9]$)|(^[0-9]+:[a-zA-Z0-9.-
]+$)
      localization_languages:
        type: list
        description: Information about localization languages of the VNF
        required: false
        entry_schema:
          type: string #IETF RFC 5646 string
      default_localization_language:
        type: string #IETF RFC 5646 string
        description: Default localization language that is instantiated if no information about
selected localization language is available
        required: false
      configurable_properties:
        type: tosca.datatypes.nfv.VnfConfigurableProperties
        description: Describes the configurable properties of the VNF
        required: false
      # derived types are expected to introduce configurable_properties
      # with its type derived from tosca.datatypes.nfv.VnfConfigurableProperties
      modifiable_attributes:
        type: tosca.datatypes.nfv.VnfInfoModifiableAttributes
        description: Describes the modifiable attributes of the VNF
        required: false
      # derived types are expected to introduce modifiable_attributes
      # with its type derived from
      # tosca.datatypes.nfv.VnfInfoModifiableAttributes
      lcm_operations_configuration:
        type: tosca.datatypes.nfv.VnfLcmOperationsConfiguration
        description: Describes the configuration parameters for the VNF LCM operations
        required: false
      monitoring_parameters:
        type: map # key: id
        entry_schema:
          type: tosca.datatypes.nfv.VnfMonitoringParameter
        description: Describes monitoring parameters applicable to the VNF.
        required: false
      flavour_id:
        type: string
        description: Identifier of the Deployment Flavour within the VNFD
        required: true
      flavour_description:
        type: string
        description: Human readable description of the DF
        required: true
      vnf_profile:
        type: tosca.datatypes.nfv.VnfProfile
        description: Describes a profile for instantiating VNFs of a particular NS DF according to
a specific VNFD and VNF DF
        required: false
```

```
    attributes:
      scale_status:
        type: map # key: aspectId
        description: Scale status of the VNF, one entry per aspect. Represents for every scaling
aspect how "big" the VNF has been scaled w.r.t. that aspect.
        entry_schema:
          type: tosca.datatypes.nfv.ScaleInfo
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
 # Additional requirements shall be defined in the VNF specific node type (deriving from
tosca.nodes.nfv.VNF) corresponding to NS virtual links that need to connect to VnfExtCps
    interfaces:
      Vnflcm:
        type: tosca.interfaces.nfv.Vnflcm
      VnfIndicator:
        type: tosca.interfaces.nfv.VnfIndicator
      # derived types are expected to introduce Vnf Indicator interfaces
      # with their type derived from tosca.interfaces.nfv.VnfIndicator
```

6.8.1.7 Artifact

None.

6.8.1.8 Additional Requirements

For a given VNFD, a new VNF node type shall be defined following the below requirements:

a) The node type shall be derived from: tosca.nodes.nfv.VNF.

b) The following properties listed in tosca.nodes.nfv.VNF where the "required:" field is set to "true" shall be included with their values indicated as constraints and as default values or assigned as final fixed values if only one value is permitted (see clause 6.8.1.9 for an example):

   1) descriptor_id

   2) descriptor_version

   3) provider

   4) product_name

   5) software_version

   6) vnfm_info

   7) flavour_id

NOTE 1: Indicating their values as default or assigning them a fixed value allows not to include them in property assignments in node templates, e.g. in the NSD.

NOTE 2: Assignment of a fixed value to the flavour_id property is not applicable if multiple deployment flavours exist.

c) An empty string shall be indicated as the default value of the flavour_description property, without providing constraints.

d) The capabilities, requirements, interfaces of tosca.nodes.nfv.VNF shall be preserved.

e) Depending on the number of external connection points of the VNF that need to connect to NS virtual links, additional requirements for VirtualLinkable capability shall be defined with the occurrences set to [0, 1]. In this case, it is the VNFD author's choice to use the requirement for VirtualLinkable capability defined in the tosca.nodes.nfv.VNF node type or use only the additional requirements defined in the derived VNF specific node type. In the latter case, the virtual_link requirement should be included in the node type definition with occurrences [0, 0].

If the external connection point exposes a VipCp, a new requirement for VirtualLinkableCapability using the VipVirtualLinksTo relationship shall be defined for this connection point.

f) The rule for naming this node type in the service template should be:

- provider.product_name.software_version.descriptor_version, by concatenating the values of the corresponding properties of the created VNF node type.

NOTE 2: If the software_version value or descriptor_version value contains a dot (i.e. "."), this character should be replaced with an underscore (i.e. "_").

g) If the VNF supports VNF indicators, the VNF node type definition shall include an interface definition of a VNF specific interface type indicating the mapping of notification outputs to the VNF node attributes and, optionally, tosca.policies.nfv.VnfIndicator policies that may invoke auto-scale or auto-heal operations. For each of the VNF indicators, the name of the notification output shall be the same as the name of the corresponding VNF attribute.

NOTE 3: The notifications keyname in TOSCA interface is defined in TOSCA-Simple-Profile-YAML-v1.3 [20].

h) If "additionalParams" are expected in the Change current VNF Package request on the API (NFV-SOL 003 or NFV-SOL 002), then they shall be defined as "additional_parameters" inputs of the change_current_package operation on the Vnflcm interface (in case the same LCM script with the same set of "additionalParams" is suitable for all change paths) or the VNF-specific operations on the ChangeCurrentVnfPackage interface (in case different change paths require different LCM scripts potentially with different sets of "additionalParams").

VNF Providers shall use the following types to derive the VNF specific modifiable attributes and additional configurable properties:

- tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions.
- tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata.
- tosca.datatypes.nfv.VnfAdditionalConfigurableProperties.
- tosca.datatypes.nfv.VnfInfoModifiableAttributes.
- tosca.datatypes.nfv.VnfConfigurableProperties.

See illustrative examples in clauses 6.8.1.9, 6.2.35.4 and 6.2.31.4.

In the derived VNF node type, the modifiable_attributes and configurable_properties (VNF-specific extension of the tosca.datatypes.nfv.VnfInfoModifiableAttributes and tosca.datatypes.nfv.VnfConfigurableProperties, respectively, by extending the above listed types) describe the name and type of the modifiable attributes (extensions and metadata) and configurable properties (vnfConfigurableProperties).

The modifiable_attributes and configurable_properties information provided in the node type is sufficient for the client of the VNF LCM API for providing values to these properties. A value provided via the VNF LCM API to such a property overrides the value (if any) assigned in the node template or defined as default value in the node type definition.

Node templates of the VNF specific node type shall not include the vnf_profile property when they are part of a VNFD service template.

For a given NSD, when describing a referenced VNFD as a node templates, the vnf_profile property shall be included with a valid value.

For a given NSD, when describing a referenced VNFD as a node templates, the monitoring_parameters property shall not be included.

6.8.1.9 Example

Example usage of modifiable_attributes:

```
tosca_definitions_version: tosca_simple_yaml_1_3
```

```
node_types:
 MyCompany.SunshineDB.1_0.1_0:
  derived_from: tosca.nodes.nfv.VNF
  properties:
   flavour_id:
    constraints:
     - valid_values: [ simple, complex ]
   modifiable_attributes:
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes


data_types:
 mycompany.datatypes.nfv.VnfInfoModifiableAttributes:
  derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributes
  properties:
   extensions:
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions

 mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
  derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
  properties:
   http_proxy:
    type: string
    required: true
   https_proxy:
    type: string
    required: false
```

Example usage of lcm_operations_configuration:

Top level service template:

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
 MyCompany.SunshineDB.1_0.1_0:
  derived_from: tosca.nodes.nfv.VNF
  properties:
   flavour_id:
    type: string
    constraints:
     - valid_values: [ simple, complex ]
   lcm_operations_configuration:
    scale:
     scaling_by_more_than_one_step_supported: true
    scale_to_level:
     arbitrary_target_levels_supported: true
    heal:
     causes:
      - service_unavailable
      - performance_degraded
    terminate:
     min_graceful_termination_timeout: 60 s
     max_recommended_graceful_termination_timeout: 600 s
    operate:
     min_graceful_stop_timeout: 60 s
     max_recommended_graceful_stop_timeout: 600 s
```

Example usage of describing a VNF node template with vnf_profile in an NSD TOSCA service template:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: an example of NSD TOSCA service template

topology template:
…

 node_templates:
  VNF_1:
   type: tosca.nodes.nfv.exampleVNF
   properties:
    flavour_id: small
    descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
    provider: MyCompany
    product_name: SunshineDB
```

```
    software_version: 1.0
    descriptor_version: 1.0
    vnf_profile:
     instantiation_Level: level_1
     min_number_of_instances: 2
     max_number_of_instances: 6
   # other properties omitted for brevity
   requirements:
     - virtual_link: NsVirtualLink
```

Example usage of VNF indicators attributes in VNF node type definition and VNF indicator notifications in interface definition:

```
tosca_definitions_version: tosca_simple_yaml_1_3

interface_types:
  tosca.interfaces.nfv.MyCompanyVnfIndicator
    derived_from: tosca.interfaces.nfv.VnfIndicator
    notifications:
      health:
        description: this notification is used to received asynchronous information of value
change of the health_vnf_indicator
      utilization:
        description: this notification is used to received asynchronous information of value
change of the utilization_vnf_indicator

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      flavour_id:
        constraints:
          - valid_values: [ simple, complex ]
      modifiable_attributes:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes
    attributes:
      health_vnf_indicator:
        type: string
        constraints:
          - valid_values: [ green, red, yellow ]
      utilization_vnf_indicator:
        type: float
        constraints:
          - in_range [ 0.0, 100.0 ]
    interfaces:
      Vnflcm:
        type: tosca.interfaces.nfv.Vnflcm
        operations:
            # omitted for brevity
      VnfIndicator:
        type: tosca.interfaces.nfv.MyCompanyVnfIndicator
        notifications:
          health:
            output:
              health_vnf_indicator: [ SELF, health_vnf_indicator ]
          utilization:
            output:
              utilization_vnf_indicator: [ SELF, utilization_vnf_indicator ]
```

Examples of VNF-specific node type definition illustrating the two methods to assign values to required properties:

Example with constraints and default values:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: A simple example VNF

imports:
  - etsi_nfv_sol001_vnfd_types.yaml

node_types:

  MyCompany.MultiFlavourVNF.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple, complex ] ]
        default: simple
      flavour_description:
        type: string
        default: "" #empty string
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
```

Example with fixed value assignments (except for flavour_id and flavour_description) using single-line grammar for parameter definitions:

```
  MyCompany.MultiFlavourVNF.1_0.1_1:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1178
      provider: MyCompany
      product_name: SunshineDB
      software_version: '1.0'
      descriptor_version: '1.0'
      flavour_id:
        constraints: [ valid_values: [ simple, complex ] ]
        default: simple
      flavour_description:
        default: "" #empty string
      vnfm_info:[ '0:MyCompany-1.0.0' ]
```

Example with fixed value assignments using multi-line grammar for parameter definitions:

```
MyCompany.SimpleVNF.1_0.1_1:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        value: “b1bb0ce7-ebca-4fa7-95ed-4840d70a1178”
      provider:
        value: “MyCompany”
      product_name:
        value: “SimpleVNF”
      software_version:
        value: “1.0”
      descriptor_version:
        value: “1.0”
      flavour_id:
        value: simple
      flavour_description:
        default: "" #empty string
      vnfm_info:
        value: [ '0:MyCompany-1.0.0' ]
```

6.8.2 tosca.nodes.nfv.VnfExtCp

6.8.2.1 Description

The VnfExtCp node type represents the VnfExtCpd information element as defined in ETSI GS NFV-IFA 011 [1], which describes a logical external connection point, exposed by this VNF enabling connecting with an external Virtual Link. Table 6.8.2.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.2.1-1: Type name, shorthand, and URI

Shorthand Name	VnfExtCp
Type Qualified Name	toscanfv:VnfExtCp
Type URI	tosca.nodes.nfv.VnfExtCp

6.8.2.2 Properties

The properties of the VnfExtCp node type shall comply with the provisions set out in table 6.8.2.2-1.

Table 6.8.2.2-1: Properties

Name	Required	Type	Constraints	Description
virtual_network_interface_requirements	no	list of tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements		The actual virtual NIC requirements that is been assigned when instantiating the connection point.

6.8.2.3 Attributes

None.

6.8.2.4 Requirements

The requirements of the VnfExtCp node type shall comply with the provisions set out in table 6.8.2.4-1.

Table 6.8.2.4-1: Requirements

Name	Required	Capability type	Constraints	Description
external_virtual_link	no	tosca.capabilities.nfv.VirtualLinkable		Specifies that CP instances require to be connected to a node that has a VirtualLinkable capability
internal_virtual_link	yes	tosca.capabilities.nfv.VirtualLinkable		Specifies that CP instances require to be connected to a node that has a VirtualLinkable capability

6.8.2.5 Capabilities

None.

6.8.2.6 Definition

The syntax of the VnfExtCp node type shall comply with the following definition:

```
  tosca.nodes.nfv.VnfExtCp:
    derived_from: tosca.nodes.nfv.Cp
    description: Describes a logical external connection point, exposed by the VNF enabling
connection with an external Virtual Link
    properties:
      virtual_network_interface_requirements:
        type: list
        description: The actual virtual NIC requirements that is been assigned when instantiating
the connection point
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements
    requirements:
      - external_virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [0, 1]
      - internal_virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [1, 1]
```

6.8.2.7 Additional Requirements

A node template of this type is used to represent a VNF external connection point only in the case the VnfExtCp is connected to an internal virtual link. The node template has the following requirements:

- internal_virtual_link requirement to allow to connect it to an internal virtual link;
- external_virtual_link requirement to allow to connect it to an external virtual link.

In the case where a VNF external connection point is re-exposing a VduCp (internal connection point)or a VipCp, the VduCp or VipCp node type shall be used in the service template, instead of the VnfExtCp node type.

6.8.2.8 Example

In a typical scenario, the VnfExtCp node template will be part of a service template representing a certain VNF deployment flavour. The service template substitutes for a VNF specific node type. In this substitution, the virtual_link requirement is mapped to the external_virtual_link requirement of the VnfExtCp node. This example is illustrated in clause A.3.3.

When a VNF external connection point re-exposes a Vdu connection point, the service template does not include an explicit node template of type VnfExtCp in a typical scenario where a VNF specific node type is substituted by a service template representing a certain VNF deployment flavour. In this substitution, the virtual_link requirement is mapped to the virtual_link requirement of the VduCp node. This example is illustrated in clause A.3.2.

When a VNF external connection point re-exposes a VIP connection point, the service template does not include an explicit node template of type VnfExtCp in a typical scenario where a VNF specific node type is substituted by a service template representing a certain VNF deployment flavour. In this substitution, the virtual_link requirement is mapped to the virtual_link requirement of the VipCp node. This example is illustrated in clause A.13.

When a VNF external connection point re-exposes a Subport connection point in the trunk mode, the service template does not include an explicit node template of type VnfExtCp in a typical scenario where a VNF specific node type is substituted by a service template representing a certain VNF deployment flavour. In this substitution, the virtual_link requirement is mapped to the virtual_link requirement of the VduSubCp node.

6.8.3 tosca.nodes.nfv.Vdu.Compute

6.8.3.1 Description

The Vdu.Compute node type describes the virtual compute part of a VDU (when realized as a VM) which is a construct supporting the description of the deployment and operational behaviour of a VNFC, as defined in ETSI GS NFV-IFA 011 [1].

Table 6.8.3.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.3.1-1: Type name, shorthand, and URI

Shorthand Name	Vdu.Compute
Type Qualified Name	toscanfv:Vdu.Compute
Type URI	tosca.nodes.nfv.Vdu.Compute

6.8.3.2 Properties

The properties of the Vdu.Compute node type shall comply with the provisions set out in table 6.8.3.2-1.

Table 6.8.3.2-1: Properties

Name	Required	Type	Constraints	Status	Description
name	yes	string			Human readable name of the Vdu.
description	yes	string			Human readable description of the Vdu.
boot_order	yes	boolean			It indicates whether the order of the virtual_storage requirements is used as the boot index (the first requirement represents the lowest index and defines highest boot priority). If no boot order is indicated or the value is false, the default boot order defined in the VIM or NFVI shall be used.
nfvi_constraints	no	map of string			Describes constraints on the NFVI for the VNFC instance(s) created from this Vdu. For example, aspects of a secure hosting environment for the VNFC instance that involve additional entities or processes. This property is reserved for future use in the present document.
monitoring_parameters	no	map of tosca.datatypes.nfv.VnfcMonitoringParameter			Describes monitoring parameters applicable to a VNFC based on this VDU.

Name	Required	Type	Constraints	Status	Description
configurable_properties	no	tosca.datatypes.nfv.VnfcConfigurableProperties			Describes the configurable properties of all VNFC instances based on this VDU.
boot_data	no	tosca.datatypes.nfv.BootData			Contains the information used to customize a virtualised compute resource at boot time. See note. The bootData may contain variable parts that are replaced by deployment specific values before being sent to the VIM. For "volatile" parameters, i.e. those that exist only during the lifetime of an LCM operation occurrence, the parameters of each variable part shall be declared in a type derived from tosca.datatypes.nfv.VnfOperationAdditionalParameters. For "persistent" parameters, i.e. those that exist during the lifetime of the VNF instance beyond the lifetime of a single LCM operation occurrence, the parameters shall be declared in a type derived from tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions or tosca.datatypes.nfv.VnfConfigurableProperties.
vdu_profile	yes	tosca.datatypes.nfv.VduProfile			Defines additional instantiation data for the VDU.Compute node.
NOTE: The boot_data structure passed to a VNFC instance cannot be changed after the boot time of the VNFC instance.					

6.8.3.3 Attributes

None.

6.8.3.4 Requirements

The requirements of the Vdu.Compute node type shall comply with the provisions set out in table 6.8.3.4-1.

Table 6.8.3.4-1: Requirements

Name	Required	Capability type	Constraints	Description
virtual_storage	no	tosca.capabilities.nfv.VirtualStorage		Describes storage requirements for a virtual_storage instance attached to the virtualisation container created from virtual_compute defined for this vdu

6.8.3.5 Capabilities

The capabilities of the Vdu.Compute node type shall comply with the provisions set out in table 6.8.3.5-1.

Table 6.8.3.5-1: Capabilities

Name	Type	Constraints	Description
virtual_compute	tosca.capabilities.nfv.VirtualCompute		Describes virtual compute resources capabilities.
virtual_binding	tosca.capabilities.nfv.VirtualBindable		Defines ability of VirtualBindable.

6.8.3.6 Definition

The syntax of the Vdu.Compute node type shall comply with the following definition:

```
  tosca.nodes.nfv.Vdu.Compute:
    derived_from: tosca.nodes.Root
    description: Describes the virtual compute part of a VDU which is a construct  supporting the
description of the deployment and operational behavior of a VNFC
    properties:
      name:
        type: string
        description: Human readable name of the VDU
        required: true
      description:
        type: string
        description: Human readable description of the VDU
        required: true
      boot_order:
        type: boolean
        description: indicates whether the order of the virtual_storage requirements is used as
the boot index (the first requirement represents the lowest index and defines highest boot
priority)
        required: true
        default: false
      nfvi_constraints:
        type: map
        description: Describes constraints on the NFVI for the VNFC instance(s) created from this
VDU. This property is reserved for future use in the present document.
        required: false
        entry_schema:
          type: string
      monitoring_parameters:
        type: map # key: id
        description: Describes monitoring parameters applicable to a VNFC instantiated from this
VDU
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.VnfcMonitoringParameter
      configurable_properties:
        type: tosca.datatypes.nfv.VnfcConfigurableProperties
        required: false
      # derived types are expected to introduce
      # configurable_properties with its type derived from
      # tosca.datatypes.nfv.VnfcConfigurableProperties
      vdu_profile:
        type: tosca.datatypes.nfv.VduProfile
        description: Defines additional instantiation data for the VDU.Compute node
        required: true
      boot_data:
        type: tosca.datatypes.nfv.BootData
        description: Contains the information used to customize a virtualised compute resource at
boot time. The bootData may contain variable parts that are replaced by deployment specific values
before being sent to the VIM.
        required: false
    capabilities:
      virtual_compute:
        type: tosca.capabilities.nfv.VirtualCompute
        occurrences: [ 1, 1 ]
      virtual_binding:
        type: tosca.capabilities.nfv.VirtualBindable
        occurrences: [ 1, UNBOUNDED ]
    requirements:
      - virtual_storage:
          capability: tosca.capabilities.nfv.VirtualStorage
          relationship: tosca.relationships.nfv.AttachesTo
          occurrences: [ 0, UNBOUNDED ]
```

6.8.3.7 Additional requirements

Node templates of type tosca.nodes.nfv.Vdu.Compute may contain an artifact definition of type tosca.artifacts.nfv.SwImage. There shall be a maximum number of one such artifact definition in a tosca.nodes.nfv.Vdu.Compute node template. The node template name of type tosca.nodes.nfv.Vdu.Compute fulfills the purpose of the "id" attribute of the SwImageDesc information element in ETSI GS NFV-IFA 011 [1] and hence it will be used in APIs to identify the software image id from the VNFD perspective. See example in clause 6.8.3.8.

When VNF-specific configurable properties are defined at the VDU-level, VNF providers shall define a VNF/VDU specific Vdu.Compute node type, where the configurable_properties property has a datatype derived from tosca.datatypes.nfv.VnfcConfigurableProperties. See example in clause 6.2.10.4.

The VNF/VDU specific Vdu.Compute node type shall be defined as follows:

- All properties listed in tosca.nodes.nfv.Vdu.Compute where the "required:" field is set to "true" shall be included.
- The capabilities and requirements of tosca.nodes.nfv.Vdu.Compute shall be preserved.
- The configurable_properties property shall have a datatype derived from tosca.datatypes.nfv.VnfcConfigurableProperties, according to the rules defined in clause 5.7.2 of the present document.

The definition of a VNF/VDU specific node type shall be included in one of the following yaml files:

1) In the yaml file which contains the corresponding VNF specific node type definition.
2) In low-level service templates or in the single TOSCA service template representing the VNFD in case of a single deployment flavour design with a single TOSCA service template.
3) In a standalone yaml file, to be imported from the low-level TOSCA service templates or from the single TOSCA service template representing the VNFD in case of a single deployment flavour design with a single TOSCA service template.
4) In any other VNF-specific files containing type definitions used by the VNFD TOSCA service template.

In the derived Vdu.Compute node type, the additional_vnfc_configurable_properties (VNF/VDU-specific extension of the tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties data type) describe the name and type of the VNFC configurable properties.

The additional_vnfc_configurable_properties information provided in the node type is sufficient for the client of the VNF LCM API for providing values to these properties. A value provided via the VNF LCM API to such a property overrides the value (if any) assigned in the node template or defined as default value in the node type definition.

The node template name of type tosca.nodes.nfv.Vdu.Compute fulfills the purpose of the 'virtualComputeDescId' attribute of the virtualComputeDesc information element in ETSI GS NFV-IFA 011 [1] and hence it will be used in APIs to identify the virtual compute id (vnfdVirtualComputeDescId).

NOTE: The use of the node template name of type tosca.nodes.nfv.Vdu.Compute for the 'virtualComputeDescId' attribute of the virtualComputeDesc information element in ETSI GS NFV-IFA 011 [1] implies in the present document version a one-to-one mapping of virtualComputeDesc with VDU. This deviates from the ETSI GS NFV-IFA 011 [1] modelling that defines a mapping where a virtualComputeDesc can be reused by one or more VDU, i.e. it implies a one-to-many mapping of virtualComputeDesc with VDU. This can have an impact in the determination of the number of compute flavours needed to be created with the VIM.

6.8.3.8 Example

This example illustrates boot data containing kvp_data by using modifiable_attributes.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
node_types:
 mycompany.nodes.nfv.SunshineDB.1_0.1_0:
  derived_from: tosca.nodes.nfv.VNF
  properties:
   ..
   modifiable_attributes:
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes
  ..

data_types:
 mycompany.datatypes.nfv.VnfInfoModifiableAttributes:
  derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributes
  properties:
   extensions:
```

```
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions
    required: false

 mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
  derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
  properties:
   http_proxy:
    type: string
    required: true
   https_proxy:
    type: string
    required: false
   ip_address_1:
    type: string
    required: false
   vm_Nname:
    type: string
    required: false

topology_template:
 inputs:
  extensions:
   type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions

 substitution_mappings:
  node_type: mycompany.nodes.nfv.SunshineDB.1_0.1_0
  ..

 node_templates:
  vnf:
   type: mycompany.nodes.nfv.SunshineDB.1_0.1_0
   properties:
    ..
    modifiable_attributes:
      extensions: { get_input: extensions }

  dbBackend:
   type: tosca.nodes.nfv.Vdu.Compute
   properties:
    ..
     boot_data:
       kvp_data:
        data:
          ip_address_1: { get_property: [vnf, modifiable_attributes, extensions, ip_address_1
] }

   ..
```

This example illustrates boot data containing kvp_data by using configurable_properties.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
node_types:
  mycompany.nodes.nfv.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
   ..
      configurable_properties:
        type: mycompany.datatypes.nfv.VnfConfigurableProperties
  ..

data_types:
  mycompany.datatypes.nfv.VnfConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfConfigurableProperties
    properties:
      additional_configurable_properties:
        type: mycompany.datatypes.nfv.VnfAdditionalConfigurableProperties
        required: false

  mycompany.datatypes.nfv.VnfAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfAdditionalConfigurableProperties
    properties:
      host_name:
        type: string
        required: false

topology_template:
  inputs:
```

```
    configurable_properties:
      type: mycompany.datatypes.nfv.VnfConfigurableProperties

  substitution_mappings:
    node_type: mycompany.nodes.nfv.SunshineDB.1_0.1_0
  ..

  node_templates:
    vnf:
     type: mycompany.nodes.nfv.SunshineDB.1_0.1_0
     properties:
    ..
       configurable_properties: { get_input: configurable_properties }

  dbBackend:
   type: tosca.nodes.nfv.Vdu.Compute
   properties:
    ..
     boot_data:
       kvp_data:
        data:
          ip_address_1: { get_property: [vnf, configurable_properties,
additional_configurable_properties, host_name ] }

   ..
```

This example illustrates fetching the boot data value by using content_or_file_data.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
node_types:
 mycompany.nodes.nfv.SunshineDB.1_0.1_0:
  derived_from: tosca.nodes.nfv.VNF
  properties:
   ..
   modifiable_attributes:
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes
  ..

data_types:
 mycompany.datatypes.nfv.VnfInfoModifiableAttributes:
  derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributes
  properties:
   extensions:
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions
    required: false

 mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
  derived_from: tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions
  properties:
   http_proxy:
    type: string
    required: true
   https_proxy:
    type: string
    required: false
   ip_address_1:
    type: string
    required: false
   vm_name:
    type: string
    required: false

topology_template:
 inputs:
  extensions:
   type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions

 substitution_mappings:
  node_type: mycompany.nodes.nfv.SunshineDB.1_0.1_0
  ..

 node_templates:
  vnf:
   type: mycompany.nodes.nfv.SunshineDB.1_0.1_0
   properties:
    ..
    modifiable_attributes:
```

```
      extensions: { get_input: extensions }

  dbBackend:
   type: tosca.nodes.nfv.Vdu.Compute
   properties:
    ..
     boot_data:
       content_or_file_data
         contents: { concat: [ "#!/bin/bash\n",
 "echo setting HTTP proxy to: ", { get_property: [vnf, modifiable_attributes, extensions,
http_proxy ] }, "\n", "..."] }
```

This example illustrates fetching the boot data value from a file by using content_or_file_data.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
topology_template:
 ..

 node_templates:
  dbBackend:
   type: tosca.nodes.nfv.Vdu.Compute
   properties:
    ..
     boot_data:
       content_or_file_data
         data:
             http_proxy: { get_property: [vnf, modifiable_attributes, extensions, http_proxy
] }
         source_path: { get_artifact : [ SELF, boot_data ] }
   artifacts:
     sw_image:
       type: tosca.artifacts.nfv.SwImage
       file: images/dbBackend.v1.0.1.qcow2
     boot_data:
       type: tosca.artifacts.example
       file: implementation/templates/boot_data.file
  ..
```

This example illustrates fetching the boot data value from a file by using content_or_file_data with destination_path.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
topology_template:
 ..

 node_templates:
  dbBackend:
   type: tosca.nodes.nfv.Vdu.Compute
   properties:
    ..
     boot_data:
       content_or_file_data:
         data:
           vm_name: get_property: [vnf, modifiable_attributes, extensions, vm_name ]
         source_path: { get_artifact : [ SELF, boot_data ] }
         destination_path: /etc/
   artifacts:
     sw_image:
       type: tosca.artifacts.nfv.SwImage
       file: images/dbBackend.v1.0.1.qcow2
     boot_data:
       type: tosca.artifacts.example
       file: implementation/templates/boot_data.file
  ..
```

This example illustrates the association of a software image artifact to a Vdu.Compute node. The name of the Vdu.Compute node template "dbBackend" will be used in external APIs to identify the image.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
topology_template:
  ..

  node_templates:
    dbBackend:
      type: tosca.nodes.nfv.Vdu.Compute
```

```
      properties:
      ..

        ..
      artifacts:
       sw_image:
         type: tosca.artifacts.nfv.SwImage
         file: images/dbBackend.v1.0.1.qcow2
         properties:
    ..
```

This example illustrates the association of a software image artifact to more than Vdu.Compute nodes. The name of the Vdu.Compute node template "dbBackend" and "oamService" will be used in external APIs to identify the image of each Vdu.Compute node.

```
tosca_definitions_version: tosca_simple_yaml_1_3
..
topology_template:
  ..

  node_templates:
    dbBackend:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
      ..
        ..
      artifacts:
        sw_image:
          type: tosca.artifacts.nfv.SwImage
          file: images/dbBackend.v1.0.1.qcow2
          properties:

    oamService:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
      ..
        ..
      artifacts:
        sw_image:
          type: tosca.artifacts.nfv.SwImage
          file: images/dbBackend.v1.0.1.qcow2
          properties:

    ..
```

6.8.4 tosca.nodes.nfv.Vdu.VirtualBlockStorage

6.8.4.1 Description

The VirtualBlockStorage node type describes the specifications of requirements related to virtual block storage resources, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.8.4.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.4.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualBlockStorage
Type Qualified Name	toscanfv:VirtualBlockStorage
Type URI	tosca.nodes.nfv.Vdu.VirtualBlockStorage

6.8.4.2 Properties

The properties of the VirtualBlockStorage node type shall comply with the provisions set out in table 6.8.4.2-1.

Table 6.8.4.2-1: Properties

Name	Required	Type	Constraints	Status	Description
virtual_block_storage_data	yes	tosca.datatypes.nfv.VirtualBlockStorage			Describes the block storage characteristics.
nfvi_maintenance_info	no	tosca.datatypes.nfv.NfviMaintenanceInfo			Provides information on the rules to be observed when an instance based on this VirtualBlockStorage is impacted during NFVI operation and maintenance (e.g. NFVI resource upgrades).

6.8.4.3 Attributes

None.

6.8.4.4 Requirements

None.

6.8.4.5 Capabilities

The capabilities of the VirtualBlockStorage node type shall comply with the provisions set out in table 6.8.4.5-1.

Table 6.8.4.5-1: Capabilities

Name	Type	Constraints	Description
virtual_storage	tosca.capabilities.nfv.VirtualStorage		Defines the capabilities of virtual_storage.

6.8.4.6 Definition

The syntax of the VirtualBlockStorage node type shall comply with the following definition:

```
  tosca.nodes.nfv.Vdu.VirtualBlockStorage:
    derived_from: tosca.nodes.Root
    description: This node type describes the specifications of requirements related to virtual
block storage resources
    properties:
      virtual_block_storage_data:
        type: tosca.datatypes.nfv.VirtualBlockStorageData
        description: Describes the block storage characteristics.
        required: true
      nfvi_maintenance_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the rules to be observed when an instance based on
this VirtualBlockStorage is impacted during NFVI operation and maintenance (e.g. NFVI resource
upgrades).
        required: false
    capabilities:
      virtual_storage:
        type: tosca.capabilities.nfv.VirtualStorage
        description: Defines the capabilities of virtual_storage.
```

6.8.4.7 Additional requirements

Node templates of type tosca.nodes.nfv.Vdu.VirtualBlockStorage may contain an artifact definition of type tosca.artifacts.nfv.SwImage. There shall be a maximum number of one such artifact definition in a tosca.nodes.nfv.Vdu.VirtualBlockStorage node template. The node template name of type tosca.nodes.nfv.Vdu.VirtualBlockStorage fulfills the purpose of the "id" attribute of the SwImageDesc information element in ETSI GS NFV-IFA 011 [1] and hence it will be used in APIs to identify the software image id from the VNFD descriptor. See example in clause 6.8.3.8.

6.8.5 tosca.nodes.nfv.Vdu.VirtualObjectStorage

6.8.5.1 Description

The VirtualObjectStorage node type describes the specifications of requirements related to virtual object storage resources, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.8.5.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.5.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualObjectStorage
Type Qualified Name	toscanfv:VirtualObjectStorage
Type URI	tosca.nodes.nfv.Vdu.VirtualObjectStorage

6.8.5.2 Properties

The properties of the VirtualObjectStorage node type shall comply with the provisions set out in table 6.8.5.2-1.

Table 6.8.5.2-1: Properties

Name	Required	Type	Constraints	Description
virtual_object_storage_data	yes	tosca.datatypes.nfv.VirtualObjectStorageData		Describes the object storage characteristics.
nfvi_maintenance_info	no	tosca.datatypes.nfv.NfviMaintenanceInfo		Provides information on the rules to be observed when an instance based on this VirtualObjectStorage is impacted during NFVI operation and maintenance (e.g. NFVI resource upgrades).

6.8.5.3 Attributes

None.

6.8.5.4 Requirements

None.

6.8.5.5 Capabilities

The capabilities of the VirtualObjectStorage node type shall comply with the provisions set out in table 6.8.5.5-1.

Table 6.8.5.5-1: Capabilities

Name	Type	Constraints	Description
virtual_storage	tosca.capabilities.nfv.VirtualStorage		Defines the capabilities of virtual_storage.

6.8.5.6 Definition

The syntax of the VirtualObjectStorage node type shall comply with the following definition:

```
  tosca.nodes.nfv.Vdu.VirtualObjectStorage:
    derived_from: tosca.nodes.Root
    description: This node type describes the specifications of requirements related to
virtual object storage resources
    properties:
      virtual_object_storage_data:
        type: tosca.datatypes.nfv.VirtualObjectStorageData
        description: Describes the object storage characteristics.
        required: true
```

```
      nfvi_maintenance_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the rules to be observed when an instance based
on this VirtualObjectStorage is impacted during NFVI operation and maintenance (e.g. NFVI
resource upgrades).
        required: false
    capabilities:
      virtual_storage:
        type: tosca.capabilities.nfv.VirtualStorage
        description: Defines the capabilities of virtual_storage.
```

6.8.5.7 Additional requirements

None.

6.8.6 tosca.nodes.nfv.Vdu.VirtualFileStorage

6.8.6.1 Description

The VirtualFileStorage node type describes the specifications of requirements related to virtual file storage resources, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.8.6.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.6.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualFileStorage
Type Qualified Name	toscanfv:VirtualFileStorage
Type URI	tosca.nodes.nfv.Vdu.VirtualFileStorage

6.8.6.2 Properties

The properties of the VirtualFileStorage node type shall comply with the provisions set out in table 6.8.6.2-1.

Table 6.8.6.2-1: Properties

Name	Required	Type	Constraints	Description
virtual_file_storage_data	yes	tosca.datatypes.nfv.VirtualFileStorageData		Describes the file storage characteristics.
nfvi_maintenance_info	no	tosca.datatypes.nfv.NfviMaintenanceInfo		Provides information on the rules to be observed when an instance based on this VirtualFileStorage is impacted during NFVI operation and maintenance (e.g. NFVI resource upgrades).

6.8.6.3 Attributes

None.

6.8.6.4 Requirements

The requirements of the VirtualFileStorage node type shall comply with the provisions set out in table 6.8.6.4-1.

Table 6.8.6.4-1: Requirements

Name	Required	Capability type	Constraints	Description
virtual_link	yes	tosca.capabilities.nfv.VirtualLinkable		Describes the requirements for linking to virtual link

6.8.6.5 Capabilities

The capabilities of the VirtualFileStorage node type shall comply with the provisions set out in table 6.8.6.5-1.

Table 6.8.6.5-1: Capabilities

Name	Type	Constraints	Description
virtual_storage	tosca.capabilities.nfv.VirtualStorage		Defines the capabilities of virtual_storage.

6.8.6.6 Definition

The syntax of the VirtualFileStorage node type shall comply with the following definition:

```
  tosca.nodes.nfv.Vdu.VirtualFileStorage:
    derived_from: tosca.nodes.Root
    description: This node type describes the specifications of requirements related to
virtual file storage resources
    properties:
      virtual_file_storage_data:
        type: tosca.datatypes.nfv.VirtualFileStorageData
        description: Describes the file  storage characteristics.
        required: true
      nfvi_maintenance_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the rules to be observed when an instance based
on this VirtualFileStorage is impacted during NFVI operation and maintenance (e.g. NFVI
resource upgrades).
        required: false
    capabilities:
      virtual_storage:
        type: tosca.capabilities.nfv.VirtualStorage
        description: Defines the capabilities of virtual_storage.
    requirements:
     - virtual_link:
         capability: tosca.capabilities.nfv.VirtualLinkable
         relationship: tosca.relationships.nfv.VirtualLinksTo
         occurrences: [1, 1]
         # description: Describes the requirements for linking to virtual link
```

6.8.6.7 Additional requirements

None.

6.8.7 tosca.nodes.nfv.Cp

6.8.7.1 Description

The Cp node type is defined in clause 9.8.1 of the present document.

6.8.8 tosca.nodes.nfv.VduCp

6.8.8.1 Description

A VduCp node type represents the VduCpd information element as defined in ETSI GS NFV-IFA 011 [1], which describes network connectivity between a VNFC instance (based on VDU) and an internal VL. Table 6.8.8.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.8.1-1: Type name, shorthand, and URI

Shorthand Name	VduCp
Type Qualified Name	toscanfv:VduCp
Type URI	tosca.nodes.nfv.VduCp

6.8.8.2 Properties

The properties of the VduCp node type shall comply with the provisions set out in table 6.8.8.2-1.

Table 6.8.8.2-1: Properties

Name	Required	Type	Constraints	Description
bitrate_requirement	no	integer	greater_or_equal: 0	Bitrate requirement in bit per second on this connection point.
virtual_network_interface_requirements	no	list of tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements		Specifies requirements on a virtual network interface realizing the CPs instantiated from this CPD.
order	no	integer	greater_or_equal: 0	The order of the NIC on the compute instance (e.g. eth2). See note. compute (a.k.a multi vNICs) and ordering is desired, it is *mandatory* that all ports will be set with an order. value and. The order values shall represent a positive, arithmetic progression that starts with 0 (e.g. 0, 1, 2, …, n). If the property is not present, it shall be left to the VIM to assign the value when creating the instance.
vnic_type	no	string	Allowed values: normal, macvtap, direct, baremetal,virtio-forwarder, direct-physical, smart-nic	Describes the type of the virtual network interface realizing the CPs instantiated from this CPD. This is used to determine which mechanism driver(s) to be used to bind the port.
NOTE: When binding more than one port to a single.				

6.8.8.3 Attributes

None.

6.8.8.4 Requirements

The requirements of the VduCp node type shall comply with the provisions set out in table 6.8.8.4-1.

Table 6.8.8.4-1: Requirements

Name	Required	Capability type	Constraints	Description
virtual_binding	no	tosca.capabilities.nfv.VirtualBindable		Describe the requirement for binding with VDU
virtual_link	yes	tosca.capabilities.nfv.VirtualLinkable		Describes the requirements for linking to virtual link

6.8.8.5 Capabilities

The capabilities of the VduCp node type shall comply with the provisions set out in table 6.8.8.5-1. This capability is available only the trunk_mode property value of this VduCp is "true" and there is at least one VduSubCp defined as subport of the same trunk.

Table 6.8.8.5-1: Capabilities

Name	Type	Constraints	Description
trunk_binding	tosca.capabilities.nfv.TrunkBindable		Defines ability of TrunkBindable.

6.8.8.6 Definition

The syntax of the VduCp node type shall comply with the following definition:

```
  tosca.nodes.nfv.VduCp:
    derived_from: tosca.nodes.nfv.Cp
    description: describes network connectivity between a VNFC instance based on this VDU and an
internal VL
    properties:
      bitrate_requirement:
        type: integer   # in bits per second
        description: Bitrate requirement in bit per second on this connection point
        required: false
        constraints:
          - greater_or_equal: 0
      virtual_network_interface_requirements:
        type: list
        description: Specifies requirements on a virtual network interface realizing  the CPs
instantiated from this CPD
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements
      order:
        type: integer
        description: The order of the NIC on the compute instance (e.g.eth2)
        required: false
        constraints:
          - greater_or_equal: 0
      vnic_type:
        type: string
        description: Describes the type of the virtual network interface realizing the CPs
instantiated from this CPD
        required: false
        constraints:
        - valid_values: [ normal, macvtap, direct, baremetal, virtio-forwarder, direct-physical,
smart-nic ]
    capabilities:
      trunk_binding: # This capability is available only the trunk_mode property value of this
VduCp is "true" and there is at least one VduSubCp defined as subport of the same trunk.
        type: tosca.capabilities.nfv.TrunkBindable
        occurrences: [ 0, UNBOUNDED ]
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [1, 1]
      - virtual_binding:
          capability: tosca.capabilities.nfv.VirtualBindable
          relationship: tosca.relationships.nfv.VirtualBindsTo
          node: tosca.nodes.nfv.Vdu.Compute
          occurrences: [0, 1]
```

6.8.8.7 Additional Requirements

The occurrence 0 of the virtual_binding requirement is applicable for node templates of tosca.nodes.nfv.VduSubCp node type derived from tosca.nodes.nfv.VduCp. For node templates of tosca.nodes.nfv.VduCp node type occurrence 1 applies.

6.8.9 tosca.nodes.nfv.VnfVirtualLink

6.8.9.1 Description

The VnfVirtualLink node type represents the VnfVirtualLinkDesc information element as defined in ETSI GS NFV-IFA 011 [1], which describes the information about an internal VNF VL. Table 6.8.9.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.9.1-1: Type name, shorthand, and URI

Shorthand Name	VnfVirtualLink
Type Qualified Name	toscanfv:VnfVirtualLink
Type URI	tosca.nodes.nfv.VnfVirtualLink

6.8.9.2 Properties

The properties of the VnfVirtualLink node type shall comply with the provisions set out in table 6.8.9.2-1.

Table 6.8.9.2-1: Properties

Name	Required	Type	Constraints	Description
connectivity_type	yes	ConnectivityType		Specifies the protocol exposed by the VL and the flow pattern supported by the VL.
description	no	string		Provides human-readable information on the purpose of the VL (e.g. control plane traffic).
test_access	no	list of string	Valid values: See YAML definition constraints	Test access facilities available on the VL.
vl_profile	yes	tosca.datatypes.nfv.VlProfile		Defines additional data for the VL: maximum and minimum bit rate requirements and QoS.
monitoring_parameters	no	map of tosca.datatypes.nfv.VirtualLinkMonitoringParameter		Describe monitoring parameters applicable to a VL instantiated from this node type.
nfvi_maintenance_info	no	tosca.datatypes.nfv.NfviMaintenanceInfo		Provides information on the rules to be observed when an instance based on this VnfVirtualLink is impacted during NFVI operation and maintenance (e.g. NFVI resource upgrades).
externally_managed	no	string	Valid values: See YAML definition constraints	Specifies the intent of the VNF designer w.r.t. the internal VL instances created from this descriptor being externally managed, i.e. whether it is "allowed" or "required" that these are externally managed. If this property is absent, the value "allowed" is assumed. If the VNFD does not reference any LCM script and if the "vnfm_info" property in the VNF-specific node type derived from the tosca.nodes.nfv.VNF node type indicates that the VNF can be managed by any ETSI NFV compliant VNFM, this property shall not be present.

6.8.9.3 Requirements

None.

6.8.9.4 Capabilities

The capabilities of the VnfVirtualLink node type shall comply with the provisions set out in table 6.8.9.4-1.

Table 6.8.9.4-1: Capabilities

Name	Type	Constraints	Description
virtual_linkable	tosca.capabilities.nfv.VirtualLinkable		Defines ability of VirtualLinkable.

6.8.9.5 Definition

The syntax of the VnfVirtualLink node type shall comply with the following definition:

```
  tosca.nodes.nfv.VnfVirtualLink:
    derived_from: tosca.nodes.Root
    description: Describes the information about an internal VNF VL
    properties:
      connectivity_type:
        type: tosca.datatypes.nfv.ConnectivityType
        description: Specifies the protocol exposed by the VL and the flow pattern supported by
the VL
        required: true
      description:
        type: string
        description: Provides human-readable information on the purpose of the VL
        required: false
      test_access:
        type: list
        description: Test access facilities available on the VL
        required: false
        entry_schema:
          type: string
          constraints:
            - valid_values: [ passive_monitoring, active_loopback ]
      vl_profile:
        type: tosca.datatypes.nfv.VlProfile
        description: Defines additional data for the VL
        required: true
      monitoring_parameters:
        type: map #key: id
        entry_schema:
          type: tosca.datatypes.nfv.VirtualLinkMonitoringParameter
        description: Describes monitoring parameters applicable to the VL
        required: false
      nfvi_maintenance_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the rules to be observed when an instance based on
this VnfVirtualLink is impacted during NFVI operation and maintenance (e.g. NFVI resource
upgrades).
        required: false
      externally_managed:
        type: string
        description: Specifies the intent of the VNF designer w.r.t. the external management of
the internal VL instances created from this descriptor, i.e. whether it is "allowed" or "required"
that these are externally managed. If this property is absent, the value "allowed" is assumed. If
the VNFD does not reference any LCM script and if the "vnfm_info" property in the VNF-specific
node type derived from the tosca.nodes.nfv.VNF node type indicates that the VNF can be managed by
any ETSI NFV compliant VNFM, this property shall not be present.
        required: false

        constraints:
          - valid_values: [ allowed, required ]
    capabilities:
      virtual_linkable:
        type: tosca.capabilities.nfv.VirtualLinkable
```

6.8.10 tosca.nodes.nfv.VipCp

6.8.10.1 Description

A VipCp node type represents the VipCpd information element as defined in ETSI GS NFV-IFA 011 [1], which describes a connection point to allocate one or a set of virtual IP addresses. Table 6.8.10.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.10.1-1: Type name, shorthand, and URI

Shorthand Name	VipCp
Type Qualified Name	toscanfv:VipCp
Type URI	tosca.nodes.nfv.VipCp

6.8.10.2 Properties

The properties of the VipCp node type shall comply with the provisions set out in table 6.8.10.2-1.

Table 6.8.10.2-1: Properties

Name	Required	Type	Constraints	Description
dedicated_ip_address	yes	boolean		Indicates whether the VIP address shall be different from the addresses allocated to all associated VduCp instances or shall be the same as one of them. If set to true, the VIP address shall be different from the addresses allocated to all of the VduCp instances associated to it. If set to false, the VIP address shall be the same as one of the VduCp instances associated to it.
vip_function	yes	string	valid values: See YAML definition constraints	Indicates the function the virtual IP address is used for: high availability or load balancing. See note.
NOTE: When used for high availability, only one of the internal VDU CP instances or VNF external CP instances that share the virtual IP is bound to the VIP address at a time, i.e. only one is configured in the external (to the VNF) router to receive the packets e.g. as a result of a G-ARP message previously sent by this instance. When used for load balancing purposes all CP instances that share the virtual IP are bound to it. A load balancing function sends the packet to one or the other, but not to both.				

6.8.10.3 Attributes

None.

6.8.10.4 Requirements

The requirements of the VipCp node type shall comply with the provisions set out in table 6.8.10.4-1.

Table 6.8.10.4-1: Requirements

Name	Required	Type	Constraints	Description
target	yes	tosca.capabilities.Node		Describes the requirement for connecting to VDU CP instances that share the virtual IP address.
virtual_link	yes	tosca.capabilities.nfv.VirtualLinkable		Describes the requirements for linking to virtual link.

6.8.10.5 Definition

The syntax of the VipCp node type shall comply with the following definition:

```
  tosca.nodes.nfv.VipCp:
    derived_from: tosca.nodes.nfv.Cp
    description: Describes a connection point to allocate one or a set of virtual IP addresses
    properties:
      dedicated_ip_address:
        type: boolean
        description: Indicates whether the VIP address shall be different from the addresses
allocated to all associated VduCp instances or shall be the same as one of them.
        required: true
        default: true
      vip_function:
        type: string
        description: "Indicates the function the virtual IP address is used for: high availability
or load balancing. When used for high availability, only one of the internal VDU CP instances or
VNF external CP instances that share the virtual IP is bound to the VIP address at a time. When
used for load balancing purposes all CP instances that share the virtual IP are bound to it."
        required: true
        constraints:
          - valid_values: [ high_availability, load_balance ]
    requirements:
      - target:
          capability: tosca.capabilities.Node
          node: tosca.nodes.nfv.VduCp
          relationship: tosca.relationships.DependsOn
          occurrences: [ 1, UNBOUNDED ]
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VipVirtualLinksTo
          occurrences: [1, 1]
```

6.8.10.6 Example

See clause A.13.

6.8.11 tosca.nodes.nfv.VduSubCp

6.8.11.1 Description

A VduSubCp node type represents the Subport information element as defined in ETSI GS NFV-IFA 011 [1], which describes network connectivity between a VNFC instance (based on VDU) and an internal VL through a trunk port. Table 6.8.11.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.8.11.1-1: Type name, shorthand, and URI

Shorthand Name	VduSubCp
Type Qualified Name	toscanfv:VduSubCp
Type URI	tosca.nodes.nfv.VduSubCp

6.8.11.2 Properties

The properties of the VduSubCp node type shall comply with the provisions set out in table 6.8.11.2-1.

Table 6.8.11.2-1: Properties

Name	Required	Type	Constraints	Description
segmentation_type	no	string	Allowed values: vlan, inherit	Specifies the encapsulation type for the traffics coming in and out of the trunk subport.
segmentation_id	no	integer	greater_or_equal: 0	Specifies the segmentation ID for the subport, which is used to differentiate the traffics on different networks coming in and out of the trunk port. If a value is provided here it may be overridden by a value provided at run time when the infrastructure does not support mapping of segmentation IDs.

6.8.11.3 Attributes

None.

6.8.11.4 Requirements

The requirements of the VduSubCp node type shall comply with the provisions set out in table 6.8.11.4-1.

Table 6.8.11.4-1: Requirements

Name	Required	Capability type	Constraints	Description
trunk_binding	yes	tosca.capabilities.nfv.TrunkBindable		Describes the requirements for binding with trunk parent port.

6.8.11.5 Definition

The syntax of the VduSubCp node type shall comply with the following definition:

```
  tosca.nodes.nfv.VduSubCp:
    derived_from: tosca.nodes.nfv.VduCp
    description: describes network connectivity between a VNFC instance based on this VDU and an
internal VL through a trunk port
    properties:
      segmentation_type:
        type: string
        description: Specifies the encapsulation type for the traffics coming in and out of the
trunk subport.
        required: false
        constraints:
          - valid_values: [ vlan, inherit ]
      segmentation_id:
        type: integer
        description: Specifies the segmentation ID for the subport, which is used to differentiate
the traffics on different networks coming in and out of the trunk port.
        required: false
        constraints:
          - greater_or_equal: 0
    requirements:
      - trunk_binding:
          capability: tosca.capabilities.nfv.TrunkBindable
          relationship: tosca.relationships.nfv.TrunkBindsTo
          node: tosca.nodes.nfv.VduCp
          occurrences: [1, 1]
```

6.8.11.6 Example

See clause A.16.

6.8.11.7 Additional Requirements

The trunk_mode property of the VduSubCp node shall be set as false.

6.9 Group Types

6.9.1 tosca.groups.nfv.PlacementGroup

6.9.1.1 Description

PlacementGroup is used for describing the affinity or anti-affinity relationship applicable between the virtualisation containers to be created based on different VDUs, or between internal VLs to be created based on different VnfVirtualLinkDesc(s). Table 6.9.1.1-1 specifies the declared names for this group type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.9.1.1-1: Type name, shorthand, and URI

Shorthand Name	PlacementGroup
Type Qualified Name	toscanfv:PlacementGroup
Type URI	tosca.groups.nfv.PlacementGroup

6.9.1.2 Properties

The properties of the PlacementGroup group type shall comply with the provisions set out in table 6.9.1.2-1.

Table 6.9.1.2-1: Properties

Name	Required	Type	Constraints	Description
description	yes	string		Human readable description of the group

6.9.1.3 Definition

The syntax of the PlacementGroup group type shall comply with the following definition:

```
  tosca.groups.nfv.PlacementGroup:
    derived_from: tosca.groups.Root
    description: PlacementGroup is used for describing the affinity or anti-affinity relationship
applicable between the virtualisation containers to be created based on different VDUs, or between
internal VLs to be created based on different VnfVirtualLinkDesc(s)
    properties:
      description:
        type: string
        description: Human readable description of the group
        required: true
    members: [ tosca.nodes.nfv.Vdu.Compute, tosca.nodes.nfv.VnfVirtualLink ]
```

6.9.1.4 Additional Requirements

A group with type tosca.groups.nfv.PlacementGroup shall contain more than one member with the same node type when used as the target of an AffinityRule or AntiAffinityRule policy.

6.9.1.5 Examples

See clause 6.10.10.5.

6.10 Policy Types

6.10.1 tosca.policies.nfv.InstantiationLevels

6.10.1.1 Description

The InstantiationLevels type is a policy type representing all the instantiation levels of resources to be instantiated within a deployment flavour and including default instantiation level in term of the number of VNFC instances to be created as defined in ETSI GS NFV-IFA 011 [1]. This policy concerns the whole VNF (deployment flavour) represented by the topology_template and thus has no explicit target list. Table 6.10.1.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.1.1-1: Type name, shorthand, and URI

Shorthand Name	InstantiationLevels
Type Qualified Name	toscanfv:InstantiationLevels
Type URI	tosca.policies.nfv.InstantiationLevels

6.10.1.2 Properties

The properties of the InstantiationLevels policy type shall comply with the provisions set out in table 6.10.1.2-1.

Table 6.10.1.2-1: Properties

Name	Required	Type	Constraints	Description
levels	yes	map of tosca.datatypes .nfv.InstantiationLevel		Describes the various levels of resources that can be used to instantiate the VNF using this flavour.
default_level	no	string		The default instantiation level for this flavour.

6.10.1.3 Definition

The syntax of the InstantiationLevels policy type shall comply with the following definition:

```
  tosca.policies.nfv.InstantiationLevels:
    derived_from: tosca.policies.Root
    description: The InstantiationLevels type is a policy type representing all the instantiation
levels of resources to be instantiated within a deployment flavour and including default
instantiation level in term of the number of VNFC instances to be created as defined in ETSI GS
NFV-IFA 011.
    properties:
      levels:
        type: map # key: levelId
        description: Describes the various levels of resources that can be used to instantiate the
VNF using this flavour.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.InstantiationLevel
        constraints:
          - min_length: 1
      default_level:
        type: string # levelId
        description: The default instantiation level for this flavour.
        required: false # required if multiple entries in levels
```

6.10.2 tosca.policies.nfv.VduInstantiationLevels

6.10.2.1 Description

The VduInstantiationLevels type is a policy type representing all the instantiation levels of resources to be instantiated within a deployment flavour in term of the number of VNFC instances to be created from each vdu.Compute as defined in ETSI GS NFV-IFA 011 [1].

Table 6.10.2.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.2.1-1: Type name, shorthand, and URI

Shorthand Name	VduInstantiationLevels
Type Qualified Name	toscanfv:VduInstantiationLevels
Type URI	tosca.policies.nfv.VduInstantiationLevels

6.10.2.2 Properties

The properties of the VduInstantiationLevels policy type shall comply with the provisions set out in table 6.10.2.2-1.

Table 6.10.2.2-1: Properties

Name	Required	Type	Constraints	Description
levels	yes	map of tosca.datatypes.nfv.VduLevel		Describes the Vdu.Compute levels of resources that can be used to instantiate the VNF using this flavour.

6.10.2.3 Definition

The syntax of the VduInstantiationLevels policy type shall comply with the following definition:

```
  tosca.policies.nfv.VduInstantiationLevels:
    derived_from: tosca.policies.Root
    description: The VduInstantiationLevels type is a policy type representing all the
instantiation levels of resources to be instantiated within a deployment flavour in term of the
number of VNFC instances to be created from each vdu.Compute. as defined in ETSI GS NFV-IFA 011
    properties:
      levels:
        type: map # key: levelId
        description: Describes the Vdu.Compute levels of resources that can be used to instantiate
the VNF using this flavour
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VduLevel
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.Vdu.Compute ]
```

6.10.2.4 Additional Requirements

A VduInstantiationLevels policy shall contain an entry for each instantiation level (and only for them) defined in the InstantiationLevels policy.

6.10.3 tosca.policies.nfv.VirtualLinkInstantiationLevels

6.10.3.1 Description

The VirtualLinkInstantiationLevels type is a policy type representing all the instantiation levels of virtual link resources to be instantiated within a deployment flavour as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.3.1-1 specifies the

declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.3.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkInstantiationLevels
Type Qualified Name	toscanfv:VirtualLinkInstantiationLevels
Type URI	tosca.policies.nfv.VirtualLinkInstantiationLevels

6.10.3.2 Properties

The properties of the VirtualLinkInstantiationLevels policy type shall comply with the provisions set out in table 6.10.3.2-1.

Table 6.10.3.2-1: Properties

Name	Required	Type	Constraints	Description
levels	yes	map of tosca.datatypes.nfv.VirtualLinkBitrateLevel		Describes the virtual link levels of resources that can be used to instantiate the VNF using this flavour.

6.10.3.3 Definition

The syntax of the VirtualLinkInstantiationLevels policy type shall comply with the following definition:

```
  tosca.policies.nfv.VirtualLinkInstantiationLevels:
    derived_from: tosca.policies.Root
    description: The VirtualLinkInstantiationLevels type is a policy type representing all the
instantiation levels of virtual link resources to be instantiated within a deployment flavour as
defined in ETSI GS NFV-IFA 011.
    properties:
      levels:
        type: map # key: levelId
        description: Describes the virtual link levels of resources that can be used to
instantiate the VNF using this flavour.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VirtualLinkBitrateLevel
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VnfVirtualLink ]
```

6.10.3.4 Additional Requirements

A VirtualLinkInstantiationLevels policy shall contain an entry for each instantiation level (and only for them) defined in the InstantiationLevels policy.

6.10.4 Void

6.10.5 tosca.policies.nfv.ScalingAspects

6.10.5.1 Description

The ScalingAspects type is a policy type representing the scaling aspects used for horizontal scaling as defined in ETSI GS NFV-IFA 011 [1]. This policy concerns the whole VNF (deployment flavour) represented by the topology_template and thus has no explicit target list. Table 6.10.5.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.5.1-1: Type name, shorthand, and URI

Shorthand Name	ScalingAspects
Type Qualified Name	toscanfv:ScalingAspects
Type URI	tosca.policies.nfv.ScalingAspects

6.10.5.2 Properties

The properties of the ScalingAspects policy type shall comply with the provisions set out in table 6.10.5.2-1.

Table 6.10.5.2-1: Properties

Name	Required	Type	Constraints	Description
aspects	yes	Map of tosca.datatypes.nfv.ScalingAspect		Describe maximum scale level for total number of scaling steps that can be applied to a particular aspect.

6.10.5.3 Definition

The syntax of the ScalingAspects policy type shall comply with the following definition:

```
  tosca.policies.nfv.ScalingAspects:
    derived_from: tosca.policies.Root
    description: The ScalingAspects type is a policy type representing the scaling aspects used
for horizontal scaling as defined in ETSI GS NFV-IFA 011
    properties:
      aspects:
        type: map # key: aspectId
        description: Describe maximum scale level for total number of scaling steps that can be
applied to a particular aspect
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.ScalingAspect
        constraints:
          - min_length: 1
```

6.10.5.4 Additional Requirements

A scaling aspect for which only one scaling delta is defined in VduScalingAspectDeltas and VirtualLinkBitrateScalingAspectDeltas policies is called a "uniform aspect". In the case of "uniform aspect", the step_deltas properties of tosca.datatypes.nfv.ScalingAspect is optional. If step_deltas is included, the value shall be a list of entries of step_deltas.

6.10.5.5 Examples

See clause A.6.

6.10.6 tosca.policies.nfv.VduScalingAspectDeltas

6.10.6.1 Description

The VduScalingAspectDeltas type is a policy type representing the Vdu.Compute detail of an aspect deltas used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.6.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.6.1-1: Type name, shorthand, and URI

Shorthand Name	VduScalingAspectDeltas
Type Qualified Name	toscanfv:VduScalingAspectDeltas
Type URI	tosca.policies.nfv.VduScalingAspectDeltas

6.10.6.2 Properties

The properties of the VduScalingAspectDeltas policy type shall comply with the provisions set out in table 6.10.6.2-1.

Table 6.10.6.2-1: Properties

Name	Required	Type	Constraints	Description
aspect	yes	string		Represents the scaling aspect to which this policy applies.
deltas	yes	map of tosca.datatypes.nfv.VduLevel		Describes the Vdu.Compute scaling deltas to be applied for every scaling steps of a particular aspect.

6.10.6.3 Definition

The syntax of the VduScalingAspectDeltas policy type shall comply with the following definition:

```
  tosca.policies.nfv.VduScalingAspectDeltas:
    derived_from: tosca.policies.Root
    description: The VduScalingAspectDeltas type is a policy type representing the Vdu.Compute
detail of an aspect deltas used for horizontal scaling, as defined in ETSI GS NFV-IFA 011
    properties:
      aspect:
        type: string
        description: Represents the scaling aspect to which this policy applies
        required: true
      deltas:
        type: map # key: scalingDeltaId
        description: Describes the Vdu.Compute scaling deltas to be applied for every scaling
steps of a particular aspect.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VduLevel
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.Vdu.Compute ]
```

6.10.6.4 Additional Requirements

In the case of "uniform aspect", the deltas properties shall have only one entry.

If a policy definition of this type is included in a service template, a policy definition of the type VduInitialDelta defined in clause 6.10.8 of the present document shall also be included with the same target.

6.10.6.5 Examples

See clause A.6.

6.10.7 tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas

6.10.7.1 Description

The VirtualLinkBitrateScalingAspectDeltas type is a policy type representing the VnfVirtualLink detail of an aspect deltas used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.7.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.7.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkBitrateScalingAspectDeltas
Type Qualified Name	toscanfv:VirtualLinkBitrateScalingAspectDeltas
Type URI	tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas

6.10.7.2 Properties

The properties of the VirtualLinkBitrateScalingAspectDeltas policy type shall comply with the provisions set out in table 6.10.7.2-1.

Table 6.10.7.2-1: Properties

Name	Required	Type	Constraints	Description
aspect	yes	string		Represents the scaling aspect to which this policy applies.
deltas	yes	map of tosca.datatypes.nfv.VirtualLinkBitrateLevel		Describes the VnfVirtualLink scaling deltas to be applied for every scaling steps of a particular aspect.

6.10.7.3 Definition

The syntax of the VirtualLinkBitrateScalingAspectDeltas policy type shall comply with the following definition:

```
  tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas:
    derived_from: tosca.policies.Root
    description: The VirtualLinkBitrateScalingAspectDeltas type is a policy type representing the
VnfVirtualLink detail of an aspect deltas used for horizontal scaling, as defined in ETSI GS NFV-
IFA 011.
    properties:
      aspect:
        type: string
        description: Represents the scaling aspect to which this policy applies.
        required: true
      deltas:
        type: map # key: scalingDeltaId
        description: Describes the VnfVirtualLink scaling deltas to be applied for every scaling
steps of a particular aspect.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VirtualLinkBitrateLevel
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VnfVirtualLink ]
```

6.10.7.4 Additional Requirements

In the case of "uniform aspect", the deltas properties shall have only one entry.

If a policy definition of this type is included in a service template, a policy definition of the type VirtualLinkBitrateInitialDelta defined in clause 6.10.9 of the present document shall also be included with the same target.

6.10.7.5 Examples

See clause A.6.

6.10.8 tosca.policies.nfv.VduInitialDelta

6.10.8.1 Description

The VduInitialDelta type is a policy type representing the Vdu.Compute detail of an initial delta used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.8.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.8.1-1: Type name, shorthand, and URI

Shorthand Name	VduInitialDelta
Type Qualified Name	toscanfv:VduInitialDelta
Type URI	tosca.policies.nfv.VduInitialDelta

6.10.8.2 Properties

The properties of the VduInitialDelta policy type shall comply with the provisions set out in table 6.10.8.2-1.

Table 6.10.8.2-1: Properties

Name	Required	Type	Constraints	Description
initial_delta:	yes	tosca.datatypes.nfv.VduLevel		Represents the initial minimum size of the VNF.

6.10.8.3 Definition

The syntax of the VduInitialDelta policy type shall comply with the following definition:

```
  tosca.policies.nfv.VduInitialDelta:
    derived_from: tosca.policies.Root
    description: The VduInitialDelta type is a policy type representing the Vdu.Compute detail
of an initial delta used for horizontal scaling, as defined in ETSI GS NFV-IFA 011.
    properties:
      initial_delta:
        type: tosca.datatypes.nfv.VduLevel
        description: Represents the initial minimum size of the VNF.
        required: true
    targets: [ tosca.nodes.nfv.Vdu.Compute ]
```

6.10.8.4 Examples

See clause A.6.

6.10.9 tosca.policies.nfv.VirtualLinkBitrateInitialDelta

6.10.9.1 Description

The VirtualLinkBitrateInitialDelta type is a policy type representing the VnfVirtualLink detail of an initial deltas used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.9.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.9.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkBitrateInitialDelta
Type Qualified Name	toscanfv:VirtualLinkBitrateInitialDelta
Type URI	tosca.policies.nfv.VirtualLinkBitrateInitialDelta

6.10.9.2 Properties

The properties of the VirtualLinkBitrateInitialDelta policy type shall comply with the provisions set out in table 6.10.9.2-1.

Table 6.10.9.2-1: Properties

Name	Required	Type	Constraints	Description
initial_delta:	yes	tosca.datatypes.nfv.VirtualLinkBitrateLevel		Represents the initial minimum size of the VNF.

6.10.9.3 Definition

The syntax of the VirtualLinkBitrateInitialDelta policy type shall comply with the following definition:

```
  tosca.policies.nfv.VirtualLinkBitrateInitialDelta:
    derived_from: tosca.policies.Root
    description: The VirtualLinkBitrateInitialDelta type is a policy type representing the
VnfVirtualLink detail of an initial deltas used for horizontal scaling, as defined in ETSI GS
NFV-IFA 011.
    properties:
      initial_delta:
        type: tosca.datatypes.nfv.VirtualLinkBitrateLevel
        description: Represents the initial minimum size of the VNF.
        required: true
    targets: [ tosca.nodes.nfv.VnfVirtualLink ]
```

6.10.9.4 Examples

See clause A.6.

6.10.10 AffinityRule, AntiAffinityRule

6.10.10.1 Description

The AffinityRule or AntiAffinityRule describes the affinity or anti-affinity rules applicable for the defined targets:

- If there is only one node template with node type tosca.nodes.nfv.Vdu.Compute or tosca.nodes.nfv.VnfVirtualLink set as the targets, the AffinityRule or AntiAffinityRule applies between the virtualisation containers to be created based on a particular VDU, or between internal VLs to be created based on a particular VnfVirtualLinkDesc as described in ETSI GS NFV-IFA 011 [1].
- If there are more than one node templates with node type tosca.nodes.nfv.Vdu.Compute or tosca.nodes.nfv.VnfVirtualLink set as the targets, or a group with type tosca.groups.nfv.PlacementGroup which contains more than one members set as targets, the AffinityRule or AntiAffinityRule applies between the virtualisation containers to be created based on different VDUs, or between internal VLs to be created based on different VnfVirtualLinkDesc(s) as described in ETSI GS NFV-IFA 011 [1].

Tables 6.10.10.1-1 and 6.10.10.1-2 specify the declared names for the policy types. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.10.1-1: Type name, shorthand, and URI

Shorthand Name	AffinityRule
Type Qualified Name	toscanfv:AffinityRule
Type URI	tosca.policies.nfv.AffinityRule

Table 6.10.10.1-2: Type name, shorthand, and URI

Shorthand Name	AntiAffinityRule
Type Qualified Name	toscanfv:AntiAffinityRule
Type URI	tosca.policies.nfv.AntiAffinityRule

6.10.10.2 Properties

The properties of the AffinityRule and AntiAffinityRule types shall comply with the provisions set out in table 6.10.10.2-1.

Table 6.10.10.2-1: Properties

Name	Required	Type	Constraints	Description
scope	Yes	String	Possible values are "nfvi_pop", "zone", "zone_group", "nfvi_node", "network_link_and_node".	Specifies the scope of the local affinity rule. See note 1.
nfvi_maintenance_group_info	no	tosca.datatypes.nfv.NfviMaintenanceInfo		Provides information on the impact tolerance and rules to be observed when a group of instances based on the same Vdu.Compute node is impacted during NFVI operation and maintenance (e.g. NFVI resource upgrades). See notes 2 and 3.

NOTE 1: When used in an anti-affinity relationship, the "network_link_and_node" scope is conceptually similar to link and node disjoint paths capabilities used commonly in network Traffic Engineering (TE). For example, as in Fast Reroute Resource Reservation Protocol Traffic Engineering (RSVP-TE) for Label-Switched Path (LSP) tunnels as introduced in IETF RFC 4090 [i.17].

NOTE 2: The nfvi_maintenance_info property may only be present if there is only one node template with node type tosca.nodes.nfv.Vdu.Compute set as the targets.

NOTE 3: An NFVI level operation (e.g. restart of a virtual machine) can impact a VNF and the VNF can be able to tolerate only a limited number of such impacts simultaneously. The nfvi_maintenance_group_info provides constraints related to the tolerated simultaneous impacts on a group of resources so that negative impact on VNF functionality can be avoided during NFVI maintenance operations.

6.10.10.3 targets

The targets of the AffinityRule and AntiAffinityRule policy types shall comply with the provisions set out in table 6.10.10.3-1.

Table 6.10.10.3-1: Targets

Name	Required	Type	Constraints	Description
targets	Yes	string[]	Valid types: tosca.nodes.nfv.Vdu.Compute tosca.nodes.nfv.VnfVirtualLink tosca.groups.nfv.PlacementGroup	In case of LocalAffinityOrAntiAffinityRule as defined in ETSI GS NFV-IFA 011 [1], the valid type of the targets is tosca.nodes.nfv.Vdu.Compute or tosca.nodes.nfv.VnfVirtualLink. In case of affinityOrAntiAffinityGroup as defined in ETSI GS NFV-IFA 011 [1], the valid types of the targets are: tosca.nodes.nfv.Vdu.Compute and tosca.nodes.nfv.VnfVirtualLink or a tosca.groups.nfv.PlacementGroup.

6.10.10.4 Definition

The syntax of the AffinityRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.AffinityRule:
    derived_from: tosca.policies.Placement
    description: The AffinityRule describes the affinity rules applicable for the defined targets
    properties:
      scope:
        type: string
        description: scope of the rule is an NFVI_node, an NFVI_PoP, etc.
        required: true
        constraints:
          - valid_values: [ nfvi_node, zone, zone_group, nfvi_pop, network_link_and_node ]
      nfvi_maintenance_group_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the impact tolerance and rules to be observed when a
group of instances based on the same Vdu.Compute node is impacted during NFVI operation and
maintenance (e.g. NFVI resource upgrades).
        required: false
    targets: [ tosca.nodes.nfv.Vdu.Compute, tosca.nodes.nfv.VnfVirtualLink,
tosca.groups.nfv.PlacementGroup ]
```

The syntax of the AntiAffinityRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.AntiAffinityRule:
    derived_from: tosca.policies.Placement
    description: The AntiAffinityRule describes the anti-affinity rules applicable for the defined
targets
    properties:
      scope:
        type: string
        description: scope of the rule is an NFVI_node, an NFVI_PoP, etc.
        required: true
        constraints:
          - valid_values: [ nfvi_node, zone, zone_group, nfvi_pop, network_link_and_node ]
      nfvi_maintenance_group_info:
        type: tosca.datatypes.nfv.NfviMaintenanceInfo
        description: Provides information on the impact tolerance and rules to be observed when a
group of instances based on the same Vdu.Compute node is impacted during NFVI operation and
maintenance (e.g. NFVI resource upgrades).
        required: false
    targets: [ tosca.nodes.nfv.Vdu.Compute, tosca.nodes.nfv.VnfVirtualLink,
tosca.groups.nfv.PlacementGroup ]
```

6.10.10.5 Examples

The following example template fragments illustrate the concepts:

```
node_templates:
  VDU_1:
   type: tosca.nodes.nfv.Vdu.Compute

policies:
  policy_affinity_local_VDU_1:
   type: tosca.policies.nfv.AffinityRule
   targets: [ VDU_1 ]
   properties:
    scope: nfvi_node
```

The above example illustrates a local affinity rule for VDU_1.

```
node_template:
  VDU_1:
   type: tosca.nodes.nfv.Vdu.Compute

  VDU_2:
   type: tosca.nodes.nfv.Vdu.Compute

groups:
  affinityOrAntiAffinityGroup_1:
   type: tosca.groups.nfv.PlacementGroup
   members: [ VDU_1, VDU_2 ]

policies:
  policy_antiaffinity_group_1:
```

```
    type: tosca.policies.nfv.AntiAffinityRule
    targets: [ affinityOrAntiAffinityGroup_1 ]
    properties:
     scope: nfvi_node
```

The above example illustrates an anti-affinity policy among a group which contains VDU_1 and VDU_2 as members.

6.10.11 tosca.policies.nfv.Abstract.SecurityGroupRule

6.10.11.1 Description

The Abstract.SecurityGroupRule policy type is defined in clause 9.10.1 of the present document.

6.10.12 tosca.policies.nfv.SupportedVnfInterface

6.10.12.1 Description

The SupportedVnfInterface policy type represents interfaces produced by a VNF, the details to access them and the applicable connection points to use to access these interfaces. It corresponds to the VnfInterfaceDetails information element defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.12.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.12.1-1: Type name, shorthand, and URI

Shorthand Name	SupportedVnfInterface
Type Qualified Name	toscanfv:SupportedVnfInterface
Type URI	tosca.policies.nfv.SupportedVnfInterface

6.10.12.2 Properties

The properties of the SupportedVnfInterface policy type shall comply with the provisions set out in table 6.10.12.2-1.

Table 6.10.12.2-1: Properties

Name	Required	Type	Constraints	Description
interface_name	yes	string	Valid values: See YAML definition constraints	Identifies an interface produced by the VNF.
details	no	tosca.datatypes.nfv.InterfaceDetails		Provide additional data to access the interface endpoint (e.g. API URI prefix).

6.10.12.3 Definition

The syntax of the SupportedVnfInterface policy type shall comply with the following definition:

```
  tosca.policies.nfv.SupportedVnfInterface:
    derived_from: tosca.policies.Root
    description: this policy type represents interfaces produced by a VNF, the details to access
them and the applicable connection points to use to access these interfaces
    properties:
      interface_name:
        type: string
        description: Identifies an interface produced by the VNF.
        required: true
        constraints:
          - valid_values: [ vnf_indicator, vnf_configuration, vnf_lcm_coordination ]
      details:
        type: tosca.datatypes.nfv.InterfaceDetails
        description: Provide additional data to access the interface endpoint
        required: false
    targets: [ tosca.nodes.nfv.VnfExtCp, tosca.nodes.nfv.VduCp ]
```

6.10.12.4 Additional requirements

The valid targets for this policy type shall be the node templates representing the connection point descriptors from which to instantiate the connection point instances through which the interfaces can be accessed. This may be a VnfExtCp node template or a VduCp node template when an internal connection point is re-exposed externally.

6.10.12.5 Example

```
policies:
  policy_interface_1:
   type: tosca.policies.nfv.SupportedVnfInterface
   targets: [ MyVnfmFacingExtCp ]
   properties:
    interface_name: vnf_indicator
    details:
      uri_components:
       scheme: https
       authority:
        host: myvnf.example.com
```

6.10.13 tosca.policies.nfv.SecurityGroupRule

6.10.13.1 Description

The SecurityGroupRule type is a policy type specifying the matching criteria for the ingress and/or egress traffic to and from visited connection points as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.13.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.13.1-1: Type name, shorthand, and URI

Shorthand Name	SecurityGroupRule
Type Qualified Name	toscanfv:SecurityGroupRule
Type URI	tosca.policies.nfv.SecurityGroupRule

6.10.13.2 Properties

None.

6.10.13.3 targets

The targets of the SecurityGroupRule policy types shall comply with the provisions set out in table 6.10.13.3-1.

Table 6.10.13.3-1: Targets

Name	Required	Type	Constraints	Description
targets	yes	string[]	Valid types: tosca.nodes.nfv.VduCp, tosca.nodes.nfv.VnfExtCp	Target connection points of VduCp and/or VnfExtCp.

6.10.13.4 Definition

The syntax of the SecurityGroupRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.SecurityGroupRule:
    derived_from: tosca.policies.nfv.Abstract.SecurityGroupRule
    description: The SecurityGroupRule type is a policy type specified the matching criteria
for the ingress and/or egress traffic to/from visited connection points as defined in ETSI GS
NFV-IFA 011.
    targets: [ tosca.nodes.nfv.VduCp, tosca.nodes.nfv.VnfExtCp ]
```

6.10.13.5 Additional Requirements

None.

6.10.14 tosca.policies.nfv.VnfIndicator

6.10.14.1 Description

The VnfIndicator is a base policy type for defining VNF indicator specific policies that define the conditions to assess and the action to perform when a VNF indicator changes value as defined in ETSI GS NFV-IFA 011 [1].

Table 6.10.14.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.14.1-1: Type name, shorthand, and URI

Shorthand Name	VnfIndicator
Type Qualified Name	toscanfv:VnfIndicator
Type URI	tosca.policies.nfv.VnfIndicator

6.10.14.2 Properties

The properties of the VnfIndicator policy type shall comply with the provisions set out in table 6.10.14.2-1.

Table 6.10.14.2-1: Properties

Name	Required	Type	Constraints	Description
source	yes	string	valid values: See YAML definition constraints	Describe the source of the indicator.

6.10.14.3 Definition

The syntax of the VnfIndicator policy type shall comply with the following definition:

```
  tosca.policies.nfv.VnfIndicator:
    derived_from: tosca.policies.Root
    description: The VnfIndicator policy type is a base policy type for defining VNF indicator
specific policies that define the conditions to assess and the action to perform when a VNF
indicator changes value as defined in ETSI GS NFV-IFA 011.
    properties:
      source:
        type: string
        description: Describe the source of the indicator.
        required: true
        constraints:
          - valid_values: [ vnf, em, both_vnf_and_em ]
    targets: [ tosca.nodes.nfv.VNF ]
```

6.10.14.4 Additional requirements

The VNFD service template may include VNF indicator specific policies of VnfIndicator type with the following requirements:

a) it shall include one or more trigger definitions which:

- shall include an event with a value equal to the full name of a notification in the VnfIndicator interface definition of the VNF node where the policy applies;
- may include a condition definition which can assert the value of vnf indicator attributes and other node attributes using arbitrary AND and OR combinations of the individual assertions;
- may include an action invoking one or multiple operations of the Vnflcm interface;

b) the target shall be set to the node template to which the policy applies, i.e. to the node template of the VNF specific type present in the topology template that represents a particular deployment flavour.

6.10.15 tosca.policies.nfv.VnfPackageChange

6.10.15.1 Description

The VnfPackageChange type is a policy type specifying the processes and rules to be used for performing the resource related tasks, to change VNF instance to a different VNF Package (destination package) as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.15.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.15.1-1: Type name, shorthand, and URI

Shorthand Name	VnfPackageChange
Type Qualified Name	toscanfv:VnfPackageChange
Type URI	tosca.policies.nfv.VnfPackageChange

6.10.15.2 Properties

The properties of the VnfPackageChange policy type shall comply with the provisions set out in table 6.10.15.2-1.

Table 6.10.15.2-1: Properties

Name	Required	Type	Constraints	Description
selector	yes	tosca.datatypes.nfv.VnfPackageChangeSelector		Information to identify the source and destination VNFD for the change, and the related deployment flavours.
modification_qualifier	yes	string	up, down	Specifies the type of modification resulting from transitioning from srcVnfdId to dstVnfdId. The possible values are UP indicating that the destination VNF version is newer than the source version, DOWN indicating that the destination VNF version is older than the source version.
additional_modification_description	no	string		Additional information to qualify further the change between the two versions.
component_mappings	no	list of tosca.datatypes.nfv.VnfPackageChangeComponentMapping		Mapping information related to identifiers of components in source VNFD and destination VNFD that concern to the change process.
destination_flavour_id	yes	string		Identifies the deployment flavour in the destination VNF package for which this change applies. The flavour ID is defined in the destination VNF package.
actions	no	list of string		List of applicable supported LCM coordination action names specified in this VNFD (action_name) as a TOSCA policy of a type derived from tosca.policies.nfv.LcmCoordinationAction.
referenced_coordination_actions	no	list of string		List of names of coordination actions not specified within this VNFD as a TOSCA policy of a type derived from tosca.policies.nfv.LcmCoordinationAction. See note.
NOTE: Naming conventions for coordination names are defined in names as specified in clause 10.7 of ETSI GS NFV-SOL 002 [22].				

6.10.15.3 Definition

The syntax of the VnfPackageChange policy type shall comply with the following definition:

```
  tosca.policies.nfv.VnfPackageChange:
    derived_from: tosca.policies.Root
    description: policy type specifying the processes and rules to be used for performing the
resource related tasks, to change VNF instance to a different VNF Package (destination
package)
    properties:
      selector:
        type: tosca.datatypes.nfv.VnfPackageChangeSelector
        description: Information to identify the source and destination VNFD for the change,
and the related deployment flavours.
        required: true
      modification_qualifier:
        type: string
        description: Specifies the type of modification resulting from transitioning from
srcVnfdId to dstVnfdId. The possible values are UP indicating that the destination VNF version
is newer than the source version, DOWN indicating that the destination VNF version is older
than the source version.
        constraints: [ valid_values: [ up, down ] ]
        required: true
      additional_modification_description:
        type: string
        description: Additional information to qualify further the change between the two
versions.
        required: false
      component_mappings:
        type: list
        entry_schema:
          type: tosca.datatypes.nfv.VnfPackageChangeComponentMapping
        description: Mapping information related to identifiers of components in source VNFD
and destination VNFD that concern to the change process.
        required: false
      destination_flavour_id:
        type: string
        description: Identifies the deployment flavour in the destination VNF package for
which this change applies. The flavour ID is defined in the destination VNF package.
        required: true
      actions:
        type: list
        description: List of applicable supported LCM coordination action names (action_name)
specified in this VNFD as a TOSCA policy of a type derived from
tosca.policies.nfv.LcmCoordinationAction.
        required: false
        entry_schema:
          type: string
      referenced_coordination_actions:
        type: list
        description: List of names of coordination actions not specified within this VNFD as a
TOSCA policy of a type derived from tosca.policies.nfv.LcmCoordinationAction.
        required: false
        entry_schema:
          type: string
    targets: [ tosca.nodes.nfv.VNF ]
```

6.10.15.4 Additional Requirements

The VnfPackageChange specific type policy shall have exactly one trigger with an event and an action.

The event value shall be set to change_current_package_notification notification of Vnflcm interface.

The target shall be set to the node template to which the policy applies, i.e. to the node template of the VNF specific type present in the topology template that represents a particular deployment flavour.

The action value shall be set to either change_current_package operation on the Vnflcm (in case the same LCM script or no LCM script with the same set of "additionalParams" or no "additionalParams" is suitable for all change paths) or one of the VNF-specific operations on the ChangeCurrentVnfPackage interface (in case different change paths require different LCM scripts or no LCM script potentially with different sets of "additionalParams" or no "additionalParams").

The policy shall be applied when the actual values of the descriptor_id and flavour_id of the source VNF type and the descriptor_id of the destination VNF type match the source_descriptor_id, destination_descriptor_id and source_flavour_id properties, respectively, of the selector in the policy.

VNF-specific coordination actions shall be declared with their parameters in data types derived from tosca.datatypes.nfv.VnfLcmOpCoord (see clause 6.2.65), and a interface_name property of the tosca.policies.nfv.SupportedVnfInterface set to "vnf_lcm_coordination" shall be specified in the related deployment flavour to signal that this interface is exposed by the VNF.

6.10.15.5 Example

The following example template illustrates a VNFD which is supporting VNF package change info via using VnfPackageChange policy, additional_parameters input for each case of the selector and VNF specific interface (tosca.interfaces.nfv.ChangeCurrentVnfPackage), LCM coordination actions, and other data types. A policy definition of change_from_version_1 and change_to_version_1 has a trigger. The action will be taken when the conditions of the selector values are satisfied. The policy has an event associated to the notification of tosca.interfaces.nfv.Vnflcm.change_current_package_notification.

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
..

node_types:
  MyCompany.SunshineDB.2_0.2_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5 ]
        default: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '2.0' ]
        default: '2.0'
      descriptor_version:
        type: string
        constraints: [ equal: '2.0' ]
        default: '2.0'
      flavour_id:
        type: string
        constraints: [ equal: default ]
        default: default
      ..
    interfaces:
      MyCompanyChangeCurrentVnfPackage:
        type: MyCompany.interfaces.nfv.ChangeCurrentVnfPackage

interface_types:
  MyCompany.interfaces.nfv.ChangeCurrentVnfPackage
    derived_from: tosca.interfaces.nfv.ChangeCurrentVnfPackage
    operations:
      change_from_version_1:
        description: operation for change from version 1 to 2
        inputs:
          additional_parameters:
            type: MyCompany.datatypes.nfv.VnfChangeFromVersion1AdditionalParameters
      change_to_version_1:
        description: operation for change from version 2 to 1
        inputs:
          additional_parameters:
            type: MyCompany.datatypes.nfv.VnfChangeToVersion1AdditionalParameters

data_types:
  ..
```

```
  MyCompany.datatypes.nfv.VnfChangeFromVersion1AdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
      parameter_2:
        type: string

  MyCompany.datatypes.nfv.VnfChangeToVersion1AdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      parameter_3:
        type: string
      parameter_4:
        type: string

  MyCompany.datatypes.nfv.VnfChangeFromVersion1OpCoord:
    derived_from: tosca.datatypes.nfv.VnfLcmOpCoord
    properties:
      description:
        type: string
        required: true
        constraints: [ equal: 'MyCompany vnf change from version 1 operation coordination
information' ]
        default: 'MyCompany vnf change from version 1 operation coordination information'
      endpoint_type:
        type: string
        required: true
        constraints: [ equal: 'vnf' ]
        default: 'vnf'
      coordination_stage:
        type: string
        required: true
        constraints: [ equal: 'start' ]
        default: 'start'
      input_parameters:
        type: MyCompany.datatypes.nfv.VnfChangeFromVersion1InputOpCoordParams
        required: true
      output_parameters:
        type: MyCompany.datatypes.nfv.VnfChangeGeneralOutputOpCoordParams
        required: true

  MyCompany.datatypes.nfv.VnfChangeToVersion1OpCoord:
    derived_from: tosca.datatypes.nfv.VnfLcmOpCoord
    properties:
      description:
        type: string
        required: true
        constraints: [ equal: 'MyCompany vnf change to version 1 operation coordination
information' ]
        default: 'MyCompany vnf change to version 1 operation coordination information'
      endpoint_type:
        type: string
        required: true
        constraints: [ equal: 'vnf' ]
        default: 'vnf'
      coordination_stage:
        type: string
        required: true
        constraints: [ equal: 'start' ]
        default: 'start'
      input_parameters:
        type: MyCompany.datatypes.nfv.VnfChangeToVersion1InputOpCoordParams
        required: true
      output_parameters:
        type: MyCompany.datatypes.nfv.VnfChangeGeneralOutputOpCoordParams
        required: true


  MyCompany.datatypes.nfv.InstantiateOpCoord:
    derived_from: tosca.datatypes.nfv.VnfLcmOpCoord
    properties:
      description:
        type: string
        required: true
        constraints: [ equal: 'MyCompany vnf instantiate operation coordination information' ]
        default: 'MyCompany vnf instantiate operation coordination information'
      endpoint_type:
        type: string
```

```
        required: true
        constraints: [equal: 'vnf' ]
        default: 'vnf'
      coordination_stage:
        type: string
        required: true
        constraints: [ equal: 'start' ]
        default: 'start'
      input_parameters:
        type: MyCompany.datatypes.nfv.InstantiateInputOpCoordParams
        required: true

  MyCompany.datatypes.nfv.InstantiateInputOpCoordParams:
    derived_from: tosca.datatypes.nfv.InputOpCoordParams
    properties:
      data1:
        type: string
        required: true
        constraints: [ equal: 'value_1' ]
        default: 'value_1'

  MyCompany.datatypes.nfv.VnfChangeFromVersion1InputOpCoordParams:
    derived_from: tosca.datatypes.nfv.InputOpCoordParams
    properties:
      data2:
        type: string
        required: true
        constraints: [ equal: 'value_2' ]
        default: 'value_2'

  MyCompany.datatypes.nfv.VnfChangeToVersion1InputOpCoordParams:
    derived_from: tosca.datatypes.nfv.InputOpCoordParams
    properties:
      data3:
        type: string
        required: true
        constraints: [ equal: 'value_3' ]
        default: 'value_3'

MyCompany.datatypes.nfv.VnfChangeGeneralOutputOpCoordParams:
    derived_from: tosca.datatypes.nfv.OutputOpCoordParams
    properties:
      data4:
        type: string
        required: true
        constraints: [ equal: 'value_4' ]
        default: 'value_4'

policy_types

    tosca.policies.nfv.LcmCoordinationAction.InstantiateHelloHandshake:
      derived_from: tosca.policies.nfv.LcmCoordinationAction
      properties:
        action:
          type: MyCompany.datatypes.nfv.InstantiateOpCoord

    tosca.policies.nfv.VnfChangeFromVersion1Action1OpCoord:
      derived_from: tosca.policies.nfv.LcmCoordinationAction
        properties:
          action:
            type: MyCompany.datatypes.nfv.VnfChangeFromVersion1OpCoord

    tosca.policies.nfv.VnfChangeToVersion1Action1OpCoord:
      derived_from: tosca.policies.nfv.LcmCoordinationAction
        properties:
          action:
            type: MyCompany.datatypes.nfv.VnfChangeToVersion1OpCoord

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.2_0.2_0
    ..

  node_templates:
    sunshine_db:
      type: MyCompany.SunshineDB.2_0.2_0
      ..
      interfaces:
```

```
        MyCompanyChangeCurrentVnfPackage:
          operations:
          ..
            change_from_version_1:
              implementation: change-from-version-1.workbook.mistral.yaml
            change_to_version_1:
              implementation: change-to-version-1.workbook.mistral.yaml


    server:
      type: MyCompany.nodes.nfv.Vdu.Aux
      ..

    volume:
      type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
      ..

    server_internal_cp:
      type: tosca.nodes.nfv.VduCp
      ..

    internal_vl:
      type: tosca.nodes.nfv.VnfVirtualLink
      ..

  policies:
    ..

    - instantiation_levels:
        type: tosca.policies.nfv.InstantiationLevels
        properties:
          levels:
            single:
              description: ..
            quadruple:
              description: ..
          default_level: single

    ..
    - change_from_version_1:
        type: tosca.policies.nfv.VnfPackageChange
        properties:
          selector:
            source_descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
            destination_descriptor_id: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5
            source_flavour_id: simple
          modification_qualifier: up
          additional_modification_description: ..
          component_mappings:
            - component_type: vdu
              source_id: dbBackend
              destination_id: server
              description: ..
            - component_type: virtual_storage
              source_id: mariaDbStorage
              destination_id: volume
              description: ..
            - component_type: instantiation_level
              source_id: single
              destination_id: default
              description: ..
            - component_type: deployment_flavour
              source_id: simple
              destination_id: default
              description: ..
          destination_flavour_id: default
          actions:
            - vnd.mycompany.VnfChangeFromVersion1Action1
        triggers:
           change_from_version_1:
              event: tosca.interfaces.nfv.Vnflcm.change_current_package_notification
              action:
                - call_operation:
MyCompanyChangeCurrentVnfPackage.change_from_version_1
        targets: [sunshine_db]

    - change_to_version_1:
        type: tosca.policies.nfv.VnfPackageChange
```

```
        properties:
          selector:
            source_descriptor_id: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5
            destination_descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
            source_flavour_id: default
          modification_qualifier: down
          additional_modification_description: ..
          component_mappings:
            - component_type: vdu
              source_id: server
              destination_id: dbBackend
              description: ..
            - component_type: virtual_storage
              source_id: volume
              destination_id: mariaDbStorage
              description: ..
            - component_type: instantiation_level
              source_id: default
              destination_id: single
              description: ..
            - component_type: deployment_flavour
              source_id: default
              destination_id: simple
              description: ..
          destination_flavour_id: simple
          actions:
            - vnd.mycompany.VnfChangeToVersion1Action1
        triggers:
           change_to_version_1:
              event: tosca.interfaces.nfv.Vnflcm.change_current_package_notification
              action:
                - call_operation: MyCompanyChangeCurrentVnfPackage.change_to_version_1
        targets: [sunshine_db]

    - instantiate_HelloHandshake:
        type: tosca.policies.nfv.LcmCoordinationAction.InstantiateHelloHandshake
        properties:
          action_name: vnd.mycompany.hellohandshake

    - instantiate_OpCoord:
        type: tosca.policies.nfv.LcmCoordinationsForLcmOperation
        properties:
          vnf_lcm_operation: instantiate
          actions:
            - vnd.mycompany.hellohandshake

    - terminate_OpCoord:
        type: tosca.policies.nfv.LcmCoordinationsForLcmOperation
        properties:
          vnf_lcm_operation: terminate
          referenced_coordination_actions:
            - etsi.nfv.take-vnf-out-of-service

    - VnfChangeFromVersion1Action1_OpCoord:
        type: tosca.policies.nfv.LcmCoordinationAction
        properties:
          action_name: vnd.mycompany.VnfChangeFromVersion1Action1

    - VnfChangeToVersion1Action1_OpCoord:
        type: tosca.policies.nfv.LcmCoordinationAction
        properties:
          action_name: vnd.mycompany.VnfChangeToVersion1Action1
```

The following example template illustrates a VNFD which is supporting VNF package change info via using VnfPackageChange policy, without additional_parameters input and Vnflcm interface operation. A policy definition of change_from_version_1 and change_to_version_1 has a trigger. The action will be taken when the conditions of the selector values are satisfied. The policy has an event associated to the notification of tosca.interfaces.nfv.Vnflcm.change_current_package_notification.

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
..

node_types:
  MyCompany.SunshineDB.2_0.2_0:
    derived_from: tosca.nodes.nfv.VNF
```

```
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5 ]
        default: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '2.0' ]
        default: '2.0'
      descriptor_version:
        type: string
        constraints: [ equal: '2.0' ]
        default: '2.0'
      flavour_id:
        type: string
        constraints: [ equal: default ]
        default: default
      ..
    interfaces:
      MyCompanyVnflcm:
        type: tosca.interfaces.nfv.Vnflcm


topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.2_0.2_0
    ..

  node_templates:
    sunshine_db:
      type: MyCompany.SunshineDB.2_0.2_0
      ..
      interfaces:
        Vnflcm:
          operations:
            ..
            change_current_package:

    server:
      type: MyCompany.nodes.nfv.Vdu.Aux
      ..

    volume:
      type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
      ..

    server_internal_cp:
      type: tosca.nodes.nfv.VduCp
      ..

    internal_vl:
      type: tosca.nodes.nfv.VnfVirtualLink
      ..

  policies:
    ..

    - instantiation_levels:
        type: tosca.policies.nfv.InstantiationLevels
        properties:
          levels:
            single:
              description: ..
            quadruple:
              description: ..
          default_level: single

    ..
    - change_from_version_1:
        type: tosca.policies.nfv.VnfPackageChange
```

```
      properties:
        selector:
          source_descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
          destination_descriptor_id: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5
          source_flavour_id: simple
        modification_qualifier: up
        additional_modification_description: ..
        component_mappings:
          - component_type: vdu
            source_id: dbBackend
            destination_id: server
            description: ..
          - component_type: virtual_storage
            source_id: mariaDbStorage
            destination_id: volume
            description: ..
          - component_type: instantiation_level
            source_id: single
            destination_id: default
            description: ..
          - component_type: deployment_flavour
            source_id: simple
            destination_id: default
            description: ..
        destination_flavour_id: default
      triggers:
         change_from_version_1:
            event: tosca.interfaces.nfv.Vnflcm.change_current_package_notification
            action:
              - call_operation: Vnflcm.change_current_package
      targets: [ sunshine_db ]

  - change_to_version_1:
      type: tosca.policies.nfv.VnfPackageChange
      properties:
        selector:
          source_descriptor_id: ebc68e34-0cfa-40ba-8b45-9caa31f9dcb5
          destination_descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
          source_flavour_id: default
        modification_qualifier: down
        additional_modification_description: ..
        component_mappings:
          - component_type: vdu
            source_id: server
            destination_id: dbBackend
            description: ..
          - component_type: virtual_storage
            source_id: volume
            destination_id: mariaDbStorage
            description: ..
          - component_type: instantiation_level
            source_id: default
            destination_id: single
            description: ..
          - component_type: deployment_flavour
            source_id: default
            destination_id: simple
            description: ..
        destination_flavour_id: simple
      triggers:
         change_to_version_1:
            event: tosca.interfaces.nfv.Vnflcm.change_current_package_notification
            action:
              - call_operation: Vnflcm.change_current_package
      targets: [ sunshine_db ]
```

6.10.16 tosca.policies.nfv.LcmCoordinationAction

6.10.16.1 Description

The LcmCoordinationAction type is a base type for deriving policy types which describe the LCM coordination actions supported by a VNF and/or expected to be supported by its EM. This policy concerns the whole VNF (deployment flavour) represented by the topology_template and thus has no explicit target list. Table 6.10.16.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.16.1-1: Type name, shorthand, and URI

Shorthand Name	LcmCoordinationAction
Type Qualified Name	toscanfv:LcmCoordinationAction
Type URI	tosca.policies.nfv.LcmCoordinationAction

6.10.16.2 Properties

The properties of the LcmCoordinationAction policy type shall comply with the provisions set out in table 6.10.16.2-1.

Table 6.10.16.2-1: Properties

Name	Required	Type	Constraints	Description
action_name	yes	string		Coordination action name. See note 1
action	yes	tosca.datatypes.nfv.VnfLcmOpCoord		Describes a set of information needed for coordination action in the VNF LCM operation. See note 2
NOTE 1: The action_name shall comply with naming conventions as specified in in clause 10.7 of ETSI GS NFV-SOL 002 [22]. NOTE 2: Represents a place holder for specifying actions of a VNF-specific type derived from tosca.datatypes.nfv.VnfLcmOpCoord.				

6.10.16.3 Definition

The syntax of the LcmCoordinationAction policy type shall comply with the following definition:

```
  tosca.policies.nfv.LcmCoordinationAction:
    derived_from: tosca.policies.Root
    description: The LcmCoordinationAction type is a policy type representing the LCM coordination
actions supported by a VNF and/or expected to be supported by its EM for a particular VNF LCM
operation. This policy concerns the whole VNF (deployment flavour) represented by the
topology_template and thus has no explicit target list.
    properties:
      action_name:
        type: string
        description: Coordination action name.
        required: true
      action:  #represents a place holder for specifying actions of a VNF-specific type derived
from tosca.datatypes.nfv.VnfLcmOpCoord
        type: tosca.datatypes.nfv.VnfLcmOpCoord
        description: Describes a set of information needed for coordination action in the VNF LCM
operation.
        required: true
```

6.10.16.4 Additional Requirements

A LcmCoordinationAction policy shall contain only one LCM coordination action. The VNFD shall define a policy type derived from tosca.policies.nfv.LcmCoordinationAction for each of VNF LCM coordination action. The LCM coordination action specific derived policy type shall contain a property 'action' of a datatype derived from tosca.datatypes.nfv.VnfLcmCoord.

The interface_name property of the tosca.policies.nfv.SupportedVnfInterface set to "vnf_lcm_coordination" shall be specified in the related deployment flavour to signal that this interface is exposed by the VNF.

6.10.17 tosca.policies.nfv.LcmCoordinationsForLcmOperation

6.10.17.1 Description

The LcmCoordinationsForLcmOperation type is a policy type representing supported LCM coordination actions associated to a VNF LCM operation. This policy concerns the whole VNF (deployment flavour) represented by the topology_template and thus has no explicit target list. Table 6.10.17.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.17.1-1: Type name, shorthand, and URI

Shorthand Name	LcmCoordinationsForLcmOperation
Type Qualified Name	toscanfv:LcmCoordinationsForLcmOperation
Type URI	tosca.policies.nfv.LcmCoordinationsForLcmOperation

6.10.17.2 Properties

The properties of the LcmCoordinationsForLcmOperation policy type shall comply with the provisions set out in table 6.10.17.2-1.

Table 6.10.17.2-1: Properties

Name	Required	Type	Constraints	Description
vnf_lcm_operation	yes	string	Valid values: instantiate, scale, scale_to_level, change_flavour, terminate, heal, operate, change_ext_conn, modify_info, create_snapshot, revert_to_snapshot	The VNF LCM operation the LCM coordination actions are associated with.
actions	no	list of string		List of applicable supported LCM coordination action names (action_name) specified in this VNFD as a TOSCA policy of a type derived from tosca.policies.nfv.LcmCoordinationAction. See note 1 and 2.
referenced_coordination_actions	no	list of string		List of names of coordination actions not specified within this VNFD as a TOSCA policy of a type derived from tosca.policies.nfv.LcmCoordinationAction. See notes 1 and 2.
NOTE 1: At least one of the actions and referenced_coordination_actions properties shall be present. NOTE 2: Naming conventions for coordination names are defined in names as specified in clause 10.7 of ETSI GS NFV-SOL 002 [22].				

6.10.17.3 Definition

The syntax of the LcmCoordinationsForLcmOperation policy type shall comply with the following definition:

```
  tosca.policies.nfv.LcmCoordinationsForLcmOperation:
    derived_from: tosca.policies.Root
    description: The LcmCoordinationsForLcmOperation type is a policy type representing supported
LCM coordination actions associated to a VNF LCM operation. This policy concerns the whole VNF
(deployment flavour) represented by the topology_template and thus has no explicit target list.
    properties:
      vnf_lcm_operation:
        type: string
        description: The VNF LCM operation the LCM coordination actions are associated with.
        required: true
        constraints:
          - valid_values: [instantiate, scale, scale_to_level, change_flavour, terminate, heal,
operate, change_ext_conn, modify_info, create_snapshot, revert_to_snapshot ]
      actions:
        type: list
        description: List of applicable supported LCM coordination action names (action_name)
specified in this VNFD as a TOSCA policy of a type derived from
tosca.policies.nfv.LcmCoordinationAction.
        required: false
        entry_schema:
          type: string
      referenced_coordination_actions:
        type: list
        description: List of names of coordination actions not specified within this VNFD as a
TOSCA policy of a type derived from tosca.policies.nfv.LcmCoordinationAction.
        required: false
        entry_schema:
          type: string
```

6.10.17.4 Additional Requirements

The VNFD may define one LcmCoordinationsForLcmOperation policy per each VNF LCM operation (vnf_lcm_operation).

VNF lifecycle management coordination actions are invoked by the VNFM towards the VNF instance or towards operation supporting management systems (e.g. EM). They can be standardized or VNF-specific. To distinguish between both categories, clause X.7 of ETSI GS NFV-SOL 002 [22], clause 5.7.6 defines namespaces for the values of the coordination action names.

6.10.18 tosca.policies.nfv.VipCpScalingAspectDeltas

6.10.18.1 Description

The VipCpScalingAspectDeltas type is a policy type representing the VipCp detail of an aspect deltas used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.18.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.18.1-1: Type name, shorthand, and URI

Shorthand Name	VipCpScalingAspectDeltas
Type Qualified Name	toscanfv:VipCpScalingAspectDeltas
Type URI	tosca.policies.nfv.VipCpScalingAspectDeltas

6.10.18.2 Properties

The properties of the VipCpScalingAspectDeltas policy type shall comply with the provisions set out in table 6.10.18.2-1.

Table 6.10.18.2-1: Properties

Name	Required	Type	Constraints	Description
aspect	yes	string		Represents the scaling aspect to which this policy applies.
deltas	yes	map of tosca.datatypes .nfv.VipCpLevel		Describes the VipCp scaling deltas to be applied for every scaling steps of a particular aspect.

6.10.18.3 Definition

The syntax of the VipCpScalingAspectDeltas policy type shall comply with the following definition:

```
  tosca.policies.nfv.VipCpScalingAspectDeltas:
    derived_from: tosca.policies.Root
    description: The VipCpScalingAspectDeltas type is a policy type representing the VipCp detail
of an aspect deltas used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]
    properties:
      aspect:
        type: string
        description: Represents the scaling aspect to which this policy applies
        required: true
      deltas:
        type: map # key: scalingDeltaId
        description: Describes the VipCp scaling deltas to be applied for every scaling steps of a
particular aspect.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VipCpLevel
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VipCp ]
```

6.10.18.4 Additional Requirements

In the case of "uniform aspect", the deltas properties shall have only one entry.

If a policy definition of this type is included in a service template, a policy definition of the type VipCpInitialDelta defined in clause 6.10.19 of the present document shall also be included with the same target.

6.10.18.5 Examples

None.

6.10.19 tosca.policies.nfv.VipCpInitialDelta

6.10.19.1 Description

The VipCpInitialDelta type is a policy type representing the VipCp detail of an initial delta used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]. Table 6.10.19.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.10.19.1-1: Type name, shorthand, and URI

Shorthand Name	VipCpInitialDelta
Type Qualified Name	toscanfv:VipCpInitialDelta
Type URI	tosca.policies.nfv.VipCpInitialDelta

6.10.19.2 Properties

The properties of the VipCpInitialDelta policy type shall comply with the provisions set out in table 6.10.y.2-1.

Table 6.10.19.2-1: Properties

Name	Required	Type	Constraints	Description
initial_delta:	yes	tosca.datatypes .nfv.VipCpLevel		Represents the initial minimum size of the VNF.

6.10.19.3 Definition

The syntax of the VipCpInitialDelta policy type shall comply with the following definition:

```
  tosca.policies.nfv.VipCpInitialDelta:
    derived_from: tosca.policies.Root
    description: The VipCpInitialDelta type is a policy type representing the VipCp detail of an
initial delta used for horizontal scaling, as defined in ETSI GS NFV-IFA 011 [1]
    properties:
      initial_delta:
        type: tosca.datatypes.nfv.VipCpLevel
        description: Represents the initial minimum size of the VNF.
        required: true
    targets: [ tosca.nodes.nfv.VipCp ]
```

6.10.19.4 Additional Requirements

None.

6.10.19.5 Examples

None.

6.10.20 tosca.policies.nfv.VipCpInstantiationLevels

6.10.20.1 Description

The VipCpInstantiationLevels type is a policy type representing all the instantiation levels of resources to be instantiated within a deployment flavour in term of the number of VipCp instances to be created from each VipCp. as defined in ETSI GS NFV-IFA 011 [1].

Table 6.10.20.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA Simple-Profile-YAML-v1.3 [20].

Table 6.10.20.1-1: Type name, shorthand, and URI

Shorthand Name	VipCpInstantiationLevels
Type Qualified Name	toscanfv:VipCpInstantiationLevels
Type URI	tosca.policies.nfv.VipCpInstantiationLevels

6.10.20.2 Properties

The properties of the VipCpInstantiationLevels policy type shall comply with the provisions set out in table 6.10.20.2-1.

Table 6.10.20.2-1: Properties

Name	Required	Type	Constraints	Description
levels	yes	map of tosca.datatypes.nfv. VipCpLevel		Describes the VipCp levels of resources that can be used to instantiate the VNF using this flavour.

6.10.20.3 Definition

The syntax of the VipCpInstantiationLevels policy type shall comply with the following definition:

```
  tosca.policies.nfv.VipCpInstantiationLevels:
    derived_from: tosca.policies.Root
    description: The VipCpInstantiationLevels type is a policy type representing all the
instantiation levels of resources to be instantiated within a deployment flavour in term of the
number of VipCp instances to be created from each VipCp as defined in ETSI GS NFV-IFA 011.
    properties:
      levels:
        type: map # key: levelId
        description: Describes the VipCp levels of resources that can be used to instantiate the
VNF using this flavour
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VipCpLevel
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VipCp ]
```

6.10.20.4 Additional Requirements

A VipCpInstantiationLevels policy shall contain an entry for each instantiation level (and only for them) defined in the InstantiationLevels policy.

6.11 VNFD TOSCA service template design

6.11.1 General

The TOSCA service template design for a VNFD in the general case uses two levels of service templates as described in clause 6.11.2. In this design, the top level contains an abstract VNF node template, i.e. without an implementation of the creation operation and is therefore substituted by one of the lower level service templates. This design is applicable regardless of whether the VNF has one or multiple deployment flavours.

In the particular case of a VNF with only one deployment flavour there is an alternative design which is described in clause 6.11.3 and which uses only one service template.

6.11.2 Single or multiple deployment flavour design with two levels of service templates

VNFD shall be implemented as one top-level service template and one or multiple lower level service templates, where each lower level service template represents a deployment flavour. A separate YAML file with a VNF specific node type definition which shall be derived from tosca.nodes.nfv.VNF node type as defined in clause 6.8.1 shall be provided and is also considered as a part of a VNFD. The top level service template shall be the main entry point of the VNF package as specified in ETSI GS NFV-SOL 004 [i.6], i.e. the Entry-definitions file. The file names of all the lower service templates shall be declared as the value of the Other-Definitions key as specified in TOSCA-Simple-Profile-YAML-v1.3 [20] in the TOSCA.meta file of the VNF package.

See clause A.2 for an example of VNFD design with multiple deployment flavours.

The top level service template shall comply with TOSCA-Simple-Profile-YAML-v1.3 [20] and shall include:

a) an import statement referencing the TOSCA types definition file as defined in clause B.2;

b) an import statement referencing a yaml file which contains a VNF specific node type definition;

c) optionally, import statements referencing additional VNF-specific files containing only type definitions used by this TOSCA service template; and

d) a topology template with a node template of the VNF specific node type, which:

1) shall include the flavour_id and other properties that are marked as required but do not have a default value in the VNF specific node type definition;

2) shall include the requirements as defined in clause 6.8.1; and

3) may include other properties specified in the VNF specific node type definition, excluding the vnf_profile property; and

4) may include a substitute directive;

e) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

Irrespective of the presence of absence of the substitute directive, the deployment and lifecycle management of instances of this VNF node type shall be done by means of substitution by any of the lower level service templates as declared in the Other-Definitions of the TOSCA.meta file in the VNF package. The VNFD consumer shall silently ignore the substitute directive if explicit directives are not supported.

The lower level service template is an implementable TOSCA service template for the deployment of a specific deployment flavour. The lower level service template shall comply with TOSCA-Simple-Profile-YAML-v1.3 [20] and shall include:

a) an import statement referencing the TOSCA types definition file as defined in clause B.2;

b) an import statement referencing a yaml file which contains a VNF specific node type definition which shall be derived from tosca.nodes.nfv.VNF node type as defined in clause 6.8.1;

c) optionally, additional VNF-specific type definitions and import statements referencing additional VNF-specific files containing type definitions used by this TOSCA service template; and

d) a topology template describing the internal topology of the VNF with:

- substitution_mappings indicating:

  - the same node type as defined in the VNF specific node type definition service template;

  - a flavour_id property and its value as defined in substitution_filter which identifies the DF corresponding to this low level template within the VNFD;

NOTE 1: Starting with version 3.3.1 of the present document, the property_mapping grammar was changed to support substitution_filter. For backward compatibility, TOSCA-Simple-Profile-YAML-v1.3 [20], clause 3.8.8.3 specifies the provisions for handling the previous grammar. Support of the Release 2 property_mapping grammar can be removed in subsequent versions of the present document.

  - the mapping of the virtual_link requirements on external connection points;

- a node template referencing the VNF specific node type, implementations of the operations of the LCM interface to be executed by the VNFM, if applicable; and

- additional node templates of type Vdu.Compute (or a derived node type), Vdu.VirtualBlockStorage, Vdu.VirtualObjectStorage, Vdu.VirtualFileStorage VduCp, etc. that define the topology and composition of the VNF flavour, the dependency requirements as defined in TOSCA-Simple-Profile-YAML-v1.3 [20] may be used between different node templates of type Vdu.Compute (or a derived node type) to specify the order in which instances of the VNFCs have to be created;

- additional group definitions and policy definitions and parameter definitions if applicable;

e) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

NOTE 2: The format and structure of a VNF package is defined in ETSI GS NFV-SOL 004 [i.6].

NOTE 3: All the imported type definition files as indicated either in the top level service template or in any of the lower level service template are considered as parts of a VNFD.

When the flavour_id of a VNF has been chosen (e.g. through an input parameter of a VNF instantiation request received by a VNFM) among the values included in the VNF node type imported into the top level service template, it is then used as the filter for selecting a particular lower level TOSCA service template inside the VNF package as described in TOSCA-Simple-Profile-YAML-v1.3 [20].

6.11.3 Single deployment flavour design with one service template

In case of the single deployment flavour scenario with one service template design, the VNFD shall use TOSCA-Simple-Profile-YAML-v1.3 [20] and shall include:

a) an import statement referencing the TOSCA types definition file as defined in clause B.2;

b) either a VNF specific node type definition derived from the tosca.nodes.nfv.VNF node type, as defined in clause 6.8.1 or an import statement referencing a file that contains such definition;

c) optionally, additional VNF-specific type definitions and import statements referencing additional VNF-specific files containing type definitions used by this TOSCA service template; and

d) a topology template describing the internal topology of the VNF with:

- substitution_mappings indicating the same VNF specific node type and the mapping of the virtual_link requirements on external connection points;
- a node template of this VNF specific node type with the flavour_id and other properties and, if applicable, implementations of the operations of the LCM interface to be executed by the VNFM; and
- additional node templates of type Vdu.Compute (or a derived node type), Vdu.VirtualBlockStorage, Vdu.VirtualObjectStorage, Vdu.VirtualFileStorage, VduCp, etc. that define the topology and composition of the VNF flavour, the dependency requirements as defined in TOSCA-Simple-Profile-YAML-v1.3 [20] may be used between different node templates of type Vdu.Compute (or a derived node type) to specify the order in which instances of the VNFCs have to be created;
- additional group definitions, policy definitions and parameter definitions if applicable;

e) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

See clause A.5 for an example of VNFD design with single deployment flavour.

NOTE 1: The service template is deployed stand-alone, i.e. without performing a substitution. However including the substitution_mappings rule indicate its ability to substitute a node template of the VNF specific node type, which may appear in an NSD.

NOTE 2: All the imported type definition files as indicated in the service template are considered as parts of a VNFD.

6.11.4 Package change (handling the Change current VNF Package request)

The Change current VNF Package operation, defined in ETSI GS NFV-SOL 002 [22] and ETSI GS NFV-SOL 003 [i.9], enables the NFVO to request the VNFM to change the current VNF Package, i.e. the VNF package on which a VNF instance is based, hence enabling VNF software modification. For such a request to be handled properly by the VNFM, the VNFD provides a policy of type tosca.policies.nfv.VnfPackageChange with the following characteristics:

- there may be as many instances of this policy type in the VNFD as change paths are supported;
- either the source or the destination of a change path shall be the current VNFD i.e. the one where the policy instance is present;
- a given instance of this policy type is triggered when the combination of the source_descriptor_id, destination_descriptor_id, source_flavour_id values in its selector property matches with the following:

- source_descriptor_id: "vnfdId": attribute in VnfInstance;
- destination_descriptor_id: "vnfdId" attribute in ChangeCurrentVnfPkgRequest;
- source_flavour_id: "flavour" attribute in VnfInstance;

- the operation designated by the trigger action in the policy definition is invoked upon receiving the Change current VNF Package request on the API (ETSI GS NFV-SOL 003 [i.9] or ETSI GS NFV-SOL 002 [22]);
- if "additionalParams" are to be received in the Change current VNF Package request on the API, then the input signature (additional_parameters) of the designated operation defines what "additionalParams" can be submitted as part of the operation request.

7 NSD TOSCA model

7.1 Introduction

The NSD information model specified by ETSI GS NFV-IFA 014 [2] is mapped to the TOSCA concepts. NSD occurrences are represented as TOSCA service templates, as defined in the TOSCA-Simple-Profile-YAML-v1.3 [20], to be used by the NFVO for managing the lifecycle of NS instances.

Table 7.1-1 shows an overview of the mapping between the main NSD information elements defined in ETSI GS NFV-IFA 014 [2] and TOSCA types defined in the present document. The definition of all TOSCA types for representing all information elements is described in the following clauses.

Table 7.1-1: Mapping of ETSI GS NFV-IFA 014 [2] information elements with TOSCA types

ETSI NFV Information Element ETSI GS NFV-IFA 014 [2]	TOSCA type	Derived from
NSD	tosca.nodes.nfv.NS	tosca.nodes.Root
Sapd	tosca.nodes.nfv.Sap	tosca.nodes.Root
NsVirtualLinkDesc	tosca.nodes.nfv.NsVirtualLink	tosca.nodes.Root
Pnfd	tosca.nodes.nfv.PNF	tosca.nodes.Root
Vnfd	tosca.nodes.nfv.VNF	tosca.nodes.Root
Vnffgd	tosca.groups.nfv.VNFFG	tosca.groups.Root

7.2 Data Types

7.2.1 Void

7.2.2 tosca.datatypes.nfv.VnfProfile

7.2.2.1 Description

The VnfProfile data type is defined in clause 9.2.8 of the present document.

7.2.3 tosca.datatype.nfv.NsVlProfile

7.2.3.1 Description

The NsVlProfile data type describes additional instantiation data for a given NsVirtualLink used in a specific NS deployment flavour. Table 7.2.3.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.3.1-1: Type name, shorthand, and URI

Shorthand Name	NsVlProfile
Type Qualified Name	toscanfv:NsVlProfile
Type URI	tosca.datatypes.nfv.NsVlProfile

7.2.3.2 Properties

The properties of the NsVlProfile data type shall comply with the provisions set out in table 7.2.3.2-1.

Table 7.2.3.2-1: Properties

Name	Required	Type	Constraints	Description
max_bitrate_requirements	yes	tosca.datatypes.nfv.LinkBitrateRequirements		Specifies the maximum bitrate requirements for a VL instantiated according to this profile.
min_bitrate_requirements	yes	tosca.datatypes.nfv.LinkBitrateRequirements		Specifies the minimum bitrate requirements for a VL instantiated according to this profile.
qos	no	tosca.datatypes.nfv.NsVirtualLinkQos		Specifies the QoS requirements of a VL instantiated according to this profile.
service_availability_level	no	integer	greater_or_equal: 1	If present, specifies the service availability level for the VL instance created from this profile. See note 2.
virtual_link_protocol_data	no	list of tosca.datatypes.nfv.NsVirtualLinkProtocolData		Specifies the protocol data for a virtual link. If more than 1 values are present, the order shall be the same as the order of the layer_protocols occurrences in the connectivity_type property of the same NsVirtualLink node, i.e. the first occurrence of the virtual_link_protocol_data represents the highest layer protocol data, and the last occurrence represents the lowest layer protocol data.
NOTE 1: A virtualLinkDescId property, which exists in ETSI GS NFV-IFA 014 [2] is not needed, as the NsVlProfile is contained in the NsVirtualLink node. NOTE 2: The value '1' expresses the highest service availability level.				

7.2.3.3 Definition

The syntax of the NsVlProfile data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsVlProfile:
    derived_from: tosca.datatypes.Root
    description: Describes additional instantiation data for a given NsVirtualLink used in a
specific NS deployment flavour.
    properties:
      max_bitrate_requirements:
        type: tosca.datatypes.nfv.LinkBitrateRequirements
        description: Specifies the maximum bitrate requirements for a VL instantiated according to
this profile.
        required: true
      min_bitrate_requirements:
        type: tosca.datatypes.nfv.LinkBitrateRequirements
        description: Specifies the minimum bitrate requirements for a VL instantiated according to
this profile.
        required: true
      qos:
        type: tosca.datatypes.nfv.NsVirtualLinkQos
        description: Specifies the QoS requirements of a VL instantiated according to this
profile.
        required: false
       service_availability_level:
        type: integer
```

```
        description: Specifies the service availability level for the VL instance created from
this profile
        required: false
        constraints:
          - greater_or_equal: 1
      virtual_link_protocol_data:
        type: list
        description: Specifies the protocol data for a virtual link.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.NsVirtualLinkProtocolData
```

7.2.3.4 Examples

None.

7.2.3.5 Additional Requirements

None.

7.2.4 tosca.datatypes.nfv.ConnectivityType

7.2.4.1 Description

The ConnectivityType data type is defined in clause 9.2.4 of the present document.

7.2.5 tosca.datatypes.nfv.NsVirtualLinkQos

7.2.5.1 Description

The NsVirtualLinkQoS describes QoS data type a given NsVirtualLink used in an NS deployment flavour.
Table 7.2.5.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.5.1-1: Type name, shorthand, and URI

Shorthand Name	NsVirtualLinkQos
Type Qualified Name	toscanfv:NsVirtualLinkQos
Type URI	tosca.datatypes.nfv.NsVirtualLinkQos

7.2.5.2 Properties

The properties of the NsVirtualLinkQos data type shall comply with the provisions set out in table 7.2.5.2-1.

Table 7.2.5.2-1: Properties

Name	Required	Type	Constraints	Description
priority	no	integer	greater_or_equal: 0	Specifies the priority level in case of congestion on the underlying physical links.

7.2.5.3 Definition

The syntax of the NsVirtualLinkQos data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsVirtualLinkQos:
    derived_from: tosca.datatypes.nfv.Qos
    description: describes QoS data for a given VL used in a VNF deployment flavour
    properties:
      priority:
        type: integer
        constraints:
```

```
          - greater_or_equal: 0
        description: Specifies the priority level in case of congestion on the underlying physical
links
        required: false
```

7.2.5.4 Examples

None.

7.2.5.5 Additional Requirements

None.

7.2.6 tosca.datatypes.nfv.LinkBitrateRequirements

7.2.6.1 Description

The LinkBitrateRequirements data type is defined in clause 9.2.5 of the present document.

7.2.7 Void

7.2.8 Void

7.2.9 Void

7.2.10 Void

7.2.11 tosca.datatypes.nfv.CpProtocolData

7.2.11.1 Description

The CpProtocolData data type is defined in clause 9.2.6 of the present document.

7.2.12 tosca.datatypes.nfv.AddressData

7.2.12.1 Description

The AddressData data type is defined in clause 9.2.3 of the present document.

7.2.13 tosca.datatypes.nfv.L2AddressData

7.2.13.1 Description

The L2AddressData data type is defined in clause 9.2.1 of the present document.

7.2.14 tosca.datatypes.nfv.L3AddressData

7.2.14.1 Description

The L3AddressData data type is defined in clause 9.2.2 of the present document.

7.2.15 tosca.datatypes.nfv.Qos

7.2.15.1 Description

The Qos data type is defined in clause 9.2.7 of the present document.

7.2.16 tosca.datatypes.nfv.NsProfile

7.2.16.1 Description

The NsProfile data type describes a profile for instantiating nested NSs which are constituents of an NS with a particular NS DF as defined in ETSI GS NFV-IFA 014 [2]. Table 7.2.16.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.16.1-1: Type name, shorthand, and URI

Shorthand Name	NsProfile
Type Qualified Name	toscanfv:NsProfile
Type URI	tosca.datatypes.nfv.NsProfile

7.2.16.2 Properties

The properties of the NsProfile data type shall comply with the provisions set out in table 7.2.16.2-1.

Table 7.2.16.2-1: Properties

Name	Required	Type	Constraints	Description
ns_instantiation_level	no	string		Identifier of the instantiation level of the NS DF to be used for instantiation. If not present, the default instantiation level as declared in the NSD shall be used.
min_number_of_instances	yes	integer	greater_or_equal: 0	Minimum number of instances of the NS based on this NSD that is permitted to exist for this NsProfile.
max_number_of_instances	yes	integer	greater_or_equal: 0	Maximum number of instances of the NS based on this NSD that is permitted to exist for this NsProfile.

7.2.16.3 Definition

The syntax of the NsProfile data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsProfile:
    derived_from: tosca.datatypes.Root
    description: describes a profile for instantiating NSs of a particular NS DF according to a
specific NSD and NS DF.
    properties:
      ns_instantiation_level:
        type: string
        description: Identifier of the instantiation level of the NS DF to be used for
instantiation. If not present, the default instantiation level as declared in the NSD shall be
used.
        required: false
      min_number_of_instances:
        type: integer
        description: Minimum number of instances of the NS based on this NSD that is permitted to
exist for this NsProfile.
        required: true
        constraints:
          - greater_or_equal: 0
      max_number_of_instances:
        type: integer
        description: Maximum number of instances of the NS based on this NSD that is permitted to
exist for this NsProfile.
        required: true
        constraints:
          - greater_or_equal: 0
```

7.2.16.4 Example

None.

7.2.16.5 Additional Requirements

None.

7.2.17 tosca.datatypes.nfv.Mask

7.2.17.1 Description

The Mask data type describes the value to be matched for a sequence of bits at a particular location in a frame. Table 7.2.17.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.17.1-1: Type name, shorthand, and URI

Shorthand Name	Mask
Type Qualified Name	toscanfv:Mask
Type URI	tosca.datatypes.nfv.Mask

7.2.17.2 Properties

The properties of the Mask data type shall comply with the provisions set out in table 7.2.17.2-1.

Table 7.2.17.2-1: Properties

Name	Required	Type	Constraints	Description
starting_point	yes	integer		Indicates the offset between the last bit of the source mac address and the first bit of the sequence of bits to be matched.
length	yes	integer		Indicates the number of bits to be matched.
value	yes	string		Provides the sequence of bit values to be matched.

7.2.17.3 Definition

The syntax of the Mask data type shall comply with the following definition:

```
  tosca.datatypes.nfv.Mask:
    derived_from: tosca.datatypes.Root
    properties:
      starting_point:
        description: Indicates the offset between the last bit of the source mac address and the
first bit of the sequence of bits to be matched.
        type: integer
        constraints:
          - greater_or_equal: 1
        required: true
      length:
        description: Indicates the number of bits to be matched.
        type: integer
        constraints:
          - greater_or_equal: 1
        required: true
      value:
        description: Provide the sequence of bit values to be matched.
        type: string
        required: true
```

7.2.17.4 Examples

None.

7.2.18 tosca.datatypes.nfv.NsOperationAdditionalParameters

7.2.18.1 Description

The NsOperationAdditionalParameters data type is an empty base type for deriving data types for describing NS specific additional parameters that affect the invocation of NS Lifecycle Management operations, as defined in ETSI GS NFV-IFA 014 [2]. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20]. Table 7.2.18.1-1 specifies the declared names for this data type.

Table 7.2.18.1-1: Type name, shorthand, and URI

Shorthand Name	NsOperationAdditionalParameters
Type Qualified Name	toscanfv:NsOperationAdditionalParameters
Type URI	tosca.datatypes.nfv.NsOperationAdditionalParameters

7.2.18.2 Properties

None.

7.2.18.3 Definition

The syntax of the NsOperationAdditionalParameters data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsOperationAdditionalParameters:
    derived_from: tosca.datatypes.Root
    description: Is an empty base type for deriving data types for describing NS-specific
additional parameters to be passed when invoking NS lifecycle management operations
    #properties:
```

7.2.18.4 Examples

```
tosca_definitions_version: tosca_simple_yaml_1_3

node_types:
 tosca.example_NS:
   derived_from: tosca.nodes.nfv.NS
   properties:
   ..
   interfaces:
     Nslcm:
      operations:
        instantiate:
          inputs:
            additional_parameters:
              type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters
        scale:
          inputs:
            additional_parameters:
              type: MyCompany.datatypes.nfv.NsScaleAdditionalParameters
        heal:
          inputs:
            additional_parameters:
              type: MyCompany.datatypes.nfv.NsHealAdditionalParameters


data_types:
 MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters:
  derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
  properties:
   parameter_1:
    type: string
    required: true
   parameter_2:
```

```
    type: string
    required: true
    default: value_2


MyCompany.datatypes.nfv.NsScaleAdditionalParameters:
 derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
 properties:
  parameter_1:
   type: string
   required: true
  parameter_2:
   type: string
   required: true

MyCompany.datatypes.nfv.NsHealAdditionalParameters:
 derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
 properties:
  parameter_1:
   type: string
   required: true
  parameter_2:
   type: string
   required: true
   default: value_2
```

7.2.19 tosca.datatypes.nfv.NsMonitoringParameter

7.2.19.1 Description

This data type is used to specify information on virtualised resource related performance metrics to be monitored at the NS level. Table 7.2.19.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.19.1-1: Type name, shorthand, and URI

Shorthand Name	NsMonitoringParameter
Type Qualified Name	toscanfv:NsMonitoringParameter
Type URI	tosca.datatypes.nfv.NsMonitoringParameter

7.2.19.2 Properties

The properties of the NsMonitoringParameter data type shall comply with the provisions set out in table 7.2.19.2-1.

Table 7.2.19.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Human readable name of the monitoring parameter.
performance_metric	yes	string	valid values: See YAML definition constraints	Identifies a performance metric to be monitored. Performance metric values shall be either set to: • A measurement name defined in clause 7.3 of ETSI GS NFV-IFA 027 [7]. In this case the NFVO computes these measurements from lower-level metrics collected from the VIM. • A measurement name defined in clause 7.1 of ETSI GS NFV-IFA 027 [7], without appending a sub-counter. In this case the NFVO collects these metrics from the VIM for all network resources allocated to all NS virtual links.
collection_period	no	scalar-unit.time		Describes the periodicity at which to collect the performance information.

7.2.19.3 Definition

The syntax of the NsMonitoringParameter data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsMonitoringParameter:
    derived_from: tosca.datatypes.Root
    description: Represents information on virtualised resource related performance metrics
applicable to the NS.
    properties:
      name:
        type: string
        description: Human readable name of the monitoring parameter
        required: true
      performance_metric:
        type: string
        description: Identifies a performance metric to be monitored, according to ETSI GS NFV-IFA
027.
        required: true
        constraints:
           - valid_values: [byte_incoming_sap, byte_outgoing_sap, packet_incoming_sap,
packet_outgoing_sap, byte_incoming, byte_outgoing, packet_incoming, packet_outgoing ]
      collection_period:
        type: scalar-unit.time
        description: Describes the periodicity at which to collect the performance information.
        required: false
```

7.2.19.4 Examples

None.

7.2.19.5 Additional Requirements

None.

7.2.20 tosca.datatypes.nfv.VnfMonitoringParameter

The VnfMonitoringParameter data type is defined in clause 9.2.9 of the present document.

7.2.21 tosca.datatypes.nfv.NsVirtualLinkProtocolData

7.2.21.1 Description

The NsVirtualLinkProtocolData data type describes one protocol layer and associated protocol data for a given virtual link used in a specific NS deployment flavour. Table 7.2.21.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.21.1-1: Type name, shorthand, and URI

Shorthand Name	NsVirtualLinkProtocolData
Type Qualified Name	toscanfv:NsVirtualLinkProtocolData
Type URI	tosca.datatypes.nfv.NsVirtualLinkProtocolData

7.2.21.2 Properties

The properties of the NsVirtualLinkProtocolData data type shall comply with the provisions set out in table 7.2.21.2-1.

Table 7.2.21.2-1: Properties

Name	Required	Type	Constraints	Description
associated_layer_protocol	yes	string	Valid values: See YAML definition constraints	Identifies one of the protocols a virtualLink gives access to (ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire) as specified by the connectivity_type property.
l2_protocol_data	no	tosca.datatypes.nfv.NsL2ProtocolData		Specifies the L2 protocol data for a virtual link. Shall be present when the associatedLayerProtocol attribute indicates a L2 protocol and shall be absent otherwise.
l3_protocol_data	no	tosca.datatypes.nfv.NsL3ProtocolData		Specifies the L3 protocol data for this virtual link. Shall be present when the associatedLayerProtocol attribute indicates a L3 protocol and shall be absent otherwise.

7.2.21.3 Definition

The syntax of the NsVirtualLinkProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsVirtualLinkProtocolData:
    derived_from: tosca.datatypes.Root
    description: describes one protocol layer and associated protocol data for a given virtual
link used in a specific NS deployment flavour
    properties:
      associated_layer_protocol:
         type: string
         description: Identifies one of the protocols a virtualLink gives access to (ethernet,
mpls, odu2, ipv4, ipv6, pseudo-wire) as specified by the connectivity_type property.
         required: true
         constraints:
           - valid_values: [ ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire ]
      l2_protocol_data:
         type: tosca.datatypes.nfv.NsL2ProtocolData
         description: Specifies the L2 protocol data for a virtual link. Shall be present when
the associatedLayerProtocol attribute indicates a L2 protocol and shall be absent otherwise.
         required: false
      l3_protocol_data:
         type: tosca.datatypes.nfv.NsL3ProtocolData
         description: Specifies the L3 protocol data for this virtual link. Shall be present
when the associatedLayerProtocol attribute indicates a L3 protocol and shall be absent
otherwise.
         required: false
```

7.2.21.4 Examples

None.

7.2.21.5 Additional Requirements

None.

7.2.22 tosca.datatypes.nfv.NsL2ProtocolData

7.2.22.1 Description

The NsL2ProtocolData data type describes L2 protocol data for a given virtual link used in a specific NS deployment flavour. Table 7.2.22.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.22.1-1: Type name, shorthand, and URI

Shorthand Name	NsL2ProtocolData
Type Qualified Name	toscanfv:NsL2ProtocolData
Type URI	tosca.datatypes.nfv.NsL2ProtocolData

7.2.22.2 Properties

The properties of the NsL2ProtocolData data type shall comply with the provisions set out in table 7.2.22.2-1.

Table 7.2.22.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Identifies the network name associated with this L2 protocol.
network_type	no	string	Valid values: See YAML definition constraints	Specifies the network type for this L2 protocol. The value may be overridden at run-time.
vlan_transparent	no	boolean	default: false	Specifies whether to support VLAN transparency for this L2 protocol or not.
mtu	no	integer	greater_than : 0	Specifies the maximum transmission unit (MTU) value for this L2 protocol.
segmentation_id	no	string		If present, specifies a specific virtualised network segment, which depends on the network type. For e.g. VLAN ID for VLAN network type and tunnel ID for GRE/VXLAN network types. See note.
NOTE: If this property is included in the NSD, the property value shall be provided at run-time, unless a default value is provided at design time in the NSD. If a default value is provided at design-time, this value may be overridden at run-time.				

7.2.22.3 Definition

The syntax of the NsL2ProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsL2ProtocolData:
    derived_from: tosca.datatypes.Root
    description: describes L2 protocol data for a given virtual link used in a specific NS
deployment flavour.
    properties:
      name:
        type: string
        description: Identifies the network name associated with this L2 protocol.
        required: false
      network_type:
        type: string
        description: Specifies the network type for this L2 protocol. The value may be
overridden at run-time.
        required: false
        constraints:
          - valid_values: [ flat, vlan, vxlan, gre ]
      vlan_transparent:
        type: boolean
        description: Specifies whether to support VLAN transparency for this L2 protocol or
not.
        required: false
        default: false
      mtu:
        type: integer
        description: Specifies the maximum transmission unit (MTU) value for this L2 protocol.
        required: false
        constraints:
          - greater_than: 0
      segmentation_id:
        type: string
```

```
        description: Specifies a specific virtualised network segment, which depends on the
network type. For e.g. VLAN ID for VLAN network type and tunnel ID for GRE/VXLAN network types
        required: false
```

7.2.22.4 Examples

None.

7.2.22.5 Additional Requirements

None.

7.2.23 tosca.datatypes.nfv.NsL3ProtocolData

7.2.23.1 Description

The NsL3ProtocolData data type describes L3 protocol data for a given virtual link used in a specific NS deployment flavour. Table 7.2.23.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.23.1-1: Type name, shorthand, and URI

Shorthand Name	NsL3ProtocolData
Type Qualified Name	toscanfv:NsL3ProtocolData
Type URI	tosca.datatypes.nfv.NsL3ProtocolData

7.2.23.2 Properties

The properties of the NsL3ProtocolData data type shall comply with the provisions set out in table 7.2.23.2-1.

Table 7.2.23.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Identifies the network name associated with this L3 protocol.
ip_version	yes	string	Valid values: See YAML definition constraints	Specifies IP version of this L3 protocol. The value of the ip_version property shall be consistent with the value of the layer_protocol in the connectivity_type property of the virtual link node.
cidr	yes	string		Specifies the CIDR (Classless Inter-Domain Routing) of this L3 protocol. The value may be overridden at run-time.
ip_allocation_pools	no	list of tosca.datatypes.nfv.NsIpAllocationPool		Specifies the allocation pools with start and end IP addresses for this L3 protocol. The value may be overridden at run-time.

7.2.23.3 Definition

The syntax of the NsL3ProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsL3ProtocolData:
    derived_from: tosca.datatypes.Root
    description: describes L3 protocol data for a given virtual link used in a specific NS
deployment flavour.
    properties:
      name:
        type: string
        description: Identifies the network name associated with this L3 protocol.
        required: false
```

```
      ip_version:
        type: string
        description: Specifies IP version of this L3 protocol. The value of the ip_version
property shall be consistent with the value of the layer_protocol in the connectivity_type
property of the virtual link node.
        required: true
        constraints:
          - valid_values: [ ipv4, ipv6 ]
      cidr:
        type: string
        description: Specifies the CIDR (Classless Inter-Domain Routing) of this L3 protocol.
The value may be overridden at run-time.
        required: true
      ip_allocation_pools:
        type: list
        description: Specifies the allocation pools with start and end IP addresses for this
L3 protocol. The value may be overridden at run-time.
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.NsIpAllocationPool
```

7.2.23.4 Examples

None.

7.2.23.5 Additional Requirements

None.

7.2.24 tosca.datatypes.nfv.NsIpAllocationPool

7.2.24.1 Description

The NsIpAllocationPool data type specifies a range of IP addresses. Table 7.2.24.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.24.1-1: Type name, shorthand, and URI

Shorthand Name	NsIpAllocationPool
Type Qualified Name	toscanfv:NsIpAllocationPool
Type URI	tosca.datatypes.nfv.NsIpAllocationPool

7.2.24.2 Properties

The properties of the NsIpAllocationPool data type shall comply with the provisions set out in table 7.2.24.2-1.

Table 7.2.24.2-1: Properties

Name	Required	Type	Constraints	Description
start_ip_address	yes	string		The IP address to be used as the first one in a pool of addresses derived from the cidr block full IP range
end_ip_address	yes	string		The IP address to be used as the last one in a pool of addresses derived from the cidr block full IP range

7.2.24.3 Definition

The syntax of the NsIpAllocationPool data type shall comply with the following definition:

```
  tosca.datatypes.nfv.NsIpAllocationPool:
    derived_from: tosca.datatypes.Root
    description: Specifies a range of IP addresses
    properties:
      start_ip_address:
        type: string
        description: The IP address to be used as the first one in a pool of addresses derived
from the cidr block full IP range
        required: true
      end_ip_address:
        type: string
        description: The IP address to be used as the last one in a pool of addresses derived
from the cidr block full IP range
        required: true
```

7.2.24.4 Examples

None.

7.2.24.5 Additional Requirements

None.

7.2.25 tosca.datatypes.nfv.NsScalingAspect

7.2.25.1 Description

The NsScalingAspect data type describes the details of an aspect used for horizontal scaling. Table 7.2.25.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.25.1-1: Type name, shorthand, and URI

Shorthand Name	NsScalingAspect
Type Qualified Name	toscanfv:NsScalingAspect
Type URI	tosca.datatypes.nfv.NsScalingAspect

7.2.25.2 Properties

The properties of the NsScalingAspect data type shall comply with the provisions set out in table 7.2.25.2-1.

Table 7.2.25.2-1: Properties

Name	Required	Type	Constraints	Description
name	yes	string		Human readable name of the NS scaling aspect.
description	yes	string		Human readable description of the NS scaling aspect.
ns_scale_levels	yes	map of tosca.datatypes.nfv.NsLevels		Description of the NS levels for this scaling aspect.

7.2.25.3 Definition

The syntax of the NsScalingAspect data type shall comply with the following definition:

```
tosca.datatypes.nfv.NsScalingAspect:
  derived_from: tosca.datatypes.Root
  description: describes the details of an aspect used for horizontal scaling
  properties:
    name:
      type: string
      description: Human readable name of the aspect
      required: true
    description:
      type: string
      description: Human readable description of the aspect
      required: true
    ns_scale_levels:
      type: map
      description: Description of the NS levels for this scaling aspect.
      required: true
      key_schema:
        type: integer # Integer type in order to number the levels. First level is level 0.
        constraints:
          - greater_or_equal: 0
      entry_schema:
        type: tosca.datatypes.nfv.NsLevels
```

7.2.25.4 Examples

See clause A.17.

7.2.25.5 Additional Requirements

None.

7.2.26 tosca.datatypes.nfv.NsLevels

7.2.26.1 Description

The NsLevels data type describes the Ns levels. Table 7.2.26.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.26.1-1: Type name, shorthand, and URI

Shorthand Name	NsLevels
Type Qualified Name	toscanfv:NsLevels
Type URI	tosca.datatypes.nfv.NsLevels

7.2.26.2 Properties

The properties of the NsLevels data type shall comply with the provisions set out in table 7.2.26.2-1.

Table 7.2.26.2-1: Properties

Name	Required	Type	Constraints	Description
description	yes	string		Human readable description of the NS level.

7.2.26.3 Definition

The syntax of the NsLevels data type shall comply with the following definition:

```
tosca.datatypes.nfv.NsLevels:
  derived_from: tosca.datatypes.Root
  description: describes the Ns levels
  properties:
    description:
      type: string
      description: Human readable description of the Ns level
      required: true
```

7.2.26.4 Examples

See clause A.17.

7.2.26.5 Additional Requirements

None.

7.2.27 tosca.datatypes.nfv.ScaleNsByStepsData

7.2.27.1 Description

The scaleNsByStepsData data type describes the information needed to scale an NS instance by one or more scaling steps, with respect to a particular NS scaling aspect as defined in ETSI GS NFV-IFA 013 [i.8]. Table 7.2.27.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.27.1-1: Type name, shorthand, and URI

Shorthand Name	ScaleNsByStepsData
Type Qualified Name	toscanfv:ScaleNsByStepsData
Type URI	tosca.datatypes.nfv.ScaleNsByStepsData

7.2.27.2 Properties

The properties of the ScaleNsByStepsData data type shall comply with the provisions set out in table 7.2.27.2-1.

Table 7.2.27.2-1: Properties

Name	Required	Type	Constraints	Description
scaling_direction	yes	string	Valid values: See YAML definition constraints	Indicates the type of the scale operation requested
aspect	yes	string		Identifier of the scaling aspect
number_of_steps	yes	integer		Number of scaling steps to be executed

7.2.27.3 Definition

The syntax of the ScaleNsByStepsData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.ScaleNsByStepsData:
    derived_from: tosca.datatypes.Root
    description: describes the information needed to scale an NS instance by one or more scaling
steps, with respect to a particular NS scaling aspect
    properties:
      scaling_direction:
        type: string
        description: Indicates the type of the scale operation requested.
        required: true
        constraints:
          - valid_values: [ scale_out, scale_in ]
      aspect:
        type: string
        description: Identifier of the scaling aspect.
        required: true
      number_of_steps:
        type: integer
        description: Number of scaling steps to be executed.
        required: true
        constraints:
          - greater_than: 0
        default: 1
```

7.2.27.4 Examples

None.

7.2.27.5 Additional Requirements

None.

7.2.28 tosca.datatypes.nfv.ScaleNsToLevelData

7.2.28.1 Description

The ScaleNsByStepsData data type describes the information needed to scale an NS instance to a target size as defined in ETSI GS NFV-IFA 013 [i.8]. Table 7.2.28.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.2.28.1-1: Type name, shorthand, and URI

Shorthand Name	ScaleNsToLevelData
Type Qualified Name	toscanfv:ScaleNsToLevelData
Type URI	tosca.datatypes.nfv.ScaleNsToLevelData

7.2.28.2 Properties

The properties of the ScaleNsToLevelData data type shall comply with the provisions set out in table 7.2.28.2-1.

Table 7.2.28.2-1: Properties

Name	Required	Type	Constraints	Description
instantiation_level	no	string		Identifier of the target instantiation level of the current deployment flavour to which the NS is requested to be scaled. Either instantiation_level or ns_scale_info shall be provided.
ns_scale_info	no	map of integer		For each scaling aspect of the current deployment flavour, indicates the target scale level to which the NS is to be scaled. Either instantiation_level or ns_scale_info shall be provided.

7.2.28.3 Definition

The syntax of the ScaleNsToLevelData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.ScaleNsToLevelData:
    derived_from: tosca.datatypes.Root
    description: describes the information needed to scale an NS instance to a target size.
    properties:
      instantiation_level:
        type: string
        description: Identifier of the target instantiation level of the current deployment
flavour to which the NS is requested to be scaled. Either instantiation_level or ns_scale_info
shall be provided.
        required: false
      ns_scale_info:
        type: map # key: aspectId
        description: For each scaling aspect of the current deployment flavour, indicates the
target scale level to which the NS is to be scaled. Either instantiation_level or ns_scale_info
shall be provided.
        required: false
        entry_schema:
          type: integer
          constraints:
            - greater_or_equal: 0
```

7.2.28.4 Examples

None.

7.2.28.5 Additional Requirements

None.

7.3 Artifact Types

None.

7.4 Capability Types

7.4.1 tosca.capabilities.nfv.VirtualLinkable

7.4.1.1 Description

The VirtualLinkable capability type is defined in clause 9.4.1 of the present document.

7.4.2 tosca.capabilities.nfv.Forwarding

7.4.2.1 Description

The Forwarding capability type describes the capabilities related to nodes which can be pointed by tosca.relationships.nfv.ForwardTo relationship type. Table 7.4.2.1-1 specifies the declared names for this capability type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

NOTE: The forwarding capability represents the ability of a CP or SAP to receive and forward traffic flows. Traffic flows can be received by a CP from an NS Virtual Link and forwarded to the VNF or PNF to which the CP is attached. Symmetrically, traffic flows can be received by an external CP of the VNF or PNF and forwarded to an NS Virtual Link. Traffic flows can be received by a SAP from an external link and forwarded to the NS to which the SAP is attached. Symmetrically, traffic flows can be received from the NS to which the SAP is attached and forwarded to an external link. An ingress CP is an external CP that forwards traffic to a VNF, PNF or NS while and egress CP is an external CP that forwards traffic outside a VNF, PNF or NS. The same CP may but need not play both roles.

Table 7.4.2.1-1: Type name, shorthand, and URI

Shorthand Name	Forwarding
Type Qualified Name	toscanfv:Forwarding
Type URI	tosca.capabilities.nfv.Forwarding

7.4.2.2 Properties

None.

7.4.2.3 Definition

The syntax of the Forwarding capability type shall comply with the following definition:

```
tosca.capabilities.nfv.Forwarding:
  derived_from: tosca.capabilities.Root
```

7.5 Requirements Types

None.

7.6 Relationship Types

7.6.1 tosca.relationships.nfv.VirtualLinksTo

7.6.1.1 Description

The VirtualLinksTo relationship type is defined in clause 9.6.1 of the present document representing an association relationship between the VNF or PNF or Sap of a Nested NS and NsVirtualLink node types when used in an NSD.

7.6.2 tosca.relationships.nfv.ForwardTo

7.6.2.1 Description

The ForwardTo relationship type represents an association between two node types which are a part of NFP. Table 7.6.2.1-1 specifies the declared names for this relationship type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.6.2.1-1: Type name, shorthand, and URI

Shorthand Name	ForwardTo
Type Qualified Name	toscanfv:ForwardTo
Type URI	tosca.nodes.relationships.ForwardTo

7.6.2.2 Properties

None.

7.6.2.3 Definition

The syntax of the ForwardTo relationship type shall comply with the following definition:

```
tosca.relationships.nfv.ForwardTo:
  derived_from: tosca.relationships.Root
  valid_target_types: [ tosca.capabilities.nfv.Forwarding ]
```

7.7 Interface Types

7.7.1 tosca.interfaces.nfv.Nslcm

7.7.1.1 Description

The tosca.interfaces.nfv.Nslcm interface type contains a set of TOSCA operations corresponding to the following NS LCM operations defined in ETSI GS NFV-IFA 013 [i.8]:

- Instantiate NS
- Scale NS
- Update NS
- Heal NS
- Terminate NS

The interface also contains TOSCA operations corresponding to preamble and postamble to the execution of the aforementioned base operations. The name of these operations is constructed according to the following pattern:

<base_operation_name>_start for a preamble

<base_operation_name>_end for a postamble

The designations ("_start", "_end") in the name of TOSCA operations are postfixes so that related operations are adjacent in an alphabetical listing.

Table 7.7.1.1-1 specifies the declared names for this interface type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.7.1.1-1: Type name, shorthand, and URI

Shorthand Name	Nslcm
Type Qualified Name	toscanfv:Nslcm
Type URI	tosca.interfaces.nfv.Nslcm

7.7.1.2 Definition

The syntax of the Nslcm interface type shall comply with the following definition:

```
  tosca.interfaces.nfv.Nslcm:
    derived_from: tosca.interfaces.Root
    description: This interface encompasses a set of TOSCA operations corresponding to NS LCM
operations defined in ETSI GS NFV-IFA 013 as well as to preamble and postamble procedures to the
execution of the NS LCM operations.
    operations:
      instantiate_start:
        description: Preamble to execution of the instantiate operation
      instantiate:
        description: Base procedure for instantiating an NS, corresponding to the Instantiate NS
operation defined in ETSI GS NFV-IFA 013.
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.NsOperationAdditionalParameters
            required: false
      instantiate_end:
        description: Postamble to the execution of the instantiate operation
      terminate_start:
        description: Preamble to execution of the terminate operation
      terminate:
        description: Base procedure for terminating an NS, corresponding to the Terminate NS
operation defined in ETSI GS NFV-IFA 013.
      terminate_end:
        description: Postamble to the execution of the terminate operation
```

```
      update_start:
        description: Preamble to execution of the update operation
      update:
        description: Base procedure for updating an NS, corresponding to the Update NS operation
defined in ETSI GS NFV-IFA 013.
      update_end:
        description: Postamble to the execution of the update operation
      scale_start:
        description: Preamble to execution of the scale operation
      scale:
        description: Base procedure for scaling an NS, corresponding to the Scale NS operation
defined in ETSI GS NFV-IFA 013.
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.NsOperationAdditionalParameters
            required: false
          scale_ns_by_steps_data:
            type: tosca.datatypes.nfv.ScaleNsByStepsData
            description: Describes the information needed to scale an NS instance by one or more
scaling steps, with respect to a particular NS scaling aspect as defined in ETSI GS NFV-IFA 013.
Either scale_ns_by_steps_data or scale_ns_to_level_data shall be provided.
            required: false
          scale_ns_to_level_data:
            type: tosca.datatypes.nfv.ScaleNsToLevelData
            description: Describes the information needed to scale an NS instance to a target size
as defined in ETSI GS NFV-IFA 013. Either scale_ns_by_steps_data or scale_ns_to_level_data shall
be provided.
            required: false
      scale_end:
        description: Postamble to the execution of the scale operation
      heal_start:
        description: Preamble to execution of the heal operation
      heal:
        description: Base procedure for healing an NS, corresponding to the Heal NS operation
defined in ETSI GS NFV-IFA 013.
        inputs:
          additional_parameters:
            type: tosca.datatypes.nfv.NsOperationAdditionalParameters
            required: false
      heal_end:
        description: Postamble to the execution of the heal operation
```

7.7.1.3 Additional Requirements

The implementation and inputs keynames specified in TOSCA-Simple-Profile-YAML-v1.3 [20] for an operation definition may be included for each operation listed in the Nslcm interface definition.

When a TOSCA operation representing an NS LCM operation does not have an associated implementation keyname, the default implementation provided by the NFVO for this NS LCM operation applies.

The NSD consumer shall make available all parameters from the message invoking the NS LCM operation as inputs to the corresponding TOSCA interface operations. The `inputs` keyname can be used to specify additional input parameters for executing the operation.

In the operation definitions on the Nslcm interface, the additional_parameters (NS-specific extension of the tosca.datatypes.nfv.NsOperationAdditionalParameters) of inputs section describes the name and type of the additional parameters that can be submitted in the NS LCM operation request. Refer example in clause 7.2.17.

The implementation of preamble and postamble TOSCA operations (e.g. instantiate_start), if present, is invoked with the same parameters as the corresponding base TOSCA operation (e.g. instantiate). The inputs of the preamble and postamble operations shall not be defined in the NSD.

If an implementation is associated to a TOSCA operation that represents a preamble or a postamble to an NS LCM operation, the implementation logic is executed before or after the execution of the NS LCM operation implementation, respectively.

Starting with version 3.3.1 of the present document, the Nslcm interface type definition grammar was changed to support notifications and operations. For backward compatibility, TOSCA-Simple-Profile-YAML-v1.3 [20], clause 3.7.5.5 specifies the provisions for handling the previous grammar. Support of the Release 2 Nslcm interface type definition grammar can be removed in subsequent versions of the present document.

7.7.1.4 Support of LCM scripts

In ETSI GS NFV-IFA 014 [2], the definition of the "LifeCycleManagementScript" information element of the NSD associates LCM scripts with events, where an event can be an external or an internal stimulus. These events are mapped to TOSCA operations of the NS node type in the following way:

- external stimuli are mapped to TOSCA operations corresponding to the NS LCM operations defined in ETSI GS NFV-IFA 013 [i.8];
- internal stimuli are mapped to preamble and postamble of these TOSCA operations.

LCM scripts can be regarded as artifacts that provide an NS-specific implementation of the TOSCA operation corresponding to the stimulus.

The script input parameters shall be provided to the script according to the declaration in the inputs field of the operation definition. The artifact type definition shall enable identifying the DSL used by the script. The artifact type definition for Python is provided in section 5.4.4.1 of TOSCA-Simple-Profile-YAML-v1.3 [20]. The artifact definition for Mistral is provided in clause A.7.2 of the present document.

7.7.1.5 Examples

The following example template fragments illustrate the concept. An LCM script is associated with the instantiate_end operation. As no LCM script is associated to the instantiate operation, its default implementation runs and before running the post-instantiate-script. The inputs section of the instantiate_end operation definition provides additional input values to the post-instantiate-script, and the TOSCA artifacts definition conveys the type of DSL used as a scripting language.

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
 - ..

node_types:
 MyCompany.SunshineVPN.1_0.1_0:
  derived_from: tosca.nodes.nfv.NS
  ..

topology_template:
 substitution_mappings:
  node_type: MyCompany.SunshineVPN.1_0.1_0
  ..

 node_templates:
  SunshineVPN:
   type: MyCompany.SunshineVPN.1_0.1_0
   ..
  interfaces:
   Nslcm:
    operations:
      instantiate_end:
        implementation: post-instantiate-script
        inputs:
          script_input_1: value_1
          script_input_2: value_2

  artifacts:
   post-instantiate-script:
    description: Instantiate workflow script
    type: tosca.artifacts.Implementation.Python
    file: instantiate.py
    #repository: ..
    #deploy_path: ..
    ..
```

7.7.2 tosca.interfaces.nfv.NsVnfIndicator

7.7.2.1 Description

The tosca.interfaces.nfv.NsVnfIndictor is an empty base interface type for deriving NS specific interface types that include VNF indicator specific notifications which will be used in a NS.

Table 7.7.2.1-1 specifies the declared names for this interface type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.7.2.1-1: Type name, shorthand, and URI

Shorthand Name	NsVnfIndicator
Type Qualified Name	toscanfv:NsVnfIndicator
Type URI	tosca.interfaces.nfv.NsVnfIndicator

7.7.2.2 Definition

The syntax of the VnfIndicator interface type shall comply with the following definition:

```
  tosca.interfaces.nfv.NsVnfIndicator:
    derived_from: tosca.interfaces.Root
    description: This interface is an empty base interface type for deriving NS specific interface
types that include VNF indicator specific notifications which will be used in a NS.
```

7.7.2.3 Examples

See clause A.15.3.

7.8 Node Types

7.8.1 tosca.nodes.nfv.NS

7.8.1.1 Description

The NFV Network Service (NS) node type describes an NS in terms of deployment, operational behaviour, and requirements, as defined by ETSI GS NFV-IFA 014 [2]. Table 7.8.1.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.8.1.1-1: Type name, shorthand, and URI

Shorthand Name	NS
Type Qualified Name	toscanfv:NS
Type URI	tosca.nodes.nfv.NS

7.8.1.2 Properties

The properties of the NS node type shall comply with the provisions set out in table 7.8.1.2-1.

Table 7.8.1.2-1: Properties

Name	Required	Type	Constraints	Description
descriptor_id	yes	string		Identifier of this NS descriptor. See note 2.
designer	yes	string		Identifies the designer of the NSD.
version	yes	string		Identifies the version of the NSD.
name	yes	string		Provides the human readable name of the NSD.

Name	Required	Type	Constraints	Description
invariant_id	yes	string		Identifies an NSD in a version independent manner. This attribute is invariant across versions of NSD. See note 2.
flavour_id	yes	string		Identifier of this NS DF within the NSD.
ns_profile	no	tosca.datatypes.nfv.NsProfile		Specifies a profile of an NS, when this NS is used as nested NS within another NS. See note 1.
service_availability_level	no	integer	greater_or_equal: 1	If present, specifies the service availability level for the NS instance. See note 3.
priority	no	integer	greater_or_equal: 0	Specifies the priority for the NS instance. Examples for the usage of priority include conflict resolution in case of resource shortage. See notes 4 and 5.

NOTE 1: This property is only used in an NS node template, when it is representing a nested NS within another NS.
NOTE 2: The value of the descriptor_id string shall comply with an UUID format as specified in section 3 of IETF RFC 4122 [9].
NOTE 3: The value '1' expresses the highest service availability level.
NOTE 4: The value '0' expresses the highest priority and the fact that the NS instance based on this NS DF cannot be pre-empted during resource allocation.
NOTE 5: A NSD specific node type definition can further constrain the range of valid values by indicating an upper bound.

7.8.1.3 Attributes

The attribute of the NS node type shall comply with the provisions set out in table 7.8.1.3-1.

Table 7.8.1.3-1: Attributes

Name	Required	Type	Constraints	Description
scale_status	no	map of integer		Scale status of the NS, one entry per aspect. Represents for every scaling aspect how "big" the NS has been scaled w.r.t. that aspect.

If the NS supports VNF indicators as the monitoring data as described in ETSI GS NFV-IFA 014 [2], the NS specific node type definition shall include one TOSCA attribute of a primitive type for each monitored VNF indicator.

NOTE 1: The value of the attribute for each monitored VNF indicator can be retrieved by passing a path to the get_attribute function: { get_attribute: [<VNF_node_template_name>, <attribute_name_defined_in_the_corresponding_VNFD>] }.

NOTE 2: The rule for naming the attribute for each monitored VNF indicator should be:

- " VNF node template name "_" attribute name defined in the corresponding VNFD ". See example in clause A.15.3.

NOTE 3: In this version of the present document, the type of VNF indicators is constrained to primitive types. This is due to the limitations in the TOSCA-Simple-Profile-YAML-v1.3 [20] to define conditions on attributes of complex types.

If the scale_status attribute is used in a NS auto-scale policy, the NS specific node type definitions may include additional attribute definitions of type integer, one for each scaling aspect. See example in clause A.15.3.

NOTE 4: As the scale_status attribute is complex, the value of the individual scaling aspects can be retrieved by passing a path to the get_attribute function: { get_attribute: [SELF, scale_status, {scaling_aspect}] }. If the value of the scale_status property is needed in a constraint (tosca.policies.nfv.NsAutoScale), then its value can be retrieved in an indirect way by accessing the aforementioned additional attributes. This is due to the limitation mentioned in the previous note.

7.8.1.4 Requirements

The requirements of the NS node type shall comply with the provisions set out in table 7.8.1.4-1.

Table 7.8.1.4-1: Requirements

Name	Required	Capability type	Constraints	Description
virtual_link	no	tosca.capabilities.nfv.VirtualLinkable		Describes the requirements for linking to virtual link

7.8.1.5 Capabilities

None.

7.8.1.6 Definition

The syntax of the NS node type shall comply with the following definition:

```
  tosca.nodes.nfv.NS:
    derived_from: tosca.nodes.Root
    properties:
      descriptor_id:
        type: string # UUID
        description: Identifier of this NS descriptor
        required: true
      designer:
        type: string
        description: Identifies the designer of the NSD.
        required: true
      version:
        type: string
        description: Identifies the version of the NSD.
        required: true
      name:
        type: string
        description: Provides the human readable name of the NSD.
        required: true
      invariant_id: # UUID
        type: string
        description: Identifies an NSD in a version independent manner. This attribute is
invariant across versions of NSD
        required: true
      flavour_id:
        type: string
        description: Identifier of the NS Deployment Flavour within the NSD
        required: true
      ns_profile:
        type: tosca.datatypes.nfv.NsProfile
        description: Specifies a profile of a NS, when this NS is used as nested NS within
another NS.
        required: false
      service_availability_level:
        type: integer
        description: Specifies the service availability level for the NS instance.
        required: false
        constraints:
          - greater_or_equal: 1
      priority:
        type: integer
        description: Specifies the priority for the NS instance. Examples for the usage of
priority include conflict resolution in case of resource shortage.
        required: false
        constraints:
          - greater_or_equal: 0
    attributes:
      scale_status:
        type: map # key: aspectId
        description: Scale status of the NS, one entry per aspect. Represents for every
scaling aspect how "big" the NS has been scaled w.r.t. that aspect.
        entry_schema:
          type: integer
          constraints:
```

```
            - greater_or_equal: 0
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          node: tosca.nodes.nfv.NsVirtualLink
          occurrences: [ 0, 1 ]
    interfaces:
      Nslcm:
        type: tosca.interfaces.nfv.Nslcm
```

7.8.1.7 Artifact

None.

7.8.1.8 Additional requirements

For a given NSD, a new NS node type shall be defined following the below requirements:

a) The node type shall be derived from: tosca.nodes.nfv.NS.

b) All properties listed in tosca.nodes.nfv.NS where the "required:" field is set to "true" shall be included with their values indicated as constraints or assigned as final fixed values if only one value is permitted.

c) Properties listed in in tosca.nodes.nfv.NS where the "required:" field is set to "false" may be included.

d) The capabilities, requirements, interfaces of tosca.nodes.nfv.NS shall be preserved.

e) Depending on the number of SAPs of the NS, additional requirements for VirtualLinkable capability shall be defined with the occurrences set to [0, 1]. In this case, it is the NSD author's choice to use the requirement for VirtualLinkable capability defined in the tosca.nodes.nfv.NS node type or use only the additional requirements defined in the derived NS specific node type. In the latter case, the virtual_link requirement should be included in the node type definition with occurrences [0, 0].

7.8.2 tosca.nodes.nfv.Sap

7.8.2.1 Description

The Service Access Point (SAP) node type describes a connection point where an NS can be accessed, as defined by ETSI GS NFV-IFA 014 [2]. Table 7.8.2.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.8.2.1-1: Type name, shorthand, and URI

Shorthand Name	Sap
Type Qualified Name	toscanfv:Sap
Type URI	tosca.nodes.nfv.Sap

7.8.2.2 Properties

The properties applied to Sap node are derived from Cp node type as defined in clause 9.8.1 of the present document.

7.8.2.3 Attributes

None.

7.8.2.4 Requirements

The requirements of the Sap node type shall comply with the provisions set out in table 7.8.2.4-1.

Table 7.8.2.4-1: Requirements

Name	Required	Capability type	Constraints	Description
external_virtual_link	no	tosca.capabilities.nfv.VirtualLinkable		Specifies that CP instances require to be connected to a node that has a VirtualLinkable capability
internal_virtual_link	yes	tosca.capabilities.nfv.VirtualLinkable		Specifies that CP instances require to be connected to a node that has a VirtualLinkable capability

7.8.2.5 Capabilities

The capabilities of the Sap node type shall comply with the provisions set out in table 7.8.2.5-1.

Table 7.8.2.5-1: Capabilities

Name	Type	Constraints	Description
forwarding	tosca.capabilities.nfv.Forwarding		The forwarding capability exposed by the node.

7.8.2.6 Definition

The syntax of the Sap node type shall comply with the following definition:

```
tosca.nodes.nfv.Sap:
  derived_from: tosca.nodes.nfv.Cp
  description: node definition of SAP.
  capabilities:
    forwarding:
      type: tosca.capabilities.nfv.Forwarding
  requirements:
    - external_virtual_link:
        capability: tosca.capabilities.nfv.VirtualLinkable
        relationship: tosca.relationships.nfv.VirtualLinksTo
        occurrences: [0, 1]
    - internal_virtual_link:
        capability: tosca.capabilities.nfv.VirtualLinkable
        relationship: tosca.relationships.nfv.VirtualLinksTo
        occurrences: [1, 1]
```

7.8.2.7 Additional requirements

A node template of this type is used to represent a SAP only in the case the Sap is connected to an NsVirtualLink inside an NSD. The node template has the following requirements:

- internal_virtual_link requirement to allow to connect it to an NsVirtualLink inside an NSD;
- external_virtual_link requirement to allow to connect it to an NsVirtualLink outside an NSD.

In the case where a Sap is exposed by a VNF external connection point, a PNF external connection point or a Sap of the nested NS, the Sap node type does not apply.

7.8.2.8 Example

In a typical scenario, the Sap node template will be part of a service template representing a certain NS deployment flavour. The service template substitutes for a NS specific node type. In this substitution, the virtual_link requirement is mapped to the external_virtual_link requirement of the Sap node. This example is illustrated in clause A.7.3.

When a Sap re-exposes a VNF external connection point, the service template does not require an explicit node template of type Sap in a typical scenario where a NS specific node type is substituted by a service template representing a certain NS deployment flavour. In this substitution, the virtual_link requirement is mapped to the virtual_link requirement of the VNF node or a corresponding Forwarding node. The first case is illustrated in clause A.7.2 while the second case is illustrated in clause A.14.

7.8.3 tosca.nodes.nfv.NsVirtualLink

7.8.3.1 Description

The NsVirtualLink node type represents the NsVirtualLinkDesc information element as defined in ETSI GS NFV-IFA 014 [2], which describes the requirements for a virtual link of a network service. Table 7.8.3.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.8.3.1-1: Type name, shorthand, and URI

Shorthand Name	NsVirtualLink
Type Qualified Name	toscanfv:NsVirtualLink
Type URI	tosca.nodes.nfv.NsVirtualLink

7.8.3.2 Properties

The properties of the NsVirtualLink node type shall comply with the provisions set out in table 7.8.3.2-1.

Table 7.8.3.2-1: Properties

Name	Required	Type	Constraints	Description
vl_profile	yes	tosca.datatype.nfv.NsVlProfile		Specifies instantiation parameters for a virtual link of a particular NS deployment flavour.
connectivity_type	yes	tosca.datatypes.nfv.ConnectivityType		Network service virtual link connectivity type.
test_access	no	list of string	Valid values: See YAML definition constraints	Test access facilities available on the VL.
description	no	string		Human readable information on the purpose of the virtual link (e.g. VL for control plane traffic).

7.8.3.3 Attributes

None.

7.8.3.4 Requirements

None.

7.8.3.5 Capabilities

The capabilities of the NsVirtualLink node type shall comply with the provisions set out in table 7.8.3.5-1.

Table 7.8.3.5-1: Capabilities

Name	Type	Constraints	Description
virtual_linkable	tosca.capabilities.nfv.VirtualLinkable		VirtualLinkable capability

7.8.3.6 Definition

The syntax of the NsVirtualLink node type shall comply with the following definition:

```
tosca.nodes.nfv.NsVirtualLink:
  derived_from: tosca.nodes.Root
  description: node definition of Virtual Links
  properties:
```

```
      vl_profile:
        type: tosca.datatypes.nfv.NsVlProfile # only covers min/max bitrate requirements
        description: Specifies instantiation parameters for a virtual link of a particular NS
deployment flavour.
        required: true
      connectivity_type:
        type: tosca.datatypes.nfv.ConnectivityType
        required: true
      test_access:
        type: list
        description: Test access facilities available on the VL
        required: false
        entry_schema:
          type: string
          constraints:
            - valid_values: [ passive_monitoring, active_loopback ]
      description:
        type: string
        required: false
        description: Human readable information on the purpose of the virtual link (e.g. VL
for control plane traffic).
    capabilities:
      virtual_linkable:
        type: tosca.capabilities.nfv.VirtualLinkable
```

7.8.3.7 Artifact

None.

7.8.3.8 Additional Requirements

None.

7.8.3.9 Example

None.

7.8.4 tosca.nodes.nfv.Cp

7.8.4.1 Description

The Cp node type is defined in clause 9.8.1 of the present document.

7.8.5 tosca.nodes.nfv.NfpPositionElement

7.8.5.1 Description

The NfpPositionElement node type represents the NfpPositionElement information element as defined in ETSI GS NFV-IFA 014 [2], which describes one or two CPD(s) or SAPD(s) for a given Vnf, Pnf or Ns. Table 7.8.5.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

A NfpPositionElement node type has a requirement for a forwarding capability to be exposed by the VNFs, PNFs or NSs, in order to re-expose this capability to an NfpPosition node type.

NOTE: The NfpPosition and NfpPositionElement node types of the VNFFG model describe the entities in VIM for enabling packets/frames to traverse the constituent VNFs, PNFs or Nested NSs of the Network Forwarding Path.

Table 7.8.5.1-1: Type name, shorthand, and URI

Shorthand Name	NfpPositionElement
Type Qualified Name	toscanfv:NfpPositionElement
Type URI	tosca.nodes.nfv.NfpPositionElement

7.8.5.2 Properties

None.

7.8.5.3 Attributes

None.

7.8.5.4 Requirements

The requirements of the NfpPositionElement node type shall comply with the provisions set out in table 7.8.5.4-1.

Table 7.8.5.4-1: Requirements

Name	Required	Capability Type	Constraints	Description
profile_element	yes	tosca.capabilities.nfv.Forwarding		Describes the requirement for the constituent of the NfpPositionElement.

7.8.5.5 Capabilities

The capabilities of the NfpPositionElement node type shall comply with the provisions set out in table 7.8.5.5-1.

Table 7.8.5.5-1: Capabilities

Name	Type	Constraints	Description
forwarding	tosca.capabilities.nfv.Forwarding		NfpPositionElement forwarding capability

7.8.5.6 Definition

The syntax of the NfpPositionElement node type shall comply with the following definition:

```
  tosca.nodes.nfv.NfpPositionElement:
    derived_from: tosca.nodes.Root
    description: node definition of NfpPositionElement
    capabilities:
      forwarding:
        type: tosca.capabilities.nfv.Forwarding
    requirements:
      - profile_element:
          capability: tosca.capabilities.nfv.Forwarding
          relationship: tosca.relationships.nfv.ForwardTo
          occurrences: [ 1, 2 ]  #When the number of occurrences is 1, the ingress and egress
traffic is associated to a single VnfExtCp or Sap; When the number of occurrences is 2, the
ingress VnfExtCp or Sap is associated to the first value and the egress VnfExtCp or Sap is
associated to the second value.
```

7.8.5.7 Artifact

None.

7.8.5.8 Additional Requirements

The valid node types for the "profile_element" requirements shall be limited to tosca.nodes.nfv.Forwarding and tosca.nodes.nfv.Sap.

7.8.5.9 Example

See clause A.14.

7.8.6 tosca.nodes.nfv.NFP

7.8.6.1 Description

The NFP node type 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. Table 7.8.6.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.8.6.1-1: Type name, shorthand, and URI

Shorthand Name	NFP
Type Qualified Name	toscanfv:NFP
Type URI	tosca.nodes.nfv.NFP

7.8.6.2 Properties

None.

7.8.6.3 Attributes

None.

7.8.6.4 Requirements

The requirements of the NFP node type shall comply with the provisions set out in table 7.8.6.4-1.

Table 7.8.6.4-1: Requirements

Name	Required	Capability type	Constraints	Description
nfp_position	yes	tosca.capabilities.nfv.Forwarding		

7.8.6.5 Capabilities

None.

7.8.6.6 Definition

The syntax of the NFP node type shall comply with the following definition:

```
tosca.nodes.nfv.NFP:
  derived_from: tosca.nodes.Root
  description: node definition of NFP
  requirements:
    - nfp_position:
        capability: tosca.capabilities.nfv.Forwarding
        node: tosca.nodes.nfv.NfpPosition
        relationship: tosca.relationships.nfv.ForwardTo
        occurrences: [ 1, UNBOUNDED ]
```

7.8.7 tosca.nodes.nfv.NfpPosition

7.8.7.1 Description

The NfpPosition node type describes the reference of one or more NfpPositionElements and rules on how to route traffic flows among VnfExtCp or SAP instances corresponding to these elements. Table 7.8.7.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

NOTE: The NfpPosition and NfpPositionElement node types of the VNFFG model describe the entities in VIM for enabling packets/frames to traverse the constituent VNFs, PNFs or Nested NSs of the Network Forwarding Path.

Table 7.8.7.1-1: Type name, shorthand, and URI

Shorthand Name	NfpPosition
Type Qualified Name	toscanfv:NfpPosition
Type URI	tosca.nodes.nfv.NfpPosition

7.8.7.2 Properties

The properties of the NfpPosition node type shall comply with the provisions set out in table 7.8.7.2-1.

Table 7.8.7.2-1: Properties

Name	Required	Type	Constraints	Description
forwarding_behaviour	no	string	Possible values: "all", "lb", "ff"	Identifies a rule to apply to forward traffic to CP or SAP instances corresponding to the referenced NfpPositionElement(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 (load balancing) = 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. The following value may be used as well: ff (fast failover) = Traffic flows shall be forwarded to the next CP or SAP in case they cannot be forwarded to a CP or SAP instance created from the referenced CP profile(s). See note.
forwarding_behaviour_input_parameters	no	map of string		Provides input parameters to configure the forwarding behaviour (e.g. identifies a load balancing algorithm). This property is reserved for future use in the present document.
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.				

7.8.7.3 Attributes

None.

7.8.7.4 Requirements

The requirements of the NfpPosition node type shall comply with the provisions set out in table 7.8.7.4-1.

Table 7.8.7.4-1: Requirements

Name	Required	Capability type	Constraints	Description
element	yes	tosca.capabilities.nfv.Forwarding		Specifies that an NfpPosition requires a node that has a forwarding capability.

7.8.7.5 Capabilities

The capabilities of the NfpPosition node type shall comply with the provisions set out in table 7.8.7.5-1.

Table 7.8.7.5-1: Capabilities

Name	Type	Constraints	Description
forwarding	tosca.capabilities.nfv.Forwarding		NfpPosition forwarding capability

7.8.7.6 Definition

The syntax of the NfpPosition node type shall comply with the following definition:

```
  tosca.nodes.nfv.NfpPosition:
    derived_from: tosca.nodes.Root
    description: node definition of NFP position
    properties:
      forwarding_behaviour:
        type: string
        description: Identifies a rule to apply to forward traffic to CP or SAP instances
corresponding to the referenced NfpPositionElement(s).
        constraints:
          - valid_values: [ all, lb, ff ]
        required: false
      forwarding_behaviour_input_parameters:
        description: Provides input parameters to configure the forwarding behaviour.
        type: map
        required: false
        entry_schema:
          type: string
    capabilities:
      forwarding:
        type: tosca.capabilities.nfv.Forwarding
    requirements:
      - element:
          capability: tosca.capabilities.nfv.Forwarding
          node: tosca.nodes.nfv.NfpPositionElement
          relationship: tosca.relationships.nfv.ForwardTo
          occurrences: [ 1, UNBOUNDED ]
```

7.8.7.7 Artifact

None.

7.8.7.8 Additional Requirements

None.

7.8.7.9 Example

See clause A.14.

7.8.8 tosca.nodes.nfv.Forwarding

7.8.8.1 Description

The Forwarding node type represents a point in the NS topology that can participate as a forwarding target in a network forwarding path. A template of this type is inserted between a virtual link (VirtualLinkable) requirement of a VNF/PNF node template (in effect, an external connection point of the VNF/PNF) or a nested NS node template and the virtual link template satisfying this requirement. Table 7.8.8.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

NOTE: The Forwarding node type is only used for the VNFFGD design. A node template with this type is only present in an NSD if at least one template of the VNFFG group type is included in the NSD.

Table 7.8.8.1-1: Type name, shorthand, and URI

Shorthand Name	Forwarding
Type Qualified Name	toscanfv:Forwarding
Type URI	tosca.nodes.nfv.Forwarding

7.8.8.2 Properties

None.

7.8.8.3 Attributes

None.

7.8.8.4 Requirements

The requirements of the Forwarding node type shall comply with the provisions set out in table 7.8.8.4-1.

Table 7.8.8.4-1: Requirements

Name	Capability Type	Constraints	Description
virtual_link	tosca.capabilities.nfv.VirtualLinkable		Describes the requirement for linking to a virtual linkable node type.

7.8.8.5 Capabilities

The capabilities of the Forwarding node type shall comply with the provisions set out in table 7.8.8.5-1.

Table 7.8.8.5-1: Capabilities

Name	Type	Constraints	Description
forwarding	tosca.capabilities.nfv.Forwarding		The forwarding capability exposed by the node.
virtual_linkable	tosca.capabilities.nfv.VirtualLinkable		The virtual linkable capability exposed by the node.

7.8.8.6 Definition

The syntax of the Forwarding node type shall comply with the following definition:

```
  tosca.nodes.nfv.Forwarding:
    derived_from: tosca.nodes.Root
    capabilities:
      virtual_linkable:
        type: tosca.capabilities.nfv.VirtualLinkable
      forwarding:
        type: tosca.capabilities.nfv.Forwarding
        occurrences: [ 1, 2 ]  #When the number of occurrences is 1, the ingress and egress
traffic is associated to a single VnfExtCp, PnfExtCp or Sap; When the number of occurrences is
2, the ingress VnfExtCp, PnfExtCp or Sap is associated to the first value and the egress
VnfExtCp, PnfExtCp or Sap is associated to the second value.
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
```

7.8.8.7 Artifact

None.

7.8.8.8 Additional Requirements

None.

7.8.8.9 Example

See clause A.14.

7.9 Group Types

7.9.1 tosca.groups.nfv.NsPlacementGroup

7.9.1.1 Description

The NsPlacementGroup group type is used for describing the affinity or anti-affinity relationship applicable between VNF instances created using different VNFDs, the Virtual Link instances created using different VLDs or the nested NS instances created using different NSDs when used in an NSD.

Table 7.9.1.1-1 specifies the declared names for this group type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.9.1.1-1: Type name, shorthand, and URI

Shorthand Name	NsPlacementGroup
Type Qualified Name	toscanfv:NsPlacementGroup
Type URI	tosca.groups.nfv.NsPlacementGroup

7.9.1.2 Properties

The properties of the NsPlacementGroup group type shall comply with the provisions set out in table 7.9.1.2-1.

Table 7.9.1.2-1: Properties

Name	Required	Type	Constraints	Description
description	yes	string		Human readable description of the group

7.9.1.3 Definition

The syntax of the NsPlacementGroup group type shall comply with the following definition:

```
  tosca.groups.nfv.NsPlacementGroup:
    derived_from: tosca.groups.Root
    description: NsPlacementGroup is used for describing the affinity or anti-affinity
relationship applicable between VNF instances created using different VNFDs, the Virtual Link
instances created using different VLDs or the nested NS instances created using different NSDs
when used in a NSD.
    properties:
      description:
        type: string
        description: Human readable description of the group
        required: true
    members: [tosca.nodes.nfv.VNF, tosca.nodes.nfv.NsVirtualLink, tosca.nodes.nfv.NS]
```

7.9.1.4 Additional Requirements

A group with type tosca.groups.nfv.NsPlacementGroup shall contain more than one member either all of the same node type or a combination of tosca.nodes.nfv.VNF and tosca.nodes.nfv.NS node types when used as the target of an AffinityRule or AntiAffinityRule policy.

7.9.2 tosca.groups.nfv.VNFFG

7.9.2.1 Description

The VNF Forwarding Graph (VNFFG) group type describes a topology of the NS or a portion of the NS and optionally forwarding rules, applicable to the traffic conveyed over this topology, as defined by ETSI GS NFV-IFA 014 [2]. Table 7.9.2.1-1 specifies the declared names for this group type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.9.2.1-1: Type name, shorthand, and URI

Shorthand Name	VNFFG
Type Qualified Name	toscanfv:VNFFG
Type URI	tosca.groups.nfv.VNFFG

7.9.2.2 Properties

The properties of the VNFFG group type shall comply with the provisions set out in table 7.9.2.2-1.

Table 7.9.2.2-1: properties

Name	Required	Type	Constraints	Description
description	yes	string		Human readable description of the group

7.9.2.3 Definition

The syntax of the VNFFG group type shall comply with the following definition:

```
  tosca.groups.nfv.VNFFG:
    derived_from: tosca.groups.Root
    description: the VNFFG group type describes a topology of the NS or a portion of the NS,  and
optionally forwarding rules, applicable to the traffic conveyed over this topology
    properties:
      description:
        type: string
        description: Human readable description of the group
        required: true
    members: [ tosca.nodes.nfv.NFP, tosca.nodes.nfv.VNF, tosca.nodes.nfv.PNF, tosca.nodes.nfv.NS,
tosca.nodes.nfv.NsVirtualLink, tosca.nodes.nfv.NfpPositionElement ]
```

7.9.2.4 Additional Requirements

None.

7.9.2.5 Example

See clause A.14.

7.10 Policy Types

7.10.1 NsAffinityRule, NsAntiAffinityRule

7.10.1.1 Description

The NsAffinityRule and NsAntiAffinityRule policy describes the affinity or anti-affinity rules applicable for the defined target.

If there is only one node template with node type tosca.nodes.nfv.VNF or tosca.nodes.nfv.NsVirtualLink or tosca.nodes.nfv.NS set as the targets, the NsAffinityRule or NsAntiAffinityRule applies between the instances to be created based on the same VNFD, or between VLs to be created based on the same VLD, or between nested NS instances to be created based on the same NSD, as described in ETSI GS NFV-IFA 014 [2].

If there are more than one node templates with node type tosca.nodes.nfv.VNF or tosca.nodes.nfv.NsVirtualLink or tosca.nodes.nfv.NS set as the targets, or a group with type tosca.groups.nfv.PlacementGroup which contains more than one members set as targets, the NsAffinityRule or NsAntiAffinityRule applies between VNF instances created using different VNFD, the Virtual Link instances created using different VLD or the nested NS instances created using different NSD. as described in ETSI GS NFV-IFA 014 [2].

Tables 7.10.1.1-1 and 7.10.1.1-2 specify the declared names for the policy types. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.1.1-1: Type name, shorthand, and URI

Shorthand Name	NsAffinityRule
Type Qualified Name	toscanfv:NsAffinityRule
Type URI	tosca.policies.nfv.NsAffinityRule

Table 7.10.1.1-2: Type name, shorthand, and URI

Shorthand Name	NsAntiAffinityRule
Type Qualified Name	toscanfv:NsAntiAffinityRule
Type URI	tosca.policies.nfv.NsAntiAffinityRule

7.10.1.2 Properties

The properties of the NsAffinityRule and NsAntiAffinityRule types shall comply with the provisions set out in table 7.10.1.2-1.

Table 7.10.1.2-1: Properties

Name	Required	Type	Constraints	Description
scope	Yes	String	Valid values : See YAML definition constraints	Specifies the scope of the local affinity rule. See note.
NOTE: When used in an anti-affinity relationship, the "network_link_and_node" scope is conceptually similar to link and node disjoint paths capabilities used commonly in network Traffic Engineering (TE). For example, as in Fast Reroute Resource Reservation Protocol Traffic Engineering (RSVP-TE) for Label-Switched Path (LSP) tunnels as introduced in IETF RFC 4090 [i.17].				

7.10.1.3 Targets

The targets of the NsAffinityRule and NsAntiAffinityRule policy types shall comply with the provisions set out in table 7.10.1.3-1 when used in an NSD.

Table 7.10.1.3-1: Targets

Name	Required	Type	Constraints	Description
targets	Yes	string[]	Valid types: See YAML definition constraints	In case of LocalAffinityOrAntiAffinityRule as defined in ETSI GS NFV-IFA 014 [2], the valid type of the targets is tosca.nodes.nfv.VNF or tosca.nodes.nfv.NsVirtualLink, or tosca.nodes.nfv.NS. In case of affinityOrAntiAffinityGroup as defined in ETSI GS NFV-IFA 014 [2], the valid types of the targets are: tosca.nodes.nfv.VNF, tosca.nodes.nfv.NsVirtualLink and tosca.nodes.nfv.NS or a tosca.groups.nfv.NsPlacementGroup.

7.10.1.4 Definition

The syntax of the NsAffinityRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsAffinityRule:
    derived_from: tosca.policies.Placement
    description: The NsAffinityRule describes the affinity rules applicable for the defined
targets
    properties:
      scope:
        type: string
        description: Specifies the scope of the local affinity rule.
        required: true
        constraints:
          - valid_values: [ nfvi_node, zone, zone_group, nfvi_pop, network_link_and_node ]
    targets: [tosca.nodes.nfv.VNF, tosca.nodes.nfv.NsVirtualLink, tosca.nodes.nfv.NS,
tosca.groups.nfv.NsPlacementGroup ]
```

The syntax of the NsAntiAffinityRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsAntiAffinityRule:
    derived_from: tosca.policies.Placement
    description: The NsAntiAffinityRule describes the anti-affinity rules applicable for the
defined targets
    properties:
      scope:
        type: string
        description: Specifies the scope of the local affinity rule..
        required: true
        constraints:
          - valid_values: [ nfvi_node, zone, zone_group, nfvi_pop, network_link_and_node ]
    targets: [tosca.nodes.nfv.VNF, tosca.nodes.nfv.NsVirtualLink, tosca.nodes.nfv.NS,
tosca.groups.nfv.NsPlacementGroup ]
```

7.10.1.5 Examples

The following example template fragments illustrate the concepts:

```
node_templates:
  VNF_1:
   type: tosca.nodes.nfv.exampleVNF

policies:
  policy_affinity_local_VNF_1:
   type: tosca.policies.nfv.NsAffinityRule
   targets: [ VNF_1 ]
   properties:
    scope: nfvi_node
```

The above example illustrates a local affinity rule for all the instances of VNF_1.

```
node_template:
  VNF_1:
   type: tosca.nodes.nfv.Vdu.exampleVNF_1

  VNF_2:
   type: tosca.nodes.nfv.Vdu.exampleVNF_2

groups:
  affinityOrAntiAffinityGroup_1:
   type: tosca.groups.nfv.NsPlacementGroup
   members: [ VNF_1, VNF_2 ]

policies:
  policy_antiaffinity_group_1:
   type: tosca.policies.nfv.NsAntiAffinityRule
   targets: [ affinityOrAntiAffinityGroup_1 ]
   properties:
    scope: nfvi_node
```

The above example illustrates an anti-affinity policy among a group which contains VNF_1 and VNF_2 as members.

7.10.2 tosca.policies.nfv.NsSecurityGroupRule

7.10.2.1 Description

The NsSecurityGroupRule policy type when used in an NSD specifies the matching criteria for the ingress and/or egress traffic to and from visited SAPs. Table 7.10.2.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.2.1-1: Type name, shorthand, and URI

Shorthand Name	NsSecurityGroupRule
Type Qualified Name	toscanfv:NsSecurityGroupRule
Type URI	tosca.policies.nfv.NsSecurityGroupRule

7.10.2.2 Properties

None

7.10.2.3 targets

The targets of the SecurityGroupRule policy types shall comply with the provisions set out in table 7.10.2.3-1.

Table 7.10.2.3-1: Targets

Name	Required	Type	Constraints	Description
targets	yes	string[]	Valid types: tosca.nodes.nfv.Sap.	Target connection points of Sap.

7.10.2.4 Definition

The syntax of the NsSecurityGroupRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsSecurityGroupRule:
    derived_from: tosca.policies.nfv.Abstract.SecurityGroupRule
    description: The NsSecurityGroupRule type is a policy type specified the matching criteria
for the ingress and/or egress traffic to/from visited SAPs.
    targets: [ tosca.nodes.nfv.Sap ]
```

7.10.2.5 Additional Requirements

None.

7.10.3 tosca.policies.nfv.NfpRule

7.10.3.1 Description

The NfpRule policy type represents the NFP rule attribute of the Nfpd information element as defined in ETSI GS NFV-IFA 014 [2], which describes the conditions that shall be met in order for the NFP to be applicable to the packet. Table 7.10.3.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.3.1-1: Type name, shorthand, and URI

Shorthand Name	NfpRule
Type Qualified Name	toscanfv:NfpRule
Type URI	tosca.policies.nfv.NfpRule

7.10.3.2 Properties

The properties of the NFP policy type shall comply with the provisions set out in table 7.10.3.2-1.

Table 7.10.3.2-1: Properties

Name	Required	Type	Constraints	Description
ether_destination_address	no	string		Indicates a destination Mac address.
ether_source_address	no	string		Indicates a source Mac address.
ether_type	no	string	ipv4, ipv6	Indicates the protocol carried over the Ethernet layer.
vlan_tag	no	list of string		Indicates a VLAN identifier in an IEEE 802.1Q-2014 tag [16]. Multiple tags can be included for QinQ stacking.
protocol	no	string		Indicates the L4 protocol, For IPv4 [17] this corresponds to the field called "Protocol" to identify the next level protocol. For IPv6 [18] this corresponds to the field called the "Next Header" field. Permitted values: Any keyword defined in the IANA [19] protocol registry, e.g.: • TCP • UDP • ICMP.
dscp	no	string		For IPv4 [17] a string of "0" and "1" digits that corresponds to the 6-bit Differentiated Services Code. Point (DSCP) field of the IP header. For IPv6 [18] a string of "0" and "1" digits that corresponds to the 6 differentiated services bits of the traffic class header field.
source_port_range	no	range	0 - 65535	Indicates a range of source ports.
destination_port_range	no	range	0 - 65535	Indicates a range of destination ports.
source_ip_address_prefix	no	string		Indicates the source IP address range in CIDR format.
destination_ip_address_prefix	no	string		Indicates the destination IP address range in CIDR format.
extended_criteria	no	list of tosca.datatypes.nfv.Mask		Indicates values of specific bits in a frame.

7.10.3.3 Targets

The targets of the NfpRule policy types shall comply with the provisions set out in table 7.10.3.3-1.

Table 7.10.3.3-1: Targets

Name	Required	Type	Constraints	Description
targets	yes	string[]	Valid types: tosca.nodes.nfv.NFP.	The NFPs to which the rule applies.

7.10.3.4 Definition

The syntax of the NfpRule policy type shall comply with the following definition:

```
tosca.policies.nfv.NfpRule:
  derived_from: tosca.policies.Root
  description: policy definition of NfpRule
  properties:
    ether_destination_address:
      description: Indicates a destination Mac address.
      type: string
      required: false
```

```
      ether_source_address:
        description: Indicates a source Mac address.
        type: string
        required: false
      ether_type:
        description: Indicates the protocol carried over the Ethernet layer.
        type: string
        constraints:
          - valid_values: [ ipv4, ipv6 ]
        required: false
      vlan_tag:
        description: Indicates a VLAN identifier in an IEEE 802.1Q-2014 tag. Multiple tags can
be included for QinQ stacking.
        type: list
        entry_schema:
          type: string
        required: false
      protocol:
        description: 'Indicates the L4 protocol, For IPv4 this corresponds to the field called
"Protocol" to identify the next level protocol. For IPv6 this corresponds to the field is
called the "Next Header" field. Permitted values: Any keyword defined in the IAN protocol
registry.'
        type: string
        required: false
      dscp:
        description: For IPv4 a string of "0" and "1" digits that corresponds to the 6-bit
Differentiated Services Code Point (DSCP) field of the IP header. For IPv6 a string of "0" and
"1" digits that corresponds to the 6 differentiated services bits of the traffic class header
field.
        type: string
        required: false
      source_port_range:
        description: Indicates a range of source ports.
        type: range
        required: false
        constraints:
          - in_range: [ 0, 65535 ]
      destination_port_range:
        description: Indicates a range of destination ports.
        type: range
        required: false
        constraints:
          - in_range: [ 0, 65535 ]
      source_ip_address_prefix:
        description: Indicates the source IP address range in CIDR format.
        type: string
        required: false
      destination_ip_address_prefix:
        description: Indicates the destination IP address range in CIDR format.
        type: string
        required: false
      extended_criteria:
        description: Indicates values of specific bits in a frame.
        type: list
        entry_schema:
          type: tosca.datatypes.nfv.Mask
        required: false
    targets: [ tosca.nodes.nfv.NFP ]
```

7.10.3.5 Example

None.

7.10.4 tosca.policies.nfv.NsMonitoring

7.10.4.1 Description

The NsMonitoring policy type is a policy type representing the virtualised resource related performance metrics to be monitored during the lifetime of network service instance as defined in ETSI GS NFV-IFA 014 [2] and ETSI GS NFV-IFA 027 [7]. Table 7.10.4.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.4.1-1: Type name, shorthand, and URI

Shorthand Name	NsMonitoring
Type Qualified Name	toscanfv:NsMonitoring
Type URI	tosca.policies.nfv.NsMonitoring

7.10.4.2 Properties

The properties of the NsMonitoring policy type shall comply with the provisions set out in table 7.10.4.2-1.

Table 7.10.4.2-1: Properties

Name	Required	Type	Constraints	Description
ns_monitoring_parameters	yes	map of tosca.datatypes.nfv.NsMonitoringParameter		Specifies a virtualised resource related performance metric to be monitored on the NS level.

7.10.4.3 targets

The targets of the NsMonitoring policy types shall comply with the provisions set out in table 7.10.4.3-1.

Table 7.10.4.3-1: Targets

Name	Required	Type	Constraints	Description
targets	yes	string	Valid types: tosca.nodes.nfv.NS	Specifies the services node type(s) to which the monitoring policy applies.

7.10.4.4 Definition

The syntax of the NsMonitoring policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsMonitoring:
    derived_from: tosca.policies.Root
    description: Policy type is used to identify information to be monitored during the
lifetime of a network service instance as defined in ETSI GS NFV-IFA 014.
    properties:
      ns_monitoring_parameters:
        type: map #key: id
        description: Specifies a virtualised resource related performance metric to be
monitored on the NS level.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.NsMonitoringParameter
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.NS ]
```

7.10.4.5 Additional Requirements

When a policy of this type is specified in an NS service template, the targets set shall only include NS node template names that correspond to this NS or to a nested NS.

7.10.5 tosca.policies.nfv.VnfMonitoring

7.10.5.1 Description

The VnfMonitoring policy type is a policy type representing the virtualised resource related performance metrics to be monitored during the lifetime of VNF instance as defined in ETSI GS NFV-IFA 014 [2] and ETSI GS NFV-IFA 027 [7]. Table 7.10.5.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.5.1-1: Type name, shorthand, and URI

Shorthand Name	VnfMonitoring
Type Qualified Name	toscanfv:VnfMonitoring
Type URI	tosca.policies.nfv.VnfMonitoring

7.10.5.2 Properties

The properties of the VnfMonitoring policy type shall comply with the provisions set out in table 7.10.5.2-1.

Table 7.10.5.2-1: Properties

Name	Required	Type	Constraints	Description
vnf_monitoring_parameters	yes	map of tosca.datatypes.nfv.VnfMonitoringParameter		Specifies a virtualised resource related performance metric to be monitored on the VNF level.

7.10.5.3 targets

The targets of the VnfMonitoring policy types shall comply with the provisions set out in table 7.10.5.3-1.

Table 7.10.5.3-1: Targets

Name	Required	Type	Constraints	Description
targets	yes	string	Valid types: tosca.nodes.nfv.VNF	Specifies the VNF node type(s) to which the monitoring policy applies.

7.10.5.4 Definition

The syntax of the VnfMonitoring policy type shall comply with the following definition:

```
  tosca.policies.nfv.VnfMonitoring:
    derived_from: tosca.policies.Root
    description: Policy type is used to identify information to be monitored during the
lifetime of a VNF instance as defined in ETSI GS NFV-IFA 014.
    properties:
      vnf_monitoring_parameters:
        type: map #key: id
        description: Specifies a virtualised resource related performance metric to be
monitored on the NS level.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.VnfMonitoringParameter
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VNF ]
```

7.10.5.5 Additional Requirements

When a policy of this type is specified in an NS service template, the targets set shall only include VNF node template names representing constituent VNFs for the NS deployment flavour corresponding to this NS.

7.10.6 tosca.policies.nfv.Abstract.SecurityGroupRule

7.10.6.1 Description

The Abstract.SecurityGroupRule policy type is defined in clause 9.10.1 of the present document.

7.10.7 tosca.policies.nfv.NsScalingAspects

7.10.7.1 Description

The NsScalingAspects type is a policy type representing the scaling aspects used for horizontal scaling as defined in ETSI GS NFV-IFA 014 [2]. This policy concerns the whole NS (deployment flavour) represented by the topology_template and thus has no explicit target list. Table 7.10.7.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.7.1-1: Type name, shorthand, and URI

Shorthand Name	NsScalingAspects
Type Qualified Name	toscanfv:NsScalingAspects
Type URI	tosca.policies.nfv.NsScalingAspects

7.10.7.2 Properties

The properties of the NsScalingAspects policy type shall comply with the provisions set out in table 7.10.7.2-1.

Table 7.10.7.2-1: Properties

Name	Required	Type	Constraints	Description
aspects	yes	Map of tosca.datatypes.nfv.NsScalingAspect		Describe the details of a particular aspect including the corresponding NS levels.

7.10.7.3 Definition

The syntax of the NsScalingAspects policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsScalingAspects:
    derived_from: tosca.policies.Root
    description: The NsScalingAspects type is a policy type representing the scaling aspects used
for horizontal scaling as defined in ETSI GS NFV-IFA 014
    properties:
      aspects:
        type: map # key: aspectId
        description: Describe the details of a particular aspect including the corresponding NS
levels.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.NsScalingAspect
        constraints:
          - min_length: 1
```

7.10.7.4 Examples

See clause A.17.

7.10.8 tosca.policies.nfv.VnfToLevelMapping

7.10.8.1 Description

The VnfToLevelMapping type is a policy type representing the number of VNF instances that correspond to every NS level of a particular aspect, as defined in ETSI GS NFV-IFA 014 [2]. Table 7.10.8.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.8.1-1: Type name, shorthand, and URI

Shorthand Name	VnfToLevelMapping
Type Qualified Name	toscanfv: VnfToLevelMapping
Type URI	tosca.policies.nfv.VnfToLevelMapping

7.10.8.2 Properties

The properties of the VnfToLevelMapping policy type shall comply with the provisions set out in table 7.10.8.2-1.

Table 7.10.8.2-1: Properties

Name	Required	Type	Constraints	Description
aspect:	yes	string		Represents the scaling aspect to which this policy applies.
number_of_instances	yes	map of integer		Describes the number of VNF instances to be deployed for each NS level of a particular aspect. The first level is level 0.

7.10.8.3 Definition

The syntax of the VnfToLevelMapping policy type shall comply with the following definition:

```
  tosca.policies.nfv.VnfToLevelMapping:
    derived_from: tosca.policies.Root
    description: The VnfToLevelMapping type is a policy type representing the number of VNF
instances to be deployed at each NS level, as defined in ETSI GS NFV-IFA 014
    properties:
      aspect:
        type: string
        description: Represents the scaling aspect to which this policy applies
        required: true
      number_of_instances:
        type: map # key: Ns level
        description: Number of VNF instances to be deployed for each NS level.
        required: true
        key_schema:
          type: integer # First level is level 0.
          constraints:
            - greater_or_equal: 0
        entry_schema:
          type: integer
          constraints:
            - greater_or_equal: 0
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VNF ]
```

7.10.8.4 Examples

See clause A.17.

7.10.9 tosca.policies.nfv.NsToLevelMapping

7.10.9.1 Description

The NsToLevelMapping type is a policy type representing the number of instances of a nested NS that correspond to every NS level of the composite NS of a particular aspect, as defined in ETSI GS NFV-IFA 014 [2]. Table 7.10.9.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.9.1-1: Type name, shorthand, and URI

Shorthand Name	NsToLevelMapping
Type Qualified Name	toscanfv: NsToLevelMapping
Type URI	tosca.policies.nfv.NsToLevelMapping

7.10.9.2 Properties

The properties of the NsToLevelMapping policy type shall comply with the provisions set out in table 7.10.9.2-1.

Table 7.10.9.2-1: Properties

Name	Required	Type	Constraints	Description
aspect:	yes	string		Represents the scaling aspect to which this policy applies.
number_of_instances	yes	map of integer		Describes the number of NS instances of a nested NS to be deployed for each NS level of the composite NS of a particular aspect. The first level is level 0.

7.10.9.3 Definition

The syntax of the NsToLevelMapping policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsToLevelMapping:
    derived_from: tosca.policies.Root
    description: The NsToLevelMapping type is a policy type representing the number of NS
instances of a nested NS to be deployed at each NS level of the composite NS, as defined in ETSI
GS NFV-IFA 014
    properties:
      aspect:
        type: string
        description: Represents the scaling aspect to which this policy applies
        required: true
      number_of_instances:
        type: map # key: Ns level
        description: Number of NS instances of a nested NS to be deployed for each NS level of the
composite NS.
        required: true
        key_schema:
          type: integer # First level is level 0.
          constraints:
            - greater_or_equal: 0
        entry_schema:
          type: integer
          constraints:
            - greater_or_equal: 0
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.NS ]
```

7.10.9.4 Examples

See clause A.17.

7.10.10 tosca.policies.nfv.VirtualLinkToLevelMapping

7.10.10.1 Description

The VirtualLinkToLevelMapping type is a policy type representing the bitrate requirements of a VL for every NS level of a particular aspect, as defined in ETSI GS NFV-IFA 014 [2]. Table 7.10.10.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.10.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkToLevelMapping
Type Qualified Name	toscanfv: VirtualLinkToLevelMapping
Type URI	tosca.policies.nfv.VirtualLinkToLevelMapping

7.10.10.2 Properties

The properties of the VirtualLinkToLevelMapping policy type shall comply with the provisions set out in table 7.10.10.2-1.

Table 7.10.10.2-1: Properties

Name	Required	Type	Constraints	Description
aspect:	yes	string		Represents the scaling aspect to which this policy applies.
bit_rate_requirements	yes	map of tosca.datatypes.nfv. LinkBitrateRequirements		Describes the bitrate requirements of a VL for each NS level of a particular aspect. First level is level 0.

7.10.10.3 Definition

The syntax of the VirtualLinkToLevelMapping policy type shall comply with the following definition:

```
  tosca.policies.nfv.VirtualLinkToLevelMapping:
    derived_from: tosca.policies.Root
    description: The VirtualLinkToLevelMapping type is a policy type representing the number of NS
instances of a nested NS to be deployed at each NS level of the composite NS, as defined in ETSI
GS NFV-IFA 014
    properties:
      aspect:
        type: string
        description: Represents the scaling aspect to which this policy applies
        required: true
      bit_rate_requirements:
        type: map # key: Ns level
        description: Bitrate requirements of a VL for each NS level.
        required: true
        key_schema:
          type: integer # First level is level 0.
          constraints:
            - greater_or_equal: 0
        entry_schema:
          type: tosca.datatypes.nfv.LinkBitrateRequirements
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.NsVirtualLink ]
```

7.10.10.4 Examples

See clause A.17.

7.10.11 tosca.policies.nfv.NsInstantiationLevels

7.10.11.1 Description

The NsInstantiationLevels type is a policy type representing all the instantiation levels of resources to be instantiated within a deployment flavour and including default instantiation level in term of the number of VNF instances and nested NS instances to be created as defined in ETSI GS NFV-IFA 014 [2]. This policy concerns the whole NS(deployment flavour) represented by the topology_template and thus has no explicit target list. Table 7.10.11.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.11.1-1: Type name, shorthand, and URI

Shorthand Name	NsInstantiationLevels
Type Qualified Name	toscanfv:NsInstantiationLevels
Type URI	tosca.policies.nfv.NsInstantiationLevels

7.10.11.2 Properties

The properties of the NsInstantiationLevels policy type shall comply with the provisions set out in table 7.10.11.2-1.

Table 7.10.11.2-1: Properties

Name	Required	Type	Constraints	Description
ns_levels	yes	map of tosca.datatypes .nfv.NsLevels		Describes the various levels of resources that can be used to instantiate the NS using this flavour.
default_level	no	string		The default instantiation level for this flavour.

7.10.11.3 Definition

The syntax of the NsInstantiationLevels policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsInstantiationLevels:
    derived_from: tosca.policies.Root
    description: The NsInstantiationLevels type is a policy type representing all the
instantiation levels of resources to be instantiated within a deployment flavour and including
default instantiation level in term of the number of VNF and nested NS instances to be created as
defined in ETSI GS NFV-IFA 014.
    properties:
      ns_levels:
        type: map # key: levelId
        description: Describes the various levels of resources that can be used to instantiate the
VNF using this flavour.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.NsLevels
        constraints:
          - min_length: 1
      default_level:
        type: string # levelId
        description: The default instantiation level for this flavour.
        required: false # required if multiple entries in ns_levels
```

7.10.12 tosca.policies.nfv.VnfToInstantiationLevelMapping

7.10.12.1 Description

The VnfToIntantiationLevelMapping type is a policy type representing the number of VNF instances that correspond to every NS instantiation level, as defined in ETSI GS NFV-IFA 014 [2]. Table 7.10.12.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.12.1-1: Type name, shorthand, and URI

Shorthand Name	VnfToInstantiationLevelMapping
Type Qualified Name	toscanfv: VnfToInstantiationLevelMapping
Type URI	tosca.policies.nfv.VnfToInstantiationLevelMapping

7.10.12.2 Properties

The properties of the VnfToInstantiationLevelMapping policy type shall comply with the provisions set out in table 7.10.12.2-1.

Table 7.10.12.2-1: Properties

Name	Required	Type	Constraints	Description
number_of_instances	yes	map of integer		Describes the number of VNF instances to be deployed for each NS instantiation level.

7.10.12.3 Definition

The syntax of the VnfToInstantiationLevelMapping policy type shall comply with the following definition:

```
  tosca.policies.nfv.VnfToInstantiationLevelMapping:
    derived_from: tosca.policies.Root
    description: The VnfToInstantiationLevelMapping type is a policy type representing the number
of VNF instances to be deployed at each NS instantiation level, as defined in ETSI GS NFV-IFA 014
    properties:
      number_of_instances:
        type: map # key: Ns instantiation level
        description: Number of VNF instances to be deployed for each NS instantiation level.
        required: true
        entry_schema:
          type: integer
          constraints:
            - greater_or_equal: 0
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.VNF ]
```

7.10.12.4 Examples

See clause A.17.

7.10.12.5 Additional requirements

There shall be one VnfToInstantiationLevelMapping policy defined for each VNF of the NS. If no instances of a given VNF have to be deployed at NS instantiation time for a certain instantiation level, the number_of_instances in the corresponding map entry shall be set to 0.

7.10.13 tosca.policies.nfv.NsToInstantiationLevelMapping

7.10.13.1 Description

The NsToInstantiationLevelMapping type is a policy type representing the number of instances of a nested NS that correspond to every NS instantiation level of the composite NS, as defined in ETSI GS NFV-IFA 014 [2].
Table 7.10.13.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.13.1-1: Type name, shorthand, and URI

Shorthand Name	NsToInstantiationLevelMapping
Type Qualified Name	toscanfv: NsToInstantiationLevelMapping
Type URI	tosca.policies.nfv.NsToInstantiationLevelMapping

7.10.13.2 Properties

The properties of the NsToInstantiationLevelMapping policy type shall comply with the provisions set out in table 7.10.13.2-1.

Table 7.10.13.2-1: Properties

Name	Required	Type	Constraints	Description
number_of_instances	yes	map of integer		Describes the number of NS instances of a nested NS to be deployed for each NS instnatiation level of the composite NS.

7.10.13.3 Definition

The syntax of the NsToInstantiationLevelMapping policy type shall comply with the following definition:

```
  tosca.policies.nfv.NsToInstantiationLevelMapping:
    derived_from: tosca.policies.Root
    description: The NsToInstantiationLevelMapping type is a policy type representing the number
of NS instances of a nested NS to be deployed at each NS instantiation level of the composite NS,
as defined in ETSI GS NFV-IFA 014
    properties:
      number_of_instances:
        type: map # key: Ns instantiation level
        description: Number of NS instances of a nested NS to be deployed for each NS
instantiation level of the composite NS.
        required: true
        entry_schema:
          type: integer
          constraints:
            - greater_or_equal: 0
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.NS ]
```

7.10.13.4 Examples

See clause A.17.

7.10.13.5 Additional requirements

There shall be one NsToInstantiationLevelMapping policy defined for each nested NS of the composite NS. If no instances of a given nested NS have to be deployed at NS instantiation time for a certain instantiation level, the number_of_instances in the corresponding map entry shall be set to 0.

7.10.14 tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping

7.10.14.1 Description

The VirtualLinkToInstantiationLevelMapping type is a policy type representing the bitrate requirements of a VL for every NS instantiation level of a particular aspect, as defined in ETSI GS NFV-IFA 014 [2]. Table 7.10.14.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.14.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkToInstantiationLevelMapping
Type Qualified Name	toscanfv: VirtualLinkToInstantiationLevelMapping
Type URI	tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping

7.10.14.2 Properties

The properties of the VirtualLinkToInstantiationLevelMapping policy type shall comply with the provisions set out in table 7.10.14.2-1.

Table 7.10.14.2-1: Properties

Name	Required	Type	Constraints	Description
bit_rate_requirements	yes	map of tosca.datatypes .nfv. LinkBitrateRequ irements		Describes the bitrate requirements of a VL for each NS instantiation level.

7.10.14.3 Definition

The syntax of the VirtualLinkToInstantiationLevelMapping policy type shall comply with the following definition:

```
  tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping:
    derived_from: tosca.policies.Root
    description: The VirtualLinkToInstantiationLevelMapping type is a policy type describing the
bitrate requirements of a VL at each NS instantiation level of the composite NS, as defined in
ETSI GS NFV-IFA 014
    properties:
      bit_rate_requirements:
        type: map # key: Ns instantiation level
        description: Bitrate requirements of a VL for each NS instantiation level.
        required: true
        entry_schema:
          type: tosca.datatypes.nfv.LinkBitrateRequirements
        constraints:
          - min_length: 1
    targets: [ tosca.nodes.nfv.NsVirtualLink ]
```

7.10.14.4 Examples

See clause A.17.

7.10.15 tosca.policies.nfv.NsAutoScale

7.10.15.1 Description

The NsAutoScale is a base policy type for defining NS auto-scale specific policies as defined in ETSI GS NFV-IFA 014 [2].

Table 7.10.15.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 7.10.15.1-1: Type name, shorthand, and URI

Shorthand Name	NsAutoScale
Type Qualified Name	toscanfv:NsAutoScale
Type URI	tosca.policies.nfv.NsAutoScale

7.10.15.2 Properties

None.

7.10.15.3 Definition

The syntax of the NsAutoScale policy type shall comply with the following definition:

```
   tosca.policies.nfv.NsAutoScale:
     derived_from: tosca.policies.Root
     description: The NsAutoScale policy type is a base policy type for defining NS auto-scale
specific policies as defined in ETSI GS NFV-IFA 014.
     targets: [ tosca.nodes.nfv.NS ]
```

7.10.15.4 Additional requirements

The NSD service template may include specific policies of NsAutoScale type with the following requirements:

a) it shall include one or more trigger definitions which:

- shall include an event with a value equal to the full name of a notification in the NsVnfIndicator interface definition of the NS node where the policy applies;
- may include a condition definition which can assert the value of vnf indicator attributes and other node attributes using arbitrary AND and OR combinations of the individual assertions;
- may include an action invoking one or multiple operations of the Nslcm interface;

b) the target shall be set to the node template to which the policy applies, i.e. to the node template of the NS specific type present in the topology template that represents a particular deployment flavour.

7.11 NSD TOSCA service template design

7.11.1 General

The TOSCA service template design for an NSD in the general case uses two levels of service templates as described in clause 7.11.2. In this design, the top level contains an abstract NS node template, i.e. without an implementation of the creation operation and is therefore substituted by one of the lower level service templates. This design is applicable regardless of whether the NS has one or multiple deployment flavours.

In the particular case of an NS with only one deployment flavour there is an alternative design which is described in clause 7.11.3 and which uses only one service template.

7.11.2 Single or multiple deployment flavour design with two levels of service templates

NSD shall be implemented as one top-level service template and one or multiple lower level service templates, where each lower level service template represents a deployment flavour. A separate YAML file with an NS specific node type definition which shall be derived from tosca.nodes.nfv.NS node type as defined in clause 7.8.1 shall be provided and is also considered as a part of an NSD. The top level service template shall be the main entry point of the NSD file structure as specified in ETSI GS NFV-SOL 007 [i.11], i.e. the Entry-definitions file. The file names of all the lower service templates shall be declared as the value of the Other-Definitions key in the TOSCA.meta file of the NSD file structure as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

See clause A.11 for an example of NSD design with multiple deployment flavours.

The top level service template shall comply with TOSCA-Simple-Profile-YAML-v1.3 [20] and shall include:

a) an import statement referencing the TOSCA types definition file as defined in clause B.3;

b) an import statement referencing a yaml file which contains an NS specific node type definition;

c) a topology template with a node template of the NS-specific node type, which:

   1) shall include the flavour_id and other properties that are marked as required but do not have a default value in the VNF specific node type definition;

   2) shall include the requirements as defined in clause 7.8.1; and

   3) may include other properties specified in the NS specific node type definition, excluding the 'service_availability_level', 'ns_profile' and the 'priority' properties; and

   4) may include a substitute directive; and

d) optionally, additional NS-specific type definitions and import statements referencing additional NS-specific files containing only type definitions used by this TOSCA service template;

e) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

Irrespective of the presence of absence of the substitute directive, the deployment and lifecycle management of instances of this NS node type is done by means of substitution by any of the lower level service templates as declared in the Other-Definitions of the TOSCA.meta file in the NSD file structure. The NSD consumer shall silently ignore the substitute directive if explicit directives are not supported.

The lower level service template is an implementable TOSCA service template for the deployment of a specific deployment flavour.

The lower level service template shall comply with TOSCA-Simple-Profile-YAML-v1.3 [20] and shall include:

a) an import statement referencing the TOSCA types definition file as defined in clause B.3;

b) an import statement referencing a yaml file which contains an NS specific node type definition which shall be derived from tosca.nodes.nfv.NS node type as defined in clause 7.8.1;

c) one of more import statements respectively referencing the yaml file which contains the included VNF specific node type definition if any or the included PNF specific node type definition if any or the included NS specific node type definition if any;

   If the imported files contain a topology template, this topology template shall be ignored during the parsing of the NSD. To facilitate parsing the NSD, the imported files may be included in the NSD file structure as specified in ETSI GS NFV-SOL 007 [i.11], in which case the node type definitions they contain shall be identical to those contained in the corresponding VNF package, PNF archive and NSD file structure.

NOTE 1: These node type definitions are only used to parse the NSD. For the LCM operations of the corresponding VNF or nested NS, such node type definitions do not apply, only the files included in the related VNF package or NSD file structure will be used.

d) optionally, additional NS-specific type definitions and import statements referencing additional NS-specific files containing type definitions used by this TOSCA service template; and

e) a topology template describing the internal topology of the NS with:

   - substitution_mappings indicating:

     - the same node type as defined in the NS specific node type definition service template;

     - a flavour_id property and its value as defined in substitution_filter which identifies the DF corresponding to this low level template within the NSD;

NOTE 2: Starting with version 3.3.1 of the present document, the property_mapping grammar was changed to support substitution_filter. For backward compatibility, TOSCA-Simple-Profile-YAML-v1.3 [20], clause 3.8.8.3. specifies the provisions for handling the previous grammar. Support of the Release 2 property_mapping grammar can be removed in subsequent versions of the present document.

     - the mapping of the virtual_link requirements on SAPs;

NOTE 3: When a Sap re-exposes a VNF or PNF external connection point or a Sap of a nested NS, the virtual_link requirement of the NS is mapped to the virtual_link requirement of the VNF or PNF or nested NS node or a corresponding Forwarding node (i.e. the forwarding node that has a capability matching the virtual link requirement of the node whose external connection point or Sap is been exposed). Otherwise the virtual_link requirement of the NS is mapped to the external_virtual_link requirement of the SAP node.

- a node template referencing the NS specific node type containing the 'service_availability_level' property with a value, if applicable; the 'priority' property with a value, if applicable; implementations of the operations of the LCM interface to be executed by the NFVO, if applicable; and
- additional node templates of type VNF, PNF, NS, NsVirtualLink, Sap, etc. that define the topology and composition of the NS flavour, the dependency requirements as defined in TOSCA-Simple-Profile-YAML-v1.3 [20] may be used between different VNF node templates, or between a VNF node template and a nested NS node template, or between different nested NS node templates to specify the order in which instances of the VNFs and/or nested NSs have to be created;
- additional group definitions, policy definitions and parameter definitions if applicable;

f) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

Either the service_availability_level property in the NS node template or the service_availability_level attribute in any of the VNF node templates may be provided, but not both. Either the service_availability_level property in the NS node template or the service_availability_level attribute in any of the NsVirtualLink node templates may be provided, but not both.

NOTE 3: The format and structure of an NSD file structure is defined in ETSI GS NFV-SOL 007 [i.11].

NOTE 4: All the imported type definition files as indicated either in the top level service template or in any of the lower level service template are considered as parts of an NSD.

When the flavour_id of an NS has been chosen (e.g. through an input parameter of an NS instantiation request received by a NFVO) among the values included in the NS node type imported into the top level service template, it is then used as the filter for selecting a particular lower level TOSCA service template inside the NSD file structure as described in TOSCA-Simple-Profile-YAML-v1.3 [20].

7.11.3 Single deployment flavour design with one service template

In case of the single deployment flavour scenario with one service template design, the NSD shall use TOSCA-Simple-Profile-YAML-v1.3 [20] and shall include:

a) an import statement referencing the TOSCA types definition file as defined in clause B.3;

b) one of more import statements respectively referencing the yaml file which contains the included VNF specific node type definition if any or the included PNF specific node type definition if any or the included NS specific node type definition if any;

If the imported files contain a topology template, this topology template shall be ignored during the parsing of the NSD. To facilitate parsing the NSD, the imported files may be included in the NSD file structure as specified in ETSI GS NFV-SOL 007 [i.11], in which case the node type definitions they contain shall be identical to those contained in the corresponding VNF package, PNF archive and NSD file structure.

NOTE 1: These node type definitions are only used to parse the NSD. For the LCM operations of the corresponding VNF or nested NS, such node type definitions do not apply, only the files included in the related VNF package or NSD file structure will be used.

c) optionally, additional VNF-specific type definitions and import statements referencing additional NS-specific files containing only type definitions used by this TOSCA service template;

d) an NS specific node type definition derived from the tosca.nodes.nfv.NS node type, as defined in clause 7.8.1; and

e) a topology template describing the internal topology of the NS with:

- substitution_mappings indicating the same NS specific node type and the mapping of the virtual_link requirements on SAPs;

NOTE 2: When a Sap re-exposes a VNF or PNF external connection point or a Sap of a nested NS, the virtual_link requirement of the NS is mapped to the virtual_link requirement of the VNF or PNF or nested NS node or a corresponding Forwarding node (i.e. the forwarding node that has a capability matching the virtual link requirement of the node whose external connection point or Sap is been exposed). Otherwise the virtual_link requirement of the NS is mapped to the external_virtual_link requirement of the SAP node.

- a node template of this NS specific node type with the flavour_id and other properties and, if applicable, implementations of the operations of the LCM interface to be executed by the NFVO; and

- additional node templates of type VNF, PNF, NS, NsVirtualLink, Sap, etc. that define the topology and composition of the NS flavour, the dependency requirements as defined in TOSCA-Simple-Profile-YAML-v1.3 [20] may be used between different VNF node templates, or between a VNF node template and a nested NS node template, or between different nested NS node templates to specify the order in which instances of the VNFs and/or nested NSs have to be created;

- additional group definitions, policy definitions and parameter definitions if applicable;

f) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

See clause A.8 for an example of NSD design with single deployment flavour.

NOTE 3: The service template is deployed stand-alone, i.e. without performing a substitution. However including the substitution_mappings rule indicates its ability to substitute a node template of the NS specific node type, which may appear in an NSD.

NOTE 4: All the imported type definition files as indicated in the service template are considered as parts of an NSD.

8 PNFD TOSCA model

8.1 Introduction

The PNFD information model specified by ETSI GS NFV-IFA 014 [2] is mapped to the TOSCA concepts. It represents as TOSCA topology template to be used by NFVO for preparing network connection.

Table 8.1-1 shows the TOSCA Type "derived from" values used when applying the TOSCA-Simple-Profile-YAML-v1.3 [20] to the PNFD.

Table 8.1-1: Mapping of ETSI GS NFV-IFA 014 [2] information elements with TOSCA types

ETSI NFV Information Element ETSI GS NFV-IFA 014 [2]	TOSCA type	Derived from
Pnf	tosca.nodes.nfv.PNF	tosca.nodes.Root
PnfExtCpd (PNF External Connection Point)	tosca.nodes.nfv.PnfExtCp	tosca.nodes.Root

Figure 8.1-1 provides an overview of the TOSCA node types used to build a service template for a PNFD.

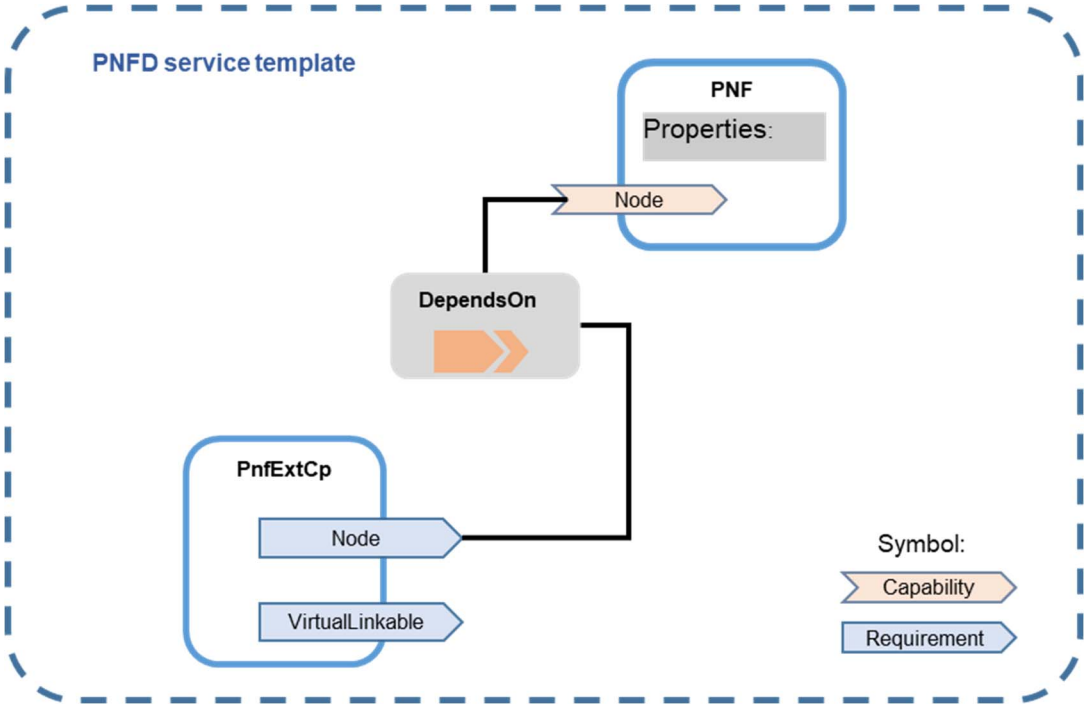


Figure 8.1-1: Service template PNFD overview

8.2 Data Types

8.2.1 tosca.datatypes.nfv.CpProtocolData

8.2.1.1 Description

The CpProtocolData data type is defined in clause 9.2.6 of the present document.

8.2.2 tosca.datatypes.nfv.AddressData

8.2.2.1 Description

The AddressData data type is defined in clause 9.2.3 of the present document.

8.2.3 tosca.datatypes.nfv.L2AddressData

8.2.3.1 Description

The L2AddressData data type is defined in clause 9.2.1 of the present document.

8.2.4 tosca.datatypes.nfv.L3AddressData

8.2.4.1 Description

The L3AddressData data type is defined in clause 9.2.2 of the present document.

8.2.5 tosca.datatypes.nfv.LocationInfo

8.2.5.1 Description

The LocationInfo data type represents geographical information on the location where a PNF is deployed as specified in ETSI GS NFV-IFA 011 [1]. Table 8.2.5.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 8.2.5.1-1: Type name, shorthand, and URI

Shorthand Name	LocationInfo
Type Qualified Name	toscanfv:LocationInfo
Type URI	tosca.datatypes.nfv.LocationInfo

8.2.5.2 Properties

The properties of the LocationInfo data type shall comply with the provisions set out in table 8.2.5.2-1.

Table 8.2.5.2-1: Properties

Name	Required	Type	Constraints	Description
country_code	yes	string		Shall be a two-letter ISO 3166 [10] country code in capital letters.
civic_address_element	no	list of tosca.datatypes.nfv.CivicAddressElement		Elements composing the civic address where the PNF is deployed.
geographic_coordinates	no	tosca.datatypes.nfv.GeographicCoordinates		Geographic coordinates (e.g. Altitude, Longitude, Latitude) where the PNF is deployed.

8.2.5.3 Definition

The syntax of the LocationInfo data type shall comply with the following definition:

```
  tosca.datatypes.nfv.LocationInfo:
    derived_from: tosca.datatypes.Root
    description: Represents geographical information on the location where a PNF is deployed.
    properties:
      country_code:
        type: string # two-letter ISO 3166 country code
        description: Country code
        required: true
      civic_address_element:
        type: list
        entry_schema:
         type: tosca.datatypes.nfv.CivicAddressElement
         description: Elements composing the civic address where the PNF is deployed.
        required: false
      geographic_coordinates:
        type: tosca.datatypes.nfv.GeographicCoordinates
        description: Geographic coordinates (e.g. Altitude, Longitude, Latitude) where the PNF is
deployed.
        required: false
```

8.2.5.4 Examples

```
<some_tosca_entity>:
 properties:
  geographical_location_info:
    country_code: FR
    civic_address_element:
     - element_1
        ca_type: 3
        ca_value: Paris
```

8.2.5.5 Additional Requirements

None.

8.2.6 tosca.datatypes.nfv.CivicAddressElement

8.2.6.1 Description

The CivicAddressElement data type represents an element of a civic location as specified in IETF RFC 4776 [11]. Table 8.2.6.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 8.2.6.1-1: Type name, shorthand, and URI

Shorthand Name	CivicAddressElement
Type Qualified Name	toscanfv: CivicAddressElement
Type URI	tosca.datatypes.nfv.CivicAddressElement

8.2.6.2 Properties

The properties of the CivicAddressElement data type shall comply with the provisions set out in table 8.2.6.2-1.

Table 8.2.6.2-1

Name	Required	Type	Constraints	Description
ca_type	yes	string		Describe the content type of caValue. The value of caType shall comply with section 3.4 of IETF RFC 4776 [11].
ca_value	yes	string		Content of civic address element corresponding to the caType. The format caValue shall comply with section 3.4 of IETF RFC 4776 [11].

8.2.6.3 Definition

The syntax of the CivicAddressElement data type shall comply with the following definition:

```
tosca.datatypes.nfv.CivicAddressElement:
  derived_from: tosca.datatypes.Root
  description: Represents an element of a civic location as specified in IETF RFC 4776.
  properties:
    ca_type:
      type: string # RFC4776
      description: caType as per RFC4776
      required: true
    ca_value:
      type: string # RFC4776
      description: caValue as per RFC4776.
      required: true
```

8.2.6.4 Examples

See clause 8.2.5.4.

8.2.6.5 Additional Requirements

None.

8.2.7 tosca.datatypes.nfv.GeographicCoordinates

8.2.7.1 Description

The GeographicCoordinates data type represents a geographic coordinate location as specified in IETF RFC 6225 [21]. Table 8.2.7.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 8.2.7.1-1: Type name, shorthand, and URI

Shorthand Name	GeographicCoordinates
Type Qualified Name	toscanfv: GeographicCoordinates
Type URI	tosca.datatypes.nfv.GeographicCoordinates

8.2.7.2 Properties

The properties of the GeographicCoordinates data type shall comply with the provisions set out in table 8.2.7.2-1.

Table 8.2.7.2-1: Properties

Name	Required	Type	Constraints	Description
latitude_uncertainty	no	string		Describe the content of latitude_uncertainty. The value of latitude_uncertainty shall comply with LatUnc in section 2.3 of IETF RFC 6225 [21].
latitude	yes	string		Describe the content of latitude. The value of latitude shall comply with Latitude in section 2.3 of IETF RFC 6225 [21].
longitude_ uncertainty	no	string		Describe the content of longitude_uncertainty. The value of longitude_uncertainty shall comply with LongUnc in section 2.3 of IETF RFC 6225 [21].
longitude	yes	string		Describe the content type of longitude. The value of longitude shall comply with Longitude in section 2.3 of IETF RFC 6225 [21].
altitude_type	yes	string		Describe the content type of altitude_type. The value of altitude_type shall comply with AType in section 2.4 of IETF RFC 6225 [21].
altitude_uncertainty	no	string		Describe the content of altitude_uncertainty. The value of altitude_uncertainty shall comply with AltUnc in section 2.4 of IETF RFC 6225 [21].
altitude	yes	string		Describe the content of altitude. The value of altitude shall comply with Altitude in section 2.4 of IETF RFC 6225 [21].

8.2.7.3 Definition

The syntax of the GeographicCoordinates data type shall comply with the following definition:

```
  tosca.datatypes.nfv.GeographicCoordinates:
    derived_from: tosca.datatypes.Root
    description: Represents an element of a geographic coordinate location as specified in IETF
RFC 6225.
    properties:
      latitude_uncertainty:
        type: string # RFC 6225
        description: LatUnc as per RFC 6225
        required: false
      latitude:
        type: string # RFC 6225
        description: Latitude value as per RFC 6225
        required: true
      longitude_uncertainty:
        type: string # RFC 6225
        description: LongUnc as per RFC 6225
        required: false
      longitude:
        type: string # RFC 6225
        description: Longitude value as per RFC 6225
        required: true
      altitude_type:
        type: string # RFC 6225
        description: AType value as per RFC 6225
        required: true
      altitude_uncertainty:
        type: string # RFC 6225
        description: AltUnc as per RFC 6225
        required: false
      altitude:
        type: string # RFC 6225
        description: Altitude value as per RFC 6225
        required: true
```

8.2.7.4 Examples

None.

8.2.7.5 Additional Requirements

None.

8.3 Artifact Types

None.

8.4 Capability Types

8.4.1 tosca.capabilities.nfv.VirtualLinkable

8.4.1.1 Description

The VirtualLinkable capability type is defined in clause 9.4.1 of the present document.

8.5 Requirements Types

None.

8.6 Relationship Types

8.6.1 tosca.relationships.nfv.VirtualLinksTo

8.6.1.1 Description

The VirtualLinksTo relationship type is defined in clause 9.6.1 of the present document representing an association relationship between a PNF external connection point and an NsVirtualLink node type.

8.7 Interface Types

None.

8.8 Node Types

8.8.1 tosca.nodes.nfv.PNF

8.8.1.1 Description

The Physical Network Function (PNF) node type describes a PNF in terms of deployment behaviour requirements, which it contains PNFD identifier, version and functional description and so on as defined by ETSI GS NFV-IFA 014 [2]. Table 8.8.1.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 8.8.1.1-1: Type name, shorthand, and URI

Shorthand Name	PNF
Type Qualified Name	tosca:PNF
Type URI	tosca.nodes.nfv.PNF

8.8.1.2 Properties

The properties of the PNF node type shall comply with the provisions set out in table 8.8.1.2-1.

Table 8.8.1.2-1: Properties

Name	Required	Type	Constraints	Description
descriptor_id	yes	string		Identifier of this PNFD information element. It uniquely identifies the PNFD. See note.
function_description	yes	string		Describes the PNF function.
provider	yes	string		Identifies the provider of the PNFD.
version	yes	string		Identifies the version of the PNFD.
descriptor_invariant_id	yes	string		Identifier of this PNFD in a version independent manner. This attribute is invariant across versions of PNFD. See note.
name	yes	string		Name to identify the PNFD.
geographical_location_info	no	tosca.datatype.nfv.LocationInfo		Provides information about the geographical location (e.g. geographic coordinates or address of the building, etc.) of the PNF.
NOTE: The value of the descriptor_id string and the value of the descriptor_invariant_id string shall comply with an UUID format as specified in section 3 of [9].				

8.8.1.3 Attributes

None.

8.8.1.4 Requirements

The requirements of the VNF node type shall comply with the provisions set out in table 8.8.1.4-1.

Table 8.8.1.4-1: Requirements

Name	Required	Capability type	Constraints	Description
virtual_link	no	tosca.capabilities.nfv.VirtualLinkable		Describes the requirements for linking to virtual link

8.8.1.5 Capabilities

None.

8.8.1.6 Definition

The syntax of the PNF node type shall comply with the following definition:

```
  tosca.nodes.nfv.PNF:
    derived_from: tosca.nodes.Root
    properties:
      descriptor_id: # instead of pnfd_id
        type: string # UUID
        required: true
        description: Identifier of this PNFD information element. It uniquely identifies the
PNFD.
      function_description:
        type: string
        required: true
        description: Describes the PNF function.
      provider:
        type: string
        required: true
        description: Identifies the provider of the PNFD.
      version:
        type: string
        required: true
        description: Identifies the version of the PNFD.
      descriptor_invariant_id: # instead of pnfd-invariant-id
        type: string # UUID
        required: true
        description: Identifier of this PNFD in a version independent manner. This attribute
is invariant across versions of PNFD.
      name:
        type: string
        required: true
        description: Name to identify the PNFD.
      geographical_location_info:
        type: tosca.datatypes.nfv.LocationInfo
        required: false
        description: Provides information about the geographical location (e.g. geographic
coordinates or address of the building, etc.) of the PNF.
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
 # Additional requirements shall be defined in the PNF specific node type (deriving from
tosca.nodes.nfv.PNF) corresponding to NS virtual links that need to connect to PnfExtCps
```

8.8.1.7 Artifact

None.

8.8.1.8 Additional Requirements

For a given PNFD, a new PNF node type shall be defined following the below requirements:

a) The node type shall be derived from: tosca.nodes.nfv.PNF.

b) All properties listed in tosca.nodes.nfv.PNF where the "required:" field is set to "true" shall be included with their values indicates as constraints or assigned as final fixed values if only one value is permitted.

c) The requirements of tosca.nodes.nfv.PNF shall be preserved.

d) Depending on the number of external connection points of the PNF that need to connect to NS virtual links, additional requirements for VirtualLinkable capability shall be defined. In this case, it is the PNFD author's choice to use the requirement for VirtualLinkable capability defined in the tosca.nodes.nfv.PNF node type or use only the additional requirements defined in the derived PNF specific node type. In the latter case, the virtual_link requirement should be included in the node type definition with occurrences [0, 0].

8.8.1.9 Example

See clause A.10.

8.8.2 tosca.nodes.nfv.PnfExtCp

8.8.2.1 Description

The PnfExtCp node type describes the characteristics of an external interface, a.k.a. an external CP, where to connect the PNF to a VL, as defined by ETSI GS NFV-IFA 014 [2]. Table 8.8.2.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 8.8.2.1-1: Type name, shorthand, and URI

Shorthand Name	PnfExtCp
Type Qualified Name	toscanfv:PnfExtCp
Type URI	tosca.nodes.nfv.PnfExtCp

8.8.2.2 Properties

The properties applied to PnfExtCp node are derived from Cp node type.

8.8.2.3 Attributes

None.

8.8.2.4 Requirements

The requirements of the PnfExtCp node type shall comply with the provisions set out in table 8.8.2.4-1.

Table 8.8.2.4-1: Requirements

Name	Required	Capability type	Constraints	Description
external_virtual_link	no	tosca.capabilities.nfv .VirtualLinkable		Specifies that CP instances require to be connected to a node that has a VirtualLinkable capability.

8.8.2.5 Capabilities

None.

8.8.2.6 Definition

The syntax of the PnfExtCp node type shall comply with the following definition:

```
tosca.nodes.nfv.PnfExtCp:
  derived_from: tosca.nodes.nfv.Cp
  description: node definition of PnfExtCp.
  requirements:
    - external_virtual_link:
        capability: tosca.capabilities.nfv.VirtualLinkable
        relationship: tosca.relationships.nfv.VirtualLinksTo
        occurrences: [0, 1]
```

8.8.3 tosca.nodes.nfv.Cp

8.8.3.1 Description

The Cp node type is defined in clause 9.8.1 of the present document.

8.9 Group Types

None.

8.10 Policy Types

8.10.1 tosca.policies.nfv.PnfSecurityGroupRule

8.10.1.1 Description

The PnfSecurityGroupRule policy type when used in a PNFD specifies the matching criteria for the ingress and/or egress traffic to and from visited PNF external connection points. Table 8.10.1.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 8.10.1.1-1: Type name, shorthand, and URI

Shorthand Name	PnfSecurityGroupRule
Type Qualified Name	toscanfv:PnfSecurityGroupRule
Type URI	tosca.policies.nfv.PnfSecurityGroupRule

8.10.1.2 Properties

None.

8.10.1.3 targets

The targets of the SecurityGroupRule policy types shall comply with the provisions set out in table 8.10.1.3-1.

Table 8.10.1.3-1: Targets

Name	Required	Type	Constraints	Description
targets	yes	string[]	Valid types: tosca.nodes.nfv.PnfExtCp	Target connection points of PnfExtCp

8.10.1.4 Definition

The syntax of the NsSecurityGroupRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.PnfSecurityGroupRule:
    derived_from: tosca.policies.nfv.Abstract.SecurityGroupRule
    description: The PnfSecurityGroupRule type is a policy type specified the matching
criteria for the ingress and/or egress traffic to/from visited PNF external connection points.
    targets: [ tosca.nodes.nfv.PnfExtCp ]
```

8.10.1.5 Additional Requirements

None.

8.10.2 tosca.policies.nfv.Abstract.SecurityGroupRule

8.10.2.1 Description

The Abstract.SecurityGroupRule policy type is defined in clause 9.10.1 of the present document.

8.11 PNFD TOSCA service template design

8.11.1 General

One single TOSCA service template is used to design a PNFD which shall comply with TOSCA-Simple-Profile-YAML-v1.3 [20] and includes:

a) an import statement referencing the TOSCA types definition file as defined in clause B.4;

b) a PNF specific node type definition derived from the tosca.nodes.nfv.PNF node type, as defined in clause 8.8.1; and

c) a topology template describing the internal topology of the PNF with:

- substitution_mappings indicating the same PNF specific node type and the mapping of the virtual_link requirements on PNF external connection point;
- a node template of this PNF specific node type with the properties as defined in tosca.nodes.nfv.PNF; and
- additional node templates of type PnfExtCp that define the connection information of the PNF;

d) optionally, metadata and dsl definitions as specified in section 3.10 of TOSCA-Simple-Profile-YAML-v1.3 [20].

See clause A.10 for an example of PNFD design.

NOTE: The service template is deployed stand-alone, i.e. without performing a substitution. However including the substitution_mappings rule indicate its ability to substitute a node template of the PNF specific node type, which may appear in an NSD.

9 Common Definitions

9.1 Introduction

This clause defines the TOSCA type definitions which are used by at least two types of deployment templates among those identified in clause 5.1.

9.2 Data Types

9.2.1 tosca.datatypes.nfv.L2AddressData

9.2.1.1 Description

The L2AddressData data type describes the information on the MAC addresses to be assigned to a connection point as defined in ETSI GS NFV-IFA 011 [1]. Table 9.2.1.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.1.1-1: Type name, shorthand, and URI

Shorthand Name	L2AddressData
Type Qualified Name	toscanfv:L2AddressData
Type URI	tosca.datatypes.nfv.L2AddressData

9.2.1.2 Properties

The properties of the L2AddressData data type shall comply with the provisions set out in table 9.2.1.2-1.

Table 9.2.1.2-1: Properties

Name	Required	Type	Constraints	Description
mac_address_assignment	yes	boolean		Specifies which mode is used for the MAC address assignment If it is set to True, a MAC address is expected to be provided by a management entity via the NFV MANO interfaces towards the VNFM using attributes standardized for this purpose in the NFV-MANO information model and is further transferred from the VNFM to the VIM. A MAC address will be automatically assigned by the VIM/NFVI as fallback if not provided. If it is set to False, a MAC address is expected to be assigned by means specific to the VNF itself (e.g. by an LCM script, by the EM) and is further transferred from the VNFM to the VIM. A MAC address will be automatically assigned by the VIM/NFVI as fallback if not provided to the VIM.

9.2.1.3 Definition

The syntax of the L2AddressData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.L2AddressData:
    derived_from: tosca.datatypes.Root
    description: Describes the information on the MAC addresses to be assigned to a connection
point.
    properties:
      mac_address_assignment:
        type: boolean
        description: Specifies which mode is used for the MAC address assignment. If it is set to
True, a MAC address is expected to be provided by a management entity via the NFV MANO interfaces
towards the VNFM using attributes standardized for this purpose in the NFV-MANO information model
and is further transferred from the VNFM to the VIM. A MAC address will be automatically assigned
by the VIM/NFVI as fallback if not provided. If it is set to False, a MAC address is expected to
it will be assigned by means specific to the VNF itself (e.g. by an LCM script, by the EM) and is
further transferred from the VNFM to the VIM. A MAC address will be automatically assigned by the
VIM/NFVI as fallback if not provided to the VIM.
        required: true
```

9.2.1.4 Examples

```
<some_tosca_entity>:
  properties:
    l2_address_data:
       mac_address_assignment: true
```

9.2.1.5 Additional Requirements

None.

9.2.2 tosca.datatypes.nfv.L3AddressData

9.2.2.1 Description

The L3AddressData data type supports providing information about Layer 3 level addressing scheme and parameters applicable to a CP, as defined in ETSI GS NFV-IFA 011 [1]. Table 9.2.2.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.2.1-1: Type name, shorthand, and URI

Shorthand Name	L3AddressData
Type Qualified Name	toscanfv:L3AddressData
Type URI	tosca.datatypes.nfv.L3AddressData

9.2.2.2 Properties

The properties of the L3AddressData data type shall comply with the provisions set out in table 9.2.2.2-1.

Table 9.2.2.2-1: Properties

Name	Required	Type	Constraints	Description
ip_address_assignment	no	boolean		Specify which mode is used for the IP address assignment. If it is set to True, IP configuration information shall be provided for the VNF by a management entity using the NFV MANO interfaces towards the VNFM. If it is set to False, the value of the ipAddressAssignmentSubtype property defines the method of IP address assignment. Shall be present if the fixed_ip_address property is not present and should be absent otherwise. See note.

Name	Required	Type	Constraints	Description
ip_address_assignment_subtype	no	string	Valid values: See YAML definition constraints	Method of IP address assignment in case the IP configuration is not provided using the NFV MANO interfaces towards the VNFM. Shall be present in case the ip_address_assignment property is set to False and shall be absent otherwise. Description of the valid values: • dynamic: the VNF gets an IP address dynamically from the NFVI (i.e. using DHCP) • vnf_pkg: an IP address defined by the VNF provider is assigned by means included as part of the VNF package (e.g. LCM script) • external: an IP address is provided by an external management entity (such as EM) directly towards the VNF.
floating_ip_activated	yes	boolean		Specify if the floating IP scheme is activated on the Connection Point or not.
ip_address_type	no	string	Valid values: See YAML definition constraints	Define address type. The address type should be aligned with the address type supported by the layer_protocols properties of the connection point.
number_of_ip_address	no	Integer	greater_than: 0	Minimum number of IP addresses to be assigned.
fixed_ip_address	no	list of string		Fixed IP addresses to be assigned to the internal CP instance. This property enables the VNF provider to define fixed IP addresses for internal CP instances to be assigned by the VNFM or the NFVO. This property is only permitted for Cpds without external connectivity, i.e. connectivity outside the VNF. If present, it shall be compatible with the values of the L3ProtocolData of the VnfVirtualLink referred to by the Cp, if L3ProtocolData is included in the VnfVirtualLink. See note.
NOTE: If the fixed_ip_address property is present: - the ip_address_assignment property should not be present. If it is present in this context, its value has no meaning and shall be ignored when processing the VNFD. Using the ip_address_assignment property in this context is deprecated; implementations need to be aware that support can be removed in subsequent versions of the present document.; - the value of the floating_ip_activated property shall be set to false; - the value of the ip_address_type property, if present, shall be set consistently with the fixed_ip_address; - the value of the number_of_ip_address property, if present, shall be set consistently with the cardinality of the fixed_ip_address.				

9.2.2.3 Definition

The syntax of the L3AddressData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.L3AddressData:
    derived_from: tosca.datatypes.Root
    description: Provides information about Layer 3 level addressing scheme and parameters
applicable to a CP
    properties:
      ip_address_assignment:
        type: boolean
        description: Specify which mode is used for the IP address assignment. If it is set to
True, IP configuration information shall be provided for the VNF by a management entity using the
NFV MANO interfaces towards the VNFM. If it is set to False, the value of the
ip_address_assignment_subtype property defines the method of IP address assignment. Shall be
present if the fixed_ip_address property is not present and should be absent otherwise. See note.
```

```
        required: false
      ip_address_assignment_subtype:
        type: string
        description: "Method of IP address assignment in case the IP configuration is not provided
using the NFV MANO interfaces towards the VNFM. Description of the valid values: (1) dynamic: the
VNF gets an IP address dynamically from the NFVI (i.e. using DHCP), (2) vnf_pkg: an IP address
defined by the VNF provider is assigned by means included as part of the VNF package (e.g. LCM
script); (3) external: an IP address is provided by an external management entity (such as EM)
directly towards the VNF.Shall be present in case the ip_address_assignment property is set to
False and shall be absent otherwise."
        required: false
        constraints:
          - valid_values: [ dynamic, vnf_pkg, external ]
      floating_ip_activated:
        type: boolean
        description: Specifies if the floating IP scheme is activated on the Connection Point or
not
        required: true
      ip_address_type:
        type: string
        description: Defines address type. The address type should be aligned with the address
type supported by the layer_protocols properties of the connection point
        required: false
        constraints:
          - valid_values: [ ipv4, ipv6 ]
      number_of_ip_address:
        type: integer
        description: Minimum number of IP addresses to be assigned
        required: false
        constraints:
          - greater_than: 0
      fixed_ip_address:
        type: list
        description: Fixed IP addresses to be assigned to the internal CP instance. This property
enables the VNF provider to define fixed IP addresses for internal CP instances to be assigned by
the VNFM or the NFVO. This property is only permitted for Cpds without external connectivity, i.e.
connectivity outside the VNF. If present, it shall be compatible with the values of the
L3ProtocolData of the VnfVirtualLink referred to by the Cp, if L3ProtocolData is included in the
VnfVirtualLink
        required: false
        entry_schema:
          type: string
```

9.2.2.4 Examples

The following is an example of the case using dynamic IP address.

```
<some_tosca_entity>:
properties:
   l3_address_data:
     ip_address_assignment: true
     floating_ip_activated: true
     ip_address_type: ipv4
     number_of_ip_address: 4
```

The following is an example of the case using fixed IP address.

```
<some_tosca_entity>:
properties:
   l3_address_data:
     floating_ip_activated: false
     ip_address_type: ipv4
     number_of_ip_address: 1
     fixed_ip_address:
       - 192.168.0.1
```

9.2.2.5 Additional Requirements

None.

9.2.3 tosca.datatypes.nfv.AddressData

9.2.3.1 Description

The AddressData data type describes information about the addressing scheme and parameters applicable to a CP, as defined in ETSI GS NFV-IFA 011 [1]. Table 9.2.3.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.3.1-1: Type name, shorthand, and URI

Shorthand Name	AddressData
Type Qualified Name	toscanfv:AddressData
Type URI	tosca.datatypes.nfv.AddressData

9.2.3.2 Properties

The properties of the AddressData data type shall comply with the provisions set out in table 9.2.3.2-1.

Table 9.2.3.2-1: Properties

Name	Required	Type	Constraints	Description
address_type	yes	string	Valid values: See YAML definition constraints	Describes the type of the address to be assigned to a connection point. The content type shall be aligned with the address type supported by the layerProtocol property of the connection point.
l2_address_data	no	tosca.datatypes.nfv.L2AddressData	Shall be present when the address_type is mac_address.	Provides the information on the MAC addresses to be assigned to a connection point.
l3_address_data	no	tosca.datatypes.nfv.L3AddressData	Shall be present when the address_type is ip_address.	Provides the information on the IP addresses to be assigned to a connection point.

9.2.3.3 Definition

The syntax of the AddressData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.AddressData:
    derived_from: tosca.datatypes.Root
    description: Describes information about the addressing scheme and parameters applicable to a
CP
    properties:
      address_type:
        type: string
        description: Describes the type of the address to be assigned to a connection point. The
content type shall be aligned with the address type supported by the layerProtocol property of the
connection point
        required: true
        constraints:
          - valid_values: [ mac_address, ip_address ]
      l2_address_data:
        type: tosca.datatypes.nfv.L2AddressData
        description: Provides the information on the MAC addresses to be assigned to a connection
point.
        required: false
      l3_address_data:
        type: tosca.datatypes.nfv.L3AddressData
        description: Provides the information on the IP addresses to be assigned to a connection
point
        required: false
```

9.2.3.4 Examples

The following is an example of the case using dynamic IP address.

```
<some_tosca_entity>:
properties:
  address_data:
    address_type: ip_address
    l3_address_data:
      ip_address_assignment: true
      floating_ip_activated: true
      ip_address_type: ipv4
      number_of_ip_address: 4
```

The following is an example of the case using fixed IP address.

```
<some_tosca_entity>:
properties:
   l3_address_data:
     ip_address_assignment: true
     floating_ip_activated: false
     ip_address_type: ipv4
     number_of_ip_address: 1
     fixed_ip_address:
       - 192.168.0.1
```

9.2.3.5 Additional Requirements

None.

9.2.4 tosca.datatypes.nfv.ConnectivityType

9.2.4.1 Description

The ConnectivityType data type describes the protocol exposed by a virtual link and the flow pattern supported by the virtual link, as defined in ETSI GS NFV-IFA 011 [1]. Table 9.2.4.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.4.1-1: Type name, shorthand, and URI

Shorthand Name	ConnectivityType
Type Qualified Name	toscanfv:ConnectivityType
Type URI	tosca.datatypes.nfv.ConnectivityType

9.2.4.2 Properties

The properties of the ConnectivityType shall comply with the provisions set out in table 9.2.4.2-1.

Table 9.2.4.2-1: Properties

Name	Required	Type	Constraints	Description
layer_protocols	yes	list of string	Valid values: See YAML definition constraints	Identifies the protocol a virtualLink gives access to (ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire). The top layer protocol of the virtualLink protocol stack shall always be provided. The lower layer protocols may be included when there are specific requirements on these layers. See note.
flow_pattern	no	string	Valid values: See YAML definition constraints	Identifies the flow pattern of the connectivity.
NOTE: If more than 1 values are present, the first value represents the highest layer protocol data, and the last value represents the lowest layer protocol data.				

9.2.4.3 Definition

The syntax of the ConnectivityType data type shall comply with the following definition:

```
  tosca.datatypes.nfv.ConnectivityType:
    derived_from: tosca.datatypes.Root
    description: describes additional connectivity information of a virtualLink
    properties:
      layer_protocols:
        type: list
        description: Identifies the protocol a virtualLink gives access to (ethernet, mpls, odu2,
ipv4, ipv6, pseudo-wire). The top layer protocol of the virtualLink protocol stack shall always be
provided. The lower layer protocols may be included when there are specific requirements on these
layers.
        required: true
        entry_schema:
          type: string
          constraints:
            - valid_values: [ ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire ]
      flow_pattern:
        type: string
        description: Identifies the flow pattern of the connectivity
        required: false
        constraints:
          - valid_values: [ line, tree, mesh ]
```

9.2.4.4 Examples

```
<some_tosca_entity>:
  properties:
    connectivity_type:
      layer_protocol:
         - ipv4
         flow_pattern: mesh
```

9.2.4.5 Additional Requirements

None.

9.2.5 tosca.datatypes.nfv.LinkBitrateRequirements

9.2.5.1 Description

The LinkBitrateRequirements data type describes the requirements in terms of bitrate for a virtual link. Table 9.2.5.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.5.1-1: Type name, shorthand, and URI

Shorthand Name	LinkBitrateRequirements
Type Qualified Name	toscanfv:LinkBitrateRequirements
Type URI	tosca.datatypes.nfv.LinkBitrateRequirements

9.2.5.2 Properties

The properties of the LinkBitrateRequirements data type shall comply with the provisions set out in table 9.2.5.2-1.

Table 9.2.5.2-1: Properties

Name	Required	Type	Constraints	Description
root	yes	integer	greater_or_equal: 0	Specifies the throughput requirement in bits per second of the link (e.g. bitrate of E-Line, root bitrate of E-Tree, aggregate capacity of E-LAN).
leaf	no	integer	greater_or_equal: 0	Specifies the throughput requirement in bits per second of leaf connections to the link when applicable to the connectivity type (e.g. for E-Tree and E-LAN branches).

9.2.5.3 Definition

The syntax of the LinkBitrateRequirements data type shall comply with the following definition:

```
  tosca.datatypes.nfv.LinkBitrateRequirements:
    derived_from: tosca.datatypes.Root
    description: describes the requirements in terms of bitrate for a virtual link
    properties:
      root:
        type: integer # in bits per second
        description: Specifies the throughput requirement in bits per second of the link (e.g.
bitrate of E-Line, root bitrate of E-Tree, aggregate capacity of E-LAN).
        required: true
        constraints:
          - greater_or_equal: 0
      leaf:
        type: integer # in bits per second
        description: Specifies the throughput requirement in bits per second of leaf connections
to the link when applicable to the connectivity type (e.g. for E-Tree and E LAN branches).
        required: false
        constraints:
          - greater_or_equal: 0
```

9.2.5.4 Examples

None.

9.2.5.5 Additional Requirements

None.

9.2.6 tosca.datatypes.nfv.CpProtocolData

9.2.6.1 Description

The CpProtocolData data type describes and associates the protocol layer that a CP uses together with other protocol and connection point information. Table 9.2.6.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.6.1-1: Type name, shorthand, and URI

Shorthand Name	CpProtocolData
Type Qualified Name	toscanfv:CpProtocolData
Type URI	tosca.datatypes.nfv.CpProtocolData

9.2.6.2 Properties

The properties of the CpProtocolData data type shall comply with the provisions set out in table 9.2.6.2-1.

Table 9.2.6.2-1: Properties

Name	Required	Type	Constraints	Description
associated_layer_protocol	yes	string	Valid values: See YAML definition constraints	One of the values of the property layer_protocols of the CP.
address_data	no	list of tosca.datatypes.nfv.AddressData		Provides information on the addresses to be assigned to the CP.

9.2.6.3 Definition

The syntax of the CpProtocolData data type shall comply with the following definition:

```
  tosca.datatypes.nfv.CpProtocolData:
    derived_from: tosca.datatypes.Root
    description: Describes and associates the protocol layer that a CP uses together with other
protocol and connection point information
    properties:
      associated_layer_protocol:
        type: string
        description: One of the values of the property layer_protocols of the CP
        required: true
        constraints:
          - valid_values: [ ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire ]
      address_data:
        type: list
        description: Provides information on the addresses to be assigned to the CP
        entry_schema:
          type: tosca.datatypes.nfv.AddressData
        required: false
```

9.2.6.4 Examples

None.

9.2.6.5 Additional Requirements

None.

9.2.7 tosca.datatypes.nfv.Qos

9.2.7.1 Description

The QoS describes QoS data type a given VL used in a VNF deployment flavour. Table 9.2.7.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.7.1-1: Type name, shorthand, and URI

Shorthand Name	Qos
Type Qualified Name	toscanfv:Qos
Type URI	tosca.datatypes.nfv.Qos

9.2.7.2 Properties

The properties of the Qos data type shall comply with the provisions set out in table 9.2.7.2-1.

Table 9.2.7.2-1: Properties

Name	Required	Type	Constraints	Description
latency	yes	scalar-unit.time	greater_than: 0 s	Specifies the maximum latency.
packet_delay_variation	yes	scalar-unit.time		Specifies the maximum jitter.
packet_loss_ratio	no	float	in_range: [0,1]	Specifies the maximum packet loss ratio.

9.2.7.3 Definition

The syntax of the Qos data type shall comply with the following definition:

```
tosca.datatypes.nfv.Qos:
  derived_from: tosca.datatypes.Root
  description: describes QoS data for a given VL used in a VNF deployment flavour
  properties:
    latency:
      type: scalar-unit.time #Number
      description: Specifies the maximum latency
      required: true
      constraints:
        - greater_than: 0 s
    packet_delay_variation:
      type: scalar-unit.time #Number
      description: Specifies the maximum jitter
      required: true
      constraints:
        - greater_or_equal: 0 s
    packet_loss_ratio:
      type: float
      description: Specifies the maximum packet loss ratio
      required: false
      constraints:
         - in_range: [ 0.0, 1.0 ]
```

9.2.7.4 Examples

None.

9.2.7.5 Additional Requirements

None.

9.2.8 tosca.datatypes.nfv.VnfProfile

9.2.8.1 Description

The VnfProfile data type describes a profile for instantiating VNFs of a particular NS DF according to a specific VNFD and VNF DF as defined in ETSI GS NFV-IFA 014 [2]. Table 9.2.8.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.8.1-1: Type name, shorthand, and URI

Shorthand Name	VnfProfile
Type Qualified Name	toscanfv:VnfProfile
Type URI	tosca.datatypes.nfv.VnfProfile

9.2.8.2 Properties

The properties of the VnfProfile data type shall comply with the provisions set out in table 9.2.8.2-1.

Table 9.2.8.2-1: Properties

Name	Required	Type	Constraints	Description
instantiation_ Level	no	string		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.
min_number_ of_instances	yes	integer	greater_or_equal : 0	Minimum number of instances of the VNF based on this VNFD that is permitted to exist for this VnfProfile.
max_number _of_instances	yes	integer	greater_or_equal : 0	Maximum number of instances of the VNF based on this VNFD that is permitted to exist for this VnfProfile.
service_avail ability_level	no	integer	greater_or_equal: 1	If present, specifies the service availability level for the VNF instance created from this profile. See note.
NOTE: The value '1' expresses the highest service availability level.				

9.2.8.3 Definition

The syntax of the VnfProfile data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfProfile:
    derived_from: tosca.datatypes.Root
    description: describes a profile for instantiating VNFs of a particular NS DF according to a
specific VNFD and VNF DF.
    properties:
      instantiation_level:
        type: string
        description: 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.
        required: false
      min_number_of_instances:
        type: integer
        description: Minimum number of instances of the VNF based on this VNFD that is permitted
to exist for this VnfProfile.
        required: true
        constraints:
          - greater_or_equal: 0
      max_number_of_instances:
        type: integer
        description: Maximum number of instances of the VNF based on this VNFD that is permitted
to exist for this VnfProfile.
        required: true
        constraints:
          - greater_or_equal: 0
      service_availability_level:
        type: integer
        description: Specifies the service availability level for the VNF instance created from
this profile.
        required: false
        constraints:
          - greater_or_equal: 1
```

9.2.8.4 Example

None.

9.2.8.5 Additional Requirements

None.

9.2.9 tosca.datatypes.nfv.VnfMonitoringParameter

9.2.9.1 Description

This data type provides information on virtualised resource related performance metrics applicable to VNF.
Table 9.2.9.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.2.9.1-1: Type name, shorthand, and URI

Shorthand Name	VnfMonitoringParameter
Type Qualified Name	toscanfv:VnfMonitoringParameter
Type URI	tosca.datatypes.nfv.VnfMonitoringParameter

9.2.9.2 Properties

The properties of the VnfMonitoringParameter data type shall comply with the provisions set out in table 9.2.9.2-1.

Table 9.2.9.2-1: Properties

Name	Required	Type	Constraints	Description
name	no	string		Human readable name of the monitoring parameter.
performance_metric	yes	string	valid values: See YAML definition constraints	Identifies a performance metric to be monitored. Performance metric values shall be set to a measurement name defined in clause 7.2 of ETSI GS NFV-IFA 027 [7], without appending a sub-counter. In this case the VNFM computes these measurements from lower-level metrics collected from the VIM.
collection_period	no	scalar-unit.time		Describes the periodicity at which to collect the performance information.

9.2.9.3 Definition

The syntax of the VnfMonitoringParameter data type shall comply with the following definition:

```
  tosca.datatypes.nfv.VnfMonitoringParameter:
    derived_from: tosca.datatypes.Root
    description: Represents information on virtualised resource related performance metrics
applicable to the VNF.
    properties:
      name:
        type: string
        description: Human readable name of the monitoring parameter
        required: true
      performance_metric:
        type: string
        description: Identifies a performance metric to be monitored, according to ETSI GS NFV-IFA
027
        required: true
        constraints:
          - valid_values: [ v_cpu_usage_mean_vnf, v_cpu_usage_peak_vnf, v_memory_usage_mean_vnf,
v_memory_usage_peak_vnf, v_disk_usage_mean_vnf, v_disk_usage_peak_vnf, byte_incoming_vnf_ext_cp,
byte_outgoing_vnf_ext_cp,
packet_incoming_vnf_ext_cp, packet_outgoing_vnf_ext_cp ]
      collection_period:
        type: scalar-unit.time
        description: Describes the periodicity at which to collect the performance information.
        required: false
        constraints:
          - greater_than: 0 s
```

9.2.9.4 Examples

See clause A.8.

9.2.9.5 Additional Requirements

None.

9.3 Artifact Types

None.

9.4 Capability Types

9.4.1 tosca.capabilities.nfv.VirtualLinkable

9.4.1.1 Description

A node type that includes the VirtualLinkable capability indicates that it can be pointed by tosca.relationships.nfv.VirtualLinksTo relationship type. which is used to model the association between a VduCpd and an intVirtualLinkDesc and the association between a VnfExtCpd and an intVirtualLinkDesc as specified in ETSI GS NFV-IFA 011 [1] as well as the association represented by the NsVirtualLinkConnectivity information element in ETSI GS NFV-IFA 014 [2]. Table 9.4.1.1-1 specifies the declared names for this capability type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.4.1.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinkable
Type Qualified Name	toscanfv:VirtualLinkable
Type URI	tosca.capabilities.nfv.VirtualLinkable

9.4.1.2 Properties

None.

9.4.1.3 Definition

The syntax of the `VirtualLinkable` capability type shall comply with the following definition:

```
  tosca.capabilities.nfv.VirtualLinkable:
    derived_from: tosca.capabilities.Node
    description: A node type that includes the VirtualLinkable capability indicates that it can be
pointed by tosca.relationships.nfv.VirtualLinksTo relationship type
```

9.4.2 Void

9.5 Requirements Types

None.

9.6 Relationship Types

9.6.1 tosca.relationships.nfv.VirtualLinksTo

9.6.1.1 Description

This relationship type represents an association between the VduCp and VnfVirtualLink node types or the association between either a VnfExtCp, a PnfExtCp or a Sap and an NsVirtualLink node types. Table 9.6.1.1-1 specifies the declared names for this relationship type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.6.1.1-1: Type name, shorthand, and URI

Shorthand Name	VirtualLinksTo
Type Qualified Name	toscanfv:VirtualLinksTo
Type URI	tosca.relationships.nfv.VirtualLinksTo

9.6.1.2 Properties

None.

9.6.1.3 Definition

The syntax of the VirtualLinksTo relationship type shall comply with the following definition:

```
  tosca.relationships.nfv.VirtualLinksTo:
    derived_from: tosca.relationships.DependsOn
    description: Represents an association relationship between the VduCp and VnfVirtualLink node
types or the association between either a VnfExtCp, a PnfExtCp or a Sap and an NsVirtualLink node
types.
    valid_target_types: [ tosca.capabilities.nfv.VirtualLinkable ]
```

9.6.2 Void

9.6.3 tosca.relationships.nfv.VipVirtualLinksTo

9.6.3.1 Description

This relationship type represents an association between the VipCp and a VnfVirtualLink node types or between the former and an NsVirtualLink node types. Table 9.6.3.1-1 specifies the declared names for this relationship type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.6.3.1-1: Type name, shorthand, and URI

Shorthand Name	VipVirtualLinksTo
Type Qualified Name	toscanfv:VipVirtualLinksTo
Type URI	tosca.relationships.nfv.VipVirtualLinksTo

9.6.3.2 Properties

None.

9.6.3.3 Definition

The syntax of the VipVirtualLinksTo relationship type shall comply with the following definition:

```
  tosca.relationships.nfv.VipVirtualLinksTo:
    derived_from: tosca.relationships.DependsOn
```

```
    description: Represents an association relationship between the VipCp and a VnfVirtualLink
node types or between the former and a NsVirtualLink node types.
    valid_target_types: [ tosca.capabilities.nfv.VirtualLinkable ]
```

9.7 Interface Types

None.

9.8 Node Types

9.8.1 tosca.nodes.nfv.Cp

9.8.1.1 Description

A Cp node type represents the Cpd information element as defined in ETSI GS NFV-IFA 011 [1], which describes network connectivity to a compute resource or a VL. This is an abstract type used as parent for the various Cp node types. Table 9.8.1.1-1 specifies the declared names for this node type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.8.1.1-1: Type name, shorthand, and URI

Shorthand Name	Cp
Type Qualified Name	toscanfv:Cp
Type URI	tosca.nodes.nfv.Cp

9.8.1.2 Properties

The properties of the Cp node type shall comply with the provisions set out in table 9.8.1.2-1.

Table 9.8.1.2-1: Properties

Name	Required	Type	Constraints	Description
layer_protocols	yes	list of string	Valid values: See YAML definition constraints	Identifies which protocol the connection point uses for connectivity purposes.
role	no	string	valid values: See YAML definition constraints	Identifies the role of the port in the context of the traffic flow patterns in the VNF or parent NS. For example a VNF with a tree flow pattern within the VNF will have legal cpRoles of ROOT and LEAF.
description	no	string		Provides human-readable information on the purpose of the connection point (e.g. connection point for control plane traffic).
protocol	no	list of tosca.datatypes.nfv.CpProtocolData		Provides information on the addresses to be assigned to the connection point(s) instantiated from this Connection Point Descriptor.

Name	Required	Type	Constraints	Description
trunk_mode	no	boolean		Information about whether the CP instantiated from this Cp is in Trunk mode (802.1Q or other). When operating in "trunk mode", the Cp is capable of carrying traffic for several VLANs. Absence of this property implies that trunkMode is not configured for the Cp i.e. It is equivalent to boolean value "false".

9.8.1.3 Attributes

None.

9.8.1.4 Requirements

None.

9.8.1.5 Capabilities

None.

9.8.1.6 Definition

The syntax of the Cp node type shall comply with the following definition:

```
  tosca.nodes.nfv.Cp:
    derived_from: tosca.nodes.Root
    description: Provides information regarding the purpose of the connection point
    properties:
      layer_protocols:
        type: list
        description: Identifies which protocol the connection point uses for connectivity purposes
        required: true
        entry_schema:
          type: string
          constraints:
            - valid_values: [ ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire ]
      role: #Name in ETSI GS NFV-IFA 011: cpRole
        type: string
        description: Identifies the role of the port in the context of the traffic flow patterns
in the VNF or parent NS
        required: false
        constraints:
          - valid_values: [ root, leaf ]
      description:
        type: string
        description: Provides human-readable information on the purpose of the connection point
        required: false
      protocol:
        type: list
        description: Provides information on the addresses to be assigned to the connection
point(s) instantiated from this Connection Point Descriptor
        required: false
        entry_schema:
          type: tosca.datatypes.nfv.CpProtocolData
      trunk_mode:
        type: boolean
        description: Provides information about whether the CP instantiated from this Cp is in
Trunk mode (802.1Q or other). When operating in "trunk mode", the Cp is capable of carrying
traffic for several VLANs. Absence of this property implies that trunkMode is not configured for
the Cp i.e. It is equivalent to boolean value "false".
        required: false
```

9.8.1.7 Additional requirements

The 'protocol' property shall not be included in a derived PnfExtCp node and shall be included in all other cases.

9.9 Group Types

None.

9.10 Policy Types

9.10.1 tosca.policies.nfv.Abstract.SecurityGroupRule

9.10.1.1 Description

The Abstract.SecurityGroupRule type represents an abstract policy type without any target requirements.
Table 9.10.1.1-1 specifies the declared names for this policy type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 9.10.1.1-1: Type name, shorthand, and URI

Shorthand Name	Abstract.SecurityGroupRule
Type Qualified Name	toscanfv:Abstract.SecurityGroupRule
Type URI	tosca.policies.nfv.Abstract.SecurityGroupRule

9.10.1.2 Properties

The properties of the Abstract.SecurityGroupRule policy type shall comply with the provisions set out in table 9.10.1.2-1.

Table 9.10.1.2-1: Properties

Name	Required	Type	Constraints	Description
description	no	string		Human readable description of the security group rule.
direction	yes	string	ingress, egress	The direction in which the security group rule is applied. The direction of 'ingress' or 'egress' is specified against the associated CP. I.e. 'ingress' means the packets entering a CP, while 'egress' means the packets sent out of a CP.
ether_type	yes	string	ipv4, ipv6	Indicates the protocol carried over the Ethernet layer.
protocol	yes	string	see note	Indicates the protocol carried over the IP layer. Permitted values: any protocol defined in the IANA protocol registry [19], e.g. TCP, UDP, ICMP, etc.
port_range_min	yes	integer	0 - 65535	Indicates minimum port number in the range that is matched by the security group rule. If a value is provided at design-time, this value may be overridden at run-time based on other deployment requirements or constraints.
port_range_max	yes	integer	0 – 65535	Indicates maximum port number in the range that is matched by the security group rule. If a value is provided at design-time, this value may be overridden at run-time based on other deployment requirements or constraints.
NOTE: "protocol" constraints values: hopopt, icmp, igmp, ggp, ipv4, st, tcp, cbt, egp, igp, bbn_rcc_mon, nvp_ii, pup, argus, emcon, xnet, chaos, udp, mux, dcn_meas, hmp, prm, xns_idp, trunk_1, trunk_2, leaf_1, leaf_2, rdp, irtp, iso_tp4, netblt, mfe_nsp, merit_inp, dccp, 3pc, idpr, xtp, ddp, idpr_cmtp, tp++, il, ipv6, sdrp, ipv6_route, ipv6_frag, idrp, rsvp, gre, dsr, bna, esp, ah, i_nlsp, swipe, narp, mobile, tlsp, skip, ipv6_icmp, ipv6_no_nxt, ipv6_opts, cftp, sat_expak, kryptolan, rvd, ippc, sat_mon, visa, ipcv, cpnx, cphb, wsn, pvp, br_sat_mon, sun_nd, wb_mon, wb_expak, iso_ip, vmtp, secure_vmtp, vines, ttp, iptm, nsfnet_igp, dgp, tcf, eigrp, ospfigp, sprite_rpc, larp, mtp, ax.25, ipip, micp, scc_sp, etherip, encap, gmtp, ifmp, pnni, pim, aris, scps, qnx, a/n, ip_comp, snp, compaq_peer, ipx_in_ip, vrrp, pgm, l2tp, ddx, iatp, stp, srp, uti, smp, sm, ptp, isis, fire, crtp, crudp, sscopmce, iplt, sps, pipe, sctp, fc, rsvp_e2e_ignore, mobility, udp_lite, mpls_in_ip, manet, hip, shim6, wesp, rohc.				

9.10.1.3 Definition

The syntax of the Abstract.SecurityGroupRule policy type shall comply with the following definition:

```
  tosca.policies.nfv.Abstract.SecurityGroupRule:
    derived_from: tosca.policies.Root
    description: The Abstract.SecurityGroupRule type represents an abstract policy type
without any target requirements
    properties:
      description:
        type: string
        description: Human readable description of the security group rule.
        required: false
      direction:
        type: string
        description: The direction in which the security group rule is applied. The direction
of 'ingress' or 'egress' is specified against the associated CP. I.e. 'ingress' means the
packets entering a CP, while 'egress' means the packets sent out of a CP.
        required: true
        constraints:
          - valid_values: [ ingress, egress ]
        default: ingress
      ether_type:
        type: string
        description: Indicates the protocol carried over the Ethernet layer.
        required: true
        constraints:
          - valid_values: [ ipv4, ipv6 ]
        default: ipv4
      protocol:
        type: string
        description: Indicates the protocol carried over the IP layer. Permitted values
include any protocol defined in the IANA protocol registry, e.g. TCP, UDP, ICMP, etc.
        required: true
        constraints:
          - valid_values: [ hopopt, icmp, igmp, ggp, ipv4, st, tcp, cbt, egp, igp,
bbn_rcc_mon, nvp_ii, pup, argus, emcon, xnet, chaos, udp, mux, dcn_meas, hmp, prm, xns_idp,
trunk_1, trunk_2, leaf_1, leaf_2, rdp, irtp, iso_tp4, netblt, mfe_nsp, merit_inp, dccp, 3pc,
idpr, xtp, ddp, idpr_cmtp, tp++, il, ipv6, sdrp, ipv6_route, ipv6_frag, idrp, rsvp, gre, dsr,
bna, esp, ah, i_nlsp, swipe, narp, mobile, tlsp, skip, ipv6_icmp, ipv6_no_nxt, ipv6_opts,
cftp, sat_expak, kryptolan, rvd, ippc, sat_mon, visa, ipcv, cpnx, cphb, wsn, pvp, br_sat_mon,
sun_nd, wb_mon, wb_expak, iso_ip, vmtp, secure_vmtp, vines, ttp, iptm, nsfnet_igp, dgp, tcf,
eigrp, ospfigp, sprite_rpc, larp, mtp, ax.25, ipip, micp, scc_sp, etherip, encap, gmtp, ifmp,
pnni, pim, aris, scps, qnx, a/n, ip_comp, snp, compaq_peer, ipx_in_ip, vrrp, pgm, l2tp, ddx,
iatp, stp, srp, uti, smp, sm, ptp, isis, fire, crtp, crudp, sscopmce, iplt, sps, pipe, sctp,
fc, rsvp_e2e_ignore, mobility, udp_lite, mpls_in_ip, manet, hip, shim6, wesp, rohc ]
        default: tcp
      port_range_min:
        type: integer
        description: Indicates minimum port number in the range that is matched by the
security group rule. If a value is provided at design-time, this value may be overridden at
run-time based on other deployment requirements or constraints.
        required: true
        constraints:
          - greater_or_equal: 0
          - less_or_equal: 65535
        default: 0
      port_range_max:
        type: integer
        description: Indicates maximum port number in the range that is matched by the
security group rule. If a value is provided at design-time, this value may be overridden at
run-time based on other deployment requirements or constraints.
        required: true
        constraints:
          - greater_or_equal: 0
          - less_or_equal: 65535
        default: 65535
```

9.10.1.4 Additional Requirements

The design of security group rule follows a permissive model where all security group rules applied to a connection point are dealt with in an "OR" logic fashion, i.e. the traffic is allowed if it matches any security group rule applied to this connection point.

Annex A (informative): Examples

A.1 Deployment flavour design mapping

A.1.1 Introduction

This clause describes the main design principle for VNF/NS deployment flavour and the mapping between VNF/NS deployment flavour elements to TOSCA concept.

A.1.2 Design principle for VNF deployment flavour

Each Deployment flavour as specified in ETSI GS NFV-IFA 011 [1] describes a given deployment configuration of a VNF in terms of its internal topology and resource needs. Different deployment flavours can define different topologies of the same VNF, with different scalingAspect, different VDUs and different internal connectivity requirements. The idea of VNF deployment flavour as specified in [1] is that each deployment flavour describes the required vduProfiles and virtualLinkProfiles which are the additional instantiation data for the given VDUs and virtualLinks, once a specific deployment flavour has been chosen at the instantiation time, in order to successfully deploy the given VDUs and virtualLinks, the bindings between the VDU with the corresponding VduProfile and the virtualLinkDesc with the corresponding virtualLinkProfile are required.

To achieve the concept of deployment flavour by using TOSCA, the main design principle is to describe each deployment flavour as a standalone implementable TOSCA service template, and binding VDU and virtualLink with the corresponding VduProfile and virtualLinkProfile, respectively, together at the design time. Once a specific deployment flavour has been chosen at the instantiation time, the corresponding TOSCA service template will be used for deploying the VNF with the given deployment flavour.

Figure A.1.2-1 shows the general principle for a VNF deployment flavour design.

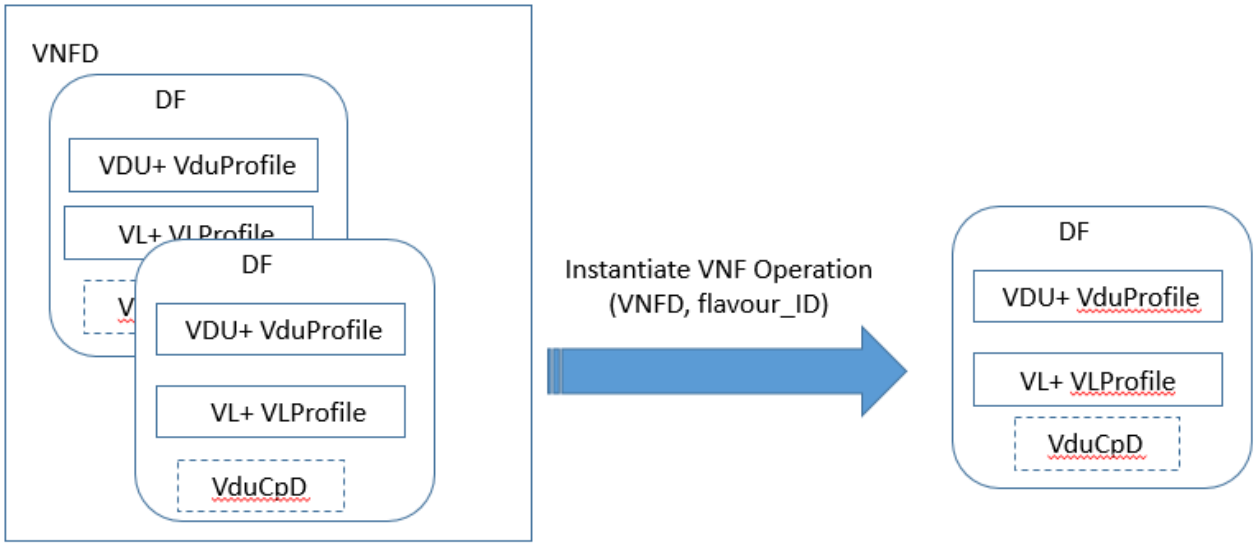


Figure A.1.2-1: General principle for a VNF deployment flavour design

A.1.3 Design principle for NS deployment flavour

The design principle for NSD deployment flavour is the same with the VNF deployment flavour design. Each NS deployment flavour is described as a standalone implementable TOSCA service template, the constituent VNF, virtualLink, nested NS and PNF is bound with the corresponding VnfProfile, VirtualLinkProfile, NsProfile and virtual_link requirements respectively together at the design time. Once a specific deployment flavour has been chosen at the instantiation time, the corresponding TOSCA service template will be used for deploying the NS with the given deployment flavour.

Figure A.1.3-1 shows the general principle for a NS deployment flavour design.

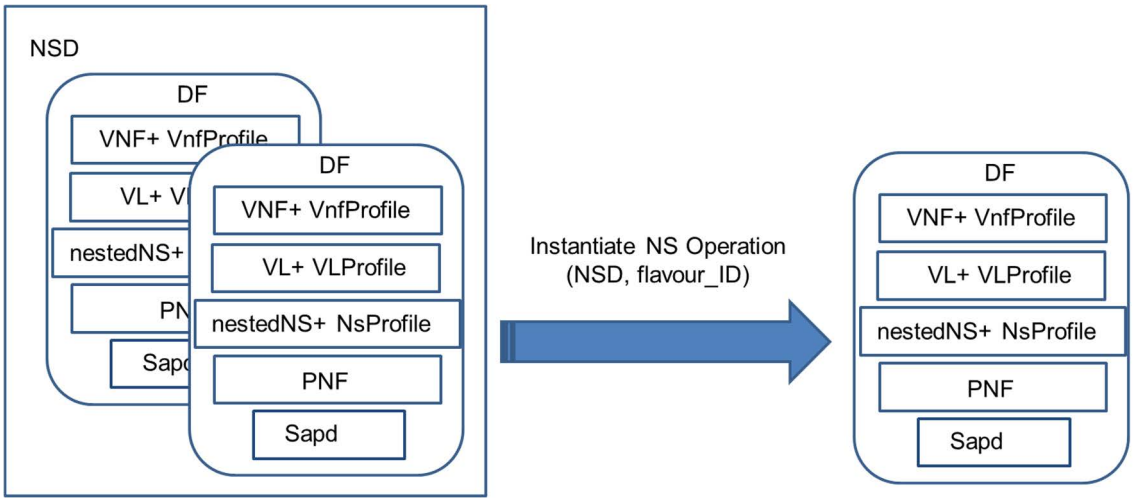


Figure A.1.3-1: General principle for a NS deployment flavour design

A.2 VNFD with deployment flavour modelling design example

Deployment flavours are represented as deployable TOSCA topology templates. This way one VNF service template represents one deployment flavour, and different deployment flavours are described by different VNF service templates. This is in line with the idea that different deployment flavours can define different topologies of the same VNF, with different scaling aspects, different VDUs and different internal connectivity.

In order to represent a VNF a top-level service template is used. This top-level service template contains a topology template with only an abstract VNF node which defines the common parts of the different deployment flavours (such as product information, modifiable attributes and parts of the lifecycle management interface definition). It also sets a constraint on the deployment flavour property (the required value of the flavour_id property); this constraint comes from the VNF instantiation request which contains a flavour_id selected among those available in the VNFD.

As a result, the VNFM will look into the available further service templates representing the different VNF deployment flavours of the VNF and use the one that has the matching flavour_id property value to substitute for the abstract VNF. These are the low-level service templates.

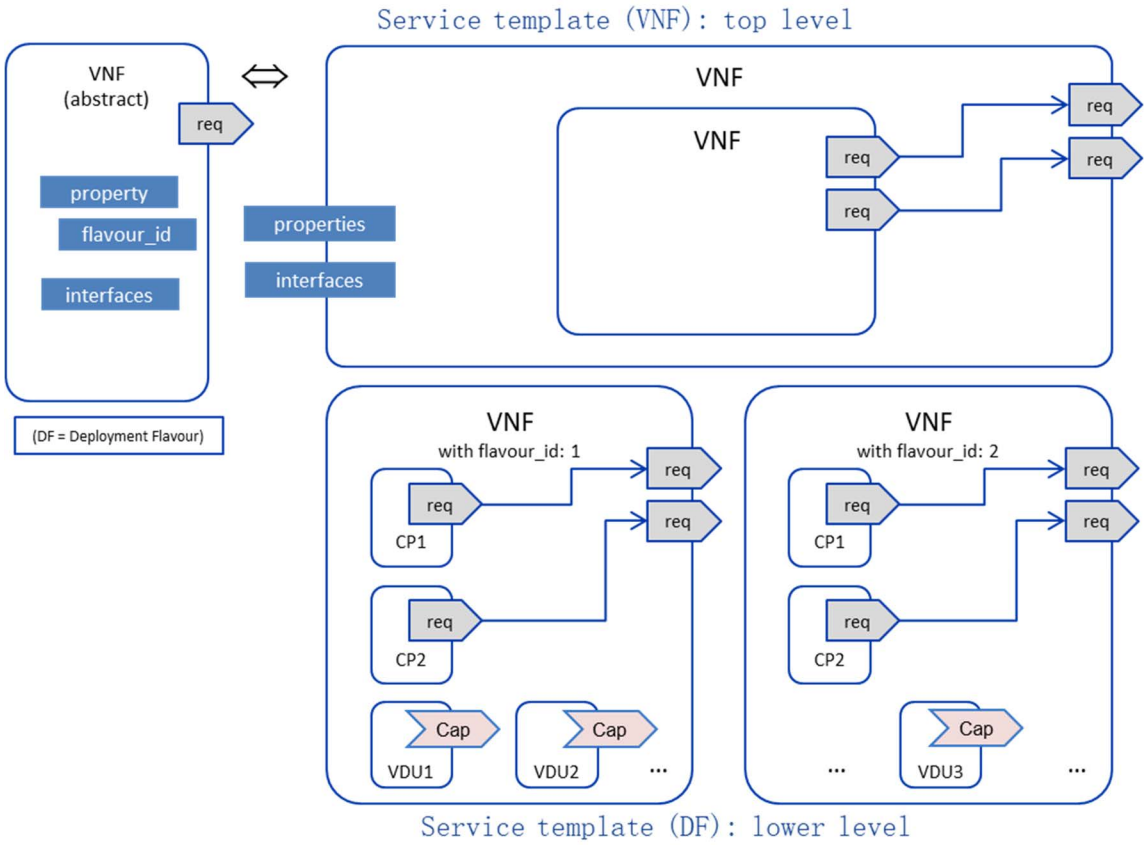


Figure A.2-1: VNFD overview with deployment flavour

A VNFD contains a TOSCA top-level Service Template as entry point in the VNF package and one or more TOSCA low-level Service templates representing the different deployment flavours (see figure A.2-1). The VNFD is interpreted by an NFVO or VNF manager. In this example, the templates describe two variants of the VNF each corresponding to a deployment flavour: a simple one and a complex one. The simple VNF consists of one server: a DB backend whereas, the complex VNF variant consists of minimum three DB backend servers and one serviceNode, which may be scaled out in one-size increments.

SunshineDB: VNFD-top level

sunshine.vnfd.tosca.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, non-scalable
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - sunshineVNF.yaml # contains the VNF node type definition


topology_template:
  inputs:
    flavour_id:
      type: string
      description: VNF deployment flavour selected by the consumer. It is provided in the API

  node_templates:
    SunshineDB:
        type: MyCompany.SunshineDB.1_0.1_0
        properties:
          flavour_id: { get_input: flavour_id }
          descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
          provider: MyCompany
          product_name: SunshineDB
          software_version: '1.0'
          descriptor_version: '1.0'
          vnfm_info:
```

```
            - '0:MyCompany-1.0.0'
       # requirements:
          #- virtual_link_backend # mapped in lower-level templates
          #- virtual_link_service # mapped in lower-level templates
```

The sunshineVNF.yaml file has the following content:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, non-scalable

imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

data_types:
  MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
        default: value_1
      parameter_2:
        type: string
        required: true
        default: value_2

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple, complex ] ]
        default: simple
      flavour_description:
        type: string
        default: "" #empty string
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 0 ]
      - virtual_link_backend:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_service:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
    interfaces:
```

```
      Vnflcm:
        type: tosca.interfaces.nfv.Vnflcm
        operations:
          instantiate:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters
                required: false
```

The vnf node template in the sunshine.vnfd.tosca.yaml file is abstract and is subject to substitution; the lower-level templates in the subsequent sections provide these substitutions. The actual lower-level template is selected based on the node type and a value constraint on the flavour_id property.

Each low level service template contains a node template of type MyCompany.SunshineDB.1_0.1_0 with implementation of the LCM interfaces.

SunshineDB (simple): Lower level

sunshinedbsimple.vnfd.tosca.yaml

This example illustrates one Vdu.Compute nodes (dbBackend) with two connection points and two virtual links (see figure A.2-2). The flavour_id is "Simple".

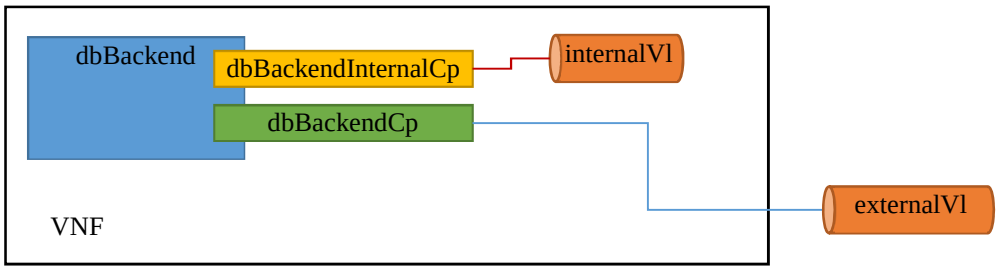


Figure A.2-2: SunshineDB (simple): Lower level

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, simple
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - sunshineVNF.yaml # contains the VNF node type definition

node_types:
  MyCompany.nodes.nfv.Vdu.Aux:
    derived_from: tosca.nodes.nfv.Vdu.Compute
    properties:
      configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties
        required: false

data_types:
  MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcConfigurableProperties
    properties:
      additional_vnfc_configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties
        required: true

  MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
    properties:
      name_prefix_in_vim:
        type: string
        required: true
        default: "MyCustomer"
      dns_server:
        type: string
        required: true
        default: "90.200.250.57"
```

```
topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
    substitution_filter:
      properties:
        - flavour_id: { equal: simple }
    requirements:
       virtual_link_backend: [ dbBackendCp, virtual_link ]  # IPv4 for SQL

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
      properties:
        flavour_description: A simple flavour
      interfaces:
        Vnflcm:
          operations:
            instantiate:
              implementation: instantiate.workbook.mistral.yaml
            terminate:
              implementation: terminate.workbook.mistral.yaml

    dbBackend:
      type: MyCompany.nodes.nfv.Vdu.Aux
      properties:
        name: dbBackend
        description: dbBackend compute node
        nfvi_constraints:
          key_1: value_1
          key_2: value_2
        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 1
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 8192 MiB
            virtual_cpu:
              cpu_architecture: x86
              num_virtual_cpu: 2
              virtual_cpu_clock: 1800 MHz
      requirements:
        - virtual_storage: mariaDbStorage

    mariaDbStorage:
      type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
      properties:
        virtual_block_storage_data:
          size_of_storage: 100 GB
          rdma_enabled: true
     #   ..
      artifacts:
        sw_image:
          type: tosca.artifacts.nfv.SwImage
          file: maria.db.image.v1.0.qcow2
          properties:
            name: Software of Maria Db
            version: '1.0'
            checksum:
              algorithm: sha-256
              hash: b9c3036539fd7a5f87a1bf38eb05fdde8b556a1a7e664dbeda90ed3cd74b4f9d
            container_format: bare
            disk_format: qcow2
            min_disk: 2 GB
            min_ram: 8192 MiB
            size: 2 GB
            operating_system: Linux
            supported_virtualisation_environments:
              - KVM

    dbBackendCp:
      type: tosca.nodes.nfv.VduCp
      properties:
        layer_protocols: [ ipv4 ]
        role: leaf
        description: External connection point to access the DB on IPv4
        protocol: [ associated_layer_protocol: ipv4 ]
```

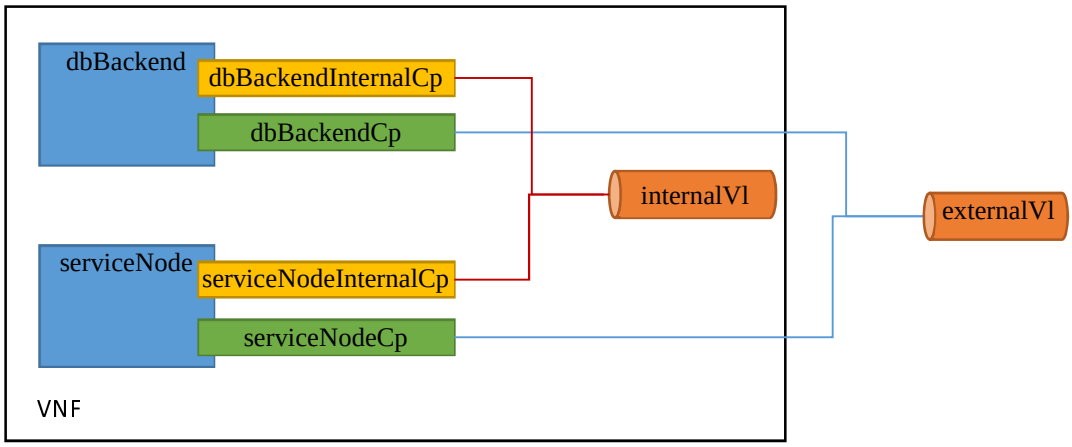
```
        trunk_mode: false
      requirements:
        - virtual_binding: dbBackend
        # - virtual_link: # the target node is determined in the NSD

    dbBackendInternalCp:
      type: tosca.nodes.nfv.VduCp
      properties:
        layer_protocols: [ ipv4 ]
        role: leaf
        description: Internal connection point on an VL
        protocol: [ associated_layer_protocol: ipv4 ]
        trunk_mode: false
      requirements:
        - virtual_binding: dbBackend
        - virtual_link: internalVl

    internalVl:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
          flow_pattern: mesh
        description: Internal Virtual link in the VNF
        vl_profile:
          max_bitrate_requirements:
            root: 100000
            leaf: 20000
          min_bitrate_requirements:
            root: 10000
            leaf: 10000
```

SunshineDB (complex): Lower level

This example illustrates two Vdu.Compute nodes (dbBackend, and serviceNode) with two connection points and two virtual links (see figure A.2-3). The flavour_id is "complex".



NOTE: The single external VL above illustrates that both serviceNodeCp and dbBackendCp are connected to the same external VL. Alternatively, external connection points can be connected to separate external VLs.

Figure A.2-3: SunshineDB (complex): Lower level

sunshinedbcomplex.vnfd.tosca.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, complex
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - sunshineVNF.yaml # contains the VNF node type definition

node_types:
  MyCompany.nodes.nfv.Vdu.Aux:
    derived_from: tosca.nodes.nfv.Vdu.Compute
```

```
    properties:
      configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties
        required: false

data_types:
  MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcConfigurableProperties
    properties:
      additional_vnfc_configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties
        required: true

  MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
    properties:
      name_prefix_in_vim:
        type: string
        required: true
        default: "MyCustomer"
      dns_server:
        type: string
        required: true
        default: "90.200.250.57"

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
    substitution_filter:
      properties:
        - flavour_id: { equal: complex }
    requirements:
      virtual_link_backend: [ dbBackendCp, virtual_link ]  # IPv4 for SQL
      virtual_link_service: [ serviceNodeCp, virtual_link ]  # IPv4 for SSH

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
      properties:
        flavour_id : complex
        flavour_description: A complex flavour
      interfaces:
        Vnflcm:
          operations:
            instantiate:
              implementation: instantiate.workbook.mistral.yaml
            terminate:
              implementation: terminate.workbook.mistral.yaml
            heal:
              implementation: heal.workbook.mistral.yaml

    dbBackend:
      type: MyCompany.nodes.nfv.Vdu.Aux
      properties:
        name: dbBackend
        description: dbBackend compute node
        nfvi_constraints:
          key_1: value_1
          key_2: value_2
        vdu_profile:
          min_number_of_instances: 3
          max_number_of_instances: 4
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 8192 MiB
            virtual_cpu:
              cpu_architecture: x86
              num_virtual_cpu: 2
              virtual_cpu_clock: 1800 MHz
      requirements:
        - virtual_storage: mariaDbStorage

    serviceNode:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: serviceNode
```

```
      description: brief description about serviceNode
      nfvi_constraints:
        key_3: value_3
        key_4: value_4
      vdu_profile:
        min_number_of_instances: 1
        max_number_of_instances: 1
    capabilities:
      virtual_compute:
        properties:
          virtual_memory:
            virtual_mem_size: 8192 MiB
          virtual_cpu:
            cpu_architecture: x86
            num_virtual_cpu: 2
            virtual_cpu_clock: 1800 MHz
    requirements:
      - virtual_storage: mariaDbStorage
    artifacts:
      sw_image:
        type: tosca.artifacts.nfv.SwImage
        file: maria.db.image.v1.0.qcow2
        properties:
          name: Software of Maria Db
          version: '1.0'
          checksum:
            algorithm: sha-256
            hash: b9c3036539fd7a5f87a1bf38eb05fdde8b556a1a7e664dbeda90ed3cd74b4f9d
          container_format: bare
          disk_format: qcow2
          min_disk: 2 GB
          min_ram: 8192 MiB
          size: 2 GB
          operating_system: Linux
          supported_virtualisation_environments:
            - KVM

  mariaDbStorage:
    type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
    properties:
      virtual_block_storage_data:
        size_of_storage: 100 GB
        rdma_enabled: true
    artifacts:
      sw_image:
        type: tosca.artifacts.nfv.SwImage
        file: maria.db.image.v1.0.qcow2
        properties:
          name: Software of Maria Db
          version: '1.0'
          checksum:
            algorithm: sha-256
            hash: b9c3036539fd7a5f87a1bf38eb05fdde8b556a1a7e664dbeda90ed3cd74b4f9d
          container_format: bare
          disk_format: qcow2
          min_disk: 2 GB
          min_ram: 8192 MiB
          size: 2 GB
          operating_system: Linux
          supported_virtualisation_environments:
            - KVM

  dbBackendCp:
    type: tosca.nodes.nfv.VduCp
    properties:
      layer_protocols: [ ipv4 ]
      role: leaf
      description: External connection point to access the DB on IPv4
      protocol: [ associated_layer_protocol: ipv4 ]
      trunk_mode: false
    requirements:
      - virtual_binding: dbBackend
      #- virtual_link: # the target node is determined in the NSD

  dbBackendInternalCp:
    type: tosca.nodes.nfv.VduCp
    properties:
      layer_protocols: [ ipv4 ]
```

```
      role: leaf
      description: Internal connection point on an VL
      protocol: [ associated_layer_protocol: ipv4 ]
      trunk_mode: false
    requirements:
      - virtual_binding: dbBackend
      - virtual_link: internalVl

  serviceNodeCp:
    type: tosca.nodes.nfv.VduCp
    properties:
      layer_protocols: [ ipv4 ]
      role: leaf
      description: External connection point to access the DB on IPv4
      protocol: [ associated_layer_protocol: ipv4 ]
      trunk_mode: false
    requirements:
      - virtual_binding: serviceNode
      #- virtual_link: # the target node is determined in the NSD

  serviceNodeInternalCp:
    type: tosca.nodes.nfv.VduCp
    properties:
      layer_protocols: [ ipv4 ]
      role: leaf
      description: Internal connection point on VL
      protocol: [ associated_layer_protocol: ipv4 ]
      trunk_mode: false
    requirements:
      - virtual_binding: serviceNode
      - virtual_link: internalVl

  internalVl:
    type: tosca.nodes.nfv.VnfVirtualLink
    properties:
      connectivity_type:
        layer_protocols: [ ipv4 ]
        flow_pattern: mesh
      description: Internal VL
      vl_profile:
        max_bitrate_requirements:
          root: 100000
          leaf: 20000
        min_bitrate_requirements:
          root: 10000
          leaf: 10000
```

A.3 VNF external connection point

A.3.1 General

A VNF external connection point may either be an internal connection point (a VDU connection point) which is re-exposed externally, i.e. it may be connected to an external virtual link, or a virtual link port. In the latter case the external connection point node has an association relationship of type VirtualLinksTo to the internal virtual link node.

The following clauses illustrate the use of both models of VNF external connection point, re-exposure of an internal connection point and connected to an internal virtual link.

A.3.2 External connection point re-exposing an internal connection point

In this case there is no need for a VnfExtCp node template. When substituting the VNFD low level service template for the abstract VNF node, the virtual_link requirement of the abstract VNF node is mapped to the VDU connection point's virtual_link requirement. This is shown in figure A.3.2-1. In this case the VNF Service Template does not include a node template of type tosca.nodes.nfv.VnfExtCp, but the functionality of it is provided by a VDU connection point.

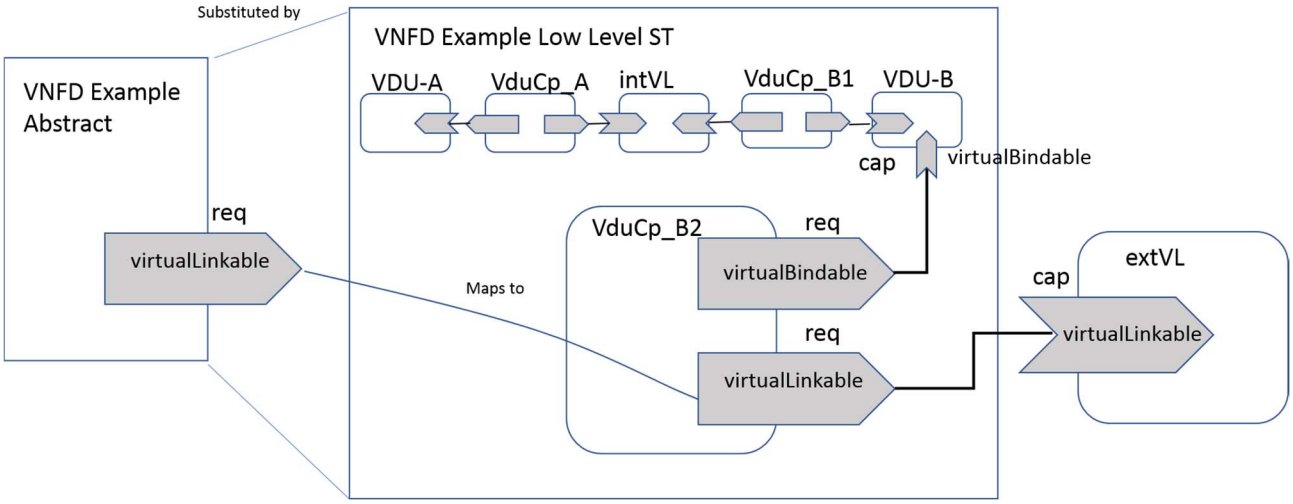


Figure A.3.2-1: VNFD with an VDU connection point acting as VnfExtCp

The following snippet shows the relevant part of the service template:

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - exampleVNF.yaml # contains the VNF node type definition



topology_template:

#...

  substitution_mappings:
    node_type: tosca.nodes.nfv.exampleVNF
    substitution_filter:
      properties:
        - flavour_id: { equal: simple }
    requirements:
      virtual_link: [vduCp_B2, virtual_link]

  node_templates:
#..
    ExampleVNF:
      type: tosca.nodes.nfv.exampleVNF
      properties:
        flavour_description: A simple flavour
      interfaces:
        Vnflcm:
          operations:
            instantiate:
              implementation: instantiate.workbook.mistral.yaml
            terminate:
              implementation: terminate.workbook.mistral.yaml

    vduCp_B2:
      type: tosca.nodes.nfv.VduCp
      properties:
        layer_protocols: [ ipv4 ]
      # other properties omitted for brevity
      requirements:
        - virtual_binding: VDU-B
        # - virtual_link: # mapped to virtual_link requirement of VNF node


  # other node template definitions (VDU-A, VDU-B, intVL, etc.):
    VDU-A:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: VDU-A
        description: VDU-A description
        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 1
```

```
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1

    vduCp_A:
      type: tosca.nodes.nfv.VduCp
      properties:
        layer_protocols: [ ipv4 ]
        protocol: [ associated_layer_protocol: ipv4 ]
        trunk_mode: true
      requirements:
        - virtual_binding: VDU-A
        - virtual_link: intVL

    intVL:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 1000000
            leaf: 100000
          min_bitrate_requirements:
            root: 100000
            leaf: 10000

    vduCp_B:
      type: tosca.nodes.nfv.VduCp
      properties:
        layer_protocols: [ ipv4 ]
        protocol: [ associated_layer_protocol: ipv4 ]
        trunk_mode: true
      requirements:
        - virtual_binding: VDU-B
        - virtual_link: intVL

    VDU-B:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: VDU-B
        description: VDU-B description
        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 1
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1
```

The following snippet shows the relevant part of the file containing the imported node type definition:

exampleVNF.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

node_types:
  tosca.nodes.nfv.exampleVNF:
    derived_from: tosca.nodes.nfv.VNF
    properties:
        descriptor_id:
          type: string
          constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
          default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
        provider:
          type: string
          constraints: [ equal: MyCompany ]
          default: MyCompany
        product_name:
```

```
        type: string
        constraints: [ equal: ExampleVNF ]
        default: ExampleVNF
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple, complex ] ]
        default: simple
      flavour_description:
        type: string
        default: "" #empty string
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
  # other properties omitted for brevity
  requirements:
     - virtual_link:
         capability: tosca.capabilities.nfv.VirtualLinkable
         relationship: tosca.relationships.nfv.VirtualLinksTo
```

A.3.3 External connection point connected to an internal virtual link

In this case a VnfExtCp node template is needed. When substituting the VNFD low level service template for the abstract VNF node type, the virtual_link requirement of the abstract VNF node maps to the external_virtual_link requirement of the VnfExtCp node. The internal_virtual_link requirement of the VnfExtCp node is fulfilled with the corresponding capability of the internal VirtualLink node. This is shown in figure A.3.3-1.

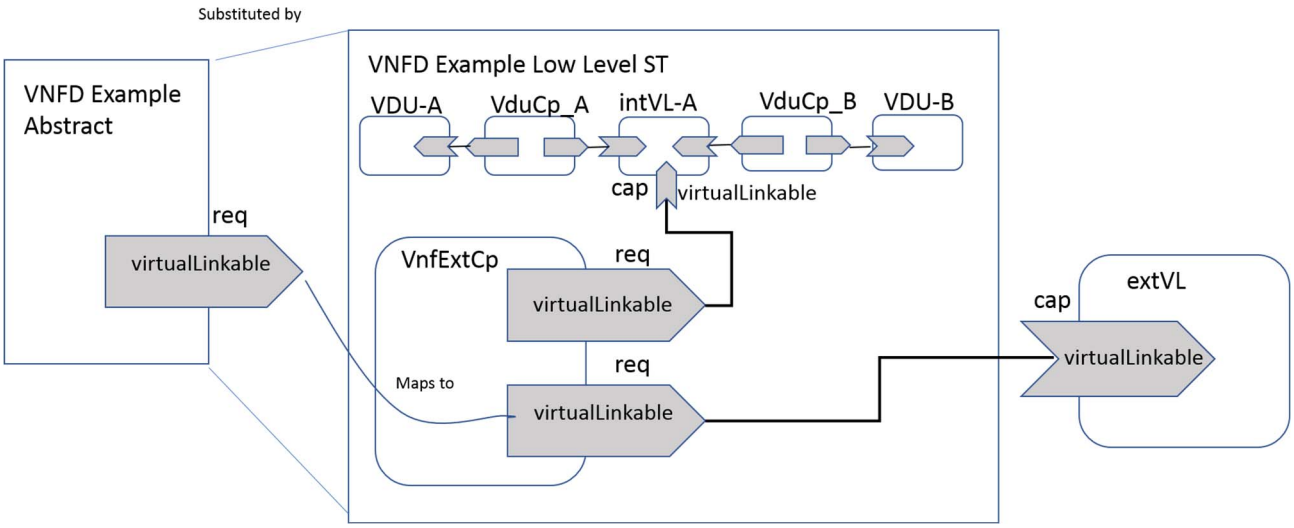


Figure A.3.3-1: VNFD with a VnfExtCp connected to an internal virtual link

The following snippet shows the corresponding node template definition.

The node type definition is assumed to be identical to the example in clause A.3.2.

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - exampleVNF.yaml # contains the VNF node type definition
```

```
topology_template:
#...

  substitution_mappings:
    node_type: tosca.nodes.nfv.exampleVNF
    substitution_filter:
      properties:
        - flavour_id: { equal: simple }
    requirements:
      virtual_link: [myMRFExtCp, external_virtual_link]

  node_templates:
    ExampleVNF:
      type: tosca.nodes.nfv.exampleVNF
      properties:
        flavour_description: A simple flavour
      interfaces:
        Vnflcm:
          operations:
            instantiate:
              implementation: instantiate.workbook.mistral.yaml
            terminate:
              implementation: terminate.workbook.mistral.yaml

    myMRFExtCp:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
      # other properties omitted for brevity
         # ...
      requirements:
        # - external_virtual_link: # mapped to virtual_link requirement of VNF node
        - internal_virtual_link: intVL-A


    intVL-A:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
          flow_pattern: mesh
        description: Internal VL
        vl_profile:
          max_bitrate_requirements:
            root: 1000000
            leaf: 100000
          min_bitrate_requirements:
            root: 100000
            leaf: 10000
          qos:
            latency: 100 ms
            packet_delay_variation: 80 ms
            packet_loss_ratio: 0.00001


  # Other node templates e.g. VDU-A, VDU-B, VduCP_A, etc.:
# ...
```

A.4 VNFD modelling design example by using TOSCA composition

The following example in figure A.4-1 shows a VNF descriptor contains three VDUs, which are interconnected by two virtualLinks.

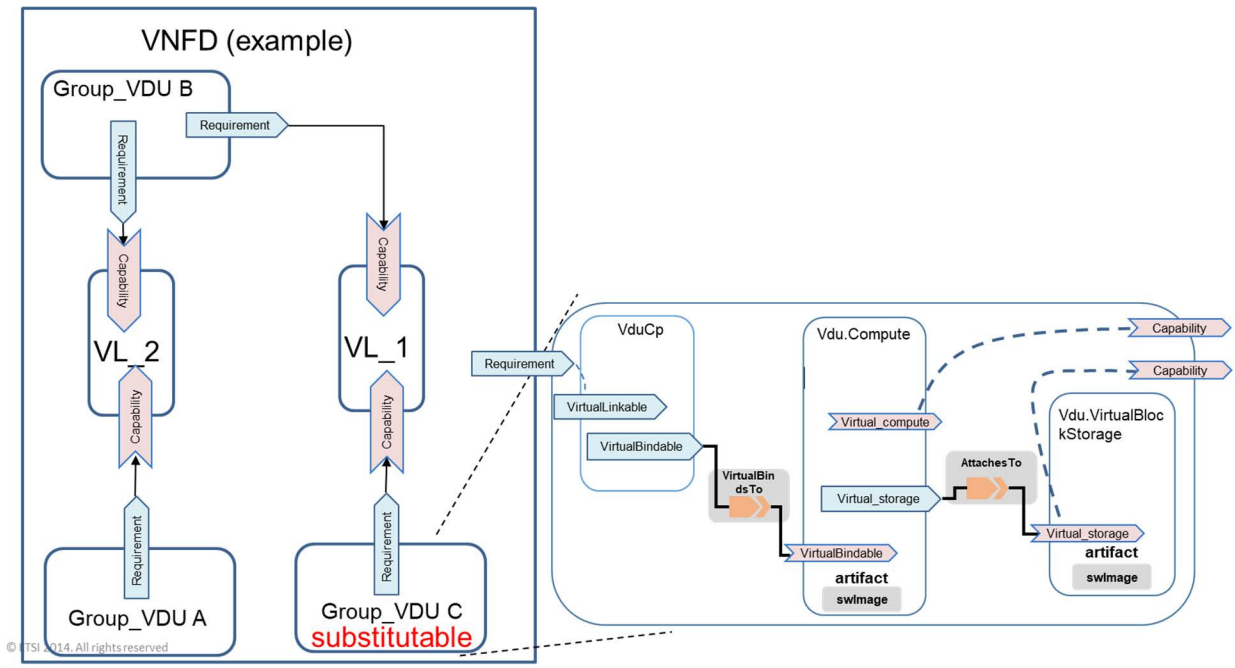


Figure A.4-1: Example of using substitution mapping for the VNFD design

In this example, a separate service template is used to describe the composition of Vdu.Compute, Vdu.VirtualBlockStorage and VduCp, and then substituted as a node template in a VNFD service template. tosca.nodes.nfv.groupVDU_A, tosca.nodes.nfv.groupVDU_B, tosca.nodes.nfv.groupVDU_C types are used for substitution_mapping.

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: Template of a VNFD example
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - MyGroups.yaml #contains the node type definitions

topology_template:

  node_templates:
    Group_VDU_A:
      type: tosca.nodes.nfv.groupVDU_A
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1
      requirements:
        - virtual_link: VL_2

    Group_VDU_B:
      type: tosca.nodes.nfv.groupVDU_B
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1
      requirements:
        - virtual_link: VL_2
        - virtual_link1: VL_1

    Group_VDU_C:
      type: tosca.nodes.nfv.groupVDU_C # the description of this type is described
                                       # in another service template.
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
```

```
            virtual_mem_size: 1 GB
          virtual_cpu:
            num_virtual_cpu: 1
    requirements:
      - virtual_link: VL_1

  VL_1:
    type: tosca.nodes.nfv.VnfVirtualLink
    properties:
      connectivity_type:
        layer_protocols: [ ipv4 ]
      vl_profile:
        max_bitrate_requirements:
          root: 1000000
          leaf: 100000
        min_bitrate_requirements:
          root: 100000
          leaf: 10000
   # other properties omitted here for brevity

  VL_2:
    type: tosca.nodes.nfv.VnfVirtualLink
    properties:
      connectivity_type:
        layer_protocols: [ ipv4 ]
      vl_profile:
        max_bitrate_requirements:
          root: 1000000
          leaf: 100000
        min_bitrate_requirements:
          root: 100000
          leaf: 10000
   # other properties omitted here for brevity
```

The TOSCA service template example of Group_VDU C is showing in figure A.4-2.

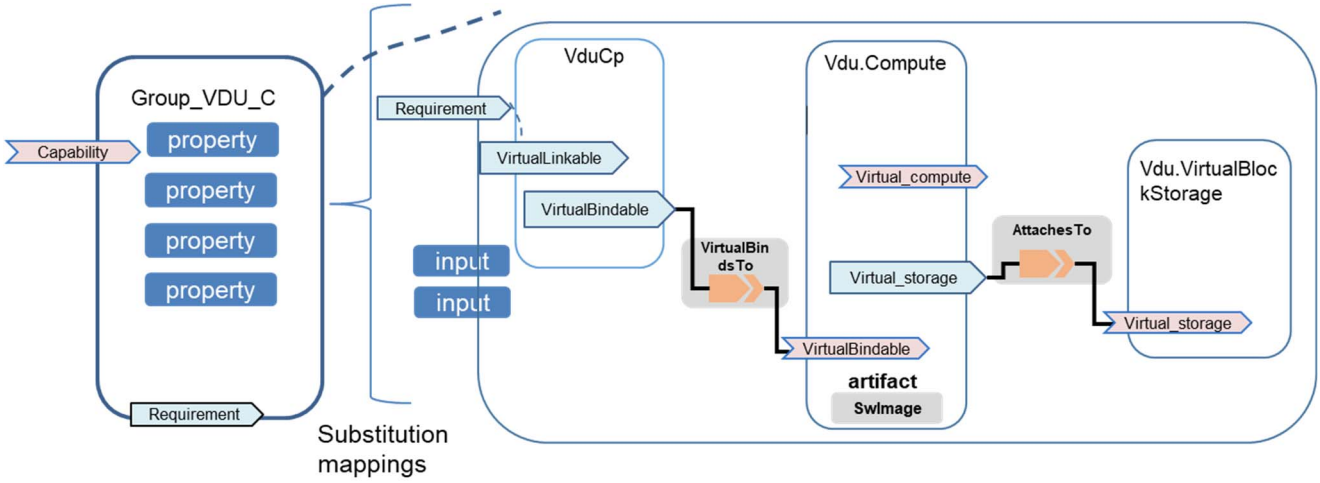


Figure A.4-2: Example of composition Vdu.Compute, Vdu.VirtualBlockStorage and VduCp together using TOSCA substitution mapping

```
tosca_definitions_version: tosca_simple_yaml_1_3

imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001
  - MyGroups.yaml #contains the node type definitions
description: composition of Vdu.Compute, Vdu.VirtualBlockStorage and VduCp.

topology_template:
   substitution_mappings:
     node_type: tosca.nodes.nfv.groupVDU_C # substituted as a node type
     requirements:
        virtual_link: [ internalCpd, virtual_link ]
     capabilities:
        virtual_compute: [vduC_compute, virtual_compute]
        virtual_storage: [vduC_storage, virtual_storage]

   node_templates:
```

```
    vduC_compute:
       type: tosca.nodes.nfv.Vdu.Compute
       properties:
         name: vduC_compute
         description: vduC_compute ..
         vdu_profile:
           min_number_of_instances: 1
           max_number_of_instances: 1
         # other properties omitted here for brevity
       capabilities:
          virtual_compute:
            properties:
             virtual_memory:
               virtual_mem_size: 1 GB
             virtual_cpu:
               num_virtual_cpu: 1
 #     artifacts:
 #       sw_image:             # omitted here for brevity
       requirements:
         - virtual_storage: vduC_storage

    vduC_storage:
       type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
       properties:
         virtual_block_storage_data:
           size_of_storage: 2 GB
         # other properties omitted here for brevity

    internalCpd:
       type: tosca.nodes.nfv.VduCp
       properties:
         layer_protocols: [ ipv4 ]
#           protocol: [ associated_layer_protocol: ipv4 ]
#           trunk_mode: false
 # properties omitted here for brevity
       requirements:
         # - virtual_link:
         - virtual_binding: vduC_compute
```

The following template fragment provides the group definitions used in the above examples.

MyGroups.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of VNFD types as defined in NFV SOL 001 GS

node_types:

  tosca.nodes.nfv.groupVDU:
    description: Abstract group VDU.
    derived_from: tosca.nodes.Root
    capabilities:
      virtual_compute:
        description: Describes virtual compute resources capabilities.
        type: tosca.capabilities.nfv.VirtualCompute
      virtual_storage:
        description: Defines the capabilities of virtual_storage.
        type: tosca.capabilities.nfv.VirtualStorage
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          node: tosca.nodes.nfv.VnfVirtualLink
          occurrences: [ 1, 1 ]

  tosca.nodes.nfv.groupVDU_A:
    description: Abstract group VDU A.
    derived_from: tosca.nodes.nfv.groupVDU

  tosca.nodes.nfv.groupVDU_B:
    description: Abstract group VDU B.
    derived_from: tosca.nodes.nfv.groupVDU
    requirements:
      - virtual_link1:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          node: tosca.nodes.nfv.VnfVirtualLink
```

```
          occurrences: [ 1, 1 ]

  tosca.nodes.nfv.groupVDU_C:
    description: Abstract group VDU C.
    derived_from: tosca.nodes.nfv.groupVDU
```

A.5 VNFD with Single deployment flavour modelling design example

In this example, there is one deployment flavour applied to this VNFD, and TOSCA-Simple-Profile-YAML-v1.3 [20] is used for designing and processing this VNFD TOSCA model.

The one service template design illustrated by this example is only applicable when the VNF has only one deployment flavour.

The service template is the main entry point in the VNF Package, i.e. the Entry-definitions file, and is deployed as a stand-alone service template, i.e. without substituting for a node template. However, the service template still contains substitution_mappings to indicate its ability to substitute for a node template of the specific node type.

The service template contains a node template of type MyCompany.SunshineDB.1_0.1_0. The node template contains the properties defined in the node type definition and implementations for the LCM interfaces.

sunshinesimple.vnfd.tosca.yaml

This example illustrates a VNF with one VDU.Compute nodes (dbBackend) with two VDU connection points and one VNF virtual link (see figure A.5-1). The VNF is also connected to an external virtual link. The flavour_id is "simple".

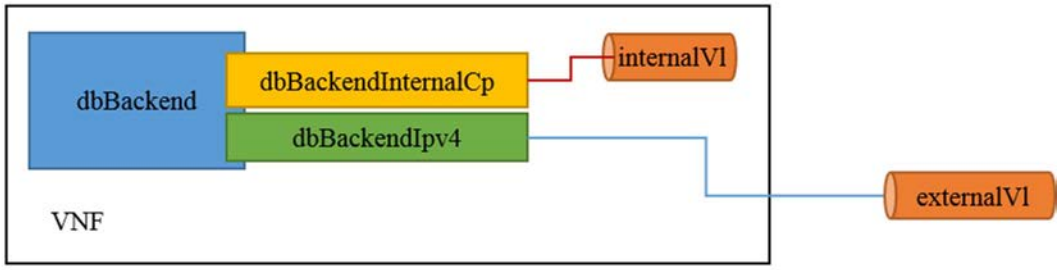


Figure A.5-1: SunshineDB (simple)

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, simple

imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001 for
a VNFD

data_types:
  MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      segmentation_id_of_internalVl:
        type: string
        required: true
        default: 1-4095
      parameter_2:
        type: string
        required: true
        default: value_2

  MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcConfigurableProperties
    properties:
      additional_vnfc_configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties
        required: true
```

```
  MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties:
    derived_from: tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties
    properties:
      name_prefix_in_vim:
        type: string
        required: true
        default: "MyCustomer"
      dns_server:
        type: string
        required: true
        default: "90.200.250.57"

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    interfaces:
      Vnflcm:
        type: tosca.interfaces.nfv.Vnflcm
        operations:
          instantiate:
            inputs:
              additional_parameters:
                 type: MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters
                 required: false
          #terminate:

  MyCompany.nodes.nfv.Vdu.Aux:
    derived_from: tosca.nodes.nfv.Vdu.Compute
    properties:
      configurable_properties:
        type: MyCompany.datatypes.nfv.AuxVnfcConfigurableProperties
        required: false

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
    requirements:
      virtual_link: [ dbBackendIpv4, virtual_link ] # IPv4 for SQL

  inputs:
    segmentation_id_of_internalVl:
      type: string
      required: true
```

```
node_templates:
  SunshineDB:
    type: MyCompany.SunshineDB.1_0.1_0
    properties:
      descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider: MyCompany
      product_name: SunshineDB
      software_version: '1.0'
      descriptor_version: '1.0'
      vnfm_info:
        - '0:MyCompany-1.0.0'
      flavour_id: simple
      flavour_description: 'vnf simple flavour description'
    interfaces:
      Vnflcm:
        operations:
          instantiate:
            implementation: instantiate.workbook.mistral.yaml
          terminate:
            implementation: terminate.workbook.mistral.yaml
          heal:
            implementation: heal.workbook.mistral.yaml

  dbBackend:
    type: MyCompany.nodes.nfv.Vdu.Aux
    properties:
      name: dbbackend
      description: dbBackend
      nfvi_constraints:
        key_1: value_1
        key_2: value_2
      vdu_profile:
        min_number_of_instances: 1
        max_number_of_instances: 4
    capabilities:
      virtual_compute:
        properties:
          virtual_memory:
            virtual_mem_size: 8192 MiB
          virtual_cpu:
            cpu_architecture: x86
            num_virtual_cpu: 2
            virtual_cpu_clock: 1800 MHz
    requirements:
      - virtual_storage: mariaDbStorage

  mariaDbStorage:
    type: tosca.nodes.nfv.Vdu.VirtualBlockStorage
    properties:
      virtual_block_storage_data:
        size_of_storage: '200 GB'
        rdma_enabled: true
    artifacts:
      sw_image:
        type: tosca.artifacts.nfv.SwImage
        file: maria.db.image.v1.0.qcow2
        properties:
          name: Software of Maria Db
          version: '1.0'
          checksum:
            algorithm: sha-256
            hash: b9c3036539fd7a5f87a1bf38eb05fdde8b556a1a7e664dbeda90ed3cd74b4f9d
          container_format: bare
          disk_format: qcow2
          min_disk: 2 GB
          min_ram: 8192 MiB
          size: 2 GB
          operating_system: Linux
          supported_virtualisation_environments:
            - KVM

  dbBackendInternalCp:
    type: tosca.nodes.nfv.VduCp
    properties:
      protocol: [associated_layer_protocol: ipv4 ]
      trunk_mode: false
      layer_protocols: [ ipv4 ]
```

```
      role: leaf
      description: Internal connection point on an VL
    requirements:
      - virtual_binding: dbBackend
      - virtual_link: internalVl

  internalVl:
    type: tosca.nodes.nfv.VnfVirtualLink
    properties:
      connectivity_type:
        layer_protocols: [ ipv4, ethernet ]
        flow_pattern: mesh
      test_access: []
      description: Internal Virtual link in the VNF
      vl_profile:
        max_bitrate_requirements:
          root: 100000
          leaf: 20000
        min_bitrate_requirements:
          root: 10000
          leaf: 10000
        virtual_link_protocol_data:
          - associated_layer_protocol: ethernet
            l2_protocol_data:
              network_type: vlan
              segmentation_id: { get_input: segmentation_id_of_internalVl }

  dbBackendIpv4:
    type: tosca.nodes.nfv.VduCp
    properties:
      protocol: [ associated_layer_protocol: ipv4 ]
      trunk_mode: false
      layer_protocols: [ ipv4 ]
      role: leaf
      description: External connection point to access the DB on IPv4
    requirements:
     #- virtual_link: # the target node is determined in the NSD
      - virtual_binding: dbBackend
```

A.6 Scaling and Instantiation Level examples

A.6.1 ScalingAspect and InstantiationLevels policies with uniform delta

This example shows instantiationLevels, and ScalingAspect policies types in the complex scaling scenario where scaling aspect delta is based on "uniform delta" values , where it has only one entry. For a uniform aspect, the example 1 shows that step_deltas is omitted, whereas the example 2 shows step_deltas is included as a list of entries.

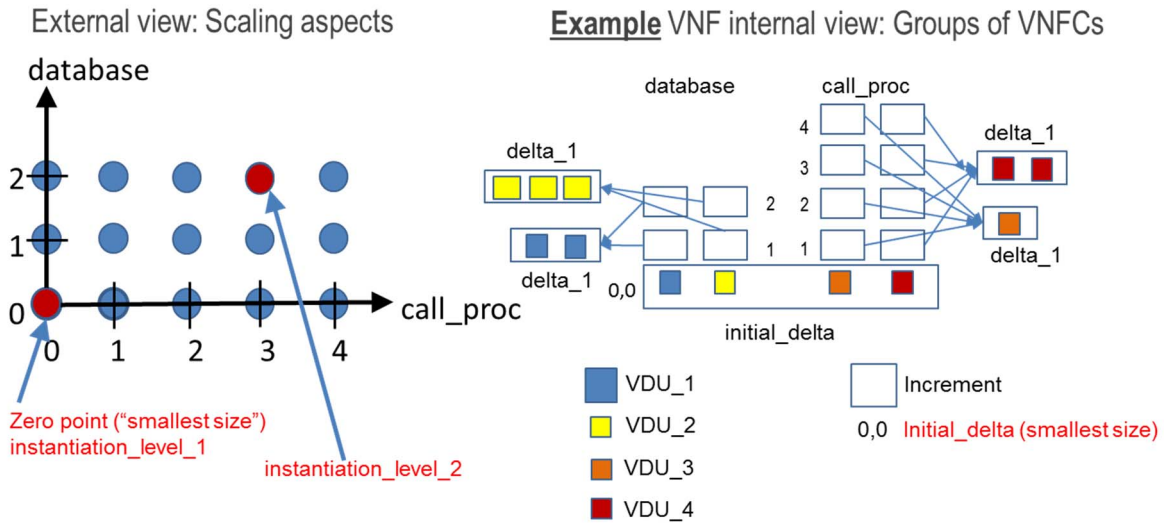


Figure A.6.1-1: Complex scaling example with uniform delta

EXAMPLE 1:

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: Complex scaling example (uniform delta value) described with policies
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

topology_template:
  node_templates:
    vdu_1:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: ..
        description: ..
        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 5
        nfvi_constraints:
          key_1: value_1
          key_2: value_2
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1

    vdu_2:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: ..
        description: ..
        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 7
        nfvi_constraints:
          key_1: value_1
          key_2: value_2
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1

    vdu_3:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: ..
        description: ..
```

```
      vdu_profile:
        min_number_of_instances: 1
        max_number_of_instances: 5
      nfvi_constraints:
        key_1: value_1
        key_2: value_2
    capabilities:
      virtual_compute:
        properties:
          virtual_memory:
            virtual_mem_size: 1 GB
          virtual_cpu:
            num_virtual_cpu: 1

  vdu_4:
    type: tosca.nodes.nfv.Vdu.Compute
    properties:
      name: ..
      description: ..
      vdu_profile:
        min_number_of_instances: 1
        max_number_of_instances: 9
      nfvi_constraints:
        key_1: value_1
        key_2: value_2
    capabilities:
      virtual_compute:
        properties:
          virtual_memory:
            virtual_mem_size: 1 GB
          virtual_cpu:
            num_virtual_cpu: 1

  vl_1:
    type: tosca.nodes.nfv.VnfVirtualLink
    properties:
      connectivity_type:
        layer_protocols: [ ipv4 ]
      vl_profile:
        min_bitrate_requirements:
          root: 1000000
        max_bitrate_requirements:
          root: 2000000

  vl_2:
    type: tosca.nodes.nfv.VnfVirtualLink
    properties:
      connectivity_type:
        layer_protocols: [ ipv4 ]
      vl_profile:
        min_bitrate_requirements:
          root: 1000000
        max_bitrate_requirements:
          root: 4000000

policies:
  - scaling_aspects:
      type: tosca.policies.nfv.ScalingAspects
      properties:
        aspects:
          database:
            name: ..
            description: ..
            max_scale_level: 2
          call_proc:
            name: ..
            description: ..
            max_scale_level: 4


  - vdu_1_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 1
      targets: [ vdu_1 ]

  - vdu_1_scaling_aspect_deltas:
```

```
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: database
        deltas:
          delta_1:
            number_of_instances: 2
      targets: [ vdu_1 ]


  - vdu_2_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 1
      targets: [ vdu_2 ]

  - vdu_2_scaling_aspect_deltas:
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: database
        deltas:
          delta_1:
            number_of_instances: 3
      targets: [ vdu_2 ]


  - vl_1_bitrate_initial_delta:
      type: tosca.policies.nfv.VirtualLinkBitrateInitialDelta
      properties:
        initial_delta:
          bitrate_requirements:
            root: 1000000
      targets: [ vl_1 ]

  - vl_1_bitrate_scaling_aspect_deltas:
      type: tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas
      properties:
        aspect: database
        deltas:
          delta_1:
            bitrate_requirements:
              root: 1000000
      targets: [ vl_1 ]


  - vdu_3_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
         number_of_instances: 1
      targets: [ vdu_3 ]

  - vdu_3_scaling_aspect_deltas:
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: call_proc
        deltas:
          delta_1:
            number_of_instances: 1
      targets: [ vdu_3 ]

  - vdu_4_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 1
      targets: [ vdu_4 ]

  - vdu_4_scaling_aspect_deltas:
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: call_proc
        deltas:
          delta_1:
            number_of_instances: 2
      targets: [ vdu_4 ]

  - vl_2_bitrate_initial_delta:
```

```
      type: tosca.policies.nfv.VirtualLinkBitrateInitialDelta
      properties:
        initial_delta:
          bitrate_requirements:
            root: 1000000
      targets: [ vl_2 ]

  - vl_2_bitrate_scaling_aspect_deltas:
      type: tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas
      properties:
        aspect: call_proc
        deltas:
          delta_1:
            bitrate_requirements:
              root: 1000000
      targets: [ vl_2 ]

  - instantiation_levels:
      type: tosca.policies.nfv.InstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            description: ..
            scale_info:
              database:
                scale_level: 0
              call_proc:
                scale_level: 0
          instantiation_level_2:
            description: ..
            scale_info:
              database:
                scale_level: 2
              call_proc:
                scale_level: 3
        default_level: instantiation_level_1

  - vdu_1_instantiation_levels:
      type: tosca.policies.nfv.VduInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            number_of_instances: 1
          instantiation_level_2:
            number_of_instances: 5
      targets: [ vdu_1 ]

  - vdu_2_instantiation_levels:
      type: tosca.policies.nfv.VduInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            number_of_instances: 1
          instantiation_level_2:
            number_of_instances: 7
      targets: [ vdu_2 ]

  - vl_1_instantiation_levels:
      type: tosca.policies.nfv.VirtualLinkInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            bitrate_requirements:
              root: 30000
          instantiation_level_2:
            bitrate_requirements:
              root: 30000
      targets: [ vl_1 ]

  - vdu_3_instantiation_levels:
      type: tosca.policies.nfv.VduInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            number_of_instances: 1
          instantiation_level_2:
            number_of_instances: 4
      targets: [ vdu_3 ]
```

```
    - vdu_4_instantiation_levels:
        type: tosca.policies.nfv.VduInstantiationLevels
        properties:
          levels:
            instantiation_level_1:
              number_of_instances: 1
            instantiation_level_2:
              number_of_instances: 7
        targets: [ vdu_4 ]

    - vl_2_instantiation_levels:
        type: tosca.policies.nfv.VirtualLinkInstantiationLevels
        properties:
          levels:
            instantiation_level_1:
              bitrate_requirements:
                root: 30000
            instantiation_level_2:
              bitrate_requirements:
                root: 60000

        targets: [ vl_2 ]
```

EXAMPLE 2: This example is same as the example 1, except for ScalingAspects, which shows step_deltas list of entries.

```
topology_template:
. . .
  policies:
     - scaling_aspects:
        type: tosca.policies.nfv.ScalingAspects
        properties:
          aspects:
            database:
              name: ..
              description: ..
              max_scale_level: 2
              step_deltas:
                - delta_1
                - delta_1
            call_proc:
              name: ..
              description: ..
              max_scale_level: 4
              step_deltas:
                - delta_1
                - delta_1
                - delta_1
                - delta_1
. . .
```

A.6.2 ScalingAspect and InstantationLevels policies with non-uniform deltas

This example shows instantiationLevel, ScalingAspect policies and group types in the complex scaling scenario where scaling aspect delta is based on "delta" (non-uniform) values for Processing Auxiliary VNFC.

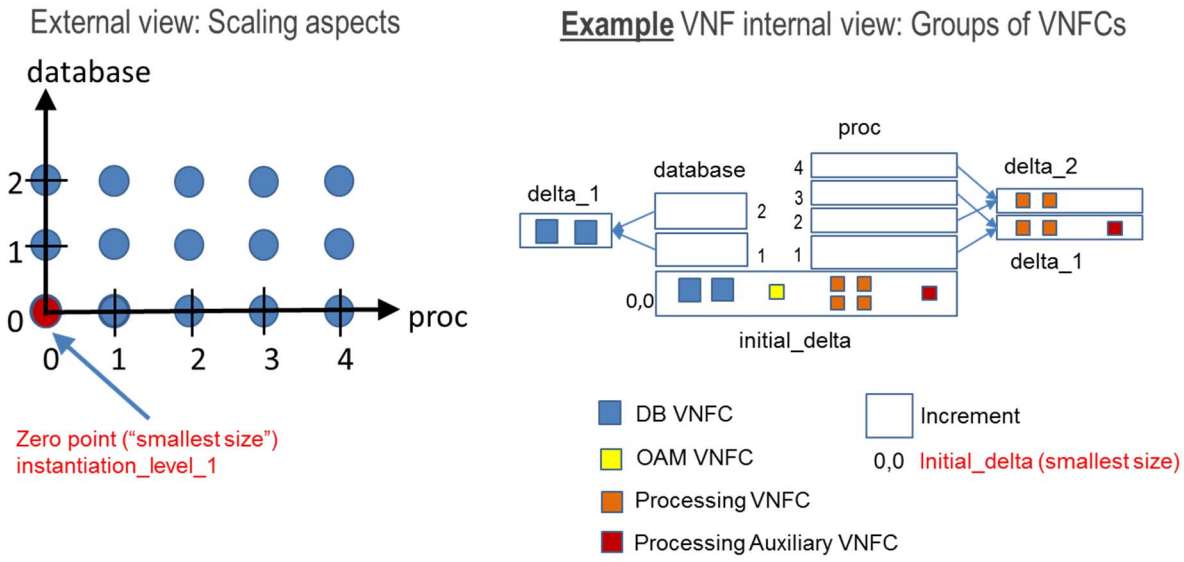


Figure A.6.2-1: Complex scaling example with non-uniform delta

For simplicity, virtual link is not illustrated and instantiation level is one level (default) in this example, as these properties are already illustrated in clause A.6.1.

The "Proc" aspect contains a uniform delta part ("processing" and a non-uniform part ("processing_auxiliary").

The "DB" aspect contains a non-uniform part ("db"), and no delta information for "oam".

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: Complex example (uniform and non-uniform delta value) described with policies
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

topology_template:
  node_templates:
    db:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: ..
        description: ..
        vdu_profile:
          min_number_of_instances: 2
          max_number_of_instances: 6
        nfvi_constraints:
          key_1: value_1
          key_2: value_2
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1

    oam:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: ..
        description: ..
        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 1
        nfvi_constraints:
          key_1: value_1
          key_2: value_2
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
```

```
            num_virtual_cpu: 1


  processing:
    type: tosca.nodes.nfv.Vdu.Compute
    properties:
      name: ..
      description: ..
      vdu_profile:
        min_number_of_instances: 4
        max_number_of_instances: 12
      nfvi_constraints:
        key_1: value_1
        key_2: value_2
    capabilities:
      virtual_compute:
        properties:
          virtual_memory:
            virtual_mem_size: 1 GB
          virtual_cpu:
            num_virtual_cpu: 1

  processing_auxiliary:
    type: tosca.nodes.nfv.Vdu.Compute
    properties:
      name: ..
      description: ..
      vdu_profile:
        min_number_of_instances: 1
        max_number_of_instances: 3
      nfvi_constraints:
        key_1: value_1
        key_2: value_2
    capabilities:
      virtual_compute:
        properties:
          virtual_memory:
            virtual_mem_size: 1 GB
          virtual_cpu:
            num_virtual_cpu: 1


policies:
  - scaling_aspects:
      type: tosca.policies.nfv.ScalingAspects
      properties:
        aspects:
          database:
            name: ..
            description: ..
            max_scale_level: 2
            step_deltas:
              - delta_1
              - delta_1
          proc:
            name: ..
            description: ..
            max_scale_level: 4
            step_deltas:
              - delta_1
              - delta_2
              - delta_1
              - delta_2

  - db_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 2
      targets: [ db ]

  - db_scaling_aspect_deltas:
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: database
        deltas:
          delta_1:
            number_of_instances: 2
```

```
      targets: [ db ]

  - oam_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 1
      targets: [ oam ]

  - processing_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 4
      targets: [ processing ]

  - processing_scaling_aspect_deltas:
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: proc
        deltas:
          delta_1:
            number_of_instances: 2
          delta_2:
            number_of_instances: 2
      targets: [ processing ]

  - processing_auxiliary_initial_delta:
      type: tosca.policies.nfv.VduInitialDelta
      properties:
        initial_delta:
          number_of_instances: 1
      targets: [ processing_auxiliary ]

  - processing_auxiliary_scaling_aspect_deltas:
      type: tosca.policies.nfv.VduScalingAspectDeltas
      properties:
        aspect: proc
        deltas:
          delta_1:
            number_of_instances: 1
          delta_2:
            number_of_instances: 0
      targets: [ processing_auxiliary ]

  - instantiation_levels:
      type: tosca.policies.nfv.InstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            description: ..
            scale_info:
              database:
                scale_level: 0
              proc:
                scale_level: 0

  - db_instantiation_levels:
      type: tosca.policies.nfv.VduInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            number_of_instances: 2
      targets: [ db ]

  - oam_instantiation_levels:
      type: tosca.policies.nfv.VduInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
            number_of_instances: 1
      targets: [ oam ]

  - processing_instantiation_levels:
      type: tosca.policies.nfv.VduInstantiationLevels
      properties:
        levels:
          instantiation_level_1:
```

```
            number_of_instances: 4
        targets: [ processing ]

    - processing_auxiliary_instantiation_levels:
        type: tosca.policies.nfv.VduInstantiationLevels
        properties:
          levels:
            instantiation_level_1:
              number_of_instances: 1
        targets: [ processing_auxiliary ]
```

A.7 Service Access Point

A.7.1 General

A SAP may either be a VNF external connection point (or a PNF external connection points or a Sap of a nested NS of this NS) which is exposed as CP of one of the NS constituents (VnfExtCp, PnfExtCp, nested NS Sap externally, or be exposed as a new CP on NS virtual link. This is shown in figure A.7.1-1. In the latter case the Sap node has an association relationship of type VirtualLinksTo to the NsVirtualLink node.

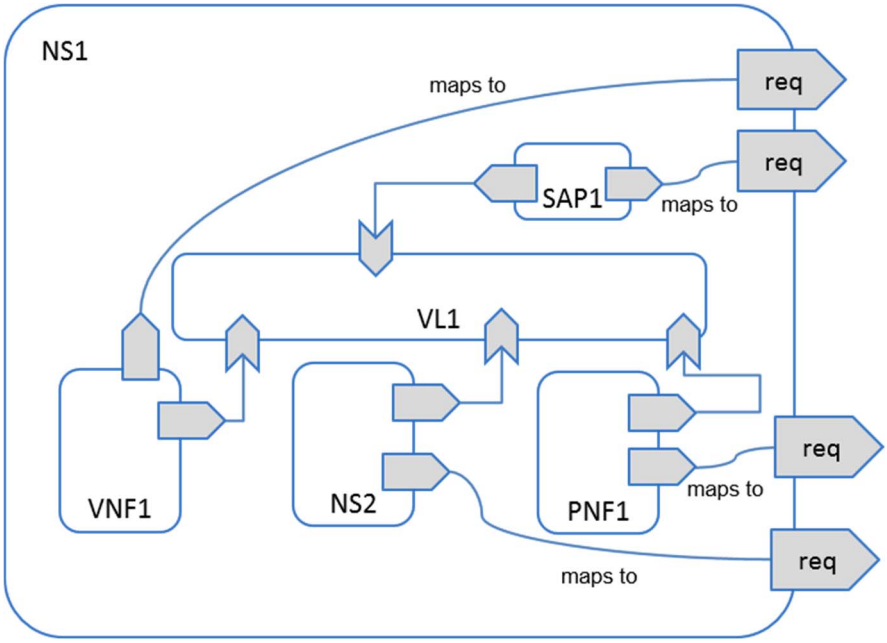


Figure A.7.1-1: Overview of SAP options

The following clauses illustrate the use of both models of SAP, re-exposure of a VNF external connection point and connected to an NS virtual link.

A.7.2 VNF External connection point exposing as a SAP

In this case, Sap node template is not required. When substituting the NSD service template for the abstract NS node, the virtual_link requirement of the abstract NS node is mapped to the VNF external connection point's virtual_link requirement. This is shown in figure A.7.2-1. In this case the NS Service Template does not include a node template of type tosca.nodes.nfv.Sap, but the functionality of it is provided by a VNF external connection point.

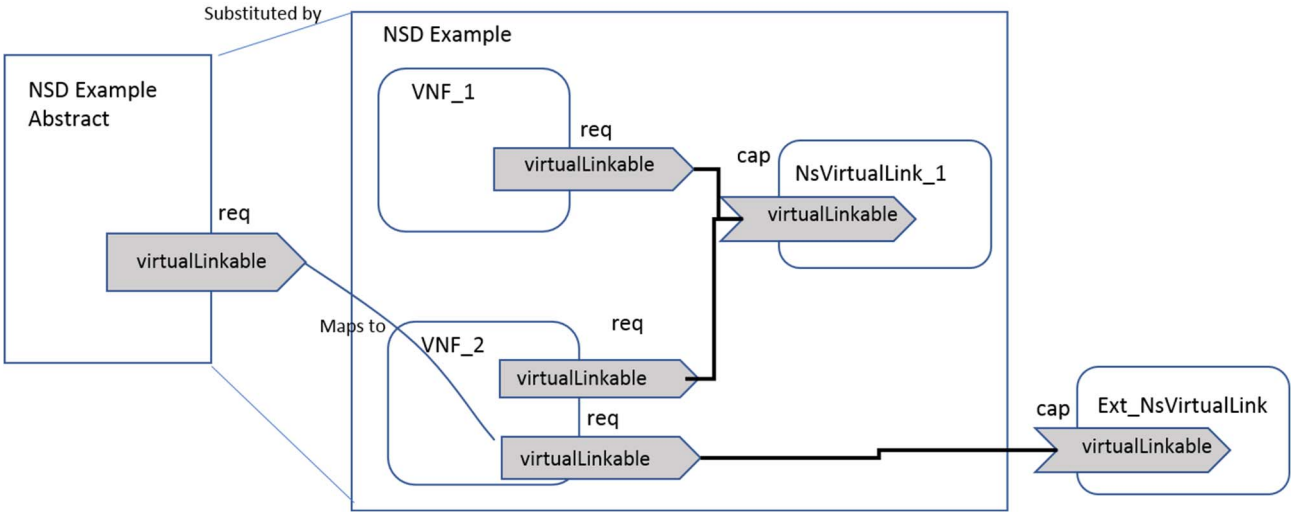


Figure A.7.2-1: VNF_2 External connection point (VnfExtCp) exposed as a Sap

The following snippet shows the relevant part of the NS service template:

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001
  - example_VNF_2.yaml


node_types:
  tosca.nodes.nfv.exampleNS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ valid_values: [ b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ] ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ valid_values: [ MyCompany] ]
        default: MyCompany
      name:
        type: string
        constraints: [ valid_values: [ ExampleService ] ]
        default: ExampleService
      version:
        type: string
        constraints: [ valid_values: [ '1.0' ] ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ valid_values: [ 1111-2222-aaaa-bbbb ] ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
        constraints: [ valid_values: [ small, big ] ]
        default: small
    requirements:
       - virtual_link:
           capability:   tosca.capabilities.nfv.VirtualLinkable
           relationship: tosca.relationships.nfv.VirtualLinksTo

#...

topology_template:

#...

  substitution_mappings:
    node_type: tosca.nodes.nfv.exampleNS
    requirements:
      virtual_link: [VNF_2, virtual_link_2] # the External connection point of VNF_2
                                            # will be used as the Sap of this NS
```

```
  node_templates:
    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      # properties omitted for brevity
      requirements:
        - virtual_link_1: NsVirtualLink_1 # connects to the External connection
                                          # point which maps to the
                                          # virtual_link_1 requirement of VNF_2
        # - virtual_link_2: # mapped to virtual_link requirement of NS node

    NsVirtualLink_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        vl_profile:
          min_bitrate_requirements:
            root: 100000
          max_bitrate_requirements:
            root: 200000
        connectivity_type:
          layer_protocols: [ ipv4 ]

  # other node template definitions
  #...
```

A.7.3 SAP connected to an NS virtual link

In this case, a Sap node template is required. When substituting the NSD service template for the abstract NS node type, the virtual_link requirement of the abstract NS node maps to the virtual_link requirement of the Sap node. This is shown in figure A.7.3-1.

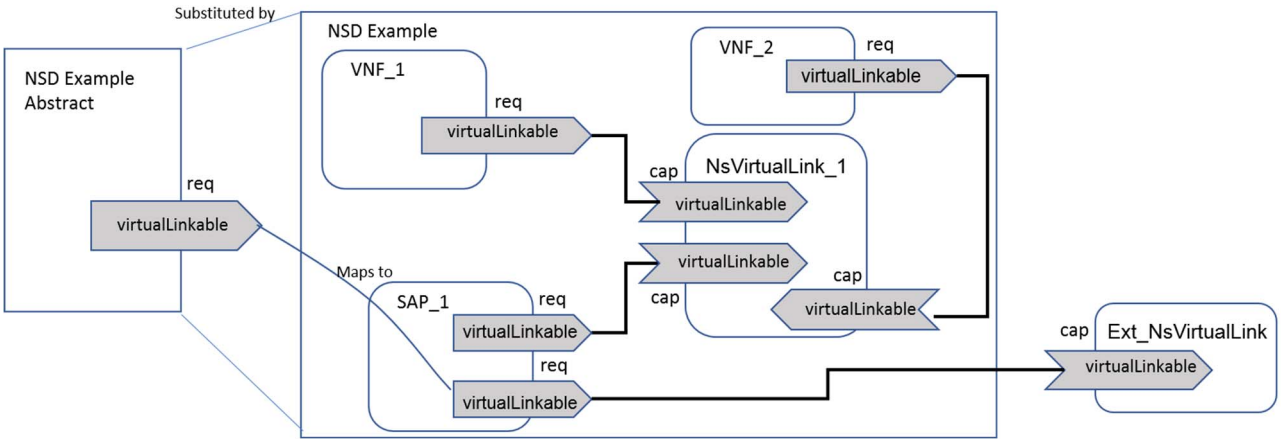


Figure A.7.3-1: SAP_1 exposed as new CP on an internal virtual link

The following snippet shows the corresponding node template definition:

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001

node_types:
  tosca.nodes.nfv.exampleNS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ valid_values: [ b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ] ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ valid_values: [ MyCompany] ]
        default: MyCompany
      name:
        type: string
        constraints: [ valid_values: [ ExampleService ] ]
        default: ExampleService
      version:
```

```
        type: string
        constraints: [ valid_values: [ '1.0' ] ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ valid_values: [ 1111-2222-aaaa-bbbb ] ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
        constraints: [ valid_values: [ small, big ] ]
        default: small
    requirements:
       - virtual_link:
           capability: tosca.capabilities.nfv.VirtualLinkable
           relationship: tosca.relationships.nfv.VirtualLinksTo

topology_template:
#...

  substitution_mappings:
    node_type: tosca.nodes.nfv.exampleNS
    requirements:
      virtual_link: [SAP_1, external_virtual_link] #SAP_1 is the Sap of the NS

  node_templates:
    SAP_1:
      type: tosca.nodes.nfv.Sap
      properties:
        protocol: [ associated_layer_protocol: ipv4 ]
        trunk_mode: false
        layer_protocols: [ ipv4 ]
      # other properties omitted for brevity
      requirements:
       - internal_virtual_link: NsVirtualLink_1
       # - external_virtual_link: # map to virtual_link requirement of the NS node

    NsVirtualLink_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        vl_profile:
          min_bitrate_requirements:
            root: 100000
          max_bitrate_requirements:
            root: 200000
        connectivity_type:
          layer_protocols: [ ipv4 ]


 # Other node templates
 #...
```

A.8 NSD with Single deployment flavour modelling design example

In this example, there is one deployment flavour applied to this NSD, and TOSCA-Simple-Profile-YAML-v1.3 [20] is used for designing and processing this NSD TOSCA model.

The one service template design illustrated by this example is only applicable when the NS has only one deployment flavour.

The service template is the main entry point in the NSD file structure, i.e. the Entry-definitions file, and is deployed as a stand-alone service template, i.e. without substituting for a node template. However, the service template still contains substitution_mappings to indicate its ability to substitute for a node template of the specific node type.

example_NS.yaml

This example illustrates an NS which contains two VNF: VNF_1 and VNF_2, they connect through NsVirtualLink_1. One of the VnfExtCp of VNF_2 is exposed as the Sap of this NS. The flavour_id is "simple". In the VNF_2 node template, it defines a dependency requirement to VNF_1, which indicates that all the instances of VNF_1 have to be deployed first before deploy the instances of VNF_2. NsMonitoring and VnfMonitoring policies represent information to be monitored during the lifetime of a network service and VNF instances.

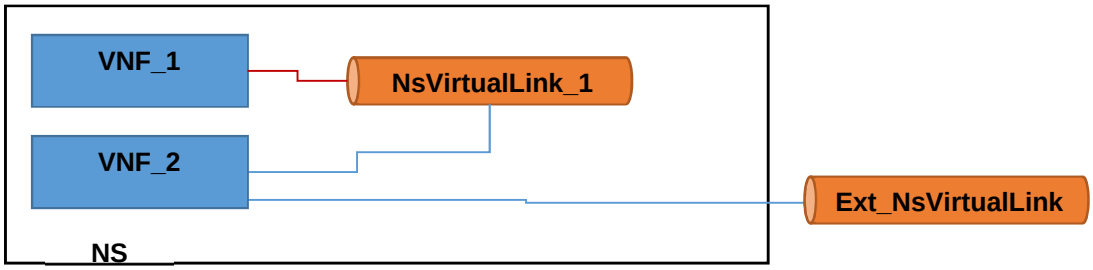


Figure A.8-1: example_NS (simple)

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, simple

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of NSD related TOSCA types as defined in ETSI GS NFV-SOL
001
  - example_VNF_1.yaml  # uri of the yaml file which contains the definition of
tosca.nodes.nfv.example_VNF1, this file might be included in the NSD file structure
  - example_VNF_2.yaml  # uri of the yaml file which contains the definition of
tosca.nodes.nfv.example_VNF2, this file might be included in the NSD file structure


data_types:
  MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
        default: value_1
      parameter_2:
        type: string
        required: true
        default: value_2

node_types:
  tosca.example_NS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      name:
        type: string
        constraints: [ equal: ExampleService ]
        default: ExampleService
      version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ equal: 1111-2222-aaaa-bbbb ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
```

```
        constraints: [ equal: simple ]
        default: simple
    interfaces:
        Nslcm:
          type: tosca.interfaces.nfv.Nslcm
          operations:
            instantiate:
              inputs:
                additional_parameters:
                  type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters
                  required: false


topology_template:
  substitution_mappings:
    node_type: tosca.example_NS
    requirements:
       virtual_link: [ VNF_2, virtual_link_2 ] # the External connection point of
                                               # VNF_2 is exposed as the Sap

  node_templates:
    my_service:
      type: tosca.example_NS
      properties:
        descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
        designer: MyCompany
        name: ExampleService
        version: '1.0'
        invariant_id: 1111-2222-aaaa-bbbb
        flavour_id: simple
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml

    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link: NsVirtualLink_1

    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3
      requirements:
        - virtual_link_1: NsVirtualLink_1
        # - virtual_link_2: # map to virtual_link requirement of the NS node
        - dependency: VNF_1

    NsVirtualLink_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4, ethernet]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000
          virtual_link_protocol_data:
            - associated_layer_protocol: ethernet
              l2_protocol_data:
```

```
              name: nsBaseNetwork
              network_type: vlan
              segmentation_id: VLAN100
           - associated_layer_protocol: ipv4
             l3_protocol_data:
              name: mybaseSubnet
              ip_version: ipv4
              cidr: 192.168.0.0/24

policies:
 - my_service_NsMonitoring:
      type: tosca.policies.nfv.NsMonitoring
      properties:
        ns_monitoring_parameters:
         ns_monitoring_1111: #key map to the id of this monitoring parameter
           name: MyService_byte_incoming_sap
           performance_metric: byte_incoming_sap
           collection_period: 1 s
         ns_monitoring_2222: #key map to the id of this monitoring parameter
           name: MyService_byte_outgoing_sap
           performance_metric: byte_outgoing_sap
           collection_period: 1 s
      targets: [ my_service ]

 - VNF_1_VnfMonitoring:
      type: tosca.policies.nfv.VnfMonitoring
      properties:
        vnf_monitoring_parameters:
         vnf_1_monitoring_1111: #key map to the id of this monitoring parameter
           name: VNF_1_v_cpu_usage_mean_vnf
           performance_metric: v_cpu_usage_mean_vnf
           collection_period: 1 s
         vnf_1_monitoring_2222: #key map to the id of this monitoring parameter
           name: VNF_1_v_disk_usage_mean_vnf
           performance_metric: v_disk_usage_mean_vnf
           collection_period: 1 s
      targets: [ VNF_1 ]

 - VNF_2_VnfMonitoring:
      type: tosca.policies.nfv.VnfMonitoring
      properties:
        vnf_monitoring_parameters:
         vnf_2_monitoring_1111: #key map to the id of this monitoring parameter
           name: VNF_2_v_cpu_usage_mean_vnf
           performance_metric: v_cpu_usage_mean_vnf
           collection_period: 1 s
         vnf_2_monitoring_2222: #key map to the id of this monitoring parameter
           name: VNF_2_v_disk_usage_mean_vnf
           performance_metric: v_disk_usage_mean_vnf
           collection_period: 1 s
         vnf_2_monitoring_3333: #key map to the id of this monitoring parameter
           name: VNF_2_v_memory_usage_mean_vnf
           performance_metric: v_memory_usage_mean_vnf
           collection_period: 1 s
      targets: [ VNF_2 ]
```

The above example illustrates three policies (1 NS-level policy and 2 VNF-level policies). Each of the policies has different monitoring parameters. In the case, where the values of vnf_monitoring_parameters are the same across all constituent VNFs, a single VnfMonitoring policy can be used with a targets referencing all VNF node types.

A.9 Mapping between NFV IM and TOSCA concepts

A.9.1 Introduction

This clause describes the mapping between the NFV information model and the TOSCA concepts.

A.9.2 Mapping between ETSI GS NFV-IFA 011 IM and TOSCA concepts

Table A.9.2-1 illustrates the mapping between the information model as specified in ETSI GS NFV-IFA 011 [1] and the corresponding TOSCA concepts.

Table A.9.2-1: Mapping between ETSI GS NFV-IFA 011 [1] IM and TOSCA concepts

ETSI GS NFV-IFA 011 [1] information element	TOSCA concept
VNFD (clause 7.1.2)	TOSCA service template(s) in the VNF package
VnfExtCpd (clause 7.1.4)	node template with type tosca.nodes.nfv.VnfExtCp or tosca.nodes.nfv.VduCp or tosca.nodes.nfv.VipCp
VnfLcmOperationsConfiguration (clause 7.1.5)	property of VNF node type with data type tosca.datatypes.nfv.VnfLcmOperationsConfiguration and/or inputs additional_parameters of the corresponding operation in the Vnflcm interface with type tosca.datatypes.nfv.VnfOperationAdditionalParameters
Vdu (clause 7.1.6)	node template with type tosca.nodes.nfv.Vdu.Compute
VLd (clause 7.1.7)	node template with type tosca.nodes.nfv.VnfVirtualLink
DeploymentFlavour (clause 7.1.8)	lower level service template(s) in the VNF package
VduProfile (clause 7.1.8.3)	property of Vdu.Compute node type with data type tosca.datatypes.nfv.VduProfile
VirtualLinkProfile (clause 7.1.8.4)	property of VnfVirtualLink node type with data type tosca.datatypes.nfv.VlProfile
VirtualLinkDescFlavour (clause 7.1.8.5)	Only qos attribute in VirtualLinkDescFlavour has been defined as property of the VlProfile data type
InstantiationLevel (clause 7.1.8.7)	policy with type tosca.policies.nfv.InstantiationLevels
VduLevel (clause 7.1.8.9)	policy with type tosca.policies.nfv.VduInstantiationLevels
LocalAffinityOrAntiAffinityRule (clause 7.1.8.11)	policy with type tosca.policies.nfv.AffinityRule or tosca.policies.nfv.AntiAffinityRule
AffinityOrAntiAffinityGroup (clause 7.1.8.12)	policy with type tosca.policies.nfv.AffinityRule or tosca.policies.nfv.AntiAffinityRule
Dependencies (clause 7.8.1.19)	dependency requirements between different node templates of type Vdu.Compute (or a derived node type)
VirtualComputeDesc (clause 7.1.9.2.2)	VirtualCompute capability of the Vdu.Compute node template
VirtualStorageDesc with BlockStorageData (clause 7.1.9.4.3)	node template with type tosca.nodes.nfv.Vdu.VirtualBlockStorage
VirtualStorageDesc with ObjectStorageData (clause 7.1.9.4.4)	node template with type tosca.nodes.nfv.Vdu.VirtualObjectStorage
VirtualStorageDesc with FileStorageData (clause 7.1.9.4.5)	node template with type tosca.nodes.nfv.Vdu.VirtualFileStorage
ScalingAspect (clause 7.1.10.2)	policy with type tosca.policies.nfv.ScalingAspects
ScalingDelta (clause 7.1.10.4)	policy with type tosca.policies.nfv.VduScalingAspectDeltas and/or tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas
VnfIndicator (clause 7.1.11.2)	interface with type tosca.interfaces.nfv.VnfIndicator and related attributes of the VNF node type.
MonitoringParameter (clause 7.1.11.3)	property of the VNF, Vdu.Compute and VnfVirtualLink node types
VnfConfigurableProperties (clause 7.1.12)	property of VNF node template with data type tosca.datatypes.nfv.VnfConfigurableProperties
LifeCycleManagementScript (clause 7.1.13)	interface with type tosca.interfaces.nfv.Vnflcm or tosca.interfaces.nfv.ChangeCurrentVnfPackage
VnfInfoModifiableAttributes (clause 7.1.14)	property of VNF node template with data type tosca.datatypes.nfv.VnfInfoModifiableAttributes
VnfPackageChangeInfo (clause 7.1.15)	policy with type tosca.policies.nfv.VnfPackageChange, and tosca.interfaces.nfv.ChangeCurrentVnfPackage or tosca.interfaces.nfv.Vnflcm

A.9.3 Mapping between ETSI GS NFV-IFA 014 IM and TOSCA concepts

Table A.9.3-1 illustrates the mapping between the information model as specified in ETSI GS NFV-IFA 014 [2] and the corresponding TOSCA concepts.

Table A.9.3-1: Mapping between ETSI GS NFV-IFA 014 [2] IM and TOSCA concepts

ETSI GS NFV-IFA 014 [2] information element	TOSCA concept
NSD (clause 6.2.2)	TOSCA service template(s) in the NSD file structure
Sapd (clause 6.2.3)	node template with type tosca.nodes.nfv.Sap or the virtual_link requirement in the substitution_mapping
MonitoredData (clause 6.2.6)	policy with type tosca.policies.nfv.VnfMonitoring and tosca.policies.nfv.NsMonitoring
VnfIndicatorData (clause 6.2.7)	interface with type tosca.interfaces.nfv.NsVnfIndicator and related attributes of the NS node type
LifeCycleManagementScript (clause 6.2.9)	Interface with type Nslcm
NsDf (clause 6.3)	lower level service template(s) in the NSD file structure
VnfProfile (clause 6.3.3)	property of VNF node template with data type tosca.datatypes.nfv.VnfProfile
VirtualLinkProfile (clause 6.3.4)	property of NsVirtualLink node template with data type tosca.datatypes.nfv.VlProfile
AffinityOrAntiAffinityGroup (clause 6.3.5)	policy with type tosca.policies.nfv.NsAffinityRule or tosca.policies.nfv.NsAntiAffinityRule
NsVirtualLinkConnectivity (clause 6.3.7)	requirement and capability between PnfExtCp or VnfExtCp and NsVirtualLink node templates
NsLevel (clause 6.3.9)	policy with type tosca.policies.nfv.NsInstantiationLevels
NsProfile (clause 6.3.11)	property of NS node template with data type tosca.datatypes.nfv.NsProfile
Dependencies (clause 6.3.12)	dependency requirements
Vnffgd (clause 6.4.2)	group with type tosca.groups.nfv.VNFFG
Nfpd (clause 6.4.3)	node template with type tosca.nodes.nfv.NFP
NfpPositionElement (clause 6.4.6)	node template with type tosca.nodes.nfv.NfpPositionElement
NfpPositionDesc(clause 6.4.5)	node template with type tosca.nodes.nfv.NfpPosition
NsVirtualLinkDesc (clause 6.5.2)	node template with type tosca.nodes.nfv.NsVirtualLink
VirtualLinkDf (clause 6.5.4)	Only the serviceAvaibilityLevel and qos attributes in VirtualLinkDf have been defined as properties of the NsVlProfile data type. The flavour id is not mapped to a property as there is only one flavour of a particular NS virtual link per NS service template.
Pnfd (clause 6.6.2)	A standalone TOSCA service template
PnfExtCpd (clause 6.6.4)	node template with type tosca.nodes.nfv.PnfExtCp
NsScalingAspect (clause 6.7.2)	policy with type tosca.policies.nfv.NsScalingAspects
VnfToLevelMapping (clause 6.7.4)	policy with type tosca.policies.nfv.VnfToLevelMapping and tosca.policies.nfv.VnfToInstantiationLevelMapping
VirtualLinkToLevelMapping (clause 6.7.5)	policy with type tosca.policies.nfv.VirtualLinkToLevelMapping and tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping
NsToLevelMapping (clause 6.7.6)	policy with type tosca.policies.nfv.NsToLevelMapping and tosca.policies.nfv.NsToInstantiationLevelMapping

A.10 PNFD modelling design example

In this example, TOSCA-Simple-Profile-YAML-v1.3 [20] is used for designing and processing a PNFD TOSCA model.

The service template contains a node template of type MyCompany.examplePnf.1_0 which represents the main part of the PNF and a node template of type tosca.nodes.nfv.PnfExtCp representing the PNF external connection point.

examplePnf.yaml

This example illustrates a PNF with one external connection point, pnfExtCp_1. All the rest parts of the PNF is described as a single box, e.g. called pnf_mainPart in the PNFD.

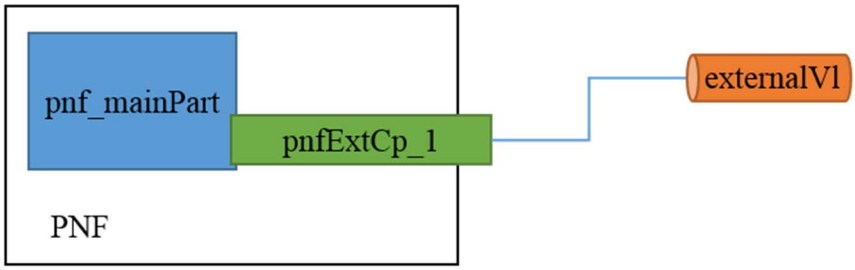


Figure A.10-1: examplePnf

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: the service template of a PNFD

imports:
  - etsi_nfv_sol001_pnfd_types.yaml

node_types:
  MyCompany.examplePnf.1_0:
    derived_from: tosca.nodes.nfv.PNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a2233 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a2233
      function_description:
        type: string
        constraints: [ equal: an example PNF ]
        default: an example PNF
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_invariant_id:
        type: string
        constraints: [ equal: 1111-2222-ccaa-bbdd ]
        default: 1111-2222-ccaa-bbdd
      name:
        type: string
        constraints: [ equal: ExamplePnf ]
        default: ExamplePnf
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable

topology_template:
  substitution_mappings:
    node_type: MyCompany.examplePnf.1_0
    requirements:
      virtual_link: [ pnfExtCp_1, external_virtual_link ]

  node_templates:
    pnf_mainPart:
      type: MyCompany.examplePnf.1_0
      properties:
        descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a2233
        function_description: an example PNF
        provider: MyCompany
        version: '1.0'
        descriptor_invariant_id: 1111-2222-ccaa-bbdd
        name: ExamplePnf

    pnfExtCp_1:
      type: tosca.nodes.nfv.PnfExtCp
      properties:
        trunk_mode: false
        layer_protocols: [ ipv4 ]
        role: leaf
```

```
      description: External connection point to access this pnf
    requirements:
    # - external_virtual_link:
      - dependency: pnf_mainPart
```

A.11 NSD with Multiple deployment flavour modelling design example

Deployment flavours are represented as deployable TOSCA topology templates. This way one NS service template represents one NS deployment flavour, and different deployment flavours are described by different NS service templates. This is in line with the concept that different deployment flavours can define different topologies of the same NS, with different scaling aspects, different constituent VNFs, PNFs and nested NSs, and different internal connectivity.

In order to represent an NS, a top-level service template is used. This top-level service template contains a topology template with only an abstract NS node which defines the common parts of the different deployment flavours (such as designer, version and parts of the lifecycle management interface definition). It also sets a constraint on the deployment flavour property (the required value of the flavour_id property); this constraint comes from the NS instantiation request which contains a flavour_id selected among those available in the NSD.

As a result, the NFVO will look into the available further service templates representing the different NS deployment flavours of the NS and use the one that has the matching flavour_id property value to substitute for the abstract NS. These are the low-level service templates.

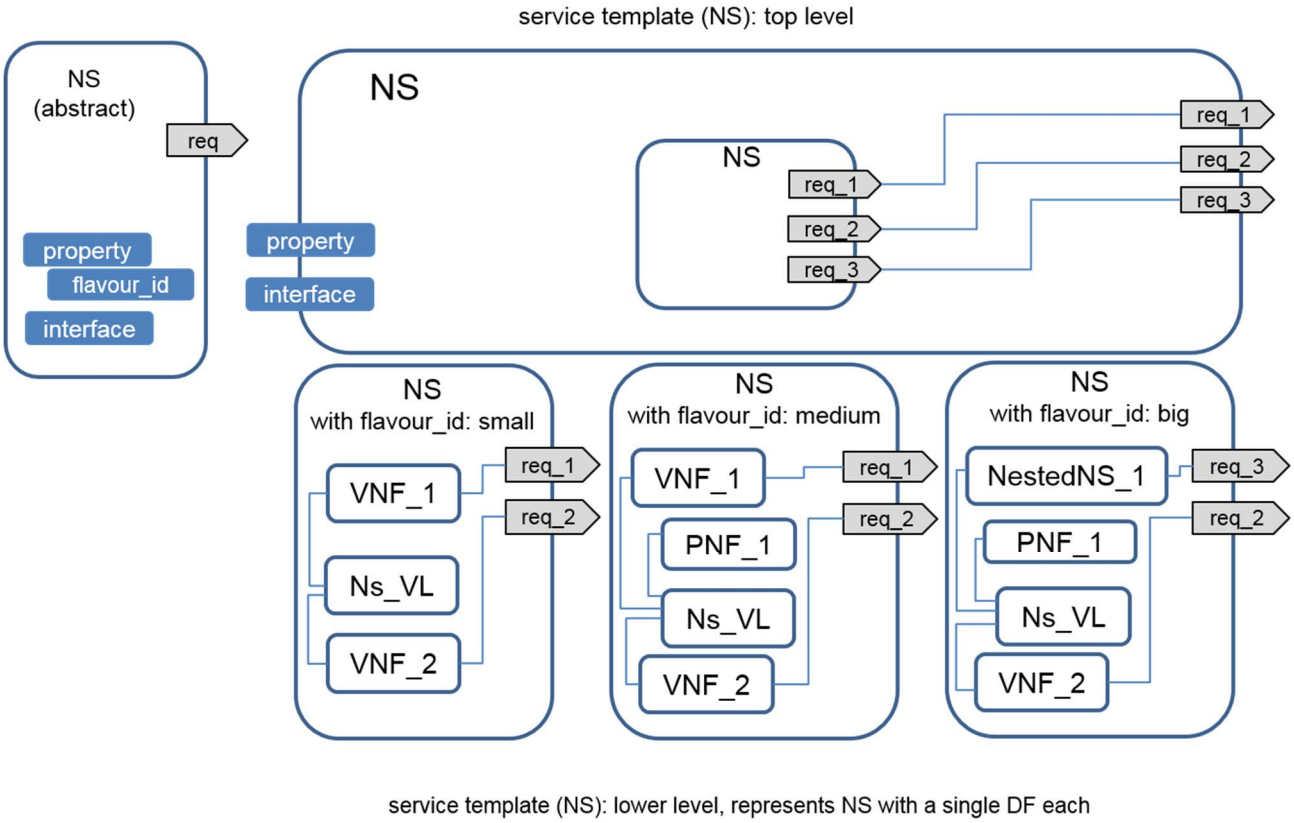


Figure A.11-1: NSD overview with multiple deployment flavour

An NSD contains a TOSCA top-level Service Template as entry point in the NSD file structure and one or more TOSCA low-level Service templates representing the different deployment flavours (see figure A.11-1). The NSD is interpreted by an NFVO. In this example, the templates describe two variants of the NS each corresponding to a deployment flavour: a small and a big one. The small NS consists of two VNFs one NS Virtual link and, the big VNF variant consists of three VNFs and one NS Virtual link.

NSD-top level MyExampleNs.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: my service
imports:
  - etsi_nfv_sol001_nsd_types.yaml
  - MyExampleNs_Type.yaml # contains the NS node type definition


topology_template:
  inputs:
    flavour_id:
      type: string
      description: NS deployment flavour selected by the consumer. It is provided in the SOL005 API

  node_templates:
    myexampleNs:
        type: tosca.MyExampleNS
        directives:
          - substitute
        properties:
          descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
          designer: MyCompany
          name: ExampleService
          version: '1.0'
          invariant_id: 1111-2222-aaaa-bbbb
          flavour_id: {get_input: flavour_id}

        # requirements:
          #- virtual_link # mapped in lower-level templates
```

The `MyExampleNs_Type.yaml` file has the following content:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: type definition of tosca.MyExampleNS

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001

data_types:
  MyCompany.datatypes.nfv.NsInstantiateNsAdditionalParameters:
    derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
        default: value_1
      parameter_2:
        type: string
        required: true
        default: value_2

node_types:
  tosca.MyExampleNS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ valid_values: [ b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ] ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ valid_values: [ MyCompany] ]
        default: MyCompany
      name:
        type: string
        constraints: [ valid_values: [ ExampleService ] ]
        default: ExampleService
      version:
        type: string
        constraints: [ valid_values: [ '1.0' ] ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ valid_values: [ 1111-2222-aaaa-bbbb ] ]
        default: 1111-2222-aaaa-bbbb
```

```
      flavour_id:
        type: string
        constraints: [ valid_values: [ small, big ] ]
        default: small
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
    interfaces:
      Nslcm:
        type: tosca.interfaces.nfv.Nslcm
        operations:
          instantiate:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.NsInstantiateNsAdditionalParameters
                required: false
```

The NS node template in the **myexample_NS.yaml** file is abstract and is subject to substitution; the lower-level templates in the subsequent sections provide these substitutions. The actual lower-level template is selected based on the node type and a value constraint on the flavour_id property.

Each low level service template contains a node template of type `tosca.MyExampleNS` with implementation of the LCM interfaces.

MyExampleNs (small): Lower level, contains 2 VNFs and 1 NS virtual link.

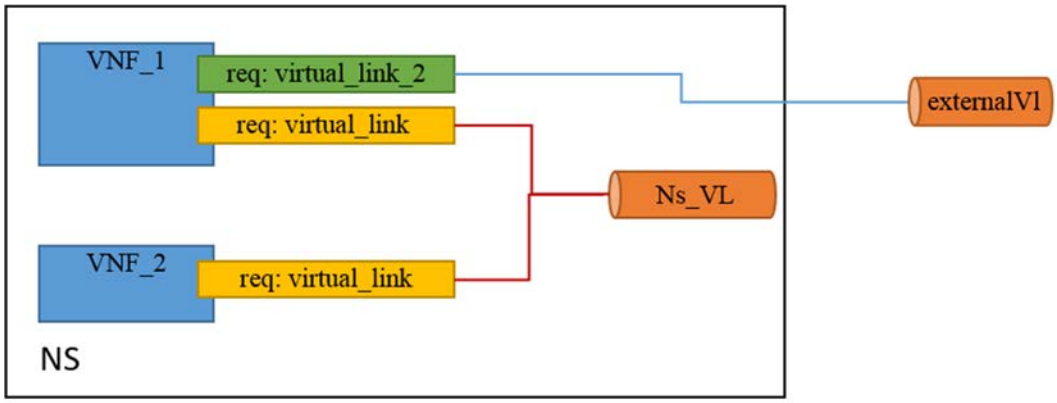


Figure A.11-2: MyExampleNs (simple): Lower level

MyExampleNs_small.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: myExampleNs with small flavour
imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001
  - MyExampleNs_Type.yaml # contains the NS node type definition
  - example_vnf1.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF1 node
type definition, this file might be included in the NSD file structure
  - example_vnf2.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF2 node
type definition, this file might be included in the NSD file structure

topology_template:
  substitution_mappings:
    node_type: tosca.MyExampleNS
    substitution_filter:
      properties:
        - flavour_id: { equal: small }
    requirements:
       virtual_link: [ VNF_1, virtual_link_2 ]

  node_templates:
    MyExampleNS:
      type: tosca.MyExampleNS
      # properties:
        #
      interfaces:
```

```
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml

    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link: Ns_VL
        # - virtual_link_2: # map to virtual_link requirement of the NS node

    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3
      requirements:
        - virtual_link_1: Ns_VL

    Ns_VL:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000
```

MyExampleNs (big): Lower level, contains 3 VNFs and 1 NS virtual link.

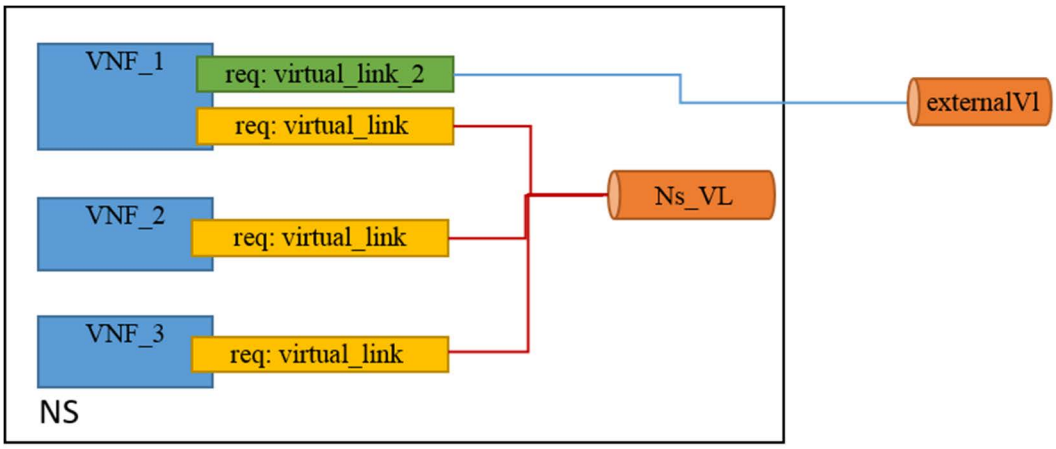


Figure A.11-3: MyExampleNs (big): Lower level

MyExampleNs_big.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: myExampleNs with big flavour
imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001
  - MyExampleNs_Type.yaml # contains the NS node type definition
```

```
  - example_vnf1.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF1 node
type definition, this file might be included in the NSD file structure
  - example_vnf2.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF2 node
type definition, this file might be included in the NSD file structure
  - example_vnf3.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF3 node
type definition, this file might be included in the NSD file structure

topology_template:
  substitution_mappings:
    node_type: tosca.MyExampleNS
    substitution_filter:
      properties:
        - flavour_id: { equal: big }
    requirements:
       virtual_link: [ VNF_1, virtual_link_2 ]

  node_templates:
    MyExampleNS:
      type: tosca.MyExampleNS
      properties:
        flavour_id : big
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml
            scale:
              implementation: scale.workbook.yaml

    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link_1: Ns_VL
        # - virtual_link_2: # map to virtual_link requirement of the NS node

    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3
      requirements:
        - virtual_link_1: Ns_VL

    VNF_3:
      type: tosca.nodes.nfv.example_VNF3
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3
      requirements:
        - virtual_link_1: Ns_VL

    Ns_VL:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000
```

A.12 NSD with nested NS design example

A TOSCA service template representing an NSD may contain a node template of some specific NS node type as one of its constituents. The latter is a nested NS. When the containing NS is deployed, the node template of the nested NS is substituted by the topology template representing the nested NS.

Figure A.12-1 illustrates a network service NS_1 that consists of one VNF (VNF_1), one NsVirtualLink (NS_VL_1_and one nested NS (NS_2).

The nested NS consists of two VNFs (VNF_3 and VNF_4) and one NsVirtualLink (NS_VL_2).

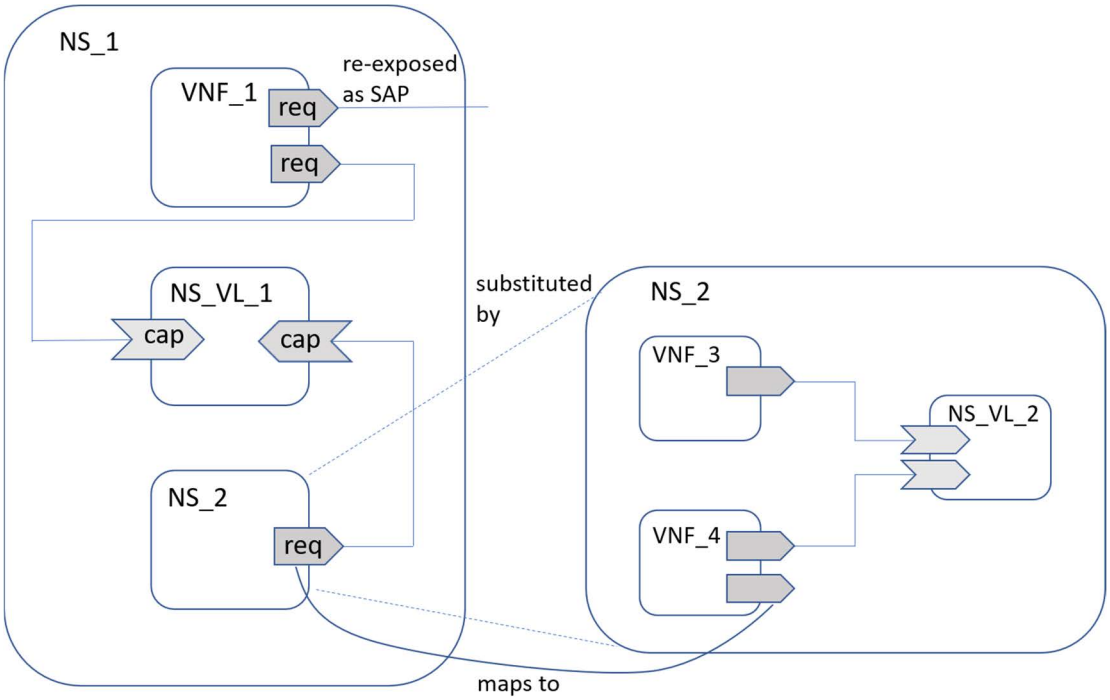


Figure A.12-1: Example of a network service containing a nested network service

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: myExampleNs with small flavour

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001
  - MyExampleNs_TypeBis.yaml # contains the NS node type definition
  - MyExampleNS_2.yaml # uri of the yaml file which contains the tosca.myExample.NS_2 node type
definition, this file might be included in the NSD file structure of NS_1
  - example_vnf1.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF1 node
type definition, this file might be included in the NSD file structure of NS_1

topology_template:
  substitution_mappings:
    node_type: tosca.MyExampleNS
    substitution_filter:
        properties:
          - flavour_id: { equal: small }
    requirements:
      virtual_link: [ VNF_1, virtual_link_2 ]

  node_templates:
    NS_1:
      type: tosca.MyExampleNS
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
```

```
            terminate:
              implementation: terminate.workflow.yaml

    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link_1: NS_VL_1
        # - virtual_link_2: # map to virtual_link requirement of the NS node

    NS_2:
      type: tosca.myExample.NS_2
      properties:
        descriptor_id: c1bb0ab8-deab-4fa7-95ed-4840d70a3574
        designer: MyCompany
        version: 1.0.0.0
        name: myExample2Service
        flavour_id: simple
        invariant_id: aaaa-bbbb-cccc-dddd
        ns_profile:
          ns_instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3


    NS_VL_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000
```

The contents of MyExampleNs_TypeBis.yaml file with the node type definition are as follows:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: type definition of tosca.MyExampleNS

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA types as defined in ETSI GS NFV-SOL 001

node_types:
  tosca.MyExampleNS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ valid_values: [ b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ] ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ valid_values: [ MyCompany] ]
        default: MyCompany
      name:
        type: string
        constraints: [ valid_values: [ ExampleService ] ]
        default: ExampleService
      version:
        type: string
        constraints: [ valid_values: [ '1.0' ] ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ valid_values: [ 1111-2222-aaaa-bbbb ] ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
```

```
        type: string
        constraints: [ valid_values: [ small, big ] ]
        default: small
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
    interfaces:
      Nslcm:
        type: tosca.interfaces.nfv.Nslcm
```

The following snippet shows the service template representing the NSD NS_2. In this example, NS_2 supports one single deployment flavour.

MyExampleNS_2.yaml:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, simple

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of NSD related TOSCA types as defined in ETSI GS NFV-SOL
001
  - example_vnf3.yaml # uri of the yaml file which contains the definition of
tosca.nodes.nfv.example_VNF3, this file might be included in the NSD file structure
  - example_vnf4.yaml # uri of the yaml file which contains the definition of
tosca.nodes.nfv.example_VNF4, this file might be included in the NSD file structure

node_types:
  tosca.myExample.NS_2:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ valid_values: [ c1bb0ab8-deab-4fa7-95ed-4840d70a3574 ] ]
        default: c1bb0ab8-deab-4fa7-95ed-4840d70a3574
      designer:
        type: string
        constraints: [ valid_values: [ MyCompany] ]
        default: MyCompany
      name:
        type: string
        constraints: [ valid_values: [ myExample2Service ] ]
        default: myExample2Service
      version:
        type: string
        constraints: [ valid_values: [ '1.0.0.0' ] ]
        default: '1.0.0.0'
      invariant_id:
        type: string
        constraints: [ valid_values: [ aaaa-bbbb-cccc-dddd ] ]
        default: aaaa-bbbb-cccc-dddd
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple ] ]
        default: simple

topology_template:
  substitution_mappings:
    node_type: tosca.myExample.NS_2
    requirements:
      virtual_link: [ VNF_4, virtual_link_2 ] # the External connection point of
                                              # VNF_2 is exposed as the Sap

  node_templates:
    NS_2:
      type: tosca.myExample.NS_2
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml

    VNF_3:
      type: tosca.nodes.nfv.example_VNF3
      properties:
```

```
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link: NS_VL_2

    VNF_4:
      type: tosca.nodes.nfv.example_VNF4
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3
      requirements:
        - virtual_link_1: NS_VL_2
        # - virtual_link_2: # map to virtual_link requirement of the NS node

    NS_VL_2:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000
```

The following template fragment is part of the content in the example_vnf4.yaml. Template fragments for example_vnf1.yaml, example_vnf2.yaml and example_vnf3.yaml are available in clause A.14.

example_vnf4.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Example VNF4 type

imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of VNFD types as defined in NFV SOL 001 GS

node_types:
  tosca.nodes.nfv.example_VNF4:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1184 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1184
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: Example_VNF4 ]
        default: Example_VNF4
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
```

```
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    requirements:
      - virtual_link_1:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 1, 1 ]
      - virtual_link_2:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 1, 1 ]
```

A.13 Virtual IP address connection point

Virtual IP address connection points (VipCps) are used to allocate one or multiple IP addresses that are shared by other CP instances, which may be instances of the same or of different VduCp or VnfExtCp nodes.

Load balancing

In the following example two or more instances of a particular VNFC are created. The respective instances of the VduCp, in addition to their default IP address which is assigned according to the 'protocol' property, share a virtual IP address. The multiple instances are created for load sharing purposes.

In this particular example the VduCp is re-exposed as VnfExtCp. Therefore the VipCp is also re-exposed as VnfExtCp.

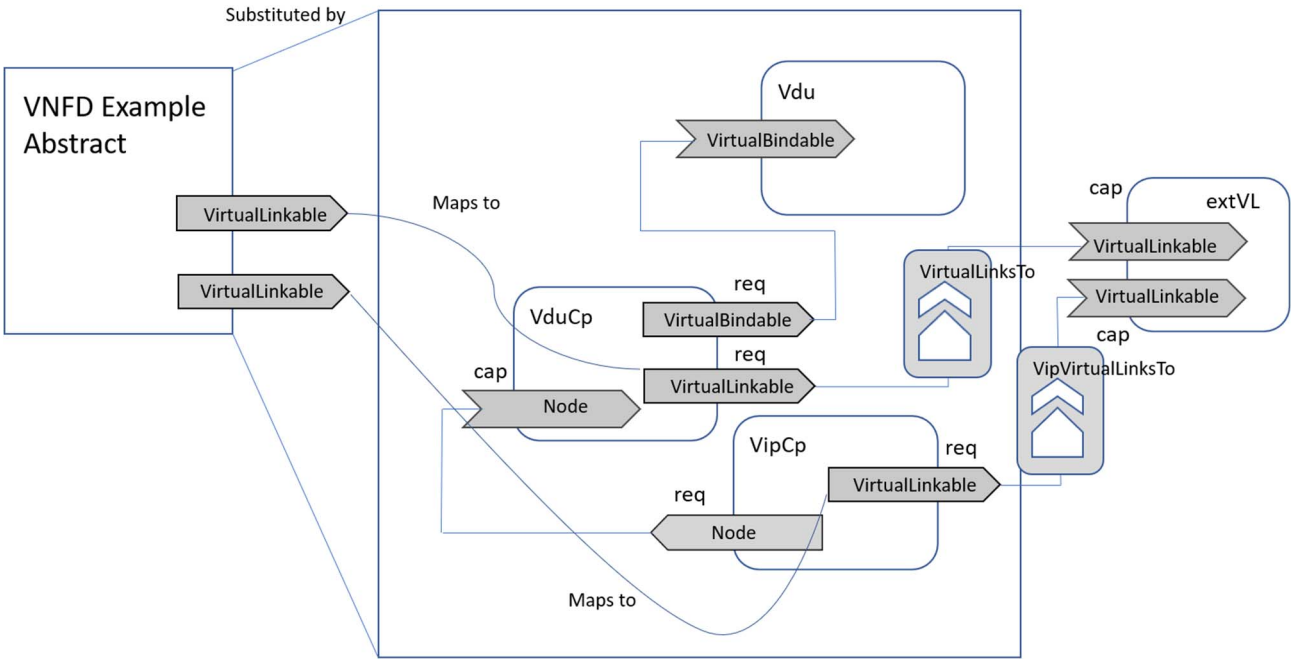


Figure A.13-1: VNFD with a VDU connection point acting as VnfExtCp and sharing a virtual IP address

In this example the VduCp and the VipCp are exposed as VnfExtCps. Thus, the VNF abstract node has two requirements for a VirtualLinkable capability. One of them uses the VirtualLinksTo relationship and the other one uses the VipVirtualLinksTo relationship. Both requirements are considered in the substitution mapping.

The following service template shows the relevant parts of the TOSCA VNFD corresponding to figure A.13-1. For simplicity, a single deployment flavour VNF is assumed.

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: Relational database, simple
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001 for
a VNFD
```

```
node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple ] ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    interfaces:
       Vnflcm:
         operations:
           instantiate: {}
           terminate:  {}
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_vip:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VipVirtualLinksTo
          occurrences: [ 0, 1 ]

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
    requirements:
      virtual_link: [ Vdu-A-Cp, virtual_link ]
      virtual_link_vip: [ VipCp, virtual_link ]

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
      # properties:
        # omitted for brevity
      # interfaces:
        # omitted for brevity

    VDU-A:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: VDU-A
        description: VDU-A description
        vdu_profile:
          min_number_of_instances: 2
          max_number_of_instances: 5
        # other properties omitted for brevity
      capabilities:
```

```
        virtual_compute:
          properties: # following properties are required.
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1
      # requirements:
        # omitted for brevity


    Vdu-A-Cp:
      type: tosca.nodes.nfv.VduCp
      properties:
        protocol: [associated_layer_protocol: ipv4 ]
        trunk_mode: false
        layer_protocols: [ ipv4 ]
        role: leaf
        description: Internal connection point on an VL
      requirements:
        - virtual_binding: VDU-A
        #- virtual_link:  # the target node is determined in the NSD


    VipCp:
      type: tosca.nodes.nfv.VipCp
      properties:
        vip_function: load_balance
        protocol:
           - associated_layer_protocol: ipv4
             address_data:
               - address_type: ip_address
                 l3_address_data:
                   ip_address_assignment: true
                   floating_ip_activated: false
                   number_of_ip_address: 1
        trunk_mode: false
        layer_protocols: [ ipv4 ]
        description: >
             Virtual IP connection point. It holds one IP address shared by all instances (between 2
and 5 according to the vdu_profile) of the Vdu-A-Cp node. Floating IP address is not used in the
VipCp. Thus, incoming packets are forwarded with unmodified destination address to one of the
instances of Vdu-A-Cp. A router external to the VNF with Equal-Cost Multi-Path (ECMP) load balancing
functionality is assumed to be properly configured to route the packets accordingly to the available
instances applying load balancing, i.e. one packet is only forwarded to one instance.
      requirements:
        - target: Vdu-A-Cp
        # - virtual_link:  # the target node is determined in the NSD
```

High availability

In the following example, a VNF uses two VNFCs to provide high availability of a service. One of them is the active one receiving IP packets, the other one is in stand-by mode. The VNF logic determines which VNFC is the active and which is the stand-by. The respective VduCp instances, in addition to their default IP address which is assigned according to the 'protocol' property, share a virtual IP address. At any point in time, only one of the VduCp instances, the one belonging to the active VNFC, is bound to the virtual IP address, i.e. only one receives the packets. During the life of the VNF the binding may change, for example in case of failure of the active VNFC, or if determined by the VNF logic. In order to bind the virtual IP address, the active VNFC sends a Gratuitous ARP (G-ARP) message with the mapping of the VIP address to its MAC address. A router external to the VNF updates its routing tables when receiving the G-ARP and thereafter routes packets that have the virtual IP address as destination address to the active VNFC.

In this particular example the VduCps are re-exposed as VnfExtCps. Therefore the VipCp is also re-exposed as VnfExtCp.

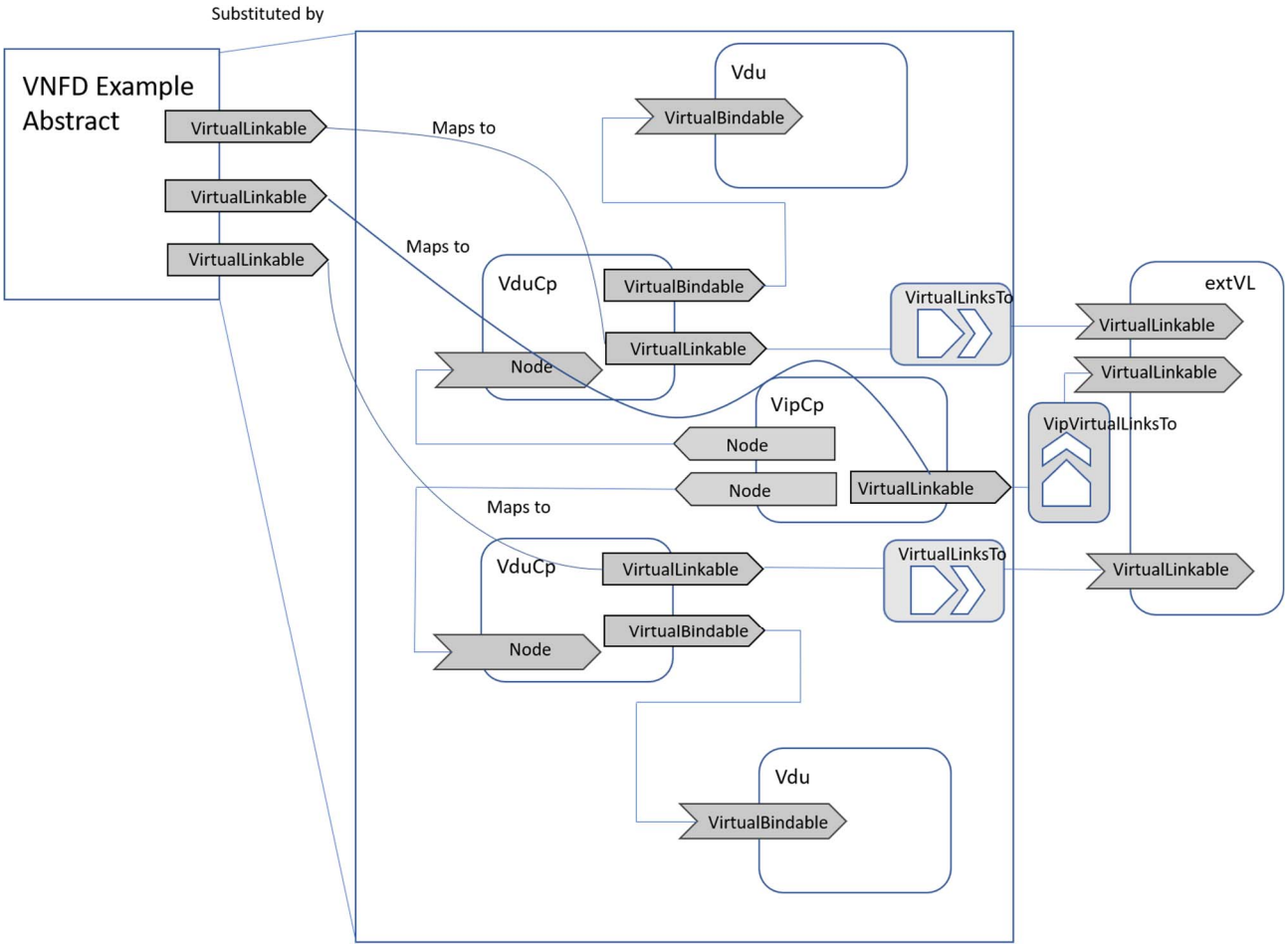


Figure A.13-2: VNFD with two VDU connection points acting as VnfExtCps and sharing a virtual IP address

In this example the two VduCps and the VipCp are exposed as VnfExtCps. Therefore the VNF abstract node has three requirements for a VirtualLinkable capability. Two of them use the VirtualLinksTo relationship and the third one uses the VipVirtualLinksTo relationship. The three of them are considered in the substitution mapping.

The following service template shows the relevant parts of the TOSCA VNFD corresponding to figure A.13-2. For simplicity, a single deployment flavour VNF is assumed.

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: Relational database, simple
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001 for
a VNFD

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
```

```
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple ] ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    # interfaces:
       # omitted for brevity
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_sby:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_vip:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VipVirtualLinksTo
          occurrences: [ 0, 1 ]

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
    requirements:
      virtual_link: [ Vdu-A-Cp, virtual_link ]
      virtual_link_sby: [ Vdu-B-Cp, virtual_link ]
      virtual_link_vip: [ VipCp, virtual_link ]


  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
      # properties:
        # omitted for brevity
      # interfaces:
        # omitted for brevity

    VDU-A:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: VDU-A
        description: VDU-A description

        vdu_profile:
          min_number_of_instances: 1
          max_number_of_instances: 1
        # other properties omitted for brevity
      capabilities:
        virtual_compute:
          properties: # following properties are required.
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1

      # requirements:
        # omitted for brevity

    VDU-B:
      type: tosca.nodes.nfv.Vdu.Compute
      properties:
        name: VDU-B
        description: VDU-B description
        vdu_profile:
          min_number_of_instances: 1
```

```
          max_number_of_instances: 1
        # other properties omitted for brevity
      capabilities:
        virtual_compute:
          properties: # following properties are required.
            virtual_memory:
              virtual_mem_size: 1 GB
            virtual_cpu:
              num_virtual_cpu: 1

      # requirements:
        # omitted for brevity


    Vdu-A-Cp:
      type: tosca.nodes.nfv.VduCp
      properties:
        protocol: [associated_layer_protocol: ipv4 ]
        trunk_mode: false
        layer_protocols: [ ipv4 ]
        role: leaf
        description: Internal connection point on an VL
      requirements:
        - virtual_binding: VDU-A
        #- virtual_link:  # the target node is determined in the NSD

    Vdu-B-Cp:
      type: tosca.nodes.nfv.VduCp
      properties:
        protocol: [associated_layer_protocol: ipv4 ]
        trunk_mode: false
        layer_protocols: [ ipv4 ]
        role: leaf
        description: Internal connection point on an VL
      requirements:
        - virtual_binding: VDU-B
        #- virtual_link:  # the target node is determined in the NSD

    VipCp:
      type: tosca.nodes.nfv.VipCp
      properties:
        vip_function: high_availability
        protocol:
           - associated_layer_protocol: ipv4
             address_data:
               - address_type: ip_address
                 l3_address_data:
                   ip_address_assignment: true
                   floating_ip_activated: true
                   number_of_ip_address: 1
        trunk_mode: false
        layer_protocols: [ ipv4 ]
        description: >
          Virtual IP connection point. It holds one IP address shared by the instances of the Vdu-A-
Cp and the Vdu-B-Cp nodes (one instance of each). Floating IP address is used. Thus, incoming
packets are first NATed to the virtual IP address and then forwarded with the virtual IP address as
destination address to the instance of Vdu-A-Cp or Vdu-B-Cp that currently has the address binding.
      requirements:
        - target: Vdu-A-Cp
        - target: Vdu-B-Cp
        # - virtual_link:  # the target node is determined in the NSD
```

In the example above, the VipCp uses a floating IP address. Thus, the incoming packets are expected to have the floating IP as destination address and they are first NATed to the virtual IP address and then forwarded to the instance of the VduCp that currently has the binding to the virtual IP address.

If the VipCp does not use floating IP address, the incoming packets are expected to have the virtual IP address as destination address.

A.14 NSD VNF Forwarding Graph design example

The following template fragment illustrates a VNF FG data model for a Network Service. The NS consists of VNF_1, VNF_2, VNF_3 and NsVirtualLink_1 as its constituents. VNF_1, VNF_2 and VNF_3 node templates have virtual link requirements pointing to node templates of the type tosca.nodes.nfv.Forwarding defined in clause 7.8.8 which in turn have virtual link requirements pointing to the NS virtual links *or to* external virtual links (i.e. *transport links beyond the SAPs*) to which these VNFs are attached.

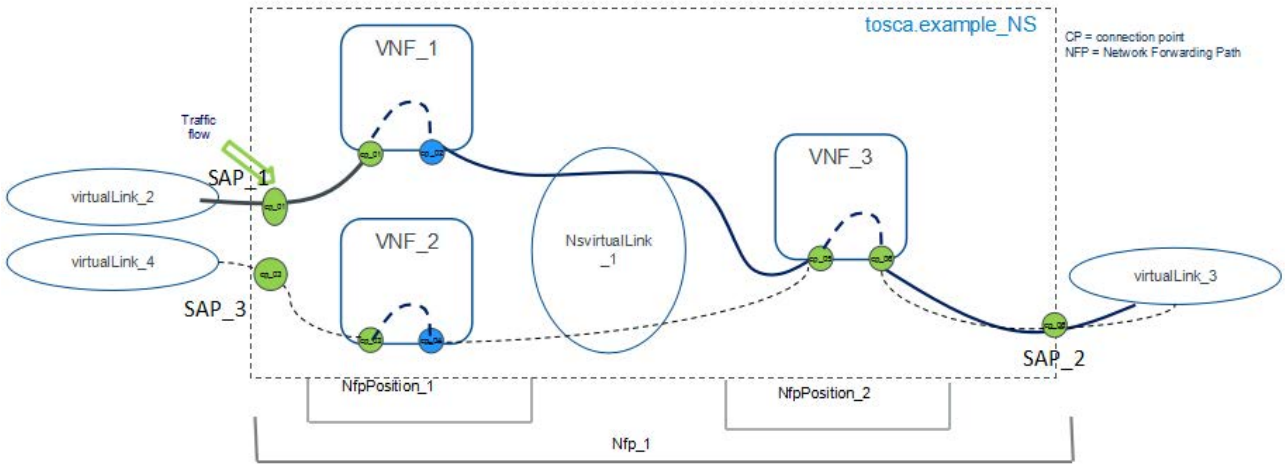


Figure A.14-1: Example Network Forwarding Path

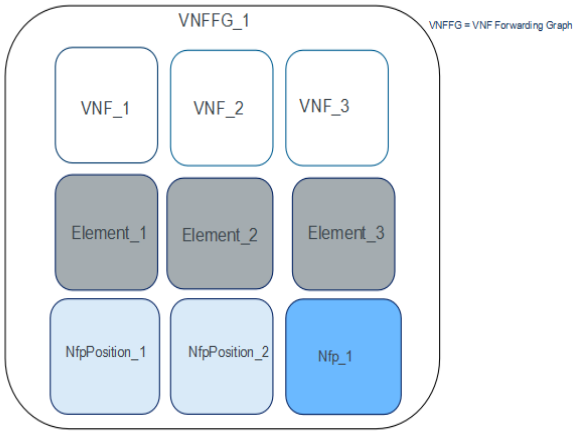


Figure A.14-2: Example VNFFG_1 group with constituent elements

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: VNF FG Model for example_NS
imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of NSD related TOSCA types as defined in ETSI
GS NFV-SOL 001
  - example_vnf1.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF1
node type definition, this file might be included in the NSD file structure
  - example_vnf2.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF2
node type definition, this file might be included in the NSD file structure
  - example_vnf3.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF3
node type definition, this file might be included in the NSD file structure


data_types:
  MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters

node_types:
  tosca.example_NS:
```

```
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      name:
        type: string
        constraints: [ equal: ExampleService ]
        default: ExampleService
      version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ equal: 1111-2222-aaaa-bbbb ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
    interfaces:
      Nslcm:
        type: tosca.interfaces.nfv.Nslcm
        operations:
          instantiate:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters
                required: false
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 0 ]
      - virtual_link_2:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_3:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_4:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]

topology_template:
  substitution_mappings:
    node_type: tosca.example_NS
    requirements:

      virtual_link_2: [ VNF_1_forward_1, virtual_link ] # the requirement of SAP_1
      virtual_link_3: [ VNF_3_forward_6, virtual_link ] # the requirement of SAP_2
      virtual_link_4: [ VNF_2_forward_3, virtual_link ] # the requirement of SAP_3
  node_templates:
    my_service:
      type: tosca.example_NS
      properties:
        descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
        designer: MyCompany
        name: ExampleService
        # . . .
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml

    NsVirtualLink_1:
```

```
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        vl_profile:
          min_bitrate_requirements:
            root: 100000
          max_bitrate_requirements:
            root: 200000
        connectivity_type:
          layer_protocols: [ ipv4 ]
        # . . .

    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        descriptor_id: b1bb0ce7-2222-4fa7-95ed-4840d70a1179
        descriptor_version: "1.0"
        # . . .
      requirements:
        - virtual_link: VNF_1_forward_1 # related to cp_01 in VNF_1
        - virtual_link_2: VNF_1_forward_2 # related to cp_02 in VNF_1

    VNF_1_forward_1:
      type: tosca.nodes.nfv.Forwarding


    VNF_1_forward_2:
      type: tosca.nodes.nfv.Forwarding
      requirements:
        - virtual_link: NsVirtualLink_1

    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      properties:
        descriptor_id: b1bb0ce7-2222-4fa7-95ed-4840d70a1182
        descriptor_version: "1.0.0"
        # . . .
      requirements:
        - virtual_link: VNF_2_forward_3 # related to cp_03 in VNF_2
        - virtual_link_4: VNF_2_forward_4 # related to cp_04 in VNF_2

    VNF_2_forward_3:
      type: tosca.nodes.nfv.Forwarding


    VNF_2_forward_4:
      type: tosca.nodes.nfv.Forwarding
      requirements:
        - virtual_link: NsVirtualLink_1

    VNF_3:
      type: tosca.nodes.nfv.example_VNF3
      properties:
        descriptor_id: b1bb0ce7-2222-4fa7-95ed-4840d70a1177
        descriptor_version: "1.0.0"
        # . . .
      requirements:
        - virtual_link: VNF_3_forward_5 # related to cp_05 in VNF_3
        - virtual_link_3: VNF_3_forward_6 # related to cp_06 in VNF_3

    VNF_3_forward_5:
      type: tosca.nodes.nfv.Forwarding
      requirements:
        - virtual_link: NsVirtualLink_1

    VNF_3_forward_6:
      type: tosca.nodes.nfv.Forwarding

# NfpPositionElement (Service Function) for VNF_1
    Element_1:
      type: tosca.nodes.nfv.NfpPositionElement
      requirements:
        - profile_element:
            node: VNF_1_forward_1
            capability: forwarding
        - profile_element:
```

```
            node: VNF_1_forward_2
            capability: forwarding

# NfpPositionElement (Service Function) for VNF_2
    Element_2:
      type: tosca.nodes.nfv.NfpPositionElement
      requirements:
        - profile_element:
            node: VNF_2_forward_3
            capability: forwarding
        - profile_element:
            node: VNF_2_forward_4
            capability: forwarding

# NfpPositionElement (Service Function) for VNF_3
    Element_3:
      type: tosca.nodes.nfv.NfpPositionElement
      requirements:
        - profile_element:
            node: VNF_3_forward_5
            capability: forwarding
        - profile_element:
            node: VNF_3_forward_6
            capability: forwarding

# NfpPosition_1 with Element_1  and Element_2 as constituents
    NfpPosition_1:
      type: tosca.nodes.nfv.NfpPosition
      properties:
        forwarding_behaviour: lb
      requirements:
          - element: Element_1
          - element: Element_2

# NfpPosition_2 with Element_3 as constituents
    NfpPosition_2:
      type: tosca.nodes.nfv.NfpPosition
      properties:
        forwarding_behaviour: all
      requirements:
          - element: Element_3

    Nfp_1:
      type: tosca.nodes.nfv.NFP
      requirements:
        - nfp_position: NfpPosition_1
        - nfp_position: NfpPosition_2

  policies:
     - NfpRule_1:
         type: tosca.policies.nfv.NfpRule
         properties:
           ether_destination_address: 00:0a:95:9d:68:16
           ether_source_address: 00:A0:C9:14:C8:29
           ether_type: ipv4
           vlan_tag:
               - "10"
               - "20"
               - "30"
           protocol: tcp
           dscp: "101111"
           source_port_range: [ 5000, 15000 ]
           destination_port_range: [ 800, 8080 ]
           source_ip_address_prefix: 10.10.10.0
           destination_ip_address_prefix: 125.1.12.111
           extended_criteria:
             - starting_point: 3
               length: 4
               value: "1000"
         targets: [ Nfp_1 ]

  groups:
    VNFFG_1:
      type: tosca.groups.nfv.VNFFG
      properties:
        description: VNF Forwarding Graph for example_NS
      members: [ Nfp_1, VNF_1, VNF_2, VNF_3, NsVirtualLink_1, Element_1, Element_2, Element_3 ]
```

The following template fragment is part of the content in the example_vnf1.yaml.

```
tosca_definitions_version: tosca_simple_yaml_1_3
description:  VNF Descriptor for VNF1
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of VNFD related TOSCA types as defined in ETSI
GS NFV-SOL 001
node_types:
  tosca.nodes.nfv.example_VNF1:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-2222-4fa7-95ed-4840d70a1179 ]
        default: b1bb0ce7-2222-4fa7-95ed-4840d70a1179
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: Example_VNF1 ]
        default: Example_VNF1
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    requirements:
      - virtual_link_1:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_2:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]

topology_template:
  substitution_mappings:
    node_type: tosca.nodes.nfv.example_VNF1
    requirements:
      virtual_link:   [ cp_01, external_virtual_link ]
      virtual_link_2: [ cp_02, external_virtual_link ]

  node_templates:
    cp_01:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . . ......
      requirements:
        - internal_virtual_link: intVL-A
    cp_02:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . . ......
      requirements:
        - internal_virtual_link: intVL-A
```

```
    intVL-A:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 1000000
            leaf: 100000
          min_bitrate_requirements:
            root: 100000
            leaf: 10000
```

The following template fragment is part of the content in the example_vnf2.yaml.

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: VNF Descriptor for VNF2
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of VNFD related TOSCA types as defined in ETSI
GS NFV-SOL 001
node_types:
  tosca.nodes.nfv.example_VNF2:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-2222-4fa7-95ed-4840d70a1182 ]
        default: b1bb0ce7-2222-4fa7-95ed-4840d70a1182
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: Example_VNF2 ]
        default: Example_VNF2
      software_version:
        type: string
        constraints: [ equal: '1.0.0' ]
        default: '1.0.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0.0' ]
        default: '1.0.0'
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    requirements:
      - virtual_link_1:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_2:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_4:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]


topology_template:
  substitution_mappings:
    node_type: tosca.nodes.nfv.example_VNF2
```

```
    requirements:
      virtual_link:   [ cp_03, external_virtual_link ]
      virtual_link_4: [ cp_04, external_virtual_link ]

  node_templates:
    cp_03:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . . .....
      requirements:
        - internal_virtual_link: intVL-A
    cp_04:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . . .....
      requirements:
        - internal_virtual_link: intVL-A

    intVL-A:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 1000000
            leaf: 100000
          min_bitrate_requirements:
            root: 100000
            leaf: 10000
```

The following template fragment is part of the content in the example_vnf3.yaml.

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: VNF Descriptor for VNF3
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of VNFD related TOSCA types as defined in ETSI GS NFV-SOL
001
node_types:
  tosca.nodes.nfv.example_VNF3:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-2222-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-2222-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: Example_VNF3 ]
        default: Example_VNF3
      software_version:
        type: string
        constraints: [ equal: '1.0.0' ]
        default: '1.0.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0.0' ]
        default: '1.0.0'
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
```

```
    requirements:
      - virtual_link_1:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_2:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_3:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]

topology_template:
  substitution_mappings:
    node_type: tosca.nodes.nfv.example_VNF3
    requirements:
      virtual_link:   [ cp_05, external_virtual_link ]
      virtual_link_3: [ cp_06, external_virtual_link ]

  node_templates:
    cp_05:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . .
      requirements:
        - internal_virtual_link: intVL-A
    cp_06:
      type: tosca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . .
      requirements:
        - internal_virtual_link: intVL-A

    intVL-A:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 1000000
            leaf: 100000
          min_bitrate_requirements:
            root: 100000
            leaf: 10000
```

A.15 Auto-scale and auto-heal design

A.15.1 Introduction

This clause describes the Auto-scale and auto-heal policy design in a VNFD or NSD.

A.15.2 Auto-scale and auto-heal design with use of VNF indicator in VNFD

This clause illustrates an example of a VNF with two VNF indicators, one VNF indicator related to the utilization of the VNF and one related to the VNF health.

The modelling and handling of the indicator in the VNFD service template involves the following definitions:

- A VNF specific VNF indicator interface type definition that includes one notification for each VNF indicator.
- New attribute definition included in the VNF specific node type definition for each of the indicators.

- Two attributes to hold the values of the current scale level of the 'call_proc' and 'database' scaling aspects.

NOTE: It is assumed that this VNF has the same scaling aspects as defined in the example in clause A.6 ('call_proc' and 'database').

- An interface definition of the VNF specific Vnflcm type with input definitions of additional_parameters for the heal operation.

- An interface definition of the VNF specific VNF indicator type with an output definition for each notificaton indicating the attribute modified by the output of the notification.

- A VNF specific auto_scale and auto_heal policy definitions of tosca.policies.nfv.VnfIndicator type Each policy includes a trigger with an event associated to the notification, as well as condition and action.

```
tosca_definitions_version: tosca_simple_yaml_1_3
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFVSOL
001

interface_types:
  MyCompany.nfv.interfaces.VnfIndicator:
    derived_from: tosca.interfaces.nfv.VnfIndicator
    notifications:
      utilization:
        description: this notification is used to received asynchronous information of value
change of the utilization_vnf_indicator
      health:
        description: this notification is used to received asynchronous information of value
change of the health_vnf_indicator

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple ] ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    attributes:
      utilization_vnf_indicator:
        type: float
        description: holds the value of the utilization VNF indicator. It is assigned the
output value of the utilization notification.
      health_vnf_indicator:
        type: string
```

```
        description: holds the value of the health VNF indicator. It is assigned the output
value of the health notification.
      call_proc_scale_level:
        type: integer
      database_scale_level:
        type: integer
    interfaces:
      Vnflcm:
        operations:
     #    scale: {}
          heal:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.HealAdditionalParameters
                required: false
      VnfIndicator:
        type: MyCompany.nfv.interfaces.VnfIndicator
        notifications:
          utilization:
            outputs:
              utilization_vnf_indicator: [ SELF, utilization_vnf_indicator ]
          health:
            outputs:
              health_vnf_indicator: [ SELF, health_vnf_indicator ]

data_types:
  MyCompany.datatypes.nfv.HealAdditionalParameters:
    derived_from: tosca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: false

policy_types:
  MyCompany.policies.nfv.VnfIndicator:
    derived_from: tosca.policies.nfv.VnfIndicator

topology_template:
  substitution_mappings:
    node_type: MyCompany.SunshineDB.1_0.1_0
  #  ..

  node_templates:
    SunshineDB:
      type: MyCompany.SunshineDB.1_0.1_0
      attributes:
        call_proc_scale_level: { get_attribute: [ SELF, scale_status, call_proc, scale_level ]
}
        database_scale_level: { get_attribute: [ SELF, scale_status, database, scale_level ] }

  policies:
    - scaling_aspects:
        type: tosca.policies.nfv.ScalingAspects
        properties:
          aspects:
            database:
              name: ..
              description: ..
              max_scale_level: 2
              step_deltas:
                - delta_1
            call_proc:
              name: ..
              description: ..
              max_scale_level: 4
              step_deltas:
                - delta_1
    - auto_scale:
        type: tosca.policies.nfv.VnfIndicator
        properties:
          source: vnf
        triggers:
          scale_out:
            event: tosca.interfaces.nfv.VnfIndicator.utilization # full name of a notification
in the VnfIndicator interface
            condition:
              - utilization_vnf_indicator: [ { greater_or_equal: 60.0 } ]
              - call_proc_scale_level: [ { less_than: 3 } ]
```

```
            action:
              - call_operation:
                  operation: Vnflcm.scale
                  inputs:
                    type:
                      value: scale_out
                    aspect:
                      value: call_proc
                    number_of_steps:
                      value: 1 # optional
          scale_in:
            event: tosca.interfaces.nfv.VnfIndicator.utilization # full name of a notification
in the VnfIndicator interface
            condition:
              - utilization_vnf_indicator: [ { less_or_equal: 20.0 } ]
              - call_proc_scale_level: [ { greater_than: 0 } ]
            action:
              - call_operation:
                  operation: Vnflcm.scale
                  inputs:
                    type:
                      value: scale_in
                    aspect:
                      value: call_proc
        targets: [SunshineDB ]

    - auto_heal:
        type: tosca.policies.nfv.VnfIndicator
        properties:
          source: vnf
        triggers:
          red:
            event: tosca.interfaces.nfv.VnfIndicator.health # full name of a notification in
the VnfIndicator interface
            condition:
              health_vnf_indicator: [ { equal: red } ]
            action:
              - call_operation:
                  operation: Vnflcm.heal
                  inputs:
                     cause:
                        value: no_service
          yellow:
            event: tosca.interfaces.nfv.VnfIndicator.health
            condition:
              health_vnf_indicator: [ { equal: yellow } ]
            action:
              - call_operation:
                  operation: Vnflcm.heal
                  inputs:
                    cause:
                      value: degraded_service
        targets: [SunshineDB ]

    - auto_heal_with_additional_parameters:
        type: MyCompany.policies.nfv.VnfIndicator
        properties:
          source: vnf
        triggers:
          red_or_yellow:
            event: tosca.interfaces.nfv.VnfIndicator.health # full name of a notification in
the VnfIndicator interface
            condition:
                or:
                  - health_vnf_indicator: [ { equal: red } ]
                  - health_vnf_indicator: [ { equal: yellow } ]
            action:
              - call_operation:
                  operation: Vnflcm.heal
                  inputs:
                    cause:
                      value: problem
                    additional_parameters:
                      value:
                        parameter_1: value_1
        targets: [SunshineDB ]
    #..
```

A.15.3 Auto-scale design with use of VNF indicator in NSD

This clause illustrates an example of a NS with two VNF indicators, one VNF indicator related to the utilization of the VNF_1 and one related to the utilization of the VNF_2.

The modelling and handling of the VNF indicator in the NSD service template involves the following definitions:

- A NS specific VNF indicator interface type definition that includes one notification for VNF indicators.
- New attribute definition included in the NS specific node type definition for each of the VNF indicators.
- Two attributes to hold the values of the current scale level of the 'call_proc' and 'database' scaling aspects.
- A NS specific auto_scale policy definitions of tosca.policies.nfv.NsAutoScale type, which includes a trigger with an event associated to the notification, as well as condition and action.

example_NS.yaml

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: Relational database, simple

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of NSD related TOSCA types as defined in ETSI GS NFV-SOL
001
  - example_VNF_1.yaml  # uri of the yaml file which contains the definition of
tosca.nodes.nfv.example_VNF1, this file might be included in the NSD file structure
  - example_VNF_2.yaml  # uri of the yaml file which contains the definition of
tosca.nodes.nfv.example_VNF2, this file might be included in the NSD file structure


data_types:
  MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
        default: value_1
      parameter_2:
        type: string
        required: true
        default: value_2

interface_types:
  MyCompany.nfv.interfaces.NsVnfIndicator:
    derived_from: tosca.interfaces.nfv.NsVnfIndicator
    notifications:
      utilization:
        description: this notification is used to received asynchronous information of value change
of the utilization_vnf_indicator

node_types:
  tosca.example_NS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      name:
        type: string
        constraints: [ equal: ExampleService ]
        default: ExampleService
      version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ equal: 1111-2222-aaaa-bbbb ]
```

```
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
        constraints: [ equal: simple ]
        default: simple
    attributes:
      vnf_1_utilization_vnf_indicator:
        type: float
        description: holds the value of the vnf_1_utilization VNF indicator. It is assigned the
output value of the utilization notification.
      vnf_2_utilization_vnf_indicator:
        type: float
        description: holds the value of the vnf_1_utilization VNF indicator. It is assigned the
output value of the utilization notification.
      call_proc_scale_level:
        type: integer
      database_scale_level:
        type: integer
    interfaces:
      Nslcm:
        type: tosca.interfaces.nfv.Nslcm
        operations:
          instantiate:
            inputs:
              additional_parameters:
                type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters
                required: false
      NsVnfIndicator:
        type: MyCompany.nfv.interfaces.NsVnfIndicator
        notifications:
           utilization: {}


topology_template:
  substitution_mappings:
    node_type: tosca.example_NS
    requirements:
       virtual_link: [ VNF_2, virtual_link_2 ] # the External connection point of
                                               # VNF_2 is exposed as the Sap

  node_templates:
    my_service:
      type: tosca.example_NS
      properties:
        descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
        designer: MyCompany
        name: ExampleService
        version: '1.0'
        invariant_id: 1111-2222-aaaa-bbbb
        flavour_id: simple
      attributes:
        call_proc_scale_level: { get_attribute: [ SELF, scale_status, call_proc ] }
        vnf_1_utilization_vnf_indicator: { get_attribute: [ VNF_1, utilization_vnf_indicator ] } #
required Vnf indicator for VNF_1 of this NS
        vnf_2_utilization_vnf_indicator: { get_attribute: [ VNF_2, utilization_vnf_indicator ] } #
required Vnf indicator for VNF_1 of this NS

      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml


    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link: NsVirtualLink_1
```

```
    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3

      requirements:
        - virtual_link_1: NsVirtualLink_1
        # - virtual_link_2: # map to virtual_link requirement of the NS node
        - dependency: VNF_1

    NsVirtualLink_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000

  policies:
    - scaling_aspects:
        type: tosca.policies.nfv.NsScalingAspects
        properties:
          aspects:
            database:
              name: DatabaseScalingAspect
              description: This scaling aspect is for database
              ns_scale_levels:
                0:
                  description: first NS level for the database scaling aspect
                1:
                  description: second NS level for the database scaling aspect
            call_proc:
              name: ProcessorScalingAspect
              description: This scaling aspect is for Processor
              ns_scale_levels:
                0:
                  description: first NS level for the processor scaling aspect
                1:
                  description: second NS level for the processor scaling aspect
                2:
                  description: third NS level for the processor scaling aspect

    - auto_scale:
        type: tosca.policies.nfv.NsAutoScale
 #       properties:
          # none
        triggers:
          scale_out:
            event: tosca.interfaces.nfv.NsVnfIndicator.utilization # full name of a notification in
the VnfIndicator interface
            condition:
              - vnf_1_utilization_vnf_indicator: [ { greater_or_equal: 80.0 } ]
              - vnf_2_utilization_vnf_indicator: [ { greater_or_equal: 80.0 } ]
              - call_proc_scale_level: [ { less_than: 2 } ]
            action:
              - call_operation:
                  operation: Nslcm.scale
                  inputs:
                    scale_ns_by_steps_data:
                      scaling_direction: scale_out
                      aspect: call_proc
                      number_of_steps: 1
          scale_in:
            event: tosca.interfaces.nfv.NsVnfIndicator.utilization # full name of a notification in
the VnfIndicator interface
            condition:
              - vnf_1_utilization_vnf_indicator: [ { less_or_equal: 10.0 } ]
              - vnf_2_utilization_vnf_indicator: [ { less_or_equal: 10.0 } ]
              - call_proc_scale_level: [ { greater_than: 2 } ]
```

```
            action:
              - call_operation:
                  operation: Nslcm.scale
                  inputs:
                    scale_ns_by_steps_data:
                      scaling_direction: scale_in
                      aspect: call_proc
                      number_of_steps: 1
        targets: [ my_service ]
```

The contents of example_VNF_1.yaml file with the VNF_1 node type definition are as follows:

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: VNFD for VNF_1

imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

interface_types:
  MyCompany.nfv.interfaces.VnfIndicator:
    derived_from: tosca.interfaces.nfv.VnfIndicator
    notifications:
      utilization:
        description: this notification is used to received asynchronous information of value change
of the utilization_vnf_indicator
      health:
        description: this notification is used to received asynchronous information of value change
of the health_vnf_indicator

node_types:
  tosca.nodes.nfv.example_VNF1:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      provider:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      product_name:
        type: string
        constraints: [ equal: SunshineDB ]
        default: SunshineDB
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple ] ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    attributes:
      utilization_vnf_indicator:
        type: float
        description: holds the value of the utilization VNF indicator. It is assigned the output
value of the utilization notification.
      health_vnf_indicator:
        type: string
        description: holds the value of the health VNF indicator. It is assigned the output value of
the health notification.
      call_proc_scale_level:
        type: integer
      database_scale_level:
```

```
        type: integer
    interfaces:
      Vnflcm:
       operations:
          scale: {}
      VnfIndicator:
        type: MyCompany.nfv.interfaces.VnfIndicator
        notifications:
          utilization:
            outputs:
              utilization_vnf_indicator: [ SELF, utilization_vnf_indicator ]
          health:
            outputs:
              health_vnf_indicator: [ SELF, health_vnf_indicator ]
```

The contents of example_VNF_2.yaml file with the VNF_2 node type definition are as follows:

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: VNFD for VNF_2

imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

interface_types:
  MyOtherCompany.nfv.interfaces.VnfIndicator:
    derived_from: tosca.interfaces.nfv.VnfIndicator
    notifications:
      utilization:
        description: this notification is used to received asynchronous information of value change
of the utilization_vnf_indicator
      health:
        description: this notification is used to received asynchronous information of value change
of the health_vnf_indicator

node_types:
  tosca.nodes.nfv.example_VNF2:
    derived_from: tosca.nodes.nfv.VNF
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a2233 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a2233
      provider:
        type: string
        constraints: [ equal: MyOtherCompany ]
        default: MyOtherCompany
      product_name:
        type: string
        constraints: [ equal: MyProduct ]
        default: MyProduct
      software_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      descriptor_version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      flavour_id:
        type: string
        constraints: [ valid_values: [ simple ] ]
        default: simple
      flavour_description:
        type: string
        default: ""
      vnfm_info:
        type: list
        entry_schema:
          type: string
        constraints: [ valid_values: [ [ '0:MyCompany-1.0.0' ] ] ]
        default: [ '0:MyCompany-1.0.0' ]
    attributes:
      utilization_vnf_indicator:
        type: float
        description: holds the value of the utilization VNF indicator. It is assigned the output
value of the utilization notification.
      health_vnf_indicator:
        type: string
```

```
        description: holds the value of the health VNF indicator. It is assigned the output value of
the health notification.
      call_proc_scale_level:
        type: integer
      database_scale_level:
        type: integer
    interfaces:
      Vnflcm:
       operations:
          scale: {}
      VnfIndicator:
        type: MyOtherCompany.nfv.interfaces.VnfIndicator
        notifications:
          utilization:
            outputs:
              utilization_vnf_indicator: [ SELF, utilization_vnf_indicator ]
          health:
            outputs:
              health_vnf_indicator: [ SELF, health_vnf_indicator ]
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 0 ]
      - virtual_link_1:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 1, 1 ]
      - virtual_link_2:
          capability: tosca.capabilities.nfv.VirtualLinkable
          relationship: tosca.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
```

A.16 VDU connection point in trunk mode

With supporting trunk mode, a VM can differentiate between traffic of many networks by different encapsulation types and Ids, instead of using many vNICs. Connection points of a VDU are combined into one VIF by turning one connection point into a trunk parent port and the other connection points into trunk subports of the same trunk. A trunk logical model is a collection of connection points. Different infrastructure technologies may have different way to implement trunk logical model.

The main concept of difference between subport and parent port:

- The parent port can associate to the VM and a network.
- The parent port can be associated by subports.
- The subport can not associate directly to the VM but through the parent port and a network.
- The traffic of sub-port can be encapsulated as required.

In the following example, there are three connection points are needed in initial deployment stage, one VdpCp node taken as trunk port and two VduSubCp nodes taken as trunk subports. With respect to VduSubCp node, requirement virtual_binding, if existing, is useless because the trunk_binding have priority over it.

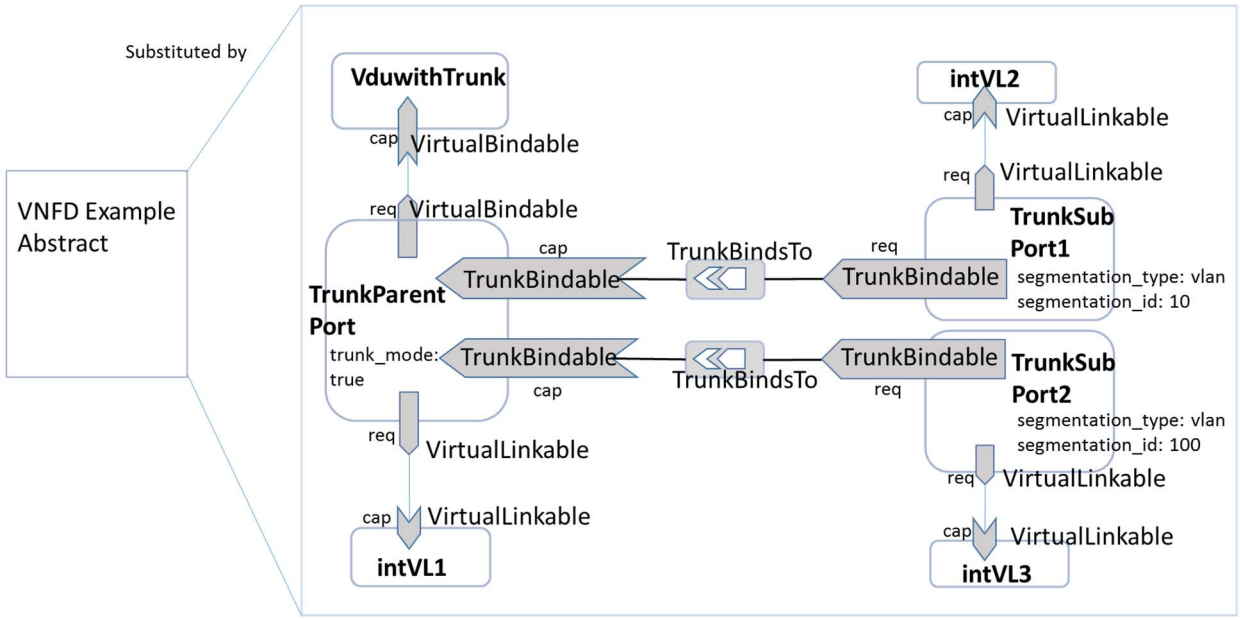


Figure A.16-1: VNFD with a VDU has three connection points group as trunk

The following service template shows the relevant parts of the TOSCA VNFD corresponding to figure A.16-1.

```
tosca_definitions_version: tosca_simple_yaml_1_3
 # ...
imports:
  - etsi_nfv_sol001_vnfd_types.yaml  # all of TOSCA VNFD types as defined in ETSI GS NFV-SOL 001

topology_template:
  node_templates:
#...
    VduwithTrunk:
      type:  tosca.nodes.nfv.Vdu.Compute
      properties:
        name: VduwithTrunk
        description: compute node with trunk port
        vdu_profile:
          min_number_of_instances: 3
          max_number_of_instances: 4
      capabilities:
        virtual_compute:
          properties:
            virtual_memory:
              virtual_mem_size: 8192 MiB
            virtual_cpu:
              num_virtual_cpu: 2
# omitted for brevity

    TrunkParentPort:
      type: tosca.nodes.nfv.VduCp
      properties:
        layer_protocols: [ ipv4 ]
        trunk_mode: true
      # omitted for brevity
      requirements:
        - virtual_binding: VduwithTrunk
        - virtual_link: intVL1

    TrunkSubPort1:
      type: tosca.nodes.nfv.VduSubCp
      properties:
      # omitted for brevity
        layer_protocols: [ ipv4 ]
        segmentation_type: vlan
        segmentation_id: 10
      requirements:
        - trunk_binding: TrunkParentPort
        - virtual_link: intVL2

    TrunkSubPort2:
```

```
      type: tosca.nodes.nfv.VduSubCp
      properties:
      # omitted for brevity
        layer_protocols: [ ipv4 ]
        segmentation_type: vlan
        segmentation_id: 100
      requirements:
        - trunk_binding: TrunkParentPort
        - virtual_link: intVL3

    intVL1:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 100000
            leaf: 20000
          min_bitrate_requirements:
            root: 10000
            leaf: 10000 # omitted for brevity

    intVL2:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 100000
            leaf: 20000
          min_bitrate_requirements:
            root: 10000
            leaf: 10000
# omitted for brevity

    intVL3:
      type: tosca.nodes.nfv.VnfVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ ipv4 ]
        vl_profile:
          max_bitrate_requirements:
            root: 100000
            leaf: 20000
          min_bitrate_requirements:
            root: 10000
            leaf: 10000
    # omitted for brevity
```

A.17 NS scaling

This clause shows the use of the NS policies to define the scaling aspects and NS scale levels.

The NSD NS_1 consists of the following components:

- Three VNFDs specified with the VNF node templates:
  - FrontEnd.
  - CentralProcess and Database.
- One nested NSD specified with the NS node template:
  - SupportFrontEnd.
- One NsVirtualLinkDesc specified with the NS VL node template:
  - NS_VL_1.

Figure A.17-1 shows the two scaling aspects and the two instantiation levels defined in this NS.

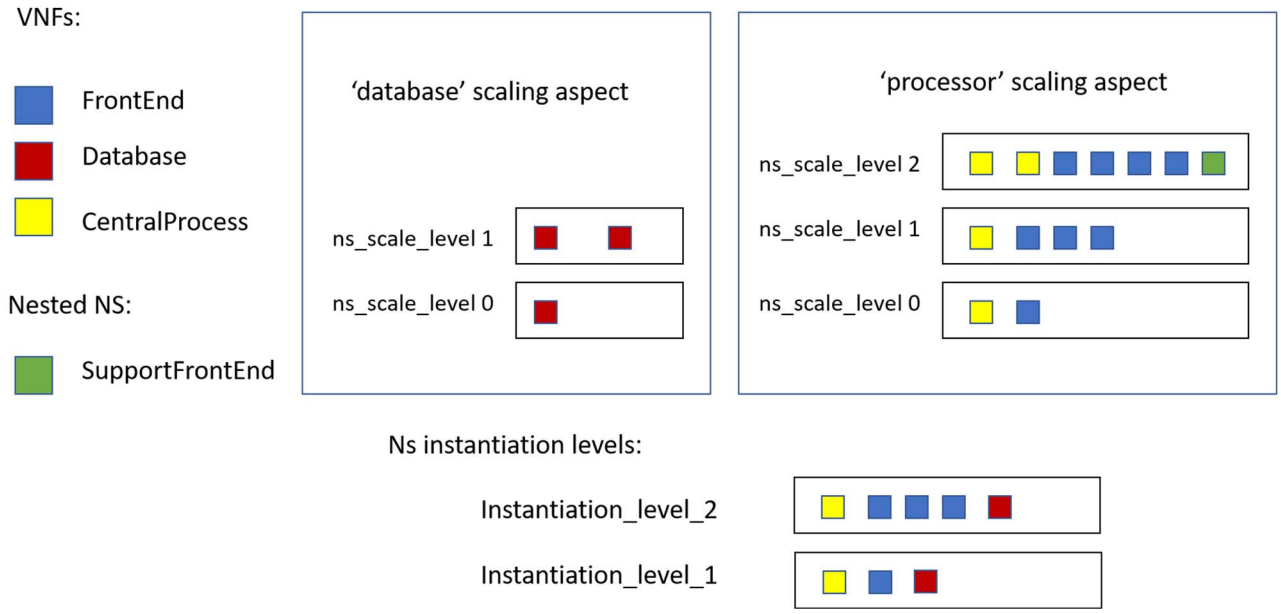


Figure A.17-1: NS scaling aspects and instantiation levels

```
tosca_definitions_version: tosca_simple_yaml_1_3
description: myExampleNs with scaling aspects
imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA NSD types as defined in ETSI GS NFV-SOL 001
  - MyScalableNs_Type.yaml # contains the NS node type definition.
  - SupportFrontEndNs.yaml # uri of the yaml file which contains the
MyProviderCompany.NS.SupportFrontEndNs node type definition, this file might be included in the NSD
file structure of NS_1.
  - FrontEnd_1_0.yaml # uri of the yaml file which contains the MyCompany.VNF.FrontEnd_1_0 node type
definition, this file might be included in the NSD file structure of NS_1.
  - Database_1_0.yaml # uri of the yaml file which contains the MyCompany.VNF.Database_1_0 node type
definition, this file might be included in the NSD file structure of NS_1.
  - CentralProcess_1_0.yaml # uri of the yaml file which contains the
MyCompany.VNF.CentralProcess_1_0 node type definition, this file might be included in the NSD file
structure of NS_1.

topology_template:
  substitution_mappings:
    node_type: MyProviderCompany.NS.MyScalableNS
    substitution_filter:
      properties:
        - flavour_id: { equal: small }
    requirements:
      virtual_link: [ FrontEnd, virtual_link_2 ]

  node_templates:
    NS_1:
      type: MyProviderCompany.NS.MyScalableNS
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml

    FrontEnd:
      type: MyCompany.VNF.FrontEnd_1_0
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 4
      requirements:
        - virtual_link_1: NS_VL_1
        # - virtual_link_2: # map to virtual_link requirement of the NS node
```

```
    Database:
      type: MyCompany.VNF.Database_1_0
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 2
      requirements:
        - virtual_link_1: NS_VL_1

    CentralProcess:
      type: MyCompany.VNF.CentralProcess_1_0
      properties:
        # no property assignments needed for required properties that have a default value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 2
      requirements:
        - virtual_link_1: NS_VL_1

    SupportFrontEnd:
      type: MyProviderCompany.NS.SupportFrontEndNs
      properties:
        descriptor_id: c1bb0ab8-deab-4fa7-95ed-4840d70a3574
        designer: MyCompany
        version: 1.0.0.0
        name: myExample2Service
        invariant_id: aaaa-bbbb-cccc-dddd
        ns_profile:
          ns_instantiation_level: level_1
          min_number_of_instances: 0
          max_number_of_instances: 1

        flavour_id: simple
      requirements:
        - virtual_link_1: NS_VL_1

    NS_VL_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
             root: 1000

  policies:
    - scaling_aspects:
        type: tosca.policies.nfv.NsScalingAspects
        properties:
          aspects:
            database:
              name: DatabaseScalingAspect
              description: This scaling aspect is used to scale the Database VNF
              ns_scale_levels:
                0:
                  description: first NS level for the database scaling aspect
                1:
                  description: second NS level for the database scaling aspect
            processor:
              name: ProcessorScalingAspect
              description: This scaling aspect is used to scale the FrontEnd and CentralProcess VNFs
and the SupportFrontEnd nested NS
              ns_scale_levels:
                0:
                  description: first NS level for the processor scaling aspect
                1:
                  description: second NS level for the processor scaling aspect
```

```
            2:
              description: second NS level for the processor scaling aspect

- FrontEndVnfToLevelMapping:
    type: tosca.policies.nfv.VnfToLevelMapping
    properties:
      aspect: processor
      number_of_instances:
        0: 1
        1: 3
        2: 4
    targets: [ FrontEnd ]

- CentralProcessVnfToLevelMapping:
    type: tosca.policies.nfv.VnfToLevelMapping
    properties:
      aspect: processor
      number_of_instances:
        0: 1
        1: 1
        2: 2
    targets: [ CentralProcess ]

- DatabaseVnfToLevelMapping:
    type: tosca.policies.nfv.VnfToLevelMapping
    properties:
      aspect: database
      number_of_instances:
        0: 1
        1: 2
    targets: [ Database ]

- SupportFrontEndNsToLevelMapping:
    type: tosca.policies.nfv.NsToLevelMapping
    properties:
      aspect: processor
      number_of_instances:
        0: 0
        1: 0
        2: 1
    targets: [ SupportFrontEnd ]

- ns_instantiation_levels:
    type: tosca.policies.nfv.NsInstantiationLevels
    properties:
      ns_levels:
        instantiation_level_1:
          description: low capacity instantiation level
        instantiation_level_2:
          description: high capacity instantiation level
      default_level: instantiation_level_1

- FrontEnd_instantiation_levels:
    type: tosca.policies.nfv.VnfToInstantiationLevelMapping
    properties:
      number_of_instances:
        instantiation_level_1: 1
        instantiation_level_2: 3
    targets: [ FrontEnd ]

- CentralProcess_instantiation_levels:
    type: tosca.policies.nfv.VnfToInstantiationLevelMapping
    properties:
      number_of_instances:
        instantiation_level_1: 1
        instantiation_level_2: 1
    targets: [ CentralProcess ]

- Database_instantiation_levels:
    type: tosca.policies.nfv.VnfToInstantiationLevelMapping
    properties:
      number_of_instances:
        instantiation_level_1: 1
        instantiation_level_2: 1
    targets: [ Database ]

- SupportFrontEnd_instantiation_levels:
    type: tosca.policies.nfv.NsToInstantiationLevelMapping
```

```
        properties:
          number_of_instances:
            instantiation_level_1: 0
            instantiation_level_2: 0
        targets: [ SupportFrontEnd ]
```

The contents of MyScalableNs_Type.yaml file with the node type definition are as follows:

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: type definition of tosca.MyScalableNS

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of TOSCA types as defined in ETSI GS NFV-SOL 001

node_types:
  MyProviderCompany.NS.MyScalableNS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ valid_values: [ b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ] ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ valid_values: [ MyCompany] ]
        default: MyCompany
      name:
        type: string
        constraints: [ valid_values: [ ExampleService ] ]
        default: ExampleService
      version:
        type: string
        constraints: [ valid_values: [ '1.0' ] ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ valid_values: [ 1111-2222-aaaa-bbbb ] ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
        constraints: [ valid_values: [ small, big ] ]
        default: small
    requirements:
      - virtual_link:
          capability: tosca.capabilities.nfv.VirtualLinkable
    interfaces:
      Nslcm:
        type: tosca.interfaces.nfv.Nslcm
```

Annex B (normative): etsi_nfv_sol001_type definitions

B.1 Purpose

All type definitions specified in clauses 6, 7, 8 and 9 of the present document are gathered in four definition files.

The file names are structured as follows:

- etsi_nfv_sol001_common_types.yaml, for the common type definitions provided in clause 9 which are used by at least two types of deployment templates among those identified in clause 5.1;
- etsi_nfv_sol001_vnfd_types.yaml, for the definitions provided in clause 6 and only used in a VNFD service template design;
- etsi_nfv_sol001_nsd_types.yaml, for the definitions provided in clause 7 and only used in an NSD service template design;
- etsi_nfv_sol001_pnfd _types.yaml, for the definitions provided in clause 8 and only used in a PNFD service template design.

B.2 VNFD type definitions file

All type definitions specified in clause 6 of the present document are contained in the file etsi_nfv_sol001_vnfd_types.yaml which is available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.7.1/etsi_nfv_sol001_vnfd_types.yaml

NOTE 1: The file etsi_nfv_sol001_vnfd_types.yaml includes a TOSCA import definition referencing etsi_nfv_sol001_common_types.yaml file. If the later file is included in the VNF package, the import definition can reference the local file using appropriate path in the VNF package.

This file is a TOSCA service template that only contains definitions. The template_version in the metadata section within this template is structured as x.y.z, where x, y and z represent the version of this file and are set respectively to "3", "3" and "1" for this version of the present document. In subsequent versions of the present document, "x", "y" and "z" in the template_version will be incremented only if there are changes in the VNFD type definitions.

A TOSCA service template representing a VNFD complying with the present document shall contain import statement referencing this file, as defined in clause 5.6.1.

NOTE 2: This file may, but need not, be included in the VNF Package.

B.3 NSD type definitions file

All type definitions specified in clause 7 of the present document are contained in the file etsi_nfv_sol001_nsd_types.yaml which is available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.7.1/etsi_nfv_sol001_nsd_types.yaml

NOTE 1: The file etsi_nfv_sol001_nsd_types.yaml includes a TOSCA import definition referencing etsi_nfv_sol001_common_types.yaml file. If the later file is included in the NSD file archive, the import definition can reference the local file using appropriate path in the NSD file archive.

This file is a TOSCA service template that only contains definitions. The template_version in the metadata section within this template is structured as x.y.z, where x, y and z represent the version of this file and are set respectively to "3", "3" and "1" for this version of the present document. In subsequent versions of the present document, "x", "y" and "z" in the template_version will be incremented only if there are changes in the NSD type definitions.

A TOSCA service template representing an NSD complying with the present document shall contain import statement referencing this file, as defined in clause 5.6.2.

NOTE 2: This file may, but need not, be included in the NSD file archive.

B.4 PNFD type definitions file

All type definitions specified in clause 8 of the present document are contained in the file etsi_nfv_sol001_pnfd_types.yaml which is available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.7.1/etsi_nfv_sol001_pnfd_types.yaml

NOTE: The file etsi_nfv_sol001_pnfd_types.yaml includes a TOSCA import definition referencing etsi_nfv_sol001_common_types.yaml file.

This file is a TOSCA service template that only contains definitions. The template_version in the metadata section within this template is structured as x.y.z, where x, y and z represent the version of this file and are set respectively to "3", "3" and "1" for this version of the present document. In subsequent versions of the present document, "x", "y" and "z" in the template_version will be incremented only if there are changes in the PNFD type definitions.

A TOSCA service template representing a PNFD complying with the present document shall contain import statement referencing this file, as defined in clause 5.6.3.

B.5 Common type definitions file

The type definitions as specified in clause 9 and used by at least two types of deployment templates are contained in the file etsi_nfv_sol001_common_types.yaml which is available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.7.1/etsi_nfv_sol001_common_types.yaml

This file is a TOSCA service template that only contains definitions. The template_version in the metadata section within this template is structured as x.y.z, where x, y and z represent the version of this file and are set respectively to "3", "3" and "1" for this version of the present document. In subsequent versions of the present document, "x", "y" and "z" in the template_version will be incremented only if there are changes in the common type definitions.

NOTE: This file may, but need not, be included in the VNF package or NSD file archive.

Annex C (normative): Conformance

C.1 Purpose

The present document specifies a data model for the VNFD, the NSD and the PNFD, by using the grammar defined in the TOSCA-Simple-Profile-YAML-v1.3 [20]. This annex specifies the requirements to be fulfilled for claiming conformance to the present document.

C.2 NFV TOSCA YAML service template

A VNFD, an NSD or a PNFD conforms to the present document if it complies with all the requirements below:

1) A VNFD conformant to the present document shall comply with the requirements in clause 6 of the present document and to the specification of the elements of the TOSCA-Simple-Profile-YAML-v1.3 [20] it uses, unless otherwise stated in clause 6 of the present document.

2) An NSD conformant to the present document shall comply with the requirements in clause 7 of the present document and to the specification of the elements of the TOSCA-Simple-Profile-YAML-v1.3 [20] it uses, unless otherwise stated in clause 7 of the present document.

3) A PNFD conformant to the present document shall comply with the requirements in clause 8 of the present document and to the specification of the elements of the TOSCA-Simple-Profile-YAML-v1.3 [20] it uses, unless otherwise stated in clause 8 of the present document.

4) When using or referring to the TOSCA normative types listed in table C.2-1, it is valid according to the definitions given in clauses 6, 7, 8 and 9 of the present document and to section 5 of the TOSCA-Simple-Profile-YAML-v1.3 [20].

Table C.2-1: TOSCA normative types used in the present document

Types	VNFD	NSD	PNFD
tosca.datatypes.Root	X	X	X
tosca.artifacts.Deployment.Image	X		
tosca.artifacts.Implementation	X		
tosca.capabilities.Root	X	X	
tosca.capabilities.Node	X	X	X
tosca.relationships.Root	X	X	
tosca.relationships.DependsOn	X	X	X
tosca.interfaces.Root	X	X	
tosca.nodes.Root	X	X	X
tosca.groups.Root	X	X	
tosca.policies.Root	X	X	X
tosca.policies.Placement	X	X	

5) A VNFD conformant to the present document shall comply with VNFD TOSCA service template design specified in clause 6.11 of the present document.

6) A NSD conformant to the present document shall comply with NSD TOSCA service template design specified in clause 7.11 of the present document.

7) A PNFD conformant to the present document shall comply with PNFD TOSCA service template design specified in clause 8.11 of the present document.

8) A VNFD and NSD conformant to the present document shall comply with rules for Type extension defined in clause 5.7 of the present document.

9) When using the TOSCA functions listed in table 5.9-1, it is valid according to section 4 of the TOSCA-Simple-Profile-YAML-v1.3 [20].

C.3 NFV TOSCA processor

A processor or program conforms to the present document as NFV TOSCA processor for VNFD, NFV TOSCA processor for NSD or NFV TOSCA processor for PNFD if it complies with all the requirements below:

1) It can parse and recognize the elements of any VNFD, NSD or PNFD that conform to the present document, and shall generate errors for those documents that fail to conform to the present document.

2) It shall comply with all requirements and implement the semantics associated with the definitions specified in clauses 6, 7, 8 and 9 of the present document.

3) It shall resolve the import definitions, as described in clause 5.6 of the present document.

Annex D (informative): Mapping between properties of TOSCA types and API attributes

D.1 Introduction

This annex provides the mapping between properties of TOSCA types defined in the present document and defined in the following API specifications: ETSI GS NFV-SOL 002 [22], ETSI GS NFV-SOL 003 [i.9], and ETSI GS NFV-SOL 005 [i.10].

NOTE: See also annex A "Mapping operations to protocol elements" of ETSI GS NFV-SOL 002 [22], ETSI GS NFV-SOL 003 [i.9] and ETSI GS NFV-SOL 005 [i.10] for each operation.

D.2 VNFD-related constructs

Table D.2-1 provides the mapping between the properties of TOSCA types related to the VNFD and API attributes, which include: resource or notification data type (and referenced structured data type when available), attribute name and type in the resource or notification data type, and the interface operation in which the data type is used.

NOTE: In the "Data model" column of the table, an arrow "->" indicates the navigation through the resource, notification and referenced structured data types.

Table D.2-1: Mapping of API attributes and TOSCA constructs

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
tosca.nodes.nfv.VNF -> descriptor_id	(Identifier) vnfdId	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfInfoModificationRequest VnfInfoModifications	Modify VNF Information (see SOL002 and SOL003)
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
		VnfPkgInfo	Create VNF package (see SOL005) Query/Read VNF Package Info (see SOL003 and SOL005)
		VnfPackageOnboardingNotification	Notify about VNF Package (see SOL003 and SOL005)
		VnfPackageChangeNotification	Notify about VNF Package (see SOL003 and SOL005)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		UpdateNsRequest -> InstantiateVnfData	Update NS (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedVnf	Notify about NS LCM (see SOL005)
		PkgmSubscriptionRequest -> PkgmNotificationsFilter	Subscription about VNF Package (see SOL003 and SOL005)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
		PkgmSubscription -> PkgmNotificationsFilter	Subscription about VNF Package (see SOL003 and SOL005)
tosca.nodes.nfv.VNF -> provider	(String) vnfProvider	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfPkgInfo	Create VNF package (see SOL005) Query/Read VNF Package Info (see SOL003 and SOL005)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		PkgmSubscriptionRequest -> PkgmNotificationsFilter -> vnfProductsFromProviders	Subscription about VNF Package (see SOL003 and SOL005)
		PkgmSubscription -> PkgmNotificationsFilter -> vnfProductsFromProviders	Subscription about VNF Package (see SOL003 and SOL005)
tosca.nodes.nfv.VNF -> product_name	(String) vnfProductName	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfPkgInfo	Create VNF package (see SOL005) Query/Read VNF Package Info (see SOL003 and SOL005)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		PkgmSubscriptionRequest -> PkgmNotificationsFilter -> vnfProductsFromProviders -> vnfProducts	Subscription about VNF Package (see SOL003 and SOL005)
		PkgmSubscription -> PkgmNotificationsFilter -> vnfProductsFromProviders -> vnfProducts	Subscription about VNF Package (see SOL003 and SOL005)
tosca.nodes.nfv.VNF -> software_version	(Version) vnfSoftwareVersion	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfPkgInfo	Create VNF package (see SOL005) Query/Read VNF Package Info (see SOL003 and SOL005)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		PkgmSubscriptionRequest -> PkgmNotificationsFilter -> vnfProductsFromProviders -> vnfProducts -> versions	Subscription about VNF Package (see SOL003 and SOL005)
		PkgmSubscription -> PkgmNotificationsFilter -> vnfProductsFromProviders -> vnfProducts -> versions	Subscription about VNF Package (see SOL003 and SOL005)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
tosca.nodes.nfv.VNF -> descriptor_version	(Version) vnfdVersion	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfInfoModifications	Modify VNF Information (see SOL002 and SOL003)
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
		VnfPkgInfo	Create VNF package (see SOL005) Query/Read VNF Package Info (see SOL003 and SOL005)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		PkgmSubscriptionRequest -> PkgmNotificationsFilter -> vnfProductsFromProviders -> vnfProducts -> versions	Subscription about VNF Package (see SOL003 and SOL005)
		PkgmSubscription -> PkgmNotificationsFilter -> vnfProductsFromProviders -> vnfProducts -> versions	Subscription about VNF Package (see SOL003 and SOL005)
tosca.nodes.nfv.VNF -> configurable_properties	(KeyValuePairs) vnfConfigurableProperties	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		VnfInfoModificationRequest VnfInfoModifications	Modify VNF Information (see SOL002 and SOL003)
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
		ChangeCurrentVnfPkgRequest	Change current VNF package (see SOL002 and SOL003)
tosca.nodes.nfv.VNF ->flavour_id	(IdentifierInVnfd) flavourId	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		InstantiateVnfRequest	Instantiate VNF (see SOL002 and SOL003)
		GrantRequest	Grant Lifecycle Operation (see SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo	Query NS (see SOL005)
	(IdentifierInVnfd) vnfFlavourId	UpdateNsRequest -> instantiateVnfData	Update NS (see SOL005)
	(IdentifierInVnfd) newFlavourId	ChangeVnfFlavourRequest	Change VNF Flavour (see SOL002 and SOL003)
		UpdateNsRequest -> ChangeVnfFlavourData	Update NS (see SOL005)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
tosca.policies.nfv.ScalingAspects ->aspects[key]	(IdentifierInVnfd) aspectId	VnfInstance -> instantiatedVnfInfo -> ScaleInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		ScaleVnfRequest	Scale VNF (see SOL002 and SOL003)
		ScaleVnfToLevelRequest -> ScaleInfo	Scale VNF to level (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> ScaleInfo	Query NS (see SOL005)
tosca.datatypes.nfv.ScaleInfo ->scale_level	(Integer) scaleLevel	VnfInstance -> instantiatedVnfInfo -> ScaleInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		ScaleVnfToLevelRequest -> ScaleInfo	Scale VNF to level (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> ScaleInfo	Query NS (see SOL005)
Node template name of type tosca.nodes.nfv.VnfExtCp	(IdentifierInVnfd) cpdId	VnfInstance -> instantiatedVnfInfo -> VnfExtCpInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		InstantiateVnfRequest -> ExtVirtualLinkData -> VnfExtCpData	Instantiate VNF (see SOL002 and SOL003)
		ChangeVnfFlavourRequest -> ExtVirtualLinkData -> VnfExtCpData	Change VNF Flavour (see SOL002 and SOL003)
		ChangeExtVnfConnectivityRequest -> ExtVirtualLinkData -> VnfExtCpData	Change External VNF Connectivity (see SOL002 and SOL003)
		Grant ->ExtVirtualLinkData ->VnfExtCpData	Grant Lifecycle Operation (see SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> VnfExtCpInfo	Query NS (see SOL005)
	(IdentifierInVnfd) resourceTemplateId	GrantRequest -> ResourceDefinition	Grant Lifecycle Operation (see SOL003)
Node template name of type tosca.nodes.nfv.VnfVirtualLink	(IdentifierInVnfd) vnfVirtualLinkDescId	VnfInstance -> instantiatedVnfInfo -> ExtManagedVirtualLinkInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfInstance -> instantiatedVnfInfo -> VnfVirtualLinkResourceInfo	Query VNF (see SOL003)
		InstantiateVnfRequest -> ExtManagedVirtualLinkData	Instantiate VNF (see SOL002 and SOL003)
		ChangeVnfFlavourRequest -> ExtManagedVirtualLinkData	Change VNF Flavour (see SOL002 and SOL003)
		VnfLcmOpOcc -> resourceChanges -> AffectedVirtualLink	Get Operation Status (see SOL002 and SOL003)
		Grant -> ExtManagedVirtualLinkData	Grant Lifecycle Operation (see SOL003)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> ExtManagedVirtualLinkInfo	Query NS (see SOL005)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> VnfVirtualLinkResourceInfo	Query NS (see SOL005)
	(IdentifierInVnfd) vnfVirtualLinkDescId	UpdateNsRequest -> InstantiateVnfData -> ExtManagedVirtualLinkData	Update NS (see SOL005)
tosca.datatypes.nfv.VnfMonitoringParameter	(IdentifierInVnfd) id	VnfInstance -> instantiatedVnfInfo -> MonitoringParameter	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> MonitoringParameter	Query NS (see SOL005)
tosca.datatypes.nfv.VnfMonitoringParameter ->name	(String) name	VnfInstance -> instantiatedVnfInfo -> MonitoringParameter	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> MonitoringParameter	Query NS (see SOL005)
tosca.nodes.nfv.VNF ->localization_languages	(String) localizationLanguage	VnfInstance -> instantiatedVnfInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo	Query NS (see SOL005)
Node template name of type tosca.nodes.nfv.Vdu.Compute	(IdentifierInVnfd)vduId	VnfInstance -> instantiatedVnfInfo -> VnfcResourceInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfInstance -> instantiatedVnfInfo -> VnfcInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfLcmOpOcc -> resourceChanges -> AffectedVnfc	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> AffectedVnfc	Notify about VNF LCM (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> VnfcResourceInfo	Query NS (see SOL005)
	(IdentifierInVnfd) vnfdVirtualComputeDescId	Grant -> vimAssets -> VimConputeResourceFlavour	Grant Lifecycle Operation (see SOL003)
Node template name of type tosca.nodes.nfv.VduCp	(IdentifierInVnfd) cpdId	VnfInstance -> instantiatedVnfInfo -> VnfcResourceInfo -> vnfcCpInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfInstance -> instantiatedVnfInfo -> VnfExtCpInfo See note 3.	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
		InstantiateVnfRequest -> ExtVirtualLinkData -> VnfExtCpData See note 3.	Instantiate VNF (see SOL002 and SOL003)
		ChangeVnfFlavourRequest -> ExtVirtualLinkData -> VnfExtCpData See note 3.	Change VNF Flavour (see SOL002 and SOL003)
		ChangeExtVnfConnectivityRequest -> ExtVirtualLinkData -> VnfExtCpData See note 3.	Change External VNF Connectivity (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> VnfExtCpInfo See note 3.	Query NS (see SOL005)
	(IdentifierInVnfd) resourceTemplateId See note 3.	GrantRequest -> ResourceDefinition See note 3.	Grant Lifecycle Operation (see SOL003)
Node template name of type tosca.nodes.nfv.Vdu.VirtualBlockStorage Node template name of type tosca.nodes.nfv.Vdu.VirtualObjectStorage Node template name of type tosca.nodes.nfv.Vdu.VirtualFileStorage	(IdentifierInVnfd) virtualStorageDescId	VnfInstance -> instantiatedVnfInfo -> VirtualStorageResourceInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnfLcmOpOcc -> resourceChanges -> AffectedVirtualStorage	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> AffectedVirtualStorage	Notify about VNF LCM (see SOL002 and SOL003)
		NsInstance -> VnfInstance -> instantiatedVnfInfo -> VirtualStorageResourceInfo	Query NS (see SOL005)
	(IdentifierInVnfd) resourceTemplateId	GrantRequest -> ResourceDefinition	Grant Lifecycle Operation (see SOL003)
tosca.datatypes.nfv.VnfInfoModifiableAttributes ->metadata	(KeyValuePairs) metadata	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		CreateVnfRequest	Create VNF Identifier (see SOL002 and SOL003)
		VnfInfoModificationRequest VnfInfoModifications	Modify VNF Information (see SOL002 and SOL003)
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
tosca.datatypes.nfv.VnfInfoModifiableAttributes ->extensions	(KeyValuePairs) extensions	VnfInstance	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnfInstance	Query NS (see SOL005)
		InstantiateVnfRequest	Instantiate VNF (see SOL002 and SOL003)
		VnfInfoModificationRequest VnfInfoModifications	Modify VNF Information (see SOL002 and SOL003)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNotification -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
		ChangeCurrentVnfPkgRequest	Change current VNF package (see SOL002 and SOL003)
tosca.policies.nfv.InstantiationLevel ->levels[key]	(IdentifierInVnfd) instantiationLevelId	InstantiateVnfRequest	Instantiate VNF (see SOL002 and SOL003)
		ScaleVnfToLevelRequest	Scale VNF to level (see SOL002 and SOL003)
		ChangeVnfFlavourRequest	Change VNF Flavour (see SOL002 and SOL003)
		GrantRequest	Grant Lifecycle Operation (see SOL003)
		UpdateNsRequest -> changeVnfFlavourData See note 4.	Update NS (see SOL005)
	(IdentifierInVnfd) vnfInstantiationLevelId	UpdateNsRequest -> InstantiateVnfData See note 4.	Update NS (see SOL005)
		ScaleNsRequest -> ScaleVnfData -> ScaleToLevelData	Scale NS (see SOL005)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the instantiate operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	InstantiateVnfRequest	Instantiate VNF (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the scale operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	ScaleVnfRequest	Scale VNF (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the 'scale to level' operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	ScaleVnfToLevelRequest	Scale VNF to level (see [22] and [i.9])l
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the 'change vnf flavour operation' of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	ChangeVnfFlavourRequest	Change VNF Flavour (see SOL002 and SOL003)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the operate operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	OperateVnfRequest	Operate VNF (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the heal operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	HealVnfRequest	Heal VNF (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the 'change external vnf connectivity' operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	ChangeExtVnfConnectivityRequest	Change External VNF Connectivity (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the terminate operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	TerminateVnfRequest	Terminate VNF (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the create snapshot operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	CreateVnfSnapshotRequest	CreateVNFSnapshot (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the revert to snapshot operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	RevertToVnfSnapshotRequest	RevertToVNFSnapshot (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOperationAdditionalParameters in the inputs of the Change current VNF operation of the Vnflcm or ChangeCurrentVnfPackage interface. See note 2	(KeyValuePairs) additionalParams	ChangeCurrentVnfPkgRequest	Change current VNF package (see SOL002 and SOL003)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
name of type tosca.nodes.nfv.Vdu.Compute Node template name of type tosca.nodes.nfv.Vdu.VirtualBlockStorage	(IdentifierInVnfd) id	VnfPkgInfo -> VnfPackageSoftwareImageInfo	Create VNF Package Info (see SOL005) Query VNF Package Info (see SOL005)
Name of attribute for VNF indicator in VNF node	(IdentifierInVnfd) Id	VnfIndicator	Get indicator value (see SOL002 and SOL003)
		VnfIndicatorValueChangeNotification	Notify about VNF indicator value change (see SOL002 and SOL003).
Name of attribute for VNF indicator in VNF	(String) Name	VnfIndicator	Get indicator value (see SOL002 and SOL003)
	(IdentifierInVnfd) vnfIndicatorId	VnfIndicatorValueChangeNotification	Notify about VNF indicator value change (see SOL002 and SOL003).
Value of attribute for VNF indicator in VNF node	(Object) value	VnfIndicator	Get indicator value (see SOL002 and SOL003)
		VnfIndicatorValueChangeNotification	Notify about VNF indicator value change (see SOL002 and SOL003).
Node template name of type tosca.nodes.nfv.Vdu.Compute Node template name of type tosca.nodes.nfv.Vdu.VirtualBlockStorage	(IdentifierInVnfd) vnfdSoftwareImageId	Grant -> vimAssets -> VimSoftwareImage	Grant Lifecycle Operation (see SOL003)
tosca.datatypes.nfv.VnfPackageChangeSelector -> destination_descriptor_id	(Identifier) vnfdId	ChangeCurrentVnfPkgRequest	Change current VNF package (see SOL002 and SOL003)
tosca.policies.nfv.LcmCoordinationsForLcmOperation ->actions -> referenced_coordination_actions	coordinationActionName	LcmCoordRequest LcmCoord	CoordinateLcmOperation for VNF LCM (see SOL002)
tosca.policies.nfv.LcmCoordinationsForLcmOperation ->actions -> referenced_coordination_actions	coordinationActionName	LcmCoordRequest LcmCoord	CoordinateLcmOperation for Change current VNF package (see SOL002)
Properties of tosca.datatypes.nfv.InputOpCoordParams See note 2	inputParameters	LcmCoordRequest	CoordinateLcmOperation for VNF LCM and Change current VNF package (see SOL002)
Properties of tosca.datatypes.nfv.OutputOpCoordParams See note 2	outputParameters	LcmCoord	CoordinateLcmOperation for VNF LCM and Change current VNF package (see SOL002)
Properties of tosca.datatypes.nfv.VnfcConfigurableProperties	(KeyValuePairs) vnfcConfigurableProperties	VnfInfoModificationRequest VnfInfoModifications	Modify VNF Information (see SOL002)

ETSI GS NFV-SOL 001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
tosca.datatypes.nfv.L3ProtocolData -> cidr -> ip_allocation_pools -> gateway_ip -> dhcp_enabled -> ipv6_address_mode	n/a (see note 5)	n/a (see note 5)	n/a (see note 5)

NOTE 1: The entry "SOL002" in the "Operation" column refers to ETSI GS NFV-SOL 002 [22], "SOL003" refers to ETSI GS NFV-SOL 003 [i.9] and "SOL005" refers to ETSI GS NFV-SOL 005 [i.10].
NOTE 2: This is an empty base type to be extended to a VNF specific type per LCM operation. The extended VNF specific and LCM operation specific type is the one that actually maps to the additionalParams in the API.
NOTE 3: Only when VduCp is re-exposed as VnfExtCp.
NOTE 4: Additional mappings corresponding to input parameter sets of VNF LCM operations in UpdateNS requests may be added in future versions of the present document.
NOTE 5: The present document specifies that these properties may be overridden at runtime. However, ETSI GS NFV-SOL 002 [22] and ETSI GS NFV-SOL 003 [i.9] do not define standard attributes to provide values to override these.

D.3 NSD-related constructs

Table D.3-1 provides the mapping between the properties of TOSCA types related to the NSD and API attributes, which include: resource or notification data type (and referenced structured data type when available), attribute name and type in the resource or notification data type, and the interface operation in which the data type is used.

NOTE: In the "Data model" column of the table, an arrow "->" indicates the navigation through the resource, notification and referenced structured data types.

Table D.3-1: Mapping of API attributes and TOSCA constructs

ETSI GS NFV-SOL001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
tosca.nodes.nfv.NS -> descriptor_id	(Identifier) nsdIds	LccnSubscriptionRequest -> LifecycleChangeNotificationsFilter -> NsInstanceSubscriptionFilter	Subscription to NS LCM notifications (see SOL005)
	(Identifier) nsdId	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdOnboardingNotification	Notification about NSD management (see SOL005)
		NsdOnboardingFailureNotification	
		NsdChangeNotification	
		NsdDeletionNotification	
		NsdmSubscriptionRequest -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		NsdmSubscription -> NsdmNotificationsFilter	
		CreateNsRequest	Create NS (see SOL005)
		NsInstance	Create NS Query NS Delete NS (see SOL005)
		NsLcmOpOcc -> AffectedNs	Query/read about NS LCM operation occurrence (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedNs	Notification about NS LCM (see SOL005)

ETSI GS NFV-SOL001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
	(Identifier) newNsdId	UpdateNsRequest -> AssocNewNsdVersionData	Update NS (see SOL005)
tosca.nodes.nfv.NS -> name	(String) nsdName	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdmSubscriptionRequest -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		NsdmSubscription -> NsdmNotificationsFilter	
tosca.nodes.nfv.NS -> version	(Version) nsdVersion	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdmSubscriptionRequest -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		NsdmSubscription -> NsdmNotificationsFilter	
tosca.nodes.nfv.NS -> designer	(String) nsdDesigner	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdmSubscriptionRequest -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		NsdmSubscription -> NsdmNotificationsFilter	
tosca.nodes.nfv.NS -> invariant_id	(Identifier) nsdInvariantId	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdmSubscriptionRequest -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		NsdmSubscription -> NsdmNotificationsFilter	
tosca.nodes.nfv.NS -> flavour_id	(IdentifierInNsd) flavourId	NsInstance	Create NS Query NS Delete NS (see SOL005)
	(IdentifierInNsd) nsFlavourId	InstantiateNsRequest	Instantiate NS (see SOL005)
	(IdentifierInNsd) newNsFlavourId	UpdateNsRequest -> ChangeNsFlavourData	Update NS (see SOL005)
Node template name of type tosca.nodes.nfv.NsVirtualLink	(IdentifierInNsd) nsVirtualLinkDescId	NsLcmOperationOccurrenceNotification -> AffectedVirtualLink	Notification about NS LCM (see SOL005)
		NsInstance -> NsVirtualLinkInfo	Create NS Query NS Delete NS (see SOL005)
(No related property in type "tosca.datatype.nfv.NsVlProfile") See note 2	(IdentifierInNsd) nsVirtualLinkProfileId	NsInstance -> NsVirtualLinkInfo	Create NS Query NS Delete NS (see SOL005)
	(IdentifierInNsd) vlProfileId	NsLcmOperationOccurrenceNotification -> AffectedVirtualLink	Notification about NS LCM (see SOL005)
See note 2	(IdentifierInNsd) nsInstantiationLevelId	InstantiateNsRequest	Instantiate NS (see SOL005)
	(IdentifierInNsd) instantiationLevelId	UpdateNsRequest -> ChangeNsFlavourData	Update NS (see SOL005)
	(IdentifierInNsd) nsInstantiationLevel	ScaleNsRequest -> ScaleNsData -> ScaleNsToLevelData	Scale NS (see SOL005)

ETSI GS NFV-SOL001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
Node template name in NSD of type derived from tosca.nodes.nfv.NS	(IdentifierInNsd) nsProfileId	UpdateNsRequest -> NestedNsInstanceData	Update NS (see SOL005)
		InstantiateNsRequest -> NestedNsInstanceData	Instantiate NS (see SOL005)
		InstantiateNsRequest -> ParamsForNestedNs	
Node template name in NSD of type derived from tosca.nodes.nfv.VNF	(IdentifierInNsd) vnfProfileId	NsLcmOpOcc -> AffectedVnf	Query/read information about NS LCM (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedVnf	Notification about NS LCM (see SOL005)
		NsInstance -> NsAffinityOrAntiAffinityRule	Create NS Query NS Delete NS (see SOL005)
		InstantiateNsRequest -> NsAffinityOrAntiAffinityRule	Instantiate NS (see SOL005)
		InstantiateNsRequest -> ParamsForVnf	
		InstantiateNsRequest -> VnfLocationConstraint	
		InstantiateNsRequest -> VnfInstanceData	
		ScaleNsRequest -> ScaleNsData -> VnfLocationConstraint	Scale NS (see SOL005)
		ScaleNsRequest -> ScaleNsData -> VnfInstanceData	
		UpdateNsRequest -> VnfInstanceData	Update NS (see SOL005)
tosca.nodes.nfv.PNF -> descriptor_id	(Identifier) pnfdIds	LccnSubscriptionRequest -> LifecycleChangeNotificationsFilter -> NsInstanceSubscriptionFilter	Subscription to NS LCM (see SOL005)
	(Identifier) pnfdId	PnfdOnboardingNotification	Notification about NSD management (see SOL005)
		PnfdOnboardingFailureNotification	
		PnfdDeletionNotification	
		NsLcmOpOcc -> AffectedPnf	Query/read information about NS LCM (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedPnf	Notification about NS LCM (see SOL005)
		NsInstance -> PnfInfo	Create NS Query NS Delete NS (see SOL005)
		InstantiateNsRequest -> AddPnfData	Instantiate NS (see SOL005)
		UpdateNsRequest -> AddPnfData	Update NS (see SOL005)
tosca.nodes.nfv.PNF -> name	(String) pnfdName	NsInstance -> PnfInfo	Create NS Query NS Delete NS (see SOL005)
tosca.nodes.nfv.PNF -> version	(Version) pnfdVersion	NsInstance -> PnfInfo	Create NS Query NS Delete NS (see SOL005)
tosca.nodes.nfv.PNF -> provider	(String) pnfdProvider	NsInstance -> PnfInfo	Create NS Query NS Delete NS (see SOL005)

ETSI GS NFV-SOL001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
tosca.nodes.nfv.PNF -> descriptor_invariant_id	(Identifier) pnfdInvariantId	NsInstance -> PnfInfo	Create NS Query NS Delete NS (see SOL005)
Node template name in NSD of type derived from tosca.nodes.nfv.PNF	(IdentifierInNsd) pnfProfileId	NsLcmOpOcc -> AffectedPnf	Query/read information about NS LCM Fail NS LCM (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedPnf	Notification about NS LCM (see SOL005)
		NsInstance -> PnfInfo	Create NS Query NS Delete NS (see SOL005)
		InstantiateNsRequest -> AddPnfData	Instantiate NS (see SOL005)
		UpdateNsRequest -> AddPnfData	Update NS (see SOL005)
Node template name of type tosca.nodes.nfv.Cp	(IdentifierInNsd) cpdId	InstantiateNsRequest -> AddPnfData -> PnfExtCpData	Instantiate NS (see SOL005)
		UpdateNsRequest -> AddPnfData -> PnfExtCpData	Update NS (see SOL005)
		UpdateNsRequest -> ModifyPnfData -> PnfExtCpData	
		NsInstance -> PnfInfo -> PnfExtCpInfo	Create NS Query NS Delete NS (see SOL005)
Group template name of type tosca.groups.nfv.VNFFG	(IdentifierInNsd) vnffgdId	NsLcmOpOcc -> AffectedVnffg	Query/read information about NS LCM Fail NS LCM (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedVnffg	Notification about NS LCM (see SOL005)
		UpdateNsRequest -> AddVnffgData	Update NS (see SOL005)
		UpdateNsRequest -> UpdateVnffgData -> VnffgInfo	
See note 2	(IdentifierInNsd) aspectId	ScaleNsRequest -> ScaleNsData -> ScaleNsByStepsData	Scale NS (see SOL005)
	(IdentifierInNsd) nsScalingAspectId	ScaleNsRequest -> ScaleNsData -> ScaleNsToLevelData -> NsScaleInfo	
Name of the policy of type tosca.policies.nfv.NsMonitoring	(IdentifierInNsd) id	NsInstance -> NsMonitoringParameter	Create NS Query NS Delete NS (see SOL005)
tosca.policies.nfv.NsMonitoring -> ns_monitoring_parameters -> name	(String) name	NsInstance -> NsMonitoringParameter	Create NS Query NS Delete NS (see SOL005)
See note 2	(Identifier) vnfPkgIds	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)

ETSI GS NFV-SOL001 (the present document)	SOL APIs		
Type and Property or entity name	**Type and attribute name**	**Data model**	**Operation (see note 1)**
		NsdmSubscriptionRequest -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		NsdmSubscription -> NsdmNotificationsFilter	
See note 2	(IdentifierInNsd) healScript	HealNsRequest -> HealNsData	Heal NS (see SOL005)
See note 2	(IdentifierInNsd) aspectId	ScaleNsRequest -> ScaleNsData -> ScaleNsByStepsData	Scale NS (see SOL005)
	(IdentifierInNsd) nsScalingAspectId	ScaleNsRequest -> ScaleNsData -> ScaleNsToLevelData -> NsScaleInfo	
Node template name of type tosca.nodes.nfv.Sap	(IdentifierInNsd) sapdId	NsInstance -> SapInfo	Query NS (see SOL005)
		InstantiateNsRequest -> SapData	Instantiate NS (see SOL005)
		UpdateNsRequest -> SapData	Update NS (see SOL005)
		NsLcmOpOcc -> AffectedSap	Query/read information about NS LCM operation occurrence (see SOL005)
		NsLcmOperationOccurrenceNotification -> AffectedSap	Notification about NS LCM (see SOL005)

NOTE 1: The entry "SOL005" refers to ETSI GS NFV-SOL 005 [i.10].
NOTE 2: The corresponding TOSCA construct is not included in the present document, the mapping may be updated in future versions of the present document.

Annex E (informative): TOSCA Imperative workflows

E.1 Purpose

This annex specifies TOSCA Imperative workflows for the NSD and the VNFD by using the grammar defined in TOSCA Simple Profile-YAML-v1.3 [20].

E.2 TOSCA Imperative workflows for the NSD

E.2.1 Introduction

TOSCA Imperative workflows based on TOSCA-Simple-Profile-YAML-v1.3 [20] may be used by the NFVO to fulfil the NS LCM operations described in ETSI GS NFV-IFA 013 [i.8]. TOSCA Imperative workflows provide an additional method for implementation of LCM operations in the Nslcm interface defined in clause 7.7.1.1 of the present document.

NOTE: Even if TOSCA Imperative workflows is described in the NSD, the NFVO will still process the NSD with Nslcm operations as defined in clause 7.7.1.1. Since this is an additional method for implementation of NS LCM operations, execution of workflows instead of NS LCM operations is optional and up to the NFVO implementation.

TOSCA Imperative workflows defined in the NSD describe procedures for the NFVO to manage the lifecycle of network services.

Workflows are comprised of steps associated with the NS LCM operations and additional steps that are preamble and postamble to the execution of the former steps. The name of the preamble and postamble steps is constructed according to the following pattern:

- <NS_LCM_base_operation_workflow_name>_start_<step_name> for preamble steps
- <NS_LCM_base_operation_workflow_name>_end_<step_name> for postamble steps

Preamble steps are specified before the execution of workflow steps. Postamble steps are specified after the execution of workflow steps.

External and internal stimuli described in clause 7.7.1.4 of the present document, are mapped to workflows as below:

- External stimuli are mapped to TOSCA Imperative workflows, i.e. <NS_LCM_base_operation_workflow_name>
- Internal stimuli are mapped to preamble and postamble steps of the workflow

E.2.2 Definition of an NS workflow

The syntax of TOSCA Imperative workflows for LCM operations on the NS has the following definition:

```
  workflows:
    description:  TOSCA Imperative workflows corresponding to NS LCM operations defined in ETSI
GS NFV-IFA 013.
    instantiate:
      description:  This workflow is invoked upon receipt of an Instantiate NS request
      # inputs:
      steps:
        instantiate_start_<step_name>:  # Invoked before steps for instantiate LCM operation
        # steps for instantiate workflow
        instantiate_end_<step_name> :  # Invoked after steps for instantiate  LCM operation

    terminate:
      description:  This workflow is invoked upon receipt of Terminate NS request
```

```
      # inputs:
      steps:
        terminate_start_<step_name> :  # Invoked before steps for terminate LCM operation
        # steps for terminate workflow
        terminate_end_<step_name>:  # Invoked after steps for terminate LCM operation
```

E.2.3 Examples

The following example template fragment, based on clause A.8 of the present document, illustrates the use of TOSCA Imperative workflows for NS LCM operations.

When the NFVO executes TOSCA Imperative workflows in the NSD, it uses standard APIs for LCM operations defined in the Or-Vnfm interface and delegates the task to VNFM; The VNFM in turn executes corresponding TOSCA Operations on the VNF, as explained in clause 6.7.1 of the present document.

NOTE 1: The NSD consumer makes available all parameters from the message invoking the NS base LCM operation as inputs to the corresponding TOSCA workflows. The additional parameters for NS base LCM operations are defined as workflow inputs.

NOTE 2: It is out of scope of the present document to specify mapping of SOL003/SOL005 API execution results with the success and failure of workflows.

```
tosca_definitions_version: tosca_simple_yaml_1_3

description: NS TOSCA Imperative Workflows

imports:
  - etsi_nfv_sol001_nsd_types.yaml  # all of NSD related TOSCA types as defined in ETSI GS NFV-SOL
001
  - example_vnf1.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF1 node
type definition, this file might be included in the NSD file structure
  - example_vnf2.yaml # uri of the yaml file which contains the tosca.nodes.nfv.example_VNF2 node
type definition, this file might be included in the NSD file structure

data_types:
  MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters:
    derived_from: tosca.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
        default: value_1
      parameter_2:
        type: string
        required: true
        default: value_2

node_types:
  tosca.example_NS:
    derived_from: tosca.nodes.nfv.NS
    properties:
      descriptor_id:
        type: string
        constraints: [ equal: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177 ]
        default: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
      designer:
        type: string
        constraints: [ equal: MyCompany ]
        default: MyCompany
      name:
        type: string
        constraints: [ equal: ExampleService ]
        default: ExampleService
      version:
        type: string
        constraints: [ equal: '1.0' ]
        default: '1.0'
      invariant_id:
        type: string
        constraints: [ equal: 1111-2222-aaaa-bbbb ]
        default: 1111-2222-aaaa-bbbb
      flavour_id:
        type: string
        constraints: [ equal: simple ]
```

```
        default: simple

topology_template:
  substitution_mappings:
    node_type: tosca.example_NS
    requirements:
      virtual_link: [ VNF_2, virtual_link_2 ] # the External connection point of
                                              # VNF_2 is exposed as the Sap

  node_templates:
# This abstract node template enables the NSD author to use Nslcm scripts if he does #not use
workflows.
    my_service:
      type: tosca.example_NS
      properties:
        descriptor_id: b1bb0ce7-ebca-4fa7-95ed-4840d70a1177
        designer: MyCompany
        name: ExampleService
        version: '1.0'
        invariant_id: 1111-2222-aaaa-bbbb
        flavour_id: simple
      interfaces:
        Nslcm:
          operations:
            instantiate:
              implementation: instantiate.workflow.yaml
            terminate:
              implementation: terminate.workflow.yaml

    VNF_1:
      type: tosca.nodes.nfv.example_VNF1
      properties:
        # no property assignments needed for required properties that have a default #value assigned
in the node type definition, e.g. descriptor_id
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 2
          max_number_of_instances: 6
      requirements:
        - virtual_link: NsVirtualLink_1
# Additional parameters input to be defined in the VNFD of VNF_1.
 #      interfaces:
  #      Vnflcm:
  #        operations:
  #          instantiate: . . .
  #          terminate: . . .

    VNF_2:
      type: tosca.nodes.nfv.example_VNF2
      properties:
        flavour_id: simple
        vnf_profile:
          instantiation_level: level_1
          min_number_of_instances: 1
          max_number_of_instances: 3
      requirements:
        - virtual_link_1: NsVirtualLink_1
  #      - virtual_link_2: # map to virtual_link requirement of the NS node
        - dependency: VNF_1

# Additional parameters input to be defined in the VNFD of VNF_2.
 #    interfaces:
 #      Vnflcm:
 #        operations:
 #          instantiate: . . .
 #          terminate: . . .

    NsVirtualLink_1:
      type: tosca.nodes.nfv.NsVirtualLink
      properties:
        connectivity_type:
          layer_protocols: [ipv4]
          flow_pattern: mesh
        vl_profile:
          max_bitrate_requirements:
             root: 1000
          min_bitrate_requirements:
```

```
            root: 1000

  workflows:
    instantiate: #instantiate workflow
      inputs:
        additional_parameters:
          type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters
          required: false
      steps:
        # preamble steps for instantiate operation. These correspond to preparatory #steps internal
to the NFVO before instantiate operation

        instantiate_start_step_1:
           #. .  .
           target: my_service
           activities: []
           on_success:
            - create_VNF_1


        # steps for instantiate workflow
        create_VNF_1:   # Step: Instantiate VNF_1
          target: VNF_1
          activities:
            - call_operation: Vnflcm.instantiate
# invoking Vnflcm.instantiate operation enables NFVO to use internal implementation of
#Vnflcm.instantiate operation which results in an ETSI GS NFV-SOL 003 API call towards #the VNFM to
call VnfInstantiate operation. This enables VNFM to execute LCM operations #to deploy VNF_1
          on_success:
           - create_VNF_2
  #     . . .

        create_VNF_2:   # Step: Instantiate VNF_2
          target: VNF_2
          activities:
            - call_operation: Vnflcm.instantiate
 # invoking Vnflcm.instantiate operation enables NFVO to use internal implementation of
#Vnflcm.instantiate operation which results in an ETSI GS NFV-SOL 003 API call towards #the VNFM to
call VnfInstantiate operation. This enables VNFM to execute LCM operations #to deploy VNF_2
          on_success:
            - instantiate_end_step_1
#. . .
        # postamble steps for instantiate operation. These correspond to closing steps #internal to
the NFVO after instantiate operation.

        instantiate_end_step_1:
          #. . .
           target: my_service
           activities: []

    terminate: #terminate workflow
      steps:
        # preamble steps for terminate operation. These correspond to preparatory #steps internal to
the NFVO before terminate operation.
        terminate_start_step_1:
   #       . . .
          target: my_service
          activities: []
          on_success:
            - terminate_VNF_2

        # steps for terminate workflow
        terminate_VNF_1:   # Step: Terminate VNF_1
          target: VNF_1
          activities:
            - call_operation: Vnflcm.terminate
# invoking Vnflcm.terminate operation enables NFVO to use internal implementation of
#Vnflcm.terminate operation which results in an ETSI GS NFV-SOL 003 API call towards #the VNFM to
call VnfTerminate operation. This enables VNFM to execute LCM operations #to terminate VNF_1
          on_success:
            - terminate_end_step_1
   #    . . .

        terminate_VNF_2:   # Step: Terminate VNF_2
          target: VNF_2
          activities:
            - call_operation: Vnflcm.terminate
```

```
 # invoking Vnflcm.terminate operation enables NFVO to use internal implementation of
#Vnflcm.terminate operation which results in an ETSI GS NFV-SOL 003 API call towards #the VNFM to
call VnfTerminate operation. This enables VNFM to execute LCM operations #to terminate VNF_2
          on_success:
            - terminate_VNF_1
            #. . .
        # post amble steps for terminate operation. These correspond to closing steps #internal to
the NFVO after terminate operation.

        terminate_end_step_1:
           target: my_service
           activities: []
 #         . . .
```

NOTE 3: As the on_success keyword is not used between steps inside the workflow for NS LCM base operation, the order of execution is decided by the NFVO.

NOTE 4: As the on_failure keyword is not present inside the workflow for NS LCM base operation, the error handling is decided by the NFVO.

Annex F (informative): Non-Backward Compatible Changes in the GS

F.1 Introduction

This annex provides the list of non-backward compatible changes during the development of the present document.

A change introduced in version n of the present document is non-backward compatible if a service template written according to a previous version n-1 of the present document, i.e. a service template that has not been updated according to this change, is invalid with respect to this change for a NFVO/VNFM compliant to version n of the present document.

This annex focuses on compatibility from a descriptor view point. It does not evaluate whether a change made to the present document leads to non-backward compatible changes on the APIs referenced in annex D of the present document.

F.2 Non-Backward Compatible changes between version 2.7.1 and 2.6.1

Table F.2-1 provides a list of non-backward compatible changes between version 2.6.1 and version 2.7.1 of the present document.

Table F.2-1: Non-backward compatible changes

No.	Description	Clause
1	nfvi_constraints type changed from list of string to map of string.	6.8.3
2	The definition of SecurityGroupRule is changed in version 2.7.1, a new policy type tosca.policies.nfv.Abstract.SecurityGroupRule is introduced in the definition, which SecurityGroupRule policy is derived from.	6.10.13
3	PlacementGroup used to be applied for both VNFD and NSD in version 2.6.1, but in version 2.7.1, it is only applied to VNFD.	6.9
4	AffinityRule, AntiAffinityRule used to be applied for both VNFD, NSD in version 2.6.1, but in version 2.7.1, it is only applied to VNFD.	6.10.10
5	SecurityGroupRule policy type used to be applied for VNFD, PNFD and NSD in version 2.6.1, but in version 2.7.1, it is only applied to VNFD.	6.10.13
6	boot_order type changed from list of string to Boolean.	6.8.3
7	boot_data type changed from string to BootData data type.	6.8.3

F.3 Non-Backward Compatible changes between version 2.8.1 and 3.3.1

Table F.3-1 provides a list of non-backward compatible changes between version 2.8.1 and version 3.3.1 of the present document.

Table F.3-1: Non-backward compatible changes

No.	Description	Clause
1	Multiple VNF deployment flavour design changed from using TOSCA v 1.2 grammar to TOSCA v 1.3 grammar: • In the top level service templates, removing the imports for lower level service templates. See note. • In the low level service templates, use of substitution filter instead of property mapping.	6.11.2
2	Multiple NS deployment flavour design changed from using TOSCA v 1.2 grammar to TOSCA v 1.3 grammar: • In the top level service templates, removing the imports for lower level service templates. See note. • In the low level service templates, use of substitution filter instead of property mapping.	7.11.2
NOTE:	Instead the low level service templates are declared in the Other-Definitions of the TOSCA.meta file as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].	

F.4 Non-Backward Compatible changes between version 3.3.1 and 3.5.1

Table F.4-1 provides a list of non-backward compatible changes between version 3.3.1 and version 3.5.1 of the present document.

Table F.4-1: Non-backward compatible changes

No.	Description	Clause
1	In VNF, Vdu.Compute and VnfVirtualLink node type definition, the type of monitoring_parameters changed from list to map.	6.8.1, 6.8.3, 6.8.9
2	In NsMonitoring policy definition, the type of ns_monitoring_parameters changed from list to map.	7.10.4
3	In VnfMonitoring policy definition, the type of vnf_monitoring_parameters changed from list to map.	7.10.5

F.5 Non-Backward Compatible changes between version 3.5.1 and 3.6.1

Table F.5-1 provides a list of non-backward compatible changes between version 3.5.1 and 3.6.1 version of the present document.

Table F.5-1: Non-backward compatible changes

No.	Description	Clause
1	In VnfConfigurableProperties data type definition, the type of vnfm_interface_info changed to a list.	6.2.31
2	In VirtualNetworkInterfaceRequirements data type definition, support_mandatory property is removed.	6.2.4

F.6 Non-Backward Compatible changes between version 3.6.1 and 3.7.1

Table F.6-1 provides a list of non-backward compatible changes between version 3.6.1 and version 3.7.1 of the present document.

Table F.6-1: Non-backward compatible changes

No.	Description	Clause
1	In the VirtualFileStorageData data type, constraints have been added on the file_system_protocol property values.	6.2.41

Annex G (informative): Change History

Date	Version	Information about changes
2016.05	0.0.1	Implemented NFVSOL(16)000005r1_GS_NFV_SOL001_ToC
2016.07	0.02	Implemented NFVSOL(16)000026r1, NFVSOL(16)000027r1, NFVSOL(16)000028r2
2017.09	0.1.0	Implemented NFVSOL(17)000539r3, NFVSOL(17)000540r3, NFVSOL(17)000542r2, NFVSOL(17)000544r1
2017.10	0.2.0	Implemented NFVSOL(17)000543r3, NFVSOL(17)000566, NFVSOL(17)000567r1, NFVSOL(17)000568r1, NFVSOL(17)000569 Editorial modification for clause numbering and format
2017.11	0.3.0	Clean-up done by *editHelp* Implemented NFVSOL(17)000545r4, NFVSOL(17)000559r2, NFVSOL(17)000560r2, NFVSOL(17)000570r1, NFVSOL(17)000575r1, NFVSOL(17)000616r1, NFVSOL(17)000641
2017.12	0.4.0	Implemented NFVSOL(17)000642r1, NFVSOL(17)000675r1, NFVSOL(17)000756
2018.01	0.5.0	Implemented NFVSOL(17)000621r6, NFVSOL(17)000676r3, NFVSOL(17)000677r2, NFVSOL(17)000736r1, NFVSOL(18)000004r2
2018.03	0.6.0	Implemented NFVSOL(18)000049, NFVSOL(18)000025r1, NFVSOL(18)00048R1, NFVSOL(18)00040, NFVSOL(18)00023r2, NFVSOL(18)00024r2, NFVSOL(18)00029r1, NFVSOL(18)00063r5, NFVSOL(18)000077, NFVSOL(18)000046r2, NFVSOL(18)000074r2, NFVSOL(17)0000611r5, NFVSOL(18)000041r1, NFVSOL(18)000038r3, NFVSOL(18)000028, NFVSOL(18)000044r2, NFVSOL(18)000055r2, NFVSOL(18)000045r1
2018.03	0.6.1	Implemented NFVSOL(18)000052r1, NFVSOL(18)000094r5, NFVSOL(18)000043r3, NFVSOL(18)0000112r1, NFVSOL(18)0000117r2, NFVSOL(18)0000124r1, NFVSOL(18)0000129r1, NFVSOL(18)000042r2, NFVSOL(18)0000115r2
2018.04	0.6.2	Implemented NFVSOL(18)000113r2, NFVSOL(18)000119r2, NFVSOL(18)000121, NFVSOL(18)000135, NFVSOL(18)000116r1, NFVSOL(18)000157, NFVSOL(18)000158r1
2018.05	0.6.3	Implemented NFVSOL(18)000168, NFVSOL(18)000169r2, NFVSOL(18)000173, NFVSOL(18)000174r2
2018.05	0.7.0	Implemented NFVSOL(18)000156r7, NFVSOL(18)000142r3, NFVSOL(18)000147, NFVSOL(18)000193r2, NFVSOL(18)000201, NFVSOL(18)000202, NFVSOL(18)000203r2, NFVSOL(18)000205r1, NFVSOL(18)000160r1, NFVSOL(18)000199r2, NFVSOL(18)000200r3, NFVSOL(18)000192r1, NFVSOL(18)000194r2, NFVSOL(18)000231r1, NFVSOL(18)000223r1, NFVSOL(18)000183r2
2018.06	0.8.0	Implemented NFVSOL(18)000287, NFVSOL(18)00012r11, NFVSOL(18)000197r2, NFVSOL(18)000198r3, NFVSOL(18)000286, NFVSOL(18)000292, NFVSOL(18)000294r1, NFVSOL(18)000295r1, NFVSOL(18)000301r2, NFVSOL(18)000302r2, NFVSOL(18)000240r1, NFVSOL(18)000253r3, NFVSOL(18)000254r2, NFVSOL(18)000256r2
2018.06	0.9.0	Implemented NFVSOL(18)000288r2 Adding etsi_nfv_sol001_vnfd_0_9_0_type.yaml and SOL001 Graphics v0_9_0.pptx in the draft GS zip package Editorial changes for all the TOSCA type definitions
2018.08	0.10.0	Implemented NFVSOL(18)000331r4, NFVSOL(18)000335r2, NFVSOL(18)000351r1, NFVSOL(18)000374r1, NFVSOL(18)000376, NFVSOL(18)000382, NFVSOL(18)000395r1, NFVSOL(18)000402r2, NFVSOL(18)000404, NFVSOL(18)000405r2, NFVSOL(18)000406r1, NFVSOL(18)000408r2, NFVSOL(18)000409r1, NFVSOL(18)000411r1, NFVSOL(18)000413, NFVSOL(18)000416r2, NFVSOL(18)000422r4, NFVSOL(18)000423r4, NFVSOL(18)000424r2, NFVSOL(18)000425r2, NFVSOL(18)000430r1, NFVSOL(18)000336r4, NFVSOL(18)000380, NFVSOL(18)000387r2, NFVSOL(18)000394r1, NFVSOL(18)000410r2, NFVSOL(18)000447r3, NFVSOL(18)000427, NFVSOL(18)000403r3, NFVSOL(18)000420r4, NFVSOL(18)000393r1, NFVSOL(18)000415, NFVSOL(18)000398r1, NFVSOL(18)000399r3, NFVSOL(18)000414r2, NFVSOL(18)000379r3, NFVSOL(18)000428r5, NFVSOL(18)000429r4, NFVSOL(18)000465r1, NFVSOL(18)000479, NFVSOL(18)000375r4, NFVSOL(18)000488r2, NFVSOL(18)000492r1

Date	Version	Information about changes
2018.09	0.11.0	Implemented NFVSOL(18)000486r7, NFVSOL(18)000495r1, NFVSOL(18)000497r3, NFVSOL(18)000498, NFVSOL(18)000500r3, NFVSOL(18)000503r1, NFVSOL(18)000504r1, NFVSOL(18)000505r1, NFVSOL(18)000508, NFVSOL(18)000514r2, NFVSOL(18)000515r1, NFVSOL(18)000516r1, NFVSOL(18)000524r1, NFVSOL(18)000529r2, NFVSOL(18)000530r1, NFVSOL(18)000536r1, NFVSOL(18)000538r1, NFVSOL(18)000541r3, NFVSOL(18)000544r1，NFVSOL(18)000545r1
2018.10	0.12.0	Implemented NFVSOL(18)000507r3, NFVSOL(18)000621r4, NFVSOL(18)000547r1, NFVSOL(18)000567r1, NFVSOL(18)000574, NFVSOL(18)000579, NFVSOL(18)000590r1
2018.11	0.13.0	Implemented NFVSOL(18)000563r5, NFVSOL(18)000575r5, NFVSOL(18)000586r2, NFVSOL(18)000587r1, NFVSOL(18)000589r2, NFVSOL(18)000591, NFVSOL(18)000592, NFVSOL(18)000604r2, NFVSOL(18)000606r1, NFVSOL(18)000607r5, NFVSOL(18)000608, NFVSOL(18)000609, NFVSOL(18)000612, NFVSOL(18)000614r1, NFVSOL(18)000615, NFVSOL(18)000616r2, NFVSOL(18)000617r3, NFVSOL(18)000619r3, NFVSOL(18)000620r5, NFVSOL(18)000628r2, NFVSOL(18)000629r1, NFVSOL(18)000630, NFVSOL(18)000631r1, NFVSOL(18)000632, NFVSOL(18)000634, NFVSOL(18)000635, NFVSOL(18)000636r3, NFVSOL(18)000637, NFVSOL(18)000655r2, NFVSOL(18)000658r3, NFVSOL(18)000659, NFVSOL(18)000660, NFVSOL(18)000665r1, NFVSOL(18)000666, NFVSOL(18)000678r1, NFVSOL(18)000679, NFVSOL(18)000682, NFVSOL(18)000684r1, NFVSOL(18)000687
2019.03	2.5.2	Implemented NFVSOL(19)000063r4, NFVSOL(19)000068r1, NFVSOL(19)000069r2, NFVSOL(19)000070r1, NFVSOL(19)00080, NFVSOL(19)000107r1, NFVSOL(19)000120r1, NFVSOL(19)000121, NFVSOL(19)00039r5, NFVSOL(19)00087r2, NFVSOL(19)00067r5, NFVSOL(19)00077, NFVSOL(19)00082r3, NFVSOL(19)00085, NFVSOL(19)00086, NFVSOL(19)000106r1
2019.03	2.5.3	Implemented NFVSOL(19)000084r4, NFVSOL(19)0000101r2, NFVSOL(19)0000165, NFVSOL(19)0000166, NFVSOL(19)0000167r1, NFVSOL(19)0000170r4, NFVSOL(19)0000173, NFVSOL(19)0000163, NFVSOL(19)0000119
2019.03.22	2.5.4	Editorial modification made by ETSI Secretariat allowing to structure the SOL repository on ETSI Forge in a future proof and maintainable way: • Forge structure updated: "v2.6.1" tag created • Yaml filenames updated: version numbers removed from filenames (still included in file header) • Import statements updated: version number removed from imported filenames. • Draft updated: – Updated all references to yaml files – Updated the forge URLs – In B.1: removed the sentence explaining the meaning of x_y_z_ in the filename structure
2019.04.23	2.5.5	2 comments were raised during the Remote Consensus approval: both requesting to implement the WG SOL approved Change Request in NFVSOL(19)000229r3 onto the final SOL001 draft (see these 2 comments in the RC report). The present version implements NFVSOL(19)000229r3: adding machine readable meta info inside the yaml file indicating the SOL001 release version to which they apply + other editorial changes
2019.05	2.6.2	Implemented NFVSOL(19)000162r1, NFVSOL(19)000194r2, NFVSOL(19)000222r2, NFVSOL(19)000241r2, NFVSOL(19)000242r2
2019.06	2.6.3	Implemented NFVSOL(19)000160r9, NFVSOL(19)000239r3, NFVSOL(19)000248, NFVSOL(19)000262r2, NFVSOL(19)000263r3, NFVSOL(19)000268r3, NFVSOL(19)000269, NFVSOL(19)000270r3, NFVSOL(19)000303r1, NFVSOL(19)000307, NFVSOL(19)000279, NFVSOL(19)000280, NFVSOL(19)000296r3, NFVSOL(19)000301r1, NFVSOL(19)000305r1, NFVSOL(19)000338, NFVSOL(19)000340, NFVSOL(19)000342r1, NFVSOL(19)000344r2, NFVSOL(19)000345r4, NFVSOL(19)000266r7
2019.08	2.6.4	Implemented NFVSOL(19)000325r8, NFVSOL(19)000346r6, NFVSOL(19)000347r2, NFVSOL(19)000380r1, NFVSOL(19)000383r1, NFVSOL(19)000384r1, NFVSOL(19)000385, NFVSOL(19)000389r1, NFVSOL(19)000428r2, NFVSOL(19)000449
2019.09	2.6.5	Implemented NFVSOL(19)000386r8, NFVSOL(19)000408r4, NFVSOL(19)000451r8, NFVSOL(19)000559

Date	Version	Information about changes
2019.11	2.6.6	Implemented NFVSOL(19)000727r1_SOL001Ed271_Miscellaneous_corrections, NFVSOL(19)000642r1_SOL001ed271_Annex_Mapping_table_for_SOL_API_NSD_related_cons, NFVSOL(19)000645r3_SOL001ed271_NBWC_issue_list_annex, NFVSOL(19)000700r1_SOL001ed271_updating_mapping_table_in_A_9, NFVSOL(19)000577r2_SOL001Ed271_-_Standards_Configurable_Properties, NFVSOL(19)000593_SOL001ed271_adding_introduction_in_clasue_9_1, NFVSOL(19)000595_SOL001ed271_resolving_requirement_occurannce_issue, NFVSOL(19)000597r3_SOL001ed271_deployment_flavour_related_CSAR_design_for_NSD, NFVSOL(19)000598r2_SOL001ed271_TOSCA_Imperative_workflows_NSD_Editor_s_Notes, NFVSOL(19)000599r2_SOL001ed271_TOSCA_Imperative_workflows_Example_Editors_Notes, NFVSOL(19)000607r2_SOL001ed271_VNFFG_clause_6_8_2_6_Editor_s_note_handling, NFVSOL(19)000608r2_SOL001ed271_VNFFG_clause_7_8_2_6_Editor_s_note_handling, NFVSOL(19)000609r2_SOL001ed271_VNFFG_clause_7_8_5_1_Editor_s_notes_handling, NFVSOL(19)000610_SOL001ed271_VNFFG_clause_7_8_6_1_Editor_s_note_handling, NFVSOL(19)000611r2_SOL001ed271_adding_TOSCA-Simple-Profile-yaml-v1_3_reference, NFVSOL(19)000616_SOL001ed271_ConnectivityType, NFVSOL(19)000617r3_SOL001ed271_nfviConstraint, NFVSOL(19)000633_SOL001ed271_VnfIndicators_editor_s_notes_resolution, NFVSOL(19)000636r2_SOL001ed271_NS_workflow_defintion_update, NFVSOL(19)000702_SOL001ed271_adding_reference_for_SwImageData, NFVSOL(19)000703r1_SOL001ed271_forwarding_behaviour_input_parameters, NFVSOL(19)000704r1_SOL001ed271_correction_on_NfpPositionElement_definition, NFVSOL(19)000705r1_SOL001ed271_correction_on_descriptor_id, NFVSOL(19)000741r1_SOL001ed271_NfpPositionElement_node_type_improvement, NFVSOL(19)000596r3_SOL001ed271_deployment_flavour_related_CSAR_design_for_VNFD, NFVSOL(19)000725r2_SOL001ed271_vnfd_common_yaml_file_for_v1_3, NFVSOL(19)000744r2_SOL001ed271_Clause_7_1_Introduction_improvement, NFVSOL(19)000566r9_SOL001ed271_adding_boot_data_type, NFVSOL(19)000674r1_SOL001Ed271_Monitoring_Parameters_-_Alignement_with_IFA027
2019.11	2.6.7	Implemented NFVSOL(19)000780r3_SOL001ed271__VnfIndicator_id_Issue_1, NFVSOL(19)000784r1_SOL001ed271_solving_remaining_editor_s_notes, NFVSOL(19)000785r1_SOL001ed271_solving_remaining_monitoring_issues, NFVSOL(19)000789_SOL001ed271_adding_boot_data_in_NBWC_list_table, NFVSOL(19)000719r12_SOL001ed271_forwarding_capability_for_VNF_node_type
2020.02	3.0.1	Implemented NFVSOL(19)000710r3_SOL001ed331_deployment_flavour_related_CSAR_design_for_VNFD, NFVSOL(19)000792r1_SOL001ed331_FEAT10_Add_specification_for_Multi-Site_Connectivity_Services, NFVSOL(19)000799r2_SOL001ed331_FEAT05_Adding_priority_to_NSD
2020.02	3.0.2	Implemented: NFVSOL(19)000714r4_SOL001ed271_support_of_auto-scaling_with_use_of_VNF_indicator, NFVSOL(20)000018r2_SOL001ed331_deployment_flavour_related_CSAR_design_for_NSD, NFVSOL(20)000067r1_SOL001ed331_FEAT16_Adding_SAL_to_NSD
2020.04	3.0.3	Implemented: NFVSOL(20)000016r6_SOL001ed331_FEAT02_VnfPackageChange, NFVSOL(20)000040r6_SOL001ed331_Criteria_for_backward_compatibility_of_changes, NFVSOL(20)000117_SOL001ed331_Vnflcm_update_TOSCA_1_3_grammar, NFVSOL(20)000172r1_SOL001ed331_VNF_specific_datatypes_naming_rules, NFVSOL(20)000239r2_SOL001ed331_release_3_mirror_adding_NS_DF_design_principle_in_annex, NFVSOL(20)000242_SOL001ed331_updating_annex_C, NFVSOL(20)000285_SOL001ed331_VNF_specific_types_naming_rules rapporteur changes: editorial, changing "will" to "with" in some places in annex C.2 and C.3 editorial, removing extra space in some of the TOSCA type definitions
2020.05	3.0.4	Implemented: NFVSOL(20)000295r3_SOL001ed331_FEAT02_ChangeCurrentVnfPackage_interface, NFVSOL(20)000320r6_SOL001ed331_FEAT15_VNF_Snapshot, NFVSOL(20)000354r1_SOL001ed331_FEAT02_ChangeCurrentVnfPackage_AnnexA_D_mapping, NFVSOL(20)000327r1_SOL001ed331_rel3_mirror_corrections_of_specific_node_tpye, NFVSOL(20)000353_SOL001ed331_Vnflcm_interface_EN_cleanup, NFVSOL(20)000376r2_SOL001ed331_mirror_of_375_PNFD_geographic_coordinates_suppor, NFVSOL(20)000378r2_SOL001ed331_rel3_mirror_add_VNF_related_type_names_in_clause, NFVSOL(20)000380r1_SOL001ed331_rel3_mirror_add_NS_related_type_names_in_clause_7, NFVSOL(20)000382r1_SOL001ed331_rel3_mirror_clarification_of_using_VnfMonitoring, NFVSOL(20)000384_SOL001ed331_rel3_mirror_clarification_on_ip_address_type, NFVSOL(20)000386_SOL001ed331_rel3_mirror_clarification_on_VirtualLinkable_cap, NFVSOL(20)000194r3_SOL001ed331_release_3_mirror_example_corrections

Date	Version	Information about changes
2020.06	3.0.5	Implemented: NFVSOL(20)000267r3_SOL001ed331_VNF_node_type_definitions, NFVSOL(20)000355r2_SOL001ed331_examples_cleanup_tosca1_3_interfaces, NFVSOL(20)000356_SOL001ed331_example_cleanup_to_tosca_1_3, NFVSOL(20)000357_SOL001ed331_all_type_defintions_metadata_cleanup, NFVSOL(20)000394r2_SOL001ed331_clause6_11_cleanup_tosca1_3, NFVSOL(20)000395r4_SOL001ed331_sw_image_data_align_with_TOSCA_1_3, NFVSOL(20)000396r5_SOL001ed331_removing_reference_of_TOSCA_1_1_and_1_2, NFVSOL(20)000397r1_SOL001ed331_clause_7_11_align_tosca_1_3, NFVSOL(20)000399r1_SOL001ed331_clause_8_11_align_tosca_1_3, NFVSOL(20)000517r1_SOL001ed331_Rel-3_mirror-_fixing_optional_properties, NFVSOL(20)000527r4_SOL001ed331_update_annex_F, NFVSOL(20)000597_SOL001ed331_resolve_remaining_issues_for_TOSCA_reference, NFVSOL(20)000598r1_SOL001ed331_resolve_editor_note_for_package_change. Undo the implementation of NFVSOL(19)000799r2, supporting for FEAT5 will be removed from this version
2020.09	3.3.2	Implemented: NFVSOL(20)000387r3_SOL001ed341_adding_virtualLinkProtocolData_for_NsVirtualLink, NFVSOL(20)000617r7_SOL001ed341_Use_of_Credentials_datatype, NFVSOL(20)000618_SOL001ed341_VnfPackageChange_corrections, NFVSOL(20)000674_SOL001ed341_modifiable_attributes_example_correction, NFVSOL(20)000676r1_SOL001ed341_update_extension_rule
2020.11	3.3.3	Implemented: NFVSOL(20)000723r4_SOL001Ed341_Fixing_examples, NFVSOL(20)000359r5_SOL001ed331_support_of_trunk_port_topology, NFVSOL(20)000679r2_SOL001ed341_monitoring_parameter_identifier, NFVSOL(20)000716r2_SOL001Ed341_Clarification_on_node_type_definitions_in_an_NSD, NFVSOL(20)000737r1_SOL001Ed341_Ambiguous_use_of__may_not_, NFVSOL(20)000744r2_SOL001ed341_uniform_delta_correction, NFVSOL(20)000747r1_SOL001ed351_fix_TOSCA_YAML_version_reference, NFVSOL(20)000749r1_SOL001ed341_Adding_NS_scaling_aspects_instantiation_levels, NFVSOL(20)000752r6_SOL001ed351_support_using_VnfConfigurableProperties_for_boot_data, NFVSOL(20)000767_SOL001ed351_Removal_of_constraint_in_VnfIndicator_attribute
2020.12	3.3.4	Implemented: NFVSOL(20)000774r1_SOL001ed351_add_Dependencies_in_VNFD, NFVSOL(20)000775_SOL001ed351_adding_example_in_NSD_for_VL_protocol_data, NFVSOL(20)000776_SOL001ed351_fix issues for VnfcConfigurableProperties, NFVSOL(20)000777_SOL001_Correct_typos_in_NsAffinityRules_etc_, NFVSOL(20)000798_SOL001ed351_Corrections_in_policies_definitions
2021.02	3.3.5	Implemented: NFVSOL(21)000001_SOL001ed351_-_Annex_A_-_Fixing_errors_in_YAML_examples_A1-A6, NFVSOL(21)000003r1_SOL001ed351_-_Annex_A_-_Fixing_errors_in_YAML_examples_A7-A17, NFVSOL(21)000004r1_SOL001ed351_-_Use_of_TOSCA_functions_-_specification, NFVSOL(21)000007_SOL001ed351_Scale_Inputs, NFVSOL(21)000008_SOL001ed351_Wrong_indentation_of_entry_schema, NFVSOL(21)000030_SOL001ed351_vducp_occurrences_correction, NFVSOL(21)000089_SOL001ed351_virtual_binding_capability
2021.02	3.3.6	Implemented: NFVSOL(20)000779r10_SOL001ed351_adding_VnfIndicator_support_in_NSD, NFVSOL(21)000117_SOL001ed351_Adding_VnfLcmCoordination_to_interfaceName, NFVSOL(21)000120_SOL001d351_-_Corrections_to_Annex_A_examples, NFVSOL(21)000124r1_SOL001ed351_add_new_NsAutoScale_policy, NFVSOL(21)000125_SOL001ed351_new_NsVnfindicator_interface, NFVSOL(21)000126r3_SOL001ed351_NS_node_attribute_for_VnfIndicator

Date	Version	Information about changes
2021.04	3.3.7	Implemented: NFVSOL(21)000121r4_SOL001d351_-_Support_of_additional_TOSCA_Functions, NFVSOL(21)000122r1_SOL001d351_-_VIP_CP_requirements, NFVSOL(21)000127r1_SOL001ed351_add_input_in_Nslcm_operation_to_support_autoscale, NFVSOL(21)000131r1_SOL001ed351_VipCp_node_property, NFVSOL(21)000208r1_SOL001ed351_Resolution_of_editors_notes_1_and_3, NFVSOL(21)000210_SOL001ed351_VNFD_TOSCA_model_update, NFVSOL(21)000212r1_SOL001ed351_correct_valid_values_format, NFVSOL(21)000061r3_SOL001ed351_VnfLcmOperationCoordination_extension, NFVSOL(21)000062r3_SOL001ed351_VnfLcmOperationCoordination_Annex, NFVSOL(21)000177_SOL001d351_-_Support_of_additional_TOSCA_Intrinsic_Functions, NFVSOL(21)000215_SOL001ed351_correct_NSD_VNFFG_example, NFVSOL(21)000234_SOL001ed351_Resolution_of_editors_notes_2
2021.04	3.3.8	Implemented: NFVSOL(20)000753r1_SOL001ed351_clarify support of autoScale, NFVSOL(21)000060r7_SOL001ed351_VnfLcmOperationCoordination, NFVSOL(21)000159_SOL001ed351_FEAT05_Adding_priority_to_NSD, NFVSOL(21)000225r2_SOL001d351_-_Inconsistencies_in_VNF_and_NS_Node_templates, NFVSOL(21)000253_SOL001ed351_update_usage_of_TOSCA_functions, NFVSOL(21)000258_SOL001ed351_update_A_9, NFVSOL(21)000265_SOL001ed351_clarification_on_virtualLinkProtocolData, NFVSOL(21)000275r1_SOL001d351_-_Use_of_the_substitution_directive_in_top-level_, NFVSOL(21)000281_SOL001ed351_VnfLcmOperationCoordination_Annex_update_based_CR60, NFVSOL(21)000257r2_SOL001ed351_multiple_errors_correction, NFVSOL(21)000276r2_SOL001d351_-_properties_and_requirements_in_top-level_templa
2021.05	3.3.9	Implemented: NFVSOL(21)000317r1_SOL001Ed351_Small_fixes_in_Yaml_definitions__mirror_of_313_, NFVSOL(21)000318_SOL001Ed351_Small_fixes_in_Annex_E__mirror_of_311, NFVSOL(21)000319r2_SOL001Ed351_Small_fixes_in_Annex_A__mirror_of_312_
2021.05	3.3.10	Implemented: NFVSOL(21)000320r7_SOL001Ed351_Clarification_on_the_contents_of_service_template
2021.09	3.5.2	Implemented: NFVSOL(21)000394_SOL001ed361_Mirror_393_sw_image_data_property_deprecated_vs_Sw Image_artifact, NFVSOL(21)000406_SOL001ed361_Bugfix_with_adding_fixedIpAddress_to_L3AddressData, NFVSOL(21)000408_SOL001ed361_VnfPackageChange_add_targets, NFVSOL(21)000438r3_SOL001ed361_Release_3_mirror_VnfExtCp_updating, NFVSOL(21)000475_SOL001ed361_FEAT03_NfviMaintenanceInfo, NFVSOL(21)000489_SOL001ed361_release_3_mirror_input_example_for_VnfcConfigurablePr operties, NFVSOL(21)000490_SOL001ed361_placementGroup_usage_clarification
2021.10	3.5.3	Implemented: NFVSOL(21)000511_SOL001Ed361_rel3_mirror_mapping_of_configurable_properties_in Vdu.Compute
2021.10	3.5.4	Implemented: NFVSOL(21)000544r1_SOL001ed361_Harmonisation_of_policy_target_specifications, NFVSOL(21)000545_SOL001ed361_Additional_YAML_fixes__mirror_of_525_, NFVSOL(21)000546r1_SOL001ed361_Additional_Requirements_violation_in_Annex_A
2021.10	3.5.5	Implemented: NFVSOL(21)000541r1_SOL001ed361_Bugfix_with_adding_min_number_of_preserved_instanc es to NfviMaintenanceInfo
2021.12	3.5.6	Implemented: NFVSOL(21)000609r2_SOL001ed361_VirtualNetworkInterfaceRequirements, NFVSOL(21)000636_SOL001ed361_Rel-3_Mirror_of_535_wrong_reference, NFVSOL(21)000638_SOL001ed361_update_vnfm_interface_info_type, NFVSOL(21)000639_SOL00ed361_removal_of_deprecated_element_in_vnfd, NFVSOL(21)000536r3_SOL001ed361_Adding_externallyManaged_to_VnfVirtualLinkDescriptor , NFVSOL(21)000629r2_SOL001ed361_follow-up_of_DP_519r1, NFVSOL(21)000642r1_SOL001ed361_fixing_definition_of_ipAddressAssignment_attribute

Date	Version	Information about changes
2022.03	3.6.2	Created based on ed361 and the following approved CRs: NFVSOL(22)000022r1_SOL001ed371_Rel-3_mirror_of_000018_Removal_of_flavour_id_in_NsProfile, NFVSOL(22)000029r1_SOL001ed371_fixing_definition_of_macAddressAssignment_attribute, NFVSOL(22)000031r1_SOL001ed371_Add_flavour_id_to_node_template, NFVSOL(22)000046r2_SOL001ed371_fixing_schema_errors, NFVSOL(22)000058_SOL001Ed371_Minor_corrections, NFVSOL(22)000101_SOL001Ed371_Fixing_vnfm_info_constraints__mirror_of_059_, NFVSOL(22)000108_SOL001Ed371_underspecified_file_system_in_VirtualFileStorage, NFVSOL(21)000514r1_SOL001Ed361_Bulk_Mirror_for_YAML_fixes
2022.06	3.6.3	Implemented: NFVSOL(22)000142r1_SOL001Ed371_Adding_missing_constraints_to_properties_of_type, NFVSOL(22)000164_SOL001Ed431_VNF_Scaling_Policies_for_initial_deltas__mirror_, NFVSOL(22)000180_SOL001Ed371_Uncommenting_modifiable_attributes_and_similar_properties (mirror of 160r1), NFVSOL(22)000181_SOL001Ed371_Simplification_of_VNF_PNF_NS-specific_node_type_, NFVSOL(22)000190r6_SOL001ed371_update_type_extension_rule_, NFVSOL(22)000214r1_SOL001ed371_mirror_of_213_update_VNFD_figure_in_6_1_, NFVSOL(22)000218r1_SOL001ed371_mirror_correct_VirtualFileStorageData_description, NFVSOL(22)000219r1_SOL001ed371_mirror_adding_vipCpDelta_policy, NFVSOL(22)000232r1_SOL001Ed371_Affinity_rules_between_instances_of_the_same_NestedNS
2022.07	3.6.4	Implemented: NFVSOL(22)000327_SOL001ed371_annex_B_update_for_yaml_files, NFVSOL(22)000348_SOL001Ed371_Minor_editorial_changes_to_Annex_A_examples, NFVSOL(22)000352_SOL001ed371_mirror_of_76_clarify_profile_element_in_NfpPosition, NFVSOL(22)000354_SOL001ed371_mirror_of_86_fix_example_in_annex_A, NFVSOL(22)000355_SOL001ed371_mirror_of_270_multiple_corrections_
2022.09	3.6.5	Implemented: NFVSOL(22)000402_SOL001Ed371_Graphical_Conventions_for_TOSCA_requirements
2022.10	3.6.6	Implemented: NFVSOL(22)000450_SOL001ed371_mirror_of_449_multiple_corrections_, NFVSOL(22)000451_SOL001ed371_corrections_for_SwImageDescId_ NFVSOL(22)000385 SOL001Ed371 Missing node types in Figures

History

Document history		
V3.3.1	September 2020	Publication
V3.5.1	July 2021	Publication
V3.6.1	February 2022	Publication
V3.7.1	December 2022	Publication