



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

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Contents

Intellectual Property Rights	22
Foreword.....	22
Modal verbs terminology.....	22
1 Scope	23
2 References	23
2.1 Normative references	23
2.2 Informative references.....	24
3 Definition of terms, symbols and abbreviations.....	25
3.1 Terms.....	25
3.2 Symbols.....	25
3.3 Abbreviations	25
4 Overview of TOSCA model.....	26
5 General concept of using TOSCA to model NFV descriptors	26
5.1 Introduction	26
5.2 Network Service Descriptor	26
5.3 Virtualised Network Function Descriptor	27
5.4 Physical Network Function Descriptor.....	27
5.5 toasca_definitions_version and Namespace prefix	27
5.6 Imports statement	28
5.6.1 VNFD TOSCA service template	28
5.6.2 NSD TOSCA service template	28
5.6.3 PNFD TOSCA service template	29
5.7 Type extension	29
5.7.1 Introduction.....	29
5.7.2 Rules	29
5.7.3 VNFD Types.....	30
5.7.4 NSD types.....	31
5.8 Non-Backward Compatible changes	32
6 VNFD TOSCA model.....	33
6.1 Introduction	33
6.2 Data Types.....	34
6.2.1 toasca.datatypes.nfv.CpProtocolData	34
6.2.1.1 Description	34
6.2.2 toasca.datatypes.nfv.AddressData	34
6.2.2.1 Description	34
6.2.3 toasca.datatypes.nfv.L2AddressData.....	34
6.2.3.1 Description	34
6.2.4 toasca.datatypes.nfv.VirtualNetworkInterfaceRequirements	34
6.2.4.1 Description	34
6.2.4.2 Properties	35
6.2.4.3 Definition	35
6.2.4.4 Examples.....	36
6.2.4.5 Additional Requirements	36
6.2.5 toasca.datatypes.nfv.L3AddressData.....	36
6.2.5.1 Description	36
6.2.6 toasca.datatypes.nfv.RequestedAdditionalCapability.....	36
6.2.6.1 Description	36
6.2.6.2 Properties	36
6.2.6.3 Definition	37
6.2.6.4 Examples.....	37
6.2.6.5 Additional Requirements	37
6.2.7 toasca.datatypes.nfv.VirtualMemory	37
6.2.7.1 Description	37

6.2.7.2	Properties	38
6.2.7.3	Definitions	38
6.2.7.4	Examples	38
6.2.7.5	Additional Requirements	39
6.2.8	tosca.datatypes.nfv.VirtualCpu	39
6.2.8.1	Description	39
6.2.8.2	Properties	39
6.2.8.3	Definition	39
6.2.8.4	Examples	40
6.2.8.5	Additional Requirements	40
6.2.9	tosca.datatypes.nfv.VirtualCpuPinning	40
6.2.9.1	Description	40
6.2.9.2	Properties	40
6.2.9.3	Definition	41
6.2.9.4	Examples	41
6.2.9.5	Additional Requirements	41
6.2.10	tosca.datatypes.nfv.VnfcConfigurableProperties	41
6.2.10.1	Description	41
6.2.10.2	Properties	42
6.2.10.3	Definition	42
6.2.10.4	Examples	42
6.2.10.5	Additional Requirements	43
6.2.11	tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties	43
6.2.11.1	Description	43
6.2.11.2	Properties	43
6.2.11.3	Definition	43
6.2.12	tosca.datatypes.nfv.VduProfile	43
6.2.12.1	Description	43
6.2.12.2	Properties	44
6.2.12.3	Definition	44
6.2.12.4	Examples	45
6.2.12.5	Additional requirements	46
6.2.13	tosca.datatypes.nfv.VIProfile	46
6.2.13.1	Description	46
6.2.13.2	Properties	46
6.2.13.3	Definition	47
6.2.13.4	Examples	47
6.2.13.5	Additional Requirements	47
6.2.14	tosca.datatypes.nfv.VirtualLinkProtocolData	47
6.2.14.1	Description	47
6.2.14.2	Properties	48
6.2.14.3	Definition	48
6.2.14.4	Examples	48
6.2.14.5	Additional Requirements	48
6.2.15	tosca.datatypes.nfv.L2ProtocolData	49
6.2.15.1	Description	49
6.2.15.2	Properties	49
6.2.15.3	Definition	49
6.2.15.4	Examples	50
6.2.15.5	Additional Requirements	50
6.2.16	tosca.datatypes.nfv.L3ProtocolData	50
6.2.16.1	Description	50
6.2.16.2	Properties	50
6.2.16.3	Definition	51
6.2.16.4	Examples	52
6.2.16.5	Additional Requirements	52
6.2.17	tosca.datatypes.nfv.IpAllocationPool	52
6.2.17.1	Description	52
6.2.17.2	Properties	52
6.2.17.3	Definition	53
6.2.17.4	Examples	53
6.2.17.5	Additional Requirements	53

6.2.18	tosca.datatypes.nfv.InstantiationLevel	53
6.2.18.1	Description	53
6.2.18.2	Properties	53
6.2.18.3	Definition	54
6.2.18.4	Examples	54
6.2.18.5	Additional Requirements	54
6.2.19	tosca.datatypes.nfv.VduLevel	54
6.2.19.1	Description	54
6.2.19.2	Properties	54
6.2.19.3	Definition	55
6.2.19.4	Examples	55
6.2.19.5	Additional Requirements	55
6.2.20	tosca.datatypes.nfv.VnfLcmOperationsConfiguration	55
6.2.20.1	Description	55
6.2.20.2	Properties	55
6.2.20.3	Definition	56
6.2.20.4	Examples	57
6.2.20.5	Additional Requirements	57
6.2.21	tosca.datatypes.nfv.VnfInstantiateOperationConfiguration	58
6.2.21.1	Description	58
6.2.21.2	Properties	58
6.2.21.3	Definition	58
6.2.21.4	Examples	58
6.2.21.5	Additional Requirements	58
6.2.22	tosca.datatypes.nfv.VnfScaleOperationConfiguration	58
6.2.22.1	Description	58
6.2.22.2	Properties	58
6.2.22.3	Definition	59
6.2.22.4	Examples	59
6.2.22.5	Additional Requirements	59
6.2.23	tosca.datatypes.nfv.VnfScaleToLevelOperationConfiguration	59
6.2.23.1	Description	59
6.2.23.2	Properties	59
6.2.23.3	Definition	60
6.2.23.4	Examples	60
6.2.23.5	Additional Requirements	60
6.2.24	tosca.datatypes.nfv.VnfHealOperationConfiguration	60
6.2.24.1	Description	60
6.2.24.2	Properties	60
6.2.24.3	Definition	60
6.2.24.4	Examples	61
6.2.24.5	Additional Requirements	61
6.2.25	tosca.datatypes.nfv.VnfTerminateOperationConfiguration	61
6.2.25.1	Description	61
6.2.25.2	Properties	61
6.2.25.3	Definition	61
6.2.25.4	Examples	62
6.2.25.5	Additional Requirements	62
6.2.26	tosca.datatypes.nfv.VnfOperateOperationConfiguration	62
6.2.26.1	Description	62
6.2.26.2	Properties	62
6.2.26.3	Definition	62
6.2.26.4	Examples	63
6.2.26.5	Additional Requirements	63
6.2.27	tosca.datatypes.nfv.ScaleInfo	63
6.2.27.1	Description	63
6.2.27.2	Properties	63
6.2.27.3	Definition	63
6.2.27.4	Examples	64
6.2.27.5	Additional Requirements	64
6.2.28	tosca.datatypes.nfv.ScalingAspect	64
6.2.28.1	Description	64

6.2.28.2	Properties	64
6.2.28.3	Definition	64
6.2.28.4	Examples	65
6.2.28.5	Additional Requirements	65
6.2.29	tosca.datatypes.nfv.LinkBitrateRequirements	65
6.2.29.1	Description	65
6.2.30	tosca.datatypes.nfv.ConnectivityType	65
6.2.30.1	Description	65
6.2.31	tosca.datatypes.nfv.VnfConfigurableProperties.....	65
6.2.31.1	Description	65
6.2.31.2	Properties	66
6.2.31.3	Definition	67
6.2.31.4	Examples	68
6.2.31.5	Additional Requirements	70
6.2.32	tosca.datatypes.nfv.VnfAdditionalConfigurableProperties.....	70
6.2.32.1	Description	70
6.2.32.2	Properties	70
6.2.32.3	Definition	70
6.2.32.4	Examples	71
6.2.32.5	Additional Requirements	71
6.2.33	tosca.datatypes.nfv.VnfInfoModifiableAttributes	71
6.2.33.1	Description	71
6.2.33.2	Properties	71
6.2.33.3	Definition	71
6.2.33.4	Examples	72
6.2.33.5	Additional Requirements	72
6.2.34	tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions	72
6.2.34.1	Description	72
6.2.34.2	Properties	72
6.2.34.3	Definition	73
6.2.34.4	Examples	73
6.2.34.5	Additional Requirements	73
6.2.35	tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata	73
6.2.35.1	Description	73
6.2.35.2	Properties	73
6.2.35.3	Definition	73
6.2.35.4	Examples	73
6.2.35.5	Additional Requirements	74
6.2.36	tosca.datatypes.nfv.Qos	74
6.2.36.1	Description	74
6.2.37	tosca.datatypes.nfv.LogicalNodeData.....	74
6.2.37.1	Description	74
6.2.37.2	Properties	74
6.2.37.3	Definition	75
6.2.37.4	Examples	75
6.2.37.5	Additional Requirements	75
6.2.38	tosca.datatypes.nfv.SwImageData	75
6.2.38.1	Description	75
6.2.38.2	Properties	76
6.2.38.3	Definition	77
6.2.38.4	Examples	78
6.2.38.5	Additional Requirements	78
6.2.39	tosca.datatypes.nfv.VirtualBlockStorageData	78
6.2.39.1	Description	78
6.2.39.2	Properties	78
6.2.39.3	Definition	78
6.2.39.4	Examples	79
6.2.39.5	Additional Requirements	79
6.2.40	tosca.datatypes.nfv.VirtualObjectStorageData	79
6.2.40.1	Description	79
6.2.40.2	Properties	79
6.2.40.3	Definition	80

6.2.40.4	Examples	80
6.2.40.5	Additional Requirements	80
6.2.41	tosca.datatypes.nfv.VirtualFileStorageData	80
6.2.41.1	Description	80
6.2.41.2	Properties	80
6.2.41.3	Definition	81
6.2.41.4	Examples	81
6.2.41.5	Additional Requirements	81
6.2.42	tosca.datatypes.nfv.VirtualLinkBitrateLevel	81
6.2.42.1	Description	81
6.2.42.2	Properties	81
6.2.42.3	Definition	82
6.2.42.4	Examples	82
6.2.42.5	Additional Requirements	82
6.2.43	tosca.datatypes.nfv.VnfOperationAdditionalParameters	82
6.2.43.1	Description	82
6.2.43.2	Properties	82
6.2.43.3	Definition	82
6.2.43.4	Examples	83
6.2.43.5	Additional Requirements	84
6.2.44	tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration	84
6.2.44.1	Description	84
6.2.44.2	Properties	84
6.2.44.3	Definition	84
6.2.44.4	Examples	84
6.2.44.5	Additional Requirements	84
6.2.45	tosca.datatypes.nfv.VnfChangeExtConnectivityOperation Configuration	84
6.2.45.1	Description	84
6.2.45.2	Properties	85
6.2.45.3	Definition	85
6.2.45.4	Examples	85
6.2.45.5	Additional Requirements	85
6.2.46	tosca.datatypes.nfv.VnfMonitoringParameter	85
6.2.47	tosca.datatypes.nfv.VnfcMonitoringParameter	85
6.2.47.1	Description	85
6.2.47.2	Properties	85
6.2.47.3	Definition	86
6.2.47.4	Examples	87
6.2.47.5	Additional Requirements	87
6.2.48	tosca.datatypes.nfv.VirtualLinkMonitoringParameter	87
6.2.48.1	Description	87
6.2.48.2	Properties	87
6.2.48.3	Definition	88
6.2.48.4	Examples	88
6.2.48.5	Additional Requirements	88
6.2.49	tosca.datatypes.nfv.InterfaceDetails	88
6.2.49.1	Description	88
6.2.49.2	Properties	88
6.2.49.3	Definition	89
6.2.49.4	Examples	89
6.2.49.5	Additional Requirements	89
6.2.50	tosca.datatypes.nfv.UriComponents	89
6.2.50.1	Description	89
6.2.50.2	Properties	89
6.2.50.3	Definition	90
6.2.50.4	Examples	90
6.2.50.5	Additional Requirements	90
6.2.51	tosca.datatypes.nfv.UriAuthority	91
6.2.51.1	Description	91
6.2.51.2	Properties	91
6.2.51.3	Definition	91
6.2.51.4	Examples	92

6.2.51.5	Additional Requirements	92
6.2.52	tosca.datatypes.nfv.VnfProfile	92
6.2.52.1	Description	92
6.2.53	tosca.datatypes.nfv.ChecksumData	92
6.2.53.1	Description	92
6.2.53.2	Properties	92
6.2.53.3	Definition	93
6.2.53.4	Examples	93
6.2.53.5	Additional Requirements	93
6.2.54	tosca.datatypes.nfv.VnfmInterfaceInfo	93
6.2.54.1	Description	93
6.2.54.2	Properties	93
6.2.54.3	Definition	94
6.2.54.4	Examples	94
6.2.54.5	Additional Requirements	94
6.2.55	tosca.datatypes.nfv.OauthServerInfo	94
6.2.55.1	Description	94
6.2.55.2	Properties	95
6.2.55.3	Definition	95
6.2.55.4	Examples	95
6.2.55.5	Additional Requirements	95
6.2.56	tosca.datatypes.nfv.BootData	95
6.2.56.1	Description	95
6.2.56.2	Properties	95
6.2.56.3	Definition	96
6.2.56.4	Examples	96
6.2.56.5	Additional Requirements	96
6.2.57	tosca.datatypes.nfv.KvpData	97
6.2.57.1	Description	97
6.2.57.2	Properties	97
6.2.57.3	Definition	97
6.2.57.4	Examples	97
6.2.57.5	Additional Requirements	97
6.2.58	tosca.datatypes.nfv.ContentOrFileData	98
6.2.58.1	Description	98
6.2.58.2	Properties	98
6.2.58.3	Definition	98
6.2.58.4	Examples	99
6.2.58.5	Additional Requirements	99
6.2.59	tosca.datatypes.nfv.BootDataVimSpecificProperties	99
6.2.59.1	Description	99
6.2.59.2	Properties	99
6.2.59.3	Definition	100
6.2.59.4	Examples	100
6.2.59.5	Additional Requirements	100
6.2.60	tosca.datatypes.nfv.VnfPackageChangeSelector	100
6.2.60.1	Description	100
6.2.60.2	Properties	101
6.2.60.3	Definition	101
6.2.60.4	Examples	101
6.2.60.5	Additional Requirements	101
6.2.61	tosca.datatypes.nfv.VnfPackageChangeComponentMapping	102
6.2.61.1	Description	102
6.2.61.2	Properties	102
6.2.61.3	Definition	102
6.2.61.4	Examples	103
6.2.61.5	Additional Requirements	103
6.2.62	tosca.datatypes.nfv.VnfChangeCurrentPackageOperation Configuration	103
6.2.62.1	Description	103
6.2.62.2	Properties	103
6.2.62.3	Definition	103
6.2.62.4	Examples	104

6.2.62.5	Additional Requirements	104
6.2.63	tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration.....	104
6.2.63.1	Description	104
6.2.63.2	Properties	104
6.2.63.3	Definition	104
6.2.63.4	Examples.....	104
6.2.63.5	Additional Requirements	104
6.2.64	tosca.datatypes.nfv.VnfRevertToSnapshotOperationConfiguration.....	104
6.2.64.1	Description	104
6.2.64.2	Properties	105
6.2.64.3	Definition	105
6.2.64.4	Examples.....	105
6.2.64.5	Additional Requirements	105
6.2.65	tosca.datatypes.nfv.VnfLcmOpCoord.....	105
6.2.65.1	Description	105
6.2.65.2	Properties	105
6.2.65.3	Definition	107
6.2.65.4	Examples.....	107
6.2.65.5	Additional Requirements	107
6.2.66	tosca.datatypes.nfv.InputOpCoordParams	108
6.2.66.1	Description	108
6.2.66.2	Properties	108
6.2.66.3	Definition	108
6.2.67	tosca.datatypes.nfv.OutputOpCoordParams	108
6.2.67.1	Description	108
6.2.67.2	Properties	108
6.2.67.3	Definition	108
6.3	Artifact Types.....	109
6.3.1	tosca.artifacts.nfv.SwImage.....	109
6.3.1.1	Description	109
6.3.1.2	Properties	109
6.3.1.3	Description	110
6.3.2	tosca.artifacts.Implementation.nfv.Mistral	111
6.3.2.1	Description	111
6.3.2.2	Definition	111
6.4	Capability Types	112
6.4.1	tosca.capabilities.nfv.VirtualBindable	112
6.4.1.1	Description	112
6.4.1.2	Properties	112
6.4.1.3	Definition	112
6.4.2	tosca.capabilities.nfv.VirtualLinkable	112
6.4.2.1	Description	112
6.4.3	tosca.capabilities.nfv.VirtualCompute.....	112
6.4.3.1	Description	112
6.4.3.2	Properties	113
6.4.3.3	Definition	113
6.4.4	tosca.capabilities.nfv.VirtualStorage	114
6.4.4.1	Description	114
6.4.4.2	Definition	114
6.4.5.3	Definition	114
6.5	Requirements Types.....	115
6.6	Relationship Types.....	115
6.6.1	tosca.relationships.nfv.VirtualBindsTo.....	115
6.6.1.1	Description	115
6.6.1.2	Properties	115
6.6.1.3	Definition	115
6.6.2	tosca.relationships.nfv.VirtualLinksTo.....	115
6.6.2.1	Description	115
6.6.3	tosca.relationships.nfv.AttachesTo	116
6.6.3.1	Description	116
6.6.3.2	Properties	116
6.6.3.3	Definition	116

6.6.4	tosca.relationships.nfv.TrunkBindsTo	116
6.6.4.1	Description	116
6.7	Interface Types	117
6.7.1	tosca.interfaces.nfv.Vnflcm	117
6.7.1.1	Description	117
6.7.1.2	Definition	118
6.7.1.3	Additional Requirements	121
6.7.1.4	Support of LCM scripts.....	122
6.7.1.5	Examples	122
6.7.2	tosca.interfaces.nfv.VnfIndicator	125
6.7.2.1	Description	125
6.7.2.2	Definition	125
6.7.2.3	Examples	125
6.7.3	tosca.interfaces.nfv.ChangeCurrentVnfPackage.....	125
6.7.3.1	Description	125
6.7.3.2	Definition	125
6.7.3.3	Examples	126
6.8	Node Types	126
6.8.1	tosca.nodes.nfv.VNF.....	126
6.8.1.1	Description	126
6.8.1.2	Properties	126
6.8.1.3	Attributes.....	128
6.8.1.4	Requirements	129
6.8.1.5	Capabilities.....	129
6.8.1.6	Definition	129
6.8.1.7	Artifact	131
6.8.1.8	Additional Requirements	131
6.8.1.9	Example	132
6.8.2	tosca.nodes.nfv.VnfExtCp	135
6.8.2.1	Description	135
6.8.2.2	Properties	135
6.8.2.3	Attributes.....	135
6.8.2.4	Requirements	135
6.8.2.5	Capabilities.....	136
6.8.2.6	Definition	136
6.8.2.7	Additional Requirements	136
6.8.2.8	Example	136
6.8.3	tosca.nodes.nfv.Vdu.Compute	137
6.8.3.1	Description	137
6.8.3.2	Properties	137
6.8.3.3	Attributes.....	138
6.8.3.4	Requirements	138
6.8.3.5	Capabilities.....	138
6.8.3.6	Definition	139
6.8.3.7	Additional requirements.....	140
6.8.3.8	Example	141
6.8.4	tosca.nodes.nfv.Vdu.VirtualBlockStorage	146
6.8.4.1	Description	146
6.8.4.2	Properties	146
6.8.4.3	Attributes.....	146
6.8.4.4	Requirements	146
6.8.4.5	Capabilities.....	147
6.8.4.6	Definition	147
6.8.4.7	Additional requirements.....	147
6.8.5	tosca.nodes.nfv.Vdu.VirtualObjectStorage.....	147
6.8.5.1	Description	147
6.8.5.2	Properties	148
6.8.5.3	Attributes.....	148
6.8.5.4	Requirements	148
6.8.5.5	Capabilities.....	148
6.8.5.6	Definition	148
6.8.5.7	Additional requirements.....	148

6.8.6	tosca.nodes.nfv.Vdu.VirtualFileStorage	149
6.8.6.1	Description	149
6.8.6.2	Properties	149
6.8.6.3	Attributes	149
6.8.6.4	Requirements	149
6.8.6.5	Capabilities	149
6.8.6.6	Definition	150
6.8.6.7	Additional requirements	150
6.8.7	tosca.nodes.nfv.Cp	150
6.8.7.1	Description	150
6.8.8	tosca.nodes.nfv.VduCp	150
6.8.8.1	Description	150
6.8.8.2	Properties	150
6.8.8.3	Attributes	151
6.8.8.4	Requirements	151
6.8.8.6	Definition	152
6.8.9	tosca.nodes.nfv.VnfVirtualLink	153
6.8.9.1	Description	153
6.8.9.2	Properties	153
6.8.9.3	Requirements	153
6.8.9.4	Capabilities	153
6.8.9.5	Definition	154
6.8.10	tosca.nodes.nfv.VipCp	154
6.8.10.1	Description	154
6.8.10.2	Properties	154
6.8.10.3	Attributes	155
6.8.10.4	Requirements	155
6.8.10.5	Definition	155
6.8.10.6	Example	156
6.8.11	tosca.nodes.nfv.VduSubCp	156
6.8.11.1	Description	156
6.8.11.2	Properties	156
6.8.11.3	Attributes	156
6.8.11.4	Requirements	156
6.8.11.5	Definition	157
6.8.11.6	Example	157
6.8.11.7	Additional Requirements	157
6.9	Group Types	158
6.9.1	tosca.groups.nfv.PlacementGroup	158
6.9.1.1	Description	158
6.9.1.2	Properties	158
6.9.1.3	Definition	158
6.9.1.4	Additional Requirements	158
6.9.1.5	Examples	158
6.10	Policy Types	159
6.10.1	tosca.policies.nfv.InstantiationLevels	159
6.10.1.1	Description	159
6.10.1.2	Properties	159
6.10.1.3	Definition	159
6.10.2	tosca.policies.nfv.VduInstantiationLevels	160
6.10.2.1	Description	160
6.10.2.2	Properties	160
6.10.2.3	Definition	160
6.10.2.4	Additional Requirements	160
6.10.3	tosca.policies.nfv.VirtualLinkInstantiationLevels	161
6.10.3.1	Description	161
6.10.3.2	Properties	161
6.10.3.3	Definition	161
6.10.3.4	Additional Requirements	161
6.10.4	Void	161
6.10.5	tosca.policies.nfv.ScopingAspects	162
6.10.5.1	Description	162

6.10.5.2	Properties	162
6.10.5.3	Definition	162
6.10.5.5	Examples	162
6.10.6	tosca.policies.nfv.VduScalingAspectDeltas	163
6.10.6.1	Description	163
6.10.6.2	Properties	163
6.10.6.3	Definition	163
6.10.6.5	Examples	164
6.10.7	tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas	164
6.10.7.1	Description	164
6.10.7.2	Properties	164
6.10.7.3	Definition	164
6.10.7.4	Additional Requirements	165
6.10.7.5	Examples	165
6.10.8	tosca.policies.nfv.VduInitialDelta	165
6.10.8.1	Description	165
6.10.8.2	Properties	165
6.10.8.3	Definition	165
6.10.8.4	Examples	165
6.10.9	tosca.policies.nfv.VirtualLinkBitrateInitialDelta	166
6.10.9.1	Description	166
6.10.9.2	Properties	166
6.10.9.3	Definition	166
6.10.9.4	Examples	166
6.10.10	AffinityRule, AntiAffinityRule	166
6.10.10.1	Description	166
6.10.10.2	Properties	167
6.10.10.3	targets	167
6.10.10.4	Definition	168
6.10.10.5	Examples	168
6.10.11	tosca.policies.nfv.Abstract.SecurityGroupRule	169
6.10.11.1	Description	169
6.10.12	tosca.policies.nfv.SupportedVnfInterface	169
6.10.12.1	Description	169
6.10.12.2	Properties	169
6.10.12.3	Definition	169
6.10.12.4	Additional requirements	170
6.10.12.5	Example	170
6.10.13	tosca.policies.nfv.SecurityGroupRule	170
6.10.13.1	Description	170
6.10.13.2	Properties	170
6.10.13.3	targets	170
6.10.13.4	Definition	171
6.10.13.5	Additional Requirements	171
6.10.14	tosca.policies.nfv.VnfIndicator	171
6.10.14.1	Description	171
6.10.14.2	Properties	171
6.10.14.3	Definition	171
6.10.14.4	Additional requirements	172
6.10.15	tosca.policies.nfv.VnfPackageChange	172
6.10.15.1	Description	172
6.10.15.2	Properties	172
6.10.15.3	Definition	173
6.10.15.4	Additional Requirements	174
6.10.15.5	Example	175
6.10.16	tosca.policies.nfv.LcmCoordinationAction	183
6.10.16.1	Description	183
6.10.16.2	Properties	184
6.10.16.3	Definition	184
6.10.16.4	Additional Requirements	184
6.10.17	tosca.policies.nfv.LcmCoordinationsForLcmOperation	184
6.10.17.1	Description	184

6.10.17.2	Properties	185
6.10.17.3	Definition	186
6.10.17.4	Additional Requirements	186
6.11	VNFD TOSCA service template design.....	186
6.11.1	General.....	186
6.11.2	Single or multiple deployment flavour design with two levels of service templates	187
6.11.3	Single deployment flavour design with one service template.....	188
6.11.4	Package change (handling the Change current VNF Package request)	189
7	NSD TOSCA model.....	189
7.1	Introduction	189
7.2	Data Types.....	190
7.2.1	Void	190
7.2.2	tosca.datatypes.nfv.VnfProfile	190
7.2.2.1	Description	190
7.2.3	tosca.datatype.nfv.NsVIProfile	190
7.2.3.1	Description	190
7.2.3.2	Properties	190
7.2.3.3	Definition	191
7.2.3.4	Examples.....	191
7.2.3.5	Additional Requirements	192
7.2.4	tosca.datatypes.nfv.ConnectivityType	192
7.2.4.1	Description	192
7.2.5	tosca.datatypes.nfv.NsVirtualLinkQos	192
7.2.5.1	Description	192
7.2.5.2	Properties	192
7.2.5.3	Definition	192
7.2.5.4	Examples.....	192
7.2.5.5	Additional Requirements	193
7.2.6	tosca.datatypes.nfv.LinkBitrateRequirements	193
7.2.6.1	Description	193
7.2.7	Void	193
7.2.8	Void	193
7.2.9	Void	193
7.2.10	Void	193
7.2.11	tosca.datatypes.nfv.CpProtocolData	193
7.2.11.1	Description	193
7.2.12	tosca.datatypes.nfv.AddressData	193
7.2.12.1	Description	193
7.2.13	tosca.datatypes.nfv.L2AddressData	193
7.2.13.1	Description	193
7.2.14	tosca.datatypes.nfv.L3AddressData	193
7.2.14.1	Description	193
7.2.15	tosca.datatypes.nfv.Qos	193
7.2.15.1	Description	193
7.2.16	tosca.datatypes.nfv.NsProfile.....	194
7.2.16.1	Description	194
7.2.16.2	Properties	194
7.2.16.3	Definition	194
7.2.16.4	Example	195
7.2.16.5	Additional Requirements	195
7.2.17	tosca.datatypes.nfv.Mask	195
7.2.17.1	Description	195
7.2.17.2	Properties	195
7.2.17.3	Definition	195
7.2.17.4	Examples.....	196
7.2.18	tosca.datatypes.nfv.NsOperationAdditionalParameters.....	196
7.2.18.1	Description	196
7.2.18.2	Properties	196
7.2.18.3	Definition	196
7.2.18.4	Examples.....	196
7.2.19	tosca.datatypes.nfv.NsMonitoringParameter	197

7.2.19.1	Description	197
7.2.19.2	Properties	198
7.2.19.3	Definition	198
7.2.19.4	Examples	199
7.2.19.5	Additional Requirements	199
7.2.20	tosca.datatypes.nfv.VnfMonitoringParameter	199
7.2.21	tosca.datatypes.nfv.NsVirtualLinkProtocolData	199
7.2.21.1	Description	199
7.2.21.2	Properties	199
7.2.21.3	Definition	199
7.2.21.4	Examples	200
7.2.21.5	Additional Requirements	200
7.2.22	tosca.datatypes.nfv.NsL2ProtocolData	200
7.2.22.1	Description	200
7.2.22.2	Properties	200
7.2.22.3	Definition	201
7.2.22.4	Examples	202
7.2.22.5	Additional Requirements	202
7.2.23	tosca.datatypes.nfv.NsL3ProtocolData	202
7.2.23.1	Description	202
7.2.23.2	Properties	202
7.2.23.3	Definition	202
7.2.23.4	Examples	203
7.2.23.5	Additional Requirements	203
7.2.24	tosca.datatypes.nfv.NsIpAllocationPool	203
7.2.24.1	Description	203
7.2.24.2	Properties	203
7.2.24.3	Definition	204
7.2.24.4	Examples	204
7.2.24.5	Additional Requirements	204
7.2.25	tosca.datatypes.nfv.NsScalingAspect	204
7.2.25.1	Description	204
7.2.25.2	Properties	204
7.2.25.3	Definition	205
7.2.25.4	Examples	205
7.2.25.5	Additional Requirements	205
7.2.26	tosca.datatypes.nfv.NsLevels	205
7.2.26.1	Description	205
7.2.26.2	Properties	205
7.2.26.3	Definition	206
7.2.26.4	Examples	206
7.2.26.5	Additional Requirements	206
7.2.27	tosca.datatypes.nfv.scaleNsByStepsData	206
7.2.27.1	Description	206
7.2.27.2	Properties	206
7.2.27.3	Definition	206
7.2.27.4	Examples	207
7.2.27.5	Additional Requirements	207
7.2.28	tosca.datatypes.nfv.scaleNsToLevelData	207
7.2.28.1	Description	207
7.2.28.2	Properties	207
7.2.28.3	Definition	208
7.2.28.4	Examples	208
7.2.28.5	Additional Requirements	208
7.3	Artifact Types	208
7.4	Capabilities Types	208
7.4.1	tosca.capabilities.nfv.VirtualLinkable	208
7.4.1.1	Description	208
7.4.2	tosca.capabilities.nfv.Forwarding	208
7.4.2.1	Description	208
7.4.2.2	Properties	209
7.4.2.3	Definition	209

7.5	Requirements Types	209
7.6	Relationship Types	209
7.6.1	tosca.relationships.nfv.VirtualLinksTo	209
7.6.1.1	Description	209
7.6.2	tosca.relationships.nfv.ForwardTo	209
7.6.2.1	Description	209
7.6.2.2	Properties	210
7.6.2.3	Definition	210
7.7	Interface Types	210
7.7.1	tosca.interfaces.nfv.Nslcm	210
7.7.1.1	Description	210
7.7.1.2	Definition	210
7.7.1.3	Additional Requirements	212
7.7.1.4	Support of LCM scripts	212
7.7.1.5	Examples	212
7.7.2	tosca.interfaces.nfv.NsVnfIndicator	213
7.7.2.1	Description	213
7.7.2.2	Definition	214
7.7.2.3	Examples	214
7.8	Node Types	214
7.8.1	tosca.nodes.nfv.NS	214
7.8.1.1	Description	214
7.8.1.2	Properties	214
7.8.1.3	Attributes	215
7.8.1.4	Requirements	216
7.8.1.5	Capabilities	216
7.8.1.6	Definition	216
7.8.1.7	Artifact	217
7.8.1.8	Additional requirements	217
7.8.2	tosca.nodes.nfv.Sap	217
7.8.2.1	Description	217
7.8.2.2	Properties	218
7.8.2.3	Attributes	218
7.8.2.4	Requirements	218
7.8.2.5	Capabilities	218
7.8.2.6	Definition	218
7.8.2.7	Additional requirements	218
7.8.2.8	Example	219
7.8.3	tosca.nodes.nfv.NsVirtualLink	219
7.8.3.1	Description	219
7.8.3.2	Properties	219
7.8.3.3	Attributes	219
7.8.3.4	Requirements	219
7.8.3.5	Capabilities	219
7.8.3.6	Definition	220
7.8.3.7	Artifact	220
7.8.3.8	Additional Requirements	220
7.8.3.9	Example	220
7.8.4	tosca.nodes.nfv.Cp	220
7.8.4.1	Description	220
7.8.5	tosca.nodes.nfv.NfpPositionElement	221
7.8.5.1	Description	221
7.8.5.2	Properties	221
7.8.5.3	Attributes	221
7.8.5.4	Requirements	221
7.8.5.5	Capabilities	221
7.8.5.6	Definition	222
7.8.5.7	Artifact	222
7.8.5.8	Additional Requirements	222
7.8.5.9	Example	222
7.8.6	tosca.nodes.nfv.NFP	222
7.8.6.1	Description	222

7.8.6.2	Properties	222
7.8.6.3	Attributes.....	222
7.8.6.4	Requirements	222
7.8.6.5	Capabilities.....	223
7.8.6.6	Definition	223
7.8.7	tosca.nodes.nfv.NfpPosition	223
7.8.7.1	Description	223
7.8.7.2	Properties	223
7.8.7.3	Attributes.....	224
7.8.7.4	Requirements	224
7.8.7.5	Capabilities.....	224
7.8.7.6	Definition	224
7.8.7.7	Artifact	225
7.8.7.8	Additional Requirements	225
7.8.7.9	Example	225
7.8.8	tosca.nodes.nfv.Forwarding	225
7.8.8.1	Description	225
7.8.8.2	Properties	226
7.8.8.3	Attributes.....	226
7.8.8.4	Requirements	226
7.8.8.5	Capabilities.....	226
7.8.8.6	Definition	226
7.8.8.7	Artifact	226
7.8.8.8	Additional Requirements	226
7.8.8.9	Example	227
7.9	Group Types.....	227
7.9.1	tosca.groups.nfv.NsPlacementGroup.....	227
7.9.1.1	Description	227
7.9.1.2	Properties	227
7.9.1.3	Definition	227
7.9.1.4	Additional Requirements	227
7.9.2	tosca.groups.nfv.VNFFG	228
7.9.2.1	Description	228
7.9.2.2	Properties	228
7.9.2.3	Definition	228
7.9.2.4	Additional Requirements	228
7.9.2.5	Example	228
7.10	Policy Types.....	229
7.10.1	NsAffinityRule, NsAntiAffinityRule.....	229
7.10.1.1	Description	229
7.10.1.2	Properties	229
7.10.1.3	Targets.....	229
7.10.1.4	Definition	230
7.10.1.5	Examples	230
7.10.2	tosca.policies.nfv.NsSecurityGroupRule	231
7.10.2.1	Description	231
7.10.2.2	Properties	231
7.10.2.3	targets	231
7.10.2.4	Definition	232
7.10.2.5	Additional Requirements	232
7.10.3	tosca.policies.nfv.NfpRule.....	232
7.10.3.1	Description	232
7.10.3.2	Properties	232
7.10.3.3	Targets.....	233
7.10.3.4	Definition	233
7.10.3.5	Example	234
7.10.4	tosca.policies.nfv.NsMonitoring	234
7.10.4.1	Description	234
7.10.4.2	Properties	235
7.10.4.3	targets	235
7.10.4.4	Definition	235
7.10.4.5	Additional Requirements	235

7.10.5	tosca.policies.nfv.VnfMonitoring	236
7.10.5.1	Description	236
7.10.5.2	Properties	236
7.10.5.3	targets	236
7.10.5.4	Definition	236
7.10.5.5	Additional Requirements	237
7.10.6	tosca.policies.nfv.Abstract.SecurityGroupRule	237
7.10.6.1	Description	237
7.10.7	tosca.policies.nfv.NsScalingAspects	237
7.10.7.1	Description	237
7.10.7.2	Properties	237
7.10.7.3	Definition	237
7.10.7.4	Examples	238
7.10.8	tosca.policies.nfv.VnfToLevelMapping	238
7.10.8.1	Description	238
7.10.8.2	Properties	238
7.10.8.3	Definition	238
7.10.8.4	Examples	239
7.10.9	tosca.policies.nfv.NsToLevelMapping	239
7.10.9.1	Description	239
7.10.9.2	Properties	239
7.10.9.3	Definition	240
7.10.9.4	Examples	240
7.10.10	tosca.policies.nfv.VirtualLinkToLevelMapping	240
7.10.10.1	Description	240
7.10.10.2	Properties	240
7.10.10.3	Definition	241
7.10.10.4	Examples	241
7.10.11	tosca.policies.nfv.NsInstantiationLevels	241
7.10.11.1	Description	241
7.10.11.2	Properties	242
7.10.11.3	Definition	242
7.10.12	tosca.policies.nfv.VnfToInstantiationLevelMapping	242
7.10.12.1	Description	242
7.10.12.2	Properties	242
7.10.12.3	Definition	243
7.10.12.4	Examples	243
7.10.12.5	Additional requirements	243
7.10.13	tosca.policies.nfv.NsToInstantiationLevelMapping	243
7.10.13.1	Description	243
7.10.13.2	Properties	243
7.10.13.3	Definition	244
7.10.13.4	Examples	244
7.10.13.5	Additional requirements	244
7.10.14	tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping	244
7.10.14.1	Description	244
7.10.14.2	Properties	244
7.10.14.3	Definition	245
7.10.14.4	Examples	245
7.10.15	tosca.policies.nfv.NsAutoScale	245
7.10.15.1	Description	245
7.10.15.2	Properties	245
7.10.15.3	Definition	245
7.10.15.4	Additional requirements	246
7.11	NSD TOSCA service template design	246
7.11.1	General	246
7.11.2	Single or multiple deployment flavour design with two levels of service templates	246
7.11.3	Single deployment flavour design with one service template	248
8	PNFD TOSCA model	249
8.1	Introduction	249
8.2	Data Types	250

8.2.1	tosca.datatypes.nfv.CpProtocolData	250
8.2.1.1	Description	250
8.2.2	tosca.datatypes.nfv.AddressData	250
8.2.2.1	Description	250
8.2.3	tosca.datatypes.nfv.L2AddressData	250
8.2.3.1	Description	250
8.2.4	tosca.datatypes.nfv.L3AddressData	250
8.2.4.1	Description	250
8.2.5	tosca.datatypes.nfv.LocationInfo	250
8.2.5.1	Description	250
8.2.5.2	Properties	250
8.2.5.3	Definition	251
8.2.5.4	Examples	251
8.2.5.5	Additional Requirements	251
8.2.6	tosca.datatypes.nfv.CivicAddressElement	251
8.2.6.1	Description	251
8.2.6.2	Properties	251
8.2.6.3	Definition	252
8.2.6.4	Examples	252
8.2.6.5	Additional Requirements	252
8.2.7	tosca.datatypes.nfv.GeographicCoordinates	252
8.2.7.1	Description	252
8.2.7.2	Properties	252
8.2.7.3	Definition	253
8.2.7.4	Examples	254
8.2.7.5	Additional Requirements	254
8.3	Artifact Types	254
8.4	Capabilities Types	254
8.4.1	tosca.capabilities.nfv.VirtualLinkable	254
8.4.1.1	Description	254
8.5	Requirements Types	254
8.6	Relationship Types	254
8.6.1	tosca.relationships.nfv.VirtualLinksTo	254
8.6.1.1	Description	254
8.7	Interface Types	254
8.8	Node Types	254
8.8.1	tosca.nodes.nfv.PNF	254
8.8.1.1	Description	254
8.8.1.2	Properties	255
8.8.1.3	Attributes	255
8.8.1.4	Requirements	255
8.8.1.5	Capabilities	255
8.8.1.6	Definition	255
8.8.1.7	Artifact	256
8.8.1.8	Additional Requirements	256
8.8.1.9	Example	257
8.8.2	tosca.nodes.nfv.PnfExtCp	257
8.8.2.1	Description	257
8.8.2.2	Properties	257
8.8.2.3	Attributes	257
8.8.2.4	Requirements	257
8.8.2.5	Capabilities	257
8.8.2.6	Definition	257
8.8.3	tosca.nodes.nfv.Cp	258
8.8.3.1	Description	258
8.9	Group Types	258
8.10	Policy Types	258
8.10.1	tosca.policies.nfv.PnfSecurityGroupRule	258
8.10.1.1	Description	258
8.10.1.2	Properties	258
8.10.1.3	targets	258
8.10.1.4	Definition	258

8.10.1.5	Additional Requirements	258
8.10.2	tosca.policies.nfv.Abstract.SecurityGroupRule	259
8.10.2.1	Description	259
8.11	PNFD TOSCA service template design	259
8.11.1	General.....	259
9	Common Definitions	259
9.1	Introduction	259
9.2	Data Types.....	259
9.2.1	tosca.datatypes.nfv.L2AddressData	259
9.2.1.1	Description	259
9.2.1.2	Properties	260
9.2.1.3	Definition	260
9.2.1.4	Examples.....	260
9.2.1.5	Additional Requirements	260
9.2.2	tosca.datatypes.nfv.L3AddressData	260
9.2.2.1	Description	260
9.2.2.2	Properties	261
9.2.2.3	Definition	261
9.2.2.4	Examples.....	262
9.2.2.5	Additional Requirements	262
9.2.3	tosca.datatypes.nfv.AddressData	262
9.2.3.1	Description	262
9.2.3.2	Properties	262
9.2.3.3	Definition	263
9.2.3.4	Examples.....	263
9.2.3.5	Additional Requirements	263
9.2.4	tosca.datatypes.nfv.ConnectivityType	263
9.2.4.1	Description	263
9.2.4.2	Properties	264
9.2.4.3	Definition	264
9.2.4.4	Examples.....	264
9.2.4.5	Additional Requirements	264
9.2.5	tosca.datatypes.nfv.LinkBitrateRequirements	265
9.2.5.1	Description	265
9.2.5.2	Properties	265
9.2.5.3	Definition	265
9.2.5.4	Examples.....	265
9.2.5.5	Additional Requirements	266
9.2.6	tosca.datatypes.nfv.CpProtocolData	266
9.2.6.1	Description	266
9.2.6.2	Properties	266
9.2.6.3	Definition	266
9.2.6.4	Examples.....	266
9.2.6.5	Additional Requirements	267
9.2.7	tosca.datatypes.nfv.Qos	267
9.2.7.1	Description	267
9.2.7.2	Properties	267
9.2.7.3	Definition	267
9.2.7.4	Examples.....	268
9.2.7.5	Additional Requirements	268
9.2.8	tosca.datatypes.nfv.VnfProfile.....	268
9.2.8.1	Description	268
9.2.8.2	Properties	268
9.2.8.3	Definition	268
9.2.8.4	Example	269
9.2.8.5	Additional Requirements	269
9.2.9	tosca.datatypes.nfv.VnfMonitoringParameter	269
9.2.9.1	Description	269
9.2.9.2	Properties	269
9.2.9.3	Definition	270
9.2.9.4	Examples.....	270

9.2.9.5	Additional Requirements	270
9.3	Artifact Types.....	271
9.4	Capabilities Types	271
9.4.1	tosca.capabilities.nfv.VirtualLinkable	271
9.4.1.1	Description	271
9.4.1.2	Properties	271
9.4.1.3	Definition	271
9.4.2	Void	271
9.5	Requirements Types	271
9.6	Relationship Types	272
9.6.1	tosca.relationships.nfv.VirtualLinksTo.....	272
9.6.1.1	Description	272
9.6.1.2	Properties	272
9.6.1.3	Definition	272
9.6.2	Void	272
9.6.3	tosca.relationships.nfv.VipVirtualLinksTo.....	272
9.6.3.1	Description	272
9.6.3.2	Properties	272
9.6.3.3	Definition	273
9.7	Interface Types	273
9.8	Node Types	273
9.8.1	tosca.nodes.nfv.Cp.....	273
9.8.1.1	Description	273
9.8.1.2	Properties	273
9.8.1.3	Attributes.....	274
9.8.1.4	Requirements	274
9.8.1.5	Capabilities.....	274
9.8.1.6	Definition	274
9.8.1.7	Additional requirements.....	275
9.9	Group Types.....	275
9.10	Policy Types.....	275
9.10.1	tosca.policies.nfv.Abstract.SecurityGroupRule	275
9.10.1.1	Description	275
9.10.1.2	Properties	275
9.10.1.3	Definition	276
9.10.1.4	Additional Requirements	277
Annex A (informative): Examples.....		278
A.1	Deployment flavour design mapping	278
A.1.1	Introduction	278
A.1.2	Design principle for VNF deployment flavour.....	278
A.1.3	Design principle for NS deployment flavour	279
A.2	VNFD with deployment flavour modelling design example.....	279
A.3	VNF external connection point	289
A.3.1	General	289
A.3.2	External connection point re-exposing an internal connection point.....	289
A.3.3	External connection point connected to an internal virtual link	293
A.4	VNFD modelling design example by using TOSCA composition.....	294
A.5	VNFD with Single deployment flavour modelling design example	299
A.6	Scaling and Instantiation Level examples	303
A.6.1	ScalingAspect and InstantiationLevels policies with uniform delta.....	303
A.6.2	ScalingAspect and InstantiationLevels policies with non-uniform deltas	309
A.7	Service Access Point	313
A.7.1	General	313
A.7.2	VNF External connection point exposing as a SAP.....	314
A.7.3	SAP connected to an NS virtual link	316
A.8	NSD with Single deployment flavour modelling design example	317

A.9	Mapping between NFV IM and TOSCA concepts.....	321
A.9.1	Introduction	321
A.9.2	Mapping between ETSI GS NFV-IFA 011 IM and TOSCA concepts.....	321
A.9.3	Mapping between ETSI GS NFV-IFA 014 IM and TOSCA concepts.....	322
A.10	PNFD modelling design example.....	323
A.11	NSD with Multiple deployment flavour modelling design example.....	325
A.12	NSD with nested NS design example.....	331
A.13	Virtual IP address connection point	336
A.14	NSD VNF Forwarding Graph design example	343
A.15	Auto-scale and auto-heal design.....	353
A.15.1	Introduction	353
A.15.2	Auto-scale and auto-heal design with use of VNF indicator in VNFD	353
A.15.3	Auto-scale design with use of VNF indicator in NSD.....	357
A.16	VDU connection point in trunk mode	364
A.17	NS scaling	367
Annex B (normative):	etsi_nfv_sol001_type definitions	373
B.1	Purpose	373
B.2	VNFD type definitions file.....	373
B.3	NSD type definitions file.....	373
B.4	PNFD type definitions file	374
B.5	Common type definitions file.....	374
Annex C (normative):	Conformance.....	375
C.1	Purpose	375
C.2	NFV TOSCA YAML service template.....	375
C.3	NFV TOSCA processor.....	376
Annex D (informative):	Mapping between properties of TOSCA types and API attributes.....	377
D.1	Introduction	377
D.2	VNFD-related constructs.....	377
D.3	NSD-related constructs.....	386
Annex E (informative):	TOSCA Imperative workflows.....	391
E.1	Purpose	391
E.2	TOSCA Imperative workflows for the NSD	391
E.2.1	Introduction	391
E.2.2	Definition of an NS workflow	391
E.2.3	Examples	392
Annex F (informative):	Non-Backward Compatible Changes in the GS.....	397
F.1	Introduction	397
F.2	Non-Backward Compatible changes between version 2.7.1 and 2.6.1	397
F.3	Non-Backward Compatible changes between version 2.8.1 and 3.3.1	397
Annex G (informative):	Change History	399
History		404

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Foreword

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

Modal verbs terminology

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

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1 Scope

The present document specifies a 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://tools.ietf.org/html/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://tools.ietf.org/html/rfc791>.

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

NOTE: Available at <https://tools.ietf.org/html/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://tools.ietf.org/html/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.

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

- [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 1: Available at <https://docs.openstack.org/glance/pike/user/formats.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.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 clause 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). A VDU 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.

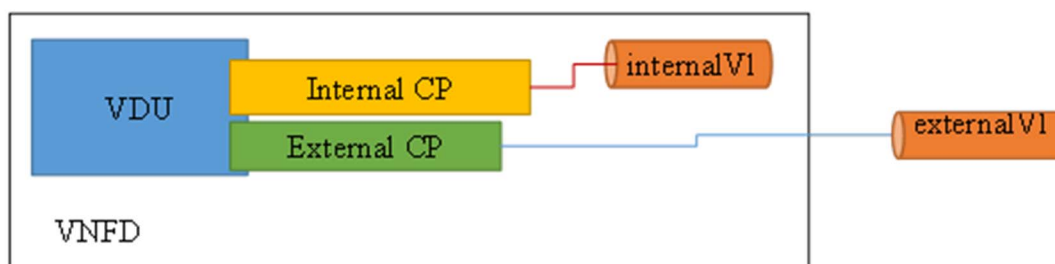


Figure 5.3-1: Overview of VNF descriptor

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.
	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.

Type	Keyname	Property name
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).
tosca.policies.nfv.LcmCoordinationAction	policies	See clause 6.10.16.4
<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>		

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
<p>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.</p>		

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 use 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.

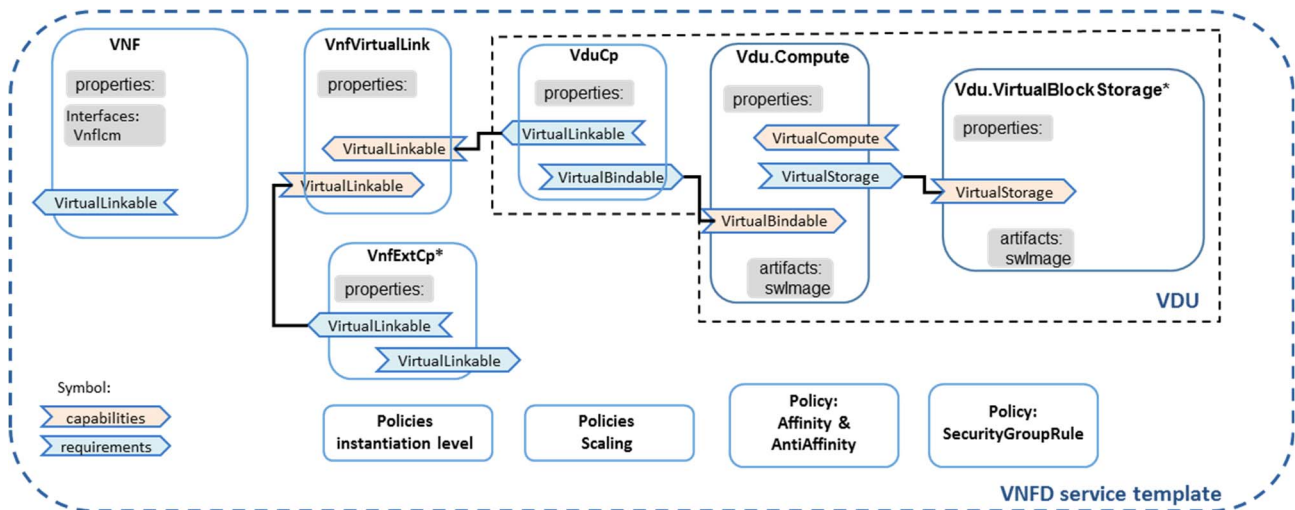


Figure 6.1-1: Service template VNFD overview when all the virtualization containers of the VNF are realized as VMs

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	<code>VirtualNetworkInterfaceRequirements</code>
Type Qualified Name	<code>toscanfv:VirtualNetworkInterfaceRequirements</code>
Type URI	<code>tosca.datatypes.nfv.VirtualNetworkInterfaceRequirements</code>

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.
support_mandatory	yes	boolean		Indicates whether fulfilling the constraint is mandatory (TRUE) for successful operation or desirable (FALSE).
network_interface_requirements	yes	map of string		The network interface requirements. A map of strings that contain a set of key-value pairs that describes the 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 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: toska.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
    support_mandatory:
      type: boolean
      description: Indicates whether fulfilling the constraint is mandatory (TRUE)
for successful operation or desirable (FALSE).
      required: true
    network_interface_requirements:
      type: map
      description: The network interface requirements. A map of strings that contain
a set of key-value pairs that describes the hardware platform specific network
interface deployment requirements.
      required: true
    entry_schema:
      type: string
    nic_io_requirements:

```

```

type: toska.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 toska.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 toska.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: toasca.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 toasca.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.
vdu_mem_requirements	no	map of string		The hardware platform specific VDU memory requirements. A map of strings that 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: toska.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 that 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 toska.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 that 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: toska.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 that contains a set of key-value pairs describing VDU CPU specific hardware
platform requirements.
    required: false
    entry_schema:
      type: string
  virtual_cpu_pinning:
    type: toska.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 toska.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: toska.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 toska.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: toska.datatypes.Root
  description: Defines the configurable properties of a VNFC
  #properties:
    # additional_vnfc_configurable_properties:
    #   type: toska.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
    # toska.datatypes.nfv.VnfcAdditionalConfigurableProperties
```

6.2.10.4 Examples

```
tosca_definitions_version: toska_simple_yaml_1_3

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

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

  MyCompany.datatypes.nfv.AuxVnfcAdditionalConfigurableProperties:
    derived_from: toska.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:
      ..

```

6.2.10.5 Additional Requirements

None.

6.2.11 toska.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	<code>VnfcAdditionalConfigurableProperties</code>
Type Qualified Name	<code>toscanfv:VnfcAdditionalConfigurableProperties</code>
Type URI	<code>tosca.datatypes.nfv.VnfcAdditionalConfigurableProperties</code>

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

```

6.2.12 toska.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.
NOTE: A vduuld property, which exists in ETSI GS NFV-IFA 011 [1] is not needed, as the VduProfile is contained in the Vdu.Compute node.				

6.2.12.3 Definition

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

```

tosca.datatypes.nfv.VduProfile:
  derived_from: toscanfv.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

```

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.VIProfile

6.2.13.1 Description

The VIProfile 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	VIProfile
Type Qualified Name	toscanfv:VIProfile
Type URI	tosca.datatypes.nfv.VIProfile

6.2.13.2 Properties

The properties of the VIProfile 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 VIProfile data type shall comply with the following definition:

```

tosca.datatypes.nfv.VIProfile:
  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.
l2_protocol_data	no	tosca.datatype s.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.datatype s.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 describes 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.

Name	Required	Type	Constraints	Description
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.IpAllocation Pool		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: toska.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 toska.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: toasca.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: toasca.datatypes.nfv.ScaleInfo

```

6.2.18.4 Examples

See clause A.6.

6.2.18.5 Additional Requirements

None.

6.2.19 toasca.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: toska.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 toska.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.
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: toska.datatypes.Root
  description: Represents information to configure lifecycle management operations
  properties:
    instantiate:
      type: toska.datatypes.nfv.VnfInstantiateOperationConfiguration
      description: Configuration parameters for the InstantiateVnf operation
      required: false
    scale:
      type: toska.datatypes.nfv.VnfScaleOperationConfiguration
      description: Configuration parameters for the ScaleVnf operation

```



```

    required: false
  scale_to_level:
    type: toasca.datatypes.nfv.VnfScaleToLevelOperationConfiguration
    description: Configuration parameters for the ScaleVnfToLevel operation
    required: false
  change_flavour:
    type: toasca.datatypes.nfv.VnfChangeFlavourOperationConfiguration
    description: Configuration parameters for the changeVnfFlavourOpConfig
operation
    required: false
  heal:
    type: toasca.datatypes.nfv.VnfHealOperationConfiguration
    description: Configuration parameters for the HealVnf operation
    required: false
  terminate:
    type: toasca.datatypes.nfv.VnfTerminateOperationConfiguration
    description: Configuration parameters for the TerminateVnf operation
    required: false
  operate:
    type: toasca.datatypes.nfv.VnfOperateOperationConfiguration
    description: Configuration parameters for the OperateVnf operation
    required: false
  change_ext_connectivity:
    type: toasca.datatypes.nfv.VnfChangeExtConnectivityOperationConfiguration
    description: Configuration parameters for the changeExtVnfConnectivityOpConfig
operation
    required: false
  change_current_package:
    type: toasca.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
    # toasca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration,
    # with the same name as the operation designated to the
ChangeCurrentVnfPackage request
  create_snapshot:
    type: toasca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration
    description: Configuration parameters for the CreateVnfSnapshot operation
    required: false
  revert_to_snapshot:
    type: toasca.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	<code>VnfInstantiateOperationConfiguration</code>
Type Qualified Name	<code>toscanfv:VnfInstantiateOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfInstantiateOperationConfiguration</code>

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: toska.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	<code>VnfScaleOperationConfiguration</code>
Type Qualified Name	<code>toscanfv:VnfScaleOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfScaleOperationConfiguration</code>

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: toska.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 toska.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: toska.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 toska.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: toska.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	<code>VnfTerminateOperationConfiguration</code>
Type Qualified Name	<code>toscanfv:VnfTerminateOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfTerminateOperationConfiguration</code>

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
<code>min_graceful_termination_timeout</code>	yes	scalar-unit.time		Minimum timeout value for graceful termination of a VNF instance.
<code>max_recommended_graceful_termination_timeout</code>	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: toasca.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	<code>VnfOperateOperationConfiguration</code>
Type Qualified Name	<code>toscanfv:VnfOperateOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfOperateOperationConfiguration</code>

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
<code>min_graceful_stop_timeout</code>	yes	scalar-unit.time		Minimum timeout value for graceful stop of a VNF instance.
<code>max_recommended_graceful_stop_timeout</code>	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: toasca.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: toasca.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	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.

Name	Required	Type	Constraints	Description
vnf_oauth_server_info	no	tosca.datatypes.nfv.OauthServerInfo		<p>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.</p> <p>If the property is not present, then configuring this VNF property is not supported.</p> <p>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.</p>
additional_configurable_property	no	tosca.datatypes.nfv.VnfAdditionalConfigurableProperties		<p>It provides VNF specific configurable properties that can be modified using the ModifyVnfInfo operation.</p> <p>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.</p>

6.2.31.3 Definition

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

```

tosca.datatypes.nfv.VnfConfigurableProperties:
  derived_from: toska.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: toska.datatypes.nfv.VnfmInterfaceInfo
      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

```

```

vnfm_oauth_server_info:
  type: toska.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: toska.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: toska.datatypes.nfv.VnfAdditionalConfigurableProperties
# derived types are expected to introduce
# additional_configurable_properties with its type derived from
# toska.datatypes.nfv.VnfAdditionalConfigurableProperties

```

6.2.31.4 Examples

Example definition of configurable properties without properties assignment value.

```

tosca_definitions_version: toska_simple_yaml_1_3

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: toska.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: toska.datatypes.nfv.VnfConfigurableProperties
    properties:
      additional_configurable_properties:
        type: MyCompany.datatypes.nfv.VnfAdditionalConfigurableProperties

  MyCompany.datatypes.nfv.VnfAdditionalConfigurableProperties:
    derived_from: toska.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.

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
    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.

6.2.31.5 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	<code>VnfAdditionalConfigurableProperties</code>
Type Qualified Name	<code>toscanfv:VnfAdditionalConfigurableProperties</code>
Type URI	<code>tosca.datatypes.nfv.VnfAdditionalConfigurableProperties</code>

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
<code>is_writable_anytime</code>	yes	boolean		It specifies whether these additional configurable properties are writable (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: toscanfv: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	<code>VnfInfoModifiableAttributes</code>
Type Qualified Name	<code>toscanfv:VnfInfoModifiableAttributes</code>
Type URI	<code>tosca.datatypes.nfv.VnfInfoModifiableAttributes</code>

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	<code>tosca.datatypes.nfv.VnfInfoModifiableAttributesExtensions</code>		"Extension" properties of <code>VnfInfo</code> that are writeable.
metadata	no	<code>tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata</code>		"Metadata" properties of <code>VnfInfo</code> 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: toasca.datatypes.Root
  description: Describes VNF-specific extension and metadata for a given VNF
  #properties:
    #extensions:
      #type: toasca.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
# tosc.datatypes.nfv.VnfInfoModifiableAttributesExtensions
#metadata:
#type: tosc.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
# tosc.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: tosc_simple_yaml_1_3

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

  mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
    derived_from: tosc.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 tosc.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: toska.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 toska.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	<code>VnfInfoModifiableAttributesMetadata</code>
Type Qualified Name	<code>toscanfv:VnfInfoModifiableAttributesMetadata</code>
Type URI	<code>tosca.datatypes.nfv.VnfInfoModifiableAttributesMetadata</code>

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: toska.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: toska_simple_yaml_1_3

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: toska.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		<p>The logical node-level compute, memory and I/O requirements. A map of strings that 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.</p> <p>More information regarding the usage of this property is available at: https://register.etsi.org.</p>

6.2.37.3 Definition

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

```

tosca.datatypes.nfv.LogicalNodeData:
  derived_from: toska.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 that 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 toska.datatypes.nfv.SwImageData

6.2.38.1 Description

The SwImageData data type describes information related to a software image artifact. Table 6.2.38.1-1 specifies the declared names for this data type. These names shall be used as specified in TOSCA-Simple-Profile-YAML-v1.3 [20].

Table 6.2.38.1-1: Type name, shorthand, and URI

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

6.2.38.2 Properties

The properties of the SwImageData data type shall comply with the provisions set out in table 6.2.38.2-1.

Table 6.2.38.2-1: 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.
checksum	yes	tosca.data types.nfv. Checksum Data		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_eq ual: 0 B	The minimal disk size requirement for this software image.
min_ram	no	scalar- unit.size	greater_or_eq ual: 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].				

6.2.38.3 Definition

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

```

tosca.datatypes.nfv.SwImageData:
  derived_from: toska.datatypes.Root
  description: describes information related to a software image artifact
  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: toska.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

```

6.2.38.4 Examples

None.

6.2.38.5 Additional Requirements

None.

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	<code>VirtualBlockStorageData</code>
Type Qualified Name	<code>toscanfv:VirtualBlockStorageData</code>
Type URI	<code>tosca.datatypes.nfv.VirtualBlockStorageData</code>

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
<code>size_of_storage</code>	yes	scalar-unit.size	greater_or_equal:0 B	Size of virtualised storage resource.
<code>vdn_storage_requirements</code>	no	map of string		The hardware platform specific storage requirements. A map of strings that 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 .
<code>rdma_enabled</code>	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: toska.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 that 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	<code>VirtualObjectStorageData</code>
Type Qualified Name	<code>toscanfv:VirtualObjectStorageData</code>
Type URI	<code>tosca.datatypes.nfv.VirtualObjectStorageData</code>

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
<code>max_size_of_storage</code>	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 VirtualObjectFileData 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	VirtualObjectFileData
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		The shared file system protocol (e.g. NFS, CIFS).

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

```

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	<code>VnfChangeFlavourOperationConfiguration</code>
Type Qualified Name	<code>toscanfv:VnfChangeFlavourOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfChangeFlavourOperationConfiguration</code>

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: toska.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.VnfChangeExtConnectivityOperationConfiguration`

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: toasca.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 toasca.datatypes.nfv.VnfMonitoringParameter

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

6.2.47 toasca.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: <ul style="list-style-type: none"> • 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 <code>_cpu_usage_mean_vnf</code> , <code>v_cpu_usage_peak_vnf</code> , <code>v_memory_usage_mean_vnf</code> , <code>v_memory_usage_peak_vnf</code> , <code>v_disk_usage_mean_vnf</code> and <code>v_disk_usage_peak_vnf</code> 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: toska.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	<code>VirtualLinkMonitoringParameter</code>
Type Qualified Name	<code>tosca.nfv:VirtualLinkMonitoringParameter</code>
Type URI	<code>tosca.datatypes.nfv.VirtualLinkMonitoringParameter</code>

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
<code>name</code>	no	string		Human readable name of the monitoring parameter.
<code>performance_metric</code>	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: <ul style="list-style-type: none"> • <code>ByteIncoming</code> • <code>ByteOutgoing</code> • <code>PacketIncoming</code> • <code>PacketOutgoing</code> 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.
<code>collection_period</code>	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: toska.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 toska.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: toska.datatypes.Root
  description: information used to access an interface exposed by a VNF
  properties:
    uri_components:
      type: toska.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 toska.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: toska.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: toska.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 is out of service or is not reachable, the VNFM is expected to try reaching the interface through another CP instance.

6.2.52 toska.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 toska.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: toasca.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 toasca.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: toska.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: toska.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 toska.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: toasca.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 toasca.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.
<p>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\$.</p> <p>NOTE 2: One and only one of the following properties shall be present: contents or source_path.</p> <p>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).</p>				

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	<code>BootDataVimSpecificProperties</code>
Type Qualified Name	<code>toscanfv: BootDataVimSpecificProperties</code>
Type URI	<code>tosca.datatypes.nfv.BootDataVimSpecificProperties</code>

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	tosca.nfv: 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: tosc.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	<code>VnfChangeCurrentPackageOperationConfiguration</code>
Type Qualified Name	<code>toscanfv.VnfChangeCurrentPackageOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfChangeCurrentPackageOperationConfiguration</code>

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: toasca.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 toasca.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	<code>VnfCreateSnapshotOperationConfiguration</code>
Type Qualified Name	<code>toscanfv:VnfCreateSnapshotOperationConfiguration</code>
Type URI	<code>tosca.datatypes.nfv.VnfCreateSnapshotOperationConfiguration</code>

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: toasca.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: toska.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 toska.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	<p>Specifies the type of the endpoint exposing the LCM operation coordination such as operations supporting management systems (e.g. EM) or the VNF instance.</p> <p>valid values:</p> <ul style="list-style-type: none"> • mgmt: coordination with other operations supporting management systems • vnf: coordination with the VNF instance <p>If the VNF produces the LCM coordination interface, this property may be omitted or may have the value "vnf".</p> <p>If this attribute is omitted, the type of endpoint that provides the interface is determined at deployment time.</p> <p>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".</p>
coordination_stage	no	string	Valid values: start, end	<p>Indicates whether the coordination action is invoked before or after all other changes performed by the VNF LCM operation. See note.</p> <p>Valid values:</p> <ul style="list-style-type: none"> - 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. <p>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.</p>
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	<code>InputOpCoordParams</code>
Type Qualified Name	<code>toscanfv:InputOpCoordParams</code>
Type URI	<code>tosca.datatypes.nfv.InputOpCoordParams</code>

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: toasca.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	<code>OutputOpCoordParams</code>
Type Qualified Name	<code>toscanfv:OutputOpCoordParams</code>
Type URI	<code>tosca.datatypes.nfv.OutputOpCoordParams</code>

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

6.3 Artifact Types

6.3.1 toska.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.
checksum	yes	tosca.data types.nfv. Checksum Data		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.

Name	Required	Type	Constraints	Description
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: toasca.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: toasca.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 toasca.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: toasca.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	<code>VirtualBindable</code>
Type Qualified Name	<code>toscanfv:VirtualBindable</code>
Type URI	<code>tosca.capabilities.nfv.VirtualBindable</code>

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: toasca.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	<code>VirtualCompute</code>
Type Qualified Name	<code>toscanfv:VirtualCompute</code>
Type URI	<code>tosca.capabilities.nfv.VirtualCompute</code>

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 tosc.datatypes.nfv.LogicalNodeData		The Logical Node requirements.
request_additional_capabilities	no	map of tosc.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 tosc.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: tosc.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: tosc.datatypes.nfv.LogicalNodeData
    requested_additional_capabilities:
      type: map
      description: Describes additional capability for a particular VDU
      required: false
      entry_schema:
        type: tosc.datatypes.nfv.RequestedAdditionalCapability
    compute_requirements:
      type: map
      required: false
      entry_schema:
        type: string
    virtual_memory:
      type: tosc.datatypes.nfv.VirtualMemory
      description: Describes virtual memory of the virtualised compute
      required: true
    virtual_cpu:
      type: tosc.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: toska.datatypes.nfv.VirtualBlockStorageData
  description: virtual system disk definition

```

6.4.4 toska.capabilities.nfv.VirtualStorage

6.4.4.1 Description

The VirtualStorage capability indicates that the node that includes it can be pointed by a toska.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: toska.capabilities.Root
  description: Describes the attachment capabilities related to Vdu.Storage

```

6.4.5 toska.capabilities.nfv.TrunkBindable

6.4.5.1 Description

The TrunkBindable capability indicates that the VduCp node that includes it can be pointed by a toska.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: toska.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 toska.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: toska.relationships.DependsOn
  description: Represents an association relationship between Vdu.Compute and VduCp
node types
  valid_target_types: [ toska.capabilities.nfv.VirtualBindable ]

```

6.6.2 toska.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	<code>AttachesTo</code>
Type Qualified Name	<code>toscanfv:AttachesTo</code>
Type URI	<code>tosca.relationships.nfv.AttachesTo</code>

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: toasca.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: [ toasca.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	<code>TrunkBindsTo</code>
Type Qualified Name	<code>toscanfv:TrunkBindsTo</code>
Type URI	<code>tosca.relationships.nfv.TrunkBindsTo</code>

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: toasca.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: [ toasca.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	<code>Vnflcm</code>
Type Qualified Name	<code>toscanfv:Vnflcm</code>
Type URI	<code>tosca.interfaces.nfv.Vnflcm</code>

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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
  #     # required: false
# derived types are expected to introduce additional_parameters with its
# type derived from toasca.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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
  #     # required: false
# derived types are expected to introduce additional_parameters with its
# type derived from toasca.datatypes.nfv.VnfOperationAdditionalParameters
inputs:
  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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
  #     # required: false
# derived types are expected to introduce additional_parameters with its
# type derived from toasca.datatypes.nfv.VnfOperationAdditionalParameters
inputs:
  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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
#     required: false
# derived types are expected to introduce additional_parameters with its
# type derived from toasca.datatypes.nfv.VnfOperationAdditionalParameters
inputs:
  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: toasca.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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
#     required: false
# derived types are expected to introduce additional_parameters with its
# type derived from toasca.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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
#     required: false
# derived types are expected to introduce additional_parameters with its
# type derived from toasca.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 toasca.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.VnfIndicator` 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	<code>VnfIndicator</code>
Type Qualified Name	<code>toscanfv:VnfIndicator</code>
Type URI	<code>tosca.interfaces.nfv.VnfIndicator</code>

6.7.2.2 Definition

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

```
tosca.interfaces.nfv.VnfIndicator:
  derived_from: toska.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	<code>ChangeCurrentVnfPackage</code>
Type Qualified Name	<code>toscanfv:ChangeCurrentVnfPackage</code>
Type URI	<code>tosca.interfaces.nfv.ChangeCurrentVnfPackage</code>

6.7.3.2 Definition

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

```
tosca.interfaces.nfv.ChangeCurrentVnfPackage:
  derived_from: toska.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 toska.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.

Name	Required	Type	Constraints	Description
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.
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.datatype pes.nfv.VnfConfigurableProperties		Describes the configurable properties of the VNF (e.g. related to auto scaling and auto healing).
modifiable_attributes	no	tosca.datatype pes.nfv.VnfInfoModifiableAttributes		Describes the modifiable attributes of the VNF.
lcm_operations_configuration	no	tosca.datatype pes.nfv.VnfLcmOperationsConfiguration		Describes the configuration parameters for the VNF LCM operations.
monitoring_parameters	no	map of tosca.datatype pes.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.datatype pes.nfv.VnfProfile		Describes a profile for instantiating VNFs of a particular NS DF according to a specific VNFD and VNF DF. See note 2.

Name	Required	Type	Constraints	Description
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 vnf_info string values shall comply with the following ABNF [6] snippet:

```
value = any_etsi_nfv_compliant_product | product_specific

any_etsi_nfv_compliant_product = "etsivnf" 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 vnf_info string values shall also comply with the pattern defined by the following regular expression [15]: $(^etsivnf: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: toska.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: (^etsivnm: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: toasca.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 toasca.datatypes.nfv.VnfConfigurableProperties
#modifiable_attributes:
  #type: toasca.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
# toasca.datatypes.nfv.VnfInfoModifiableAttributes
lcm_operations_configuration:
  type: toasca.datatypes.nfv.VnfLcmOperationsConfiguration
  description: Describes the configuration parameters for the VNF LCM operations
  required: false
monitoring_parameters:
  type: map # key: id
  entry_schema:
    type: toasca.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: toasca.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:
 - 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 allows not to include them in property assignments in node templates, e.g. in the NSD.

- 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: toska.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: toska.datatypes.nfv.VnfInfoModifiableAttributes
  properties:
  extensions:
    type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions

mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
  derived_from: toska.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: toska_simple_yaml_1_3

node_types:
MyCompany.SunshineDB.1_0.1_0:
  derived_from: toska.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.nfv.interfaces.MyCompanyVnfIndicator
    derived_from: tosca.nfv.interfaces.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: toasca.interfaces.nfv.Vnflcm
      operations:
        # omitted for brevity
    VnfIndicator:
      type: toasca.interfaces.nfv.MyCompanyVnfIndicator
      notifications:
        health:
          output:
            health_vnf_indicator: [ SELF, health_vnf_indicator ]
        utilization:
          output:
            utilization_vnf_indicator: [ SELF, utilization_vnf_indicator ]

```

6.8.2 toasca.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 toasca.datatype s.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), the VduCp 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 require 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.

6.8.3 toska.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 toska.data.types.nfv.VnfcMonitoringParameter			Describes monitoring parameters applicable to a VNFC based on this VDU.
configurable_properties	no	tosca.data.types.nfv.VnfcConfigurableProperties			Describes the configurable properties of all VNFC instances based on this VDU.

Name	Required	Type	Constraints	Status	Description
boot_data	no	tosca.data types.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.data types.nfv. VduProfile			Defines additional instantiation data for the VDU.Compute node.
sw_image_data	no	tosca.data types.nfv. SwImage Data		deprecat ed	Defines information related to a SwImage artifact used by this 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
  sw_image_data:
    type: tosca.datatypes.nfv.SwImageData
    description: Defines information related to a SwImage artifact used by this
  Vdu.Compute node
    required: false # property is required when the node template has an
  associated artifact of type tosca.artifacts.nfv.SwImage and not required otherwise
    status: deprecated
  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: toska.capabilities.nfv.VirtualCompute
      occurrences: [ 1, 1 ]
    virtual_binding:
      type: toska.capabilities.nfv.VirtualBindable
      occurrences: [ 1, UNBOUNDED ]
  requirements:
    - virtual_storage:
        capability: toska.capabilities.nfv.VirtualStorage
        relationship: toska.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 "SwImageDescId" 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.

Use of `sw_image_data` property is deprecated. For backward compatibility, the `sw_image_data` property may be used in node templates of type `tosca.nodes.nfv.Vdu.Compute` containing an artifact definition of type `tosca.artifacts.nfv.SwImage`. The properties of the `SwImage` artifact as defined in clause 6.3.1.2 should be used instead. Either the `sw_image_data` property of the `Vdu.Compute` node template or the properties of the `SwImage` artefact shall be present but not both. Support of the `sw_image_data` property can be removed in subsequent versions of the present document.

6.8.3.8 Example

This example illustrates boot data containing `kvp_data` by using `modifiable_attributes`.

```
tosca_definitions_version: toska_simple_yaml_1_3
..
node_types:
  mycompany.nodes.nfv.SunshineDB.1_0.1_0:
    derived_from: toska.nodes.nfv.VNF
    properties:
      ..
      modifiable_attributes:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes
      ..

data_types:
  mycompany.datatypes.nfv.VnfInfoModifiableAttributes:
    derived_from: toska.datatypes.nfv.VnfInfoModifiableAttributes
    properties:
    extensions:
      type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions
      required: false

  mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
    derived_from: toska.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: toska.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: toska_simple_yaml_1_3
..
node_types:
  mycompany.nodes.nfv.SunshineDB.1_0.1_0:
    derived_from: toska.nodes.nfv.VNF
    properties:
      ..
      configurable_properties:
        type: mycompany.datatypes.nfv.VnfConfigurableProperties
      ..

data_types:
  mycompany.datatypes.nfv.VnfConfigurableProperties:
    derived_from: toska.datatypes.nfv.VnfConfigurableProperties
    properties:
      additional_configurable_properties:
        type: mycompany.datatypes.nfv.VnfAdditionalConfigurableProperties
        required: false

  mycompany.datatypes.nfv.VnfAdditionalConfigurableProperties:
    derived_from: toska.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: toska.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: toska_simple_yaml_1_3
..
node_types:
  mycompany.nodes.nfv.SunshineDB.1_0.1_0:
    derived_from: toska.nodes.nfv.VNF
    properties:
      ..
      modifiable_attributes:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributes
      ..

data_types:
  mycompany.datatypes.nfv.VnfInfoModifiableAttributes:
    derived_from: toska.datatypes.nfv.VnfInfoModifiableAttributes
    properties:
      extensions:
        type: mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions
        required: false

  mycompany.datatypes.nfv.VnfInfoModifiableAttributesExtensions:
    derived_from: toska.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: toska.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: toska_simple_yaml_1_3
..
topology_template:
  ..

node_templates:
  dbBackend:
    type: toska.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: toska.artifacts.nfv.SwImage
          file: images/dbBackend.v1.0.1.qcow2
        boot_data:
          type: toska.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: toska_simple_yaml_1_3
..
topology_template:
  ..

node_templates:

```



```

dbBackend:
  type: toska.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: toska.artifacts.nfv.SwImage
        file: images/dbBackend.v1.0.1.qcow2
      boot_data:
        type: toska.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 artifact "dbBackend" will be used in external APIs to identify the image.

```

tosca_definitions_version: toska_simple_yaml_1_3
..
topology_template:
  ..

  node_templates:
    dbBackend:
      type: toska.nodes.nfv.Vdu.Compute
      properties:
        ..

        ..
      artifacts:
        sw_image:
          type: toska.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 artifact "dbBackend and oamService" will be used in external APIs to identify the image of each Vdu.Compute node.

```

tosca_definitions_version: toska_simple_yaml_1_3
..
topology_template:
  ..

  node_templates:
    dbBackend:
      type: toska.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.
sw_image_data	no	tosca.datatypes.nfv.SwImageData		deprecated	Defines information related to a SwImage artifact used by this Vdu.Compute node.

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: toska.nodes.Root
  description: This node type describes the specifications of requirements related
to virtual block storage resources
  properties:
    virtual_block_storage_data:
      type: toska.datatypes.nfv.VirtualBlockStorageData
      description: Describes the block storage characteristics.
      required: true
    sw_image_data:
      type: toska.datatypes.nfv.SwImageData
      description: Defines information related to a SwImage artifact used by this
Vdu.Compute node.
      required: false # property is required when the node template has an
associated artifact of type toska.artifacts.nfv.SwImage and not required otherwise
      status: deprecated
  capabilities:
    virtual_storage:
      type: toska.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 "SwImageDescId" 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.

Use of `sw_image_data` property is deprecated. For backward compatibility, the `sw_image_data` property may be used in node templates of type `tosca.nodes.nfv.Vdu.VirtualBlockStorage` containing an artifact definition of type `tosca.artifacts.nfv.SwImage`. The properties of the `SwImage` artifact as defined in clause 6.3.1.2 should be used instead. Either the `sw_image_data` property of the `VirtualBlockStorage` node template or the properties of the `SwImage` artefact shall be present but not both. Support of the `sw_image_data` property can be removed in subsequent versions of the present document.

6.8.5 toska.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.

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: toscanodes.Root
  description: This node type describes the specifications of requirements
related to virtual object storage resources
  properties:
    virtual_object_storage_data:
      type: toscanodes.datatypes.nfv.VirtualObjectStorageData
      description: Describes the object storage characteristics.
      required: true
  capabilities:
    virtual_storage:
      type: toscanodes.capabilities.nfv.VirtualStorage
      description: Defines the capabilities of virtual_storage.
```

6.8.5.7 Additional requirements

None.

6.8.6 toska.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.

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
  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.data types.nfv. VirtualNet workInterf aceRequir ements		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 (aka 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 toska.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 toska.datatypes.nfv.VirtualLinkMonitoringParameter		Describe monitoring parameters applicable to a VL instantiated from this node type.

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: toska.nodes.Root
  description: Describes the information about an internal VNF VL
  properties:
    connectivity_type:
      type: toska.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: toska.datatypes.nfv.VlProfile
      description: Defines additional data for the VL
      required: true
    monitoring_parameters:
      type: map #key: id
      entry_schema:
        type: toska.datatypes.nfv.VirtualLinkMonitoringParameter
        description: Describes monitoring parameters applicable to the VL
        required: false
  capabilities:
    virtual_linkable:
      type: toska.capabilities.nfv.VirtualLinkable

```

6.8.10 toska.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_addresses	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 doesn't 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: toasca.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: [ toasca.nodes.nfv.Vdu.Compute, toasca.nodes.nfv.VnfVirtualLink ]
```

6.9.1.4 Additional Requirements

A group with type `tosca.groups.nfv.PlacementGroup` shall contain more than one member 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	<code>InstantiationLevels</code>
Type Qualified Name	<code>toscanfv:InstantiationLevels</code>
Type URI	<code>tosca.policies.nfv.InstantiationLevels</code>

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
<code>levels</code>	yes	map of <code>tosca.datatypes.nfv.InstantiationLevel</code>		Describes the various levels of resources that can be used to instantiate the VNF using this flavour.
<code>default_level</code>	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: toasca.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: toasca.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	<code>VduInstantiationLevels</code>
Type Qualified Name	<code>toscanfv:VduInstantiationLevels</code>
Type URI	<code>tosca.policies.nfv.VduInstantiationLevels</code>

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
<code>levels</code>	yes	map of <code>tosca.datatypes.nfv.VduLevel</code>		Describes the <code>Vdu.Compute</code> 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: toasca.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: toasca.datatypes.nfv.VduLevel
      constraints:
        - min_length: 1
  targets: [ toasca.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.V duLevel		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.

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	<code>VirtualLinkBitrateScalingAspectDeltas</code>
Type Qualified Name	<code>toscanfv:VirtualLinkBitrateScalingAspectDeltas</code>
Type URI	<code>tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas</code>

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
<code>aspect</code>	yes	string		Represents the scaling aspect to which this policy applies.
<code>deltas</code>	yes	map of <code>tosca.datatypes.nfv.VirtualLinkBitrateLevel</code>		Describes the <code>VnfVirtualLink</code> 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.

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	<code>VduInitialDelta</code>
Type Qualified Name	<code>toscanfv:VduInitialDelta</code>
Type URI	<code>tosca.policies.nfv.VduInitialDelta</code>

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
<code>initial_delta</code> :	yes	<code>tosca.datatypes.nfv.VduLevel</code>		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: toasca.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: toasca.datatypes.nfv.VduLevel
      description: Represents the initial minimum size of the VNF.
      required: true
  targets: [ toasca.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	<code>AffinityRule</code>
Type Qualified Name	<code>toscanfv:AffinityRule</code>
Type URI	<code>tosca.policies.nfv.AffinityRule</code>

Table 6.10.10.1-2: Type name, shorthand, and URI

Shorthand Name	<code>AntiAffinityRule</code>
Type Qualified Name	<code>toscanfv:AntiAffinityRule</code>
Type URI	<code>tosca.policies.nfv.AntiAffinityRule</code>

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
<code>scope</code>	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.
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].				

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
<code>targets</code>	Yes	<code>string[]</code>	Valid types: <code>tosca.nodes.nfv.Vdu.Compute</code> , <code>tosca.nodes.nfv.VnfVirtualLink</code> , <code>tosca.groups.nfv.PlacementGroup</code>	In case of <code>LocalAffinityOrAntiAffinityRule</code> as defined in ETSI GS NFV-IFA 011 [1], the valid type of the targets is <code>tosca.nodes.nfv.Vdu.Compute</code> or <code>tosca.nodes.nfv.VnfVirtualLink</code> . In case of <code>affinityOrAntiAffinityGroup</code> as defined in ETSI GS NFV-IFA 011 [1], the valid types of the targets are: <code>tosca.nodes.nfv.Vdu.Compute</code> and <code>tosca.nodes.nfv.VnfVirtualLink</code> or a <code>tosca.groups.nfv.PlacementGroup</code> .

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 ]
      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 ]
      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: toska.groups.nfv.PlacementGroup
    members: [ VDU_1, VDU_2 ]

policies:
  policy_antiAffinity_group_1:
    type: toska.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 toska.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 toska.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: toska.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: toska.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: [ toska.nodes.nfv.VduCp, toska.nodes.nfv.VnfExtCp ]
```

6.10.13.5 Additional Requirements

None.

6.10.14 toska.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: toska.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 srcVnfId to dstVnfId. 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 X.6 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 srcVnfId to dstVnfId. 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

```

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 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 toasca.interfaces.nfv.Vnflcm.change_current_package_notification.

```
tosca_definitions_version: toasca_simple_yaml_1_3

imports:
..

node_types:
  MyCompany.SunshineDB.2_0.2_0:
    derived_from: toasca.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: toasca.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: toasca.nodes.nfv.VnfVirtualLink
..

policies:
..
- instantiation_levels:
  type: toasca.policies.nfv.InstantiationLevels
  properties:
    levels:
      single:
        description: ..
      quadruple:
        description: ..
    default_level: single
..
- change_from_version_1:
  type: toasca.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: toasca.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: toasca.policies.nfv.LcmCoordinationAction.InstantiateHelloHandshake
  properties:
    action_name: vnd.mycompany.hellohandshake

- instantiate>OpCoord:
  type: toasca.policies.nfv.LcmCoordinationsForLcmOperation
  properties:
    vnf_lcm_operation: instantiate
  actions:
    - vnd.mycompany.hellohandshake

- terminate>OpCoord:
  type: toasca.policies.nfv.LcmCoordinationsForLcmOperation
  properties:
    vnf_lcm_operation: terminate
  referenced_coordination_actions:
    - etsi.nfv.take-vnf-out-of-service

- VnfChangeFromVersion1Action1>OpCoord:
  type: toasca.policies.nfv.LcmCoordinationAction
  properties:
    action_name: vnd.mycompany.VnfChangeFromVersion1Action1

- VnfChangeToVersion1Action1>OpCoord:
  type: toasca.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: toasca.nodes.nfv.Vdu.VirtualBlockStorage
  ..

server_internal_cp:
  type: toasca.nodes.nfv.VduCp
  ..

internal_vl:
  type: toasca.nodes.nfv.VnfVirtualLink
  ..

policies:
  ..

  - instantiation_levels:
    type: toasca.policies.nfv.InstantiationLevels
    properties:
      levels:
        single:
          description: ..
        quadruple:
          description: ..
      default_level: single
  ..

  - change_from_version_1:
    type: toasca.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: toska.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 toska.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 toasca.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: toasca.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 toasca.datatypes.nfv.VnfLcmOpCoord
    # type: toasca.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 toasca.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 toasca.datatypes.nfv.VnfLcmCoord.

The interface_name property of the toasca.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 toasca.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 toasca.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 toasca.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: toska.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.
See note 1, note 2.
        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.

6.11 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 or 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.NsVIPProfile

7.2.3.1 Description

The NsVIPProfile 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	NsVIPProfile
Type Qualified Name	toscanfv:NsVIPProfile
Type URI	tosca.datatypes.nfv.NsVIPProfile

7.2.3.2 Properties

The properties of the NsVIPProfile 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.

Name	Required	Type	Constraints	Description
virtual_link_protocol_data	no	list of tosca.datatypes .nfv.NsVirtualLi nkProtocolData		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 NsVIProfile 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 NsVIProfile data type shall comply with the following definition:

```

tosca.datatypes.nfv.NsVIProfile:
  derived_from: toska.datatypes.Root
  description: Describes additional instantiation data for a given NsVirtualLink
used in a specific NS deployment flavour.
  properties:
    max_bitrate_requirements:
      type: toska.datatypes.nfv.LinkBitrateRequirements
      description: Specifies the maximum bitrate requirements for a VL instantiated
according to this profile.
      required: true
    min_bitrate_requirements:
      type: toska.datatypes.nfv.LinkBitrateRequirements
      description: Specifies the minimum bitrate requirements for a VL instantiated
according to this profile.
      required: true
    qos:
      type: toska.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: toska.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	<code>NsVirtualLinkQos</code>
Type Qualified Name	<code>toscanfv:NsVirtualLinkQos</code>
Type URI	<code>tosca.datatypes.nfv.NsVirtualLinkQos</code>

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
<code>priority</code>	no	integer	<code>greater_or_equal: 0</code>	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: toska.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 toska.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.
flavour_id	yes	string		Identifies the applicable network service DF within the scope of the NSD.

7.2.16.3 Definition

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

```
tosca.datatypes.nfv.NsProfile:
  derived_from: toska.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
  flavour_id:
    type: string
    description: Identifies the applicable network service DF within the scope of
the NSD.
    required: true

```

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
      required: true

```

```

length:
  description: Indicates the number of bits to be matched.
  type: integer
  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 toska.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	tosca.nfv.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: toska.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: toska_simple_yaml_1_3

node_types:
  toska.example_NS:
    derived_from: toska.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: toasca.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: toasca.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
      parameter_2:
        type: string
        required: true

  MyCompany.datatypes.nfv.NsHealAdditionalParameters:
    derived_from: toasca.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
      parameter_2:
        type: string
        required: true
        default: value_2

```

7.2.19 toasca.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: <ul style="list-style-type: none"> 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: toscanfv.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	<code>NsVirtualLinkProtocolData</code>
Type Qualified Name	<code>toscanfv:NsVirtualLinkProtocolData</code>
Type URI	<code>tosca.datatypes.nfv.NsVirtualLinkProtocolData</code>

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
<code>associated_layer_protocol</code>	yes	string	Valid values: See YAML definition constraints	Identifies one of the protocols a <code>virtualLink</code> gives access to (ethernet, mpls, odu2, ipv4, ipv6, pseudo-wire) as specified by the <code>connectivity_type</code> property.
<code>l2_protocol_data</code>	no	<code>tosca.datatypes.nfv.NsL2ProtocolData</code>		Specifies the L2 protocol data for a virtual link. Shall be present when the <code>associatedLayerProtocol</code> attribute indicates a L2 protocol and shall be absent otherwise.
<code>l3_protocol_data</code>	no	<code>tosca.datatypes.nfv.NsL3ProtocolData</code>		Specifies the L3 protocol data for this virtual link. Shall be present when the <code>associatedLayerProtocol</code> 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: toasca.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: toasca.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	<code>NsL3ProtocolData</code>
Type Qualified Name	<code>toscanfv:NsL3ProtocolData</code>
Type URI	<code>tosca.datatypes.nfv.NsL3ProtocolData</code>

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
<code>name</code>	no	string		Identifies the network name associated with this L3 protocol.
<code>ip_version</code>	yes	string	Valid values: See YAML definition constraints	Specifies IP version of this L3 protocol. The value of the <code>ip_version</code> property shall be consistent with the value of the <code>layer_protocol</code> in the <code>connectivity_type</code> property of the virtual link node.
<code>cidr</code>	yes	string		Specifies the CIDR (Classless Inter-Domain Routing) of this L3 protocol. The value may be overridden at run-time.
<code>ip_allocation_pools</code>	no	list of <code>tosca.datatypes.nfv.NsIpAllocationPool</code>		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: toasca.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: toasca.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 toasca.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 toasca.datatype s.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.
      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: toska.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 toska.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: toska.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	<code>scaleNsToLevelData</code>
Type Qualified Name	<code>toscanfv:scaleNsToLevelData</code>
Type URI	<code>tosca.datatypes.nfv.scaleNsToLevelData</code>

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
<code>instantiation_level</code>	no	string		Identifier of the target instantiation level of the current deployment flavour to which the NS is requested to be scaled. Either <code>instantiation_level</code> or <code>ns_scale_info</code> shall be provided.
<code>ns_scale_info</code>	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 <code>instantiation_level</code> or <code>ns_scale_info</code> 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

```

7.2.28.4 Examples

None.

7.2.28.5 Additional Requirements

None.

7.3 Artifact Types

None.

7.4 Capabilities 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: toasca.capabilities.Root
```

7.5 Requirements Types

None.

7.6 Relationship Types

7.6.1 toasca.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 toasca.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: toska.relationships.Root
  valid_target_types: [ toska.capabilities.nfv.Forwarding ]
```

7.7 Interface Types

7.7.1 toska.interfaces.nfv.Nslcm

7.7.1.1 Description

The toska.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: toska.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: toasca.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: toasca.datatypes.nfv.NsOperationAdditionalParameters
    #   required: false
    inputs:
      scale_ns_by_steps_data:
        type: toasca.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: toasca.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: toasca.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: toska_simple_yaml_1_3

imports:
- ..

node_types:
MyCompany.SunshineVPN.1_0.1_0:
  derived_from: toska.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: toska.artifacts.Implementation.Python
  file: instantiate.py
  #repository: ..
  #deploy_path: ..
  ..

```

7.7.2 toska.interfaces.nfv.NsVnfIndicator

7.7.2.1 Description

The toska.interfaces.nfv.NsVnfIndicator 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: toska.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 toska.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.
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: toska.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: toska.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
  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.
- c) Properties listed 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

None.

7.8.2.6 Definition

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

```
tosca.nodes.nfv.Sap:
  derived_from: toscanfv.Cp
  description: node definition of SAP.
  requirements:
    - external_virtual_link:
      capability: toscanfv.VirtualLinkable
      relationship: toscanfv.VirtualLinksTo
      occurrences: [0, 1]
    - internal_virtual_link:
      capability: toscanfv.VirtualLinkable
      relationship: toscanfv.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. This example is illustrated in clause A.7.2.

7.8.3 toska.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.NsVIPProfile		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 toska.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 VNF, PNF, NS and SAP.

7.8.5.9 Example

None.

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: toska.capabilities.nfv.Forwarding
requirements:
  - element:
    capability: toska.capabilities.nfv.Forwarding
    node: toska.nodes.nfv.NfpPositionElement
    relationship: toska.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 toska.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 Sap 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	<code>NsPlacementGroup</code>
Type Qualified Name	<code>toscanfv:NsPlacementGroup</code>
Type URI	<code>tosca.groups.nfv.NsPlacementGroup</code>

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
<code>description</code>	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: toasca.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, toasca.nodes.nfv.NsVirtualLink, toasca.nodes.nfv.NS]
```

7.9.1.4 Additional Requirements

A group with type `tosca.groups.nfv.NsPlacementGroup` shall contain more than one member when used as the target of an `AffinityRule` or `AntiAffinityRule` policy.

7.9.2 toska.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: toska.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: [ toska.nodes.nfv.NFP, toska.nodes.nfv.VNF, toska.nodes.nfv.PNF,
tosca.nodes.nfv.NS, toska.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` 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 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 <code>tosca.nodes.nfv.VNF</code> or <code>tosca.nodes.nfv.NsVirtualLink</code> . In case of <code>affinityOrAntiAffinityGroup</code> as defined in ETSI GS NFV-IFA 014 [2], the valid types of the targets are: <code>tosca.nodes.nfv.VNF</code> , <code>tosca.nodes.nfv.NsVirtualLink</code> and <code>tosca.nodes.nfv.NS</code> or a <code>tosca.groups.nfv.NsPlacementGroup</code> .

7.10.1.4 Definition

The syntax of the `NsAffinityRule` policy type shall comply with the following definition:

```
tosca.policies.nfv.NsAffinityRule:
  derived_from: toasca.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, toasca.nodes.nfv.NsVirtualLink, toasca.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: toasca.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, toasca.nodes.nfv.NsVirtualLink, toasca.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: toasca.nodes.nfv.exampleVNF

policies:
```

```

policy_affinity_local_VNF_1:
  type: toasca.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: toasca.nodes.nfv.Vdu.exampleVNF_1

  VNF_2:
    type: toasca.nodes.nfv.Vdu.exampleVNF_2

groups:
  affinityOrAntiAffinityGroup_1:
    type: toasca.groups.nfv.NsPlacementGroup
    members: [ VNF_1, VNF_2 ]

policies:
  policy_antiAffinity_group_1:
    type: toasca.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 toasca.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	toasca.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: toasca.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: toasca.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: [ toasca.nodes.nfv.Sap ]
```

7.10.2.5 Additional Requirements

None.

7.10.3 toasca.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.: <ul style="list-style-type: none"> • TCP • UDP • ICMP.

Name	Required	Type	Constraints	Description
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.data types.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: toasca.datatypes.nfv.Mask
    required: false
  targets: [ toasca.nodes.nfv.NFP ]

```

7.10.3.5 Example

None.

7.10.4 toasca.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 toscanfv.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: toscanfv.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: toscanfv.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: toscanfv.NsMonitoringParameter
      constraints:
        - min_length: 1
    targets: [ toscanfv.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	<code>ScalingAspects</code>
Type Qualified Name	<code>toscanfv:NsScalingAspects</code>
Type URI	<code>tosca.policies.nfv.NsScalingAspects</code>

7.10.7.2 Properties

The properties of the `NsScalingAspects` policy type shall comply with the provisions set out in table 7.10.5.2-1.

Table 7.10.7.2-1: Properties

Name	Required	Type	Constraints	Description
<code>aspects</code>	yes	Map of <code>tosca.datatypes.nfv.NsScalingAspect</code>		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: toasca.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 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: toasca.datatypes.nfv.NsScalingAspect
      constraints:
        - min_length: 1
```

7.10.7.4 Examples

See clause A.17.

7.10.8 toasca.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: toasca.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.
      entry_schema:
        type: integer
      constraints:
        - min_length: 1
  targets: [ toasca.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	<code>NsToLevelMapping</code>
Type Qualified Name	<code>tosca.nfv: NsToLevelMapping</code>
Type URI	<code>tosca.policies.nfv.NsToLevelMapping</code>

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
<code>aspect:</code>	yes	string		Represents the scaling aspect to which this policy applies.
<code>number_of_instances</code>	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.
      entry_schema:
        type: integer
      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 toscadatatypes.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: toscapolicies.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.
      entry_schema:
        type: toscadatatypes.nfv.LinkBitrateRequirements
    constraints:
      - min_length: 1
  targets: [ toscanodes.nfv.NsVirtualLink ]

```

7.10.10.4 Examples

See clause A.17.

7.10.11 toscapolicies.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	toscapolicies.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: toska.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: toska.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 toska.policies.nfv.VnfToInstantiationLevelMapping

7.10.12.1 Description

The VnfToInstantiationLevelMapping 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: toasca.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:
        - min_length: 1
    targets: [ toasca.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 toasca.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 instantiation 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: toasca.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:
        - min_length: 1
    targets: [ toasca.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 toasca.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	<code>VirtualLinkToInstantiationLevelMapping</code>
Type Qualified Name	<code>toscanfv: VirtualLinkToInstantiationLevelMapping</code>
Type URI	<code>tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping</code>

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 toasca.datatypes.nfv.LinkBitrateRequirements		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: toasca.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: toasca.datatypes.nfv.LinkBitrateRequirements
      constraints:
        - min_length: 1
  targets: [ toasca.nodes.nfv.NsVirtualLink ]

```

7.10.14.4 Examples

See clause A.17.

7.10.15 toasca.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: toasca.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 or 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;
- 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 or 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;
 - 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 2: 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 3: 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.

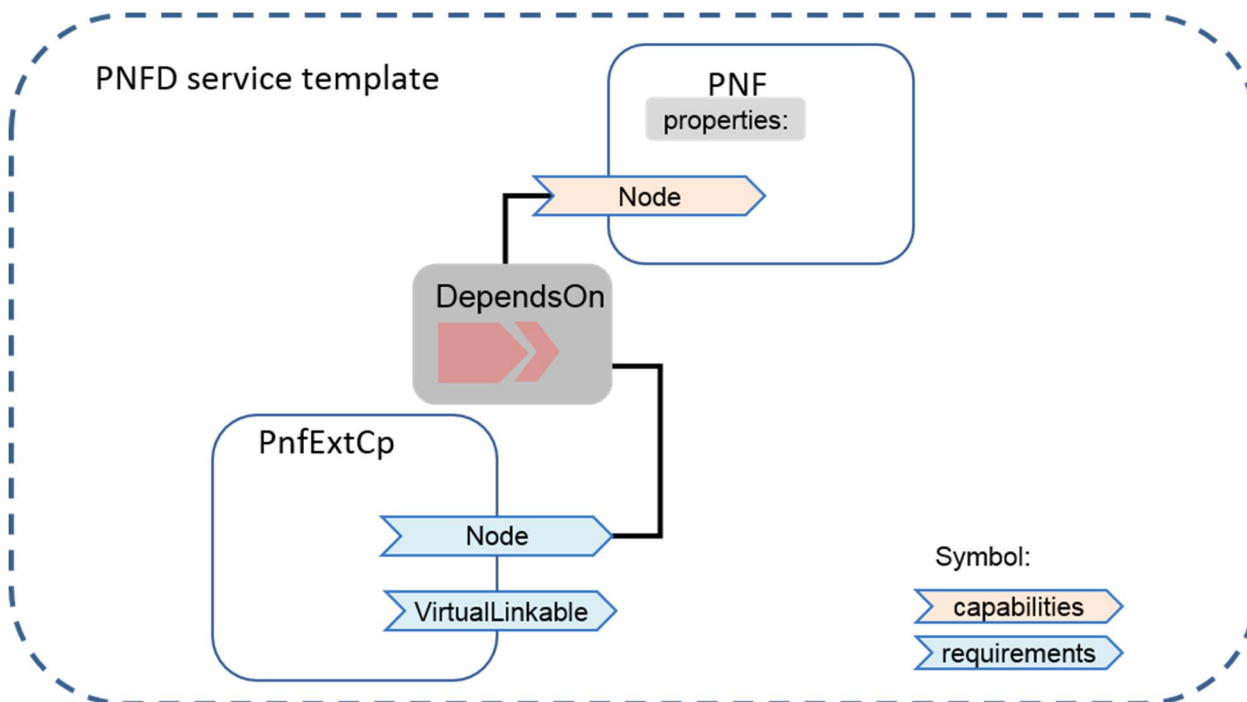


Figure 8.1-1: Service template PNFD overview

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	<code>LocationInfo</code>
Type Qualified Name	<code>toscanfv:LocationInfo</code>
Type URI	<code>tosca.datatypes.nfv.LocationInfo</code>

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
<code>country_code</code>	yes	string		Shall be a two-letter ISO 3166 [10] country code in capital letters.
<code>civic_address_element</code>	no	list of <code>tosca.datatypes.nfv.CivicAddressElement</code>		Elements composing the civic address where the PNF is deployed.
<code>geographic_coordinates</code>	no	<code>tosca.datatypes.nfv.GeographicCoordinates</code>		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: toasca.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: toasca.datatypes.nfv.CivicAddressElement
        description: Elements composing the civic address where the PNF is deployed.
        required: false
    geographic_coordinates:
      type: toasca.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 toasca.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: toska.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 toska.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: toska.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 Capabilities 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 PNF 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: toska.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 pnf-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.
- 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: toasca.nodes.nfv.Cp
  description: node definition of PnfExtCp.
  requirements:
    - external_virtual_link:
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.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 PNF 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 PNF-D TOSCA service template design

8.11.1 General

One single TOSCA service template is used to design a PNF-D 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 PNF-D 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		Specify if the address assignment is the responsibility of management and orchestration function or not. If it is set to True, it is the management and orchestration function responsibility.

9.2.1.3 Definition

The syntax of the L2AddressData data type shall comply with the following definition:

```
tosca.datatypes.nfv.L2AddressData:
  derived_from: toasca.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 if the address assignment is the responsibility of
management and orchestration function or not. If it is set to True, it is the
management and orchestration function responsibility
      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 toasca.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	yes	boolean		Specify if the address assignment is the responsibility of management and orchestration function or not. If it is set to True, it is the management and orchestration function responsibility.
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.

9.2.2.3 Definition

The syntax of the L3AddressData data type shall comply with the following definition:

```

tosca.datatypes.nfv.L3AddressData:
  derived_from: toscanfv.L3AddressData
  description: Provides information about Layer 3 level addressing scheme and
parameters applicable to a CP
  properties:
    ip_address_assignment:
      type: boolean
      description: Specifies if the address assignment is the responsibility of
management and orchestration function or not. If it is set to True, it is the
management and orchestration function responsibility
      required: true
    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

```

9.2.2.4 Examples

```
<some_tosca_entity>:
properties:
  l3_address_data:
    ip_address_assignment: true
    floating_ip_activated: true
    ip_address_type: ipv4
    number_of_ip_address: 4
```

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: toska.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: toska.datatypes.nfv.L2AddressData
      description: Provides the information on the MAC addresses to be assigned to a
      connection point.
      required: false
    l3_address_data:
      type: toska.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

```

<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

```

9.2.3.5 Additional Requirements

None.

9.2.4 toska.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 toasca.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 toasca.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: toasca.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: toasca.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	<code>VnfProfile</code>
Type Qualified Name	<code>toscanfv:VnfProfile</code>
Type URI	<code>tosca.datatypes.nfv.VnfProfile</code>

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
<code>instantiation_Level</code>	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.
<code>min_number_of_instances</code>	yes	integer	<code>greater_or_equal : 0</code>	Minimum number of instances of the VNF based on this VNFD that is permitted to exist for this <code>VnfProfile</code> .
<code>max_number_of_instances</code>	yes	integer	<code>greater_or_equal : 0</code>	Maximum number of instances of the VNF based on this VNFD that is permitted to exist for this <code>VnfProfile</code> .
<code>service_availability_level</code>	no	integer	<code>greater_or_equal: 1</code>	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: toska.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: tosc.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 Capabilities 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	<code>VirtualLinkable</code>
Type Qualified Name	<code>toscanfv:VirtualLinkable</code>
Type URI	<code>tosca.capabilities.nfv.VirtualLinkable</code>

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: toasca.capabilities.Node
  description: A node type that includes the VirtualLinkable capability indicates
  that it can be pointed by toasca.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	<code>VirtualLinksTo</code>
Type Qualified Name	<code>toscanfv:VirtualLinksTo</code>
Type URI	<code>tosca.relationships.nfv.VirtualLinksTo</code>

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: toasca.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: [ toasca.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	<code>VipVirtualLinksTo</code>
Type Qualified Name	<code>toscanfv:VipVirtualLinksTo</code>
Type URI	<code>tosca.relationships.nfv.VipVirtualLinksTo</code>

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: toasca.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: [ toasca.capabilities.nfv.VirtualLinkable ]
```

9.7 Interface Types

None.

9.8 Node Types

9.8.1 toasca.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).

Name	Required	Type	Constraints	Description
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.
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: toska.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_cmt, tp++, il, ipv6, sdrp, ipv6_route, ipv6_frag, idrp, rsvp, gre, dsr, bna, esp, ah, i_nlsp, swipe, narp, mobile, tisp, 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, gmt, 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: toasca.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, egg, 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_cmt, 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, ipc, 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.

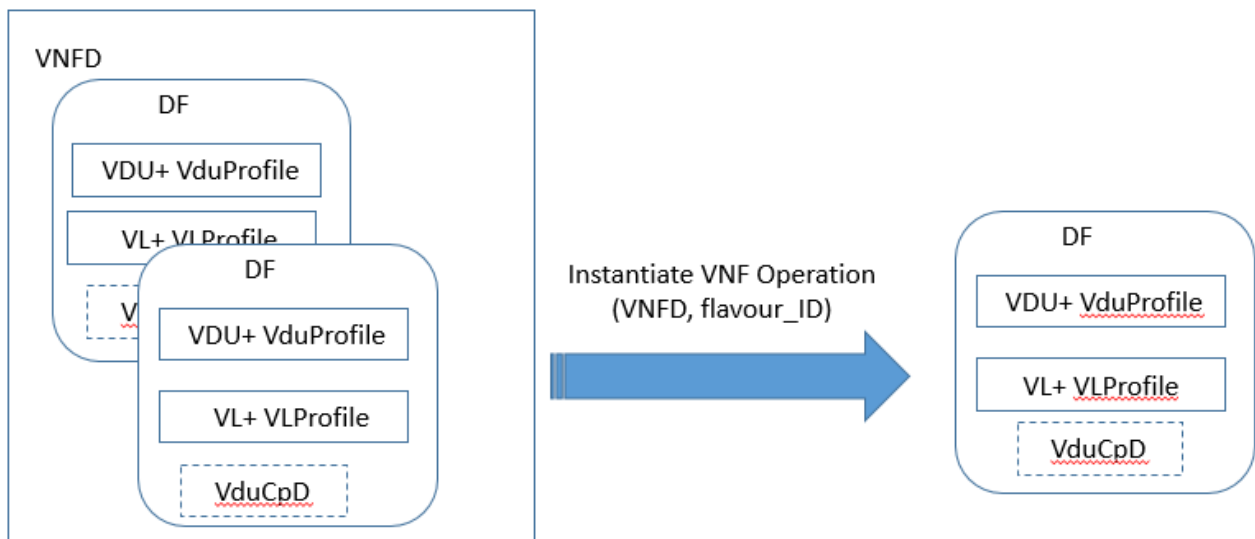


Figure A.1.2-1: General principle for a VNF deployment flavour design

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.

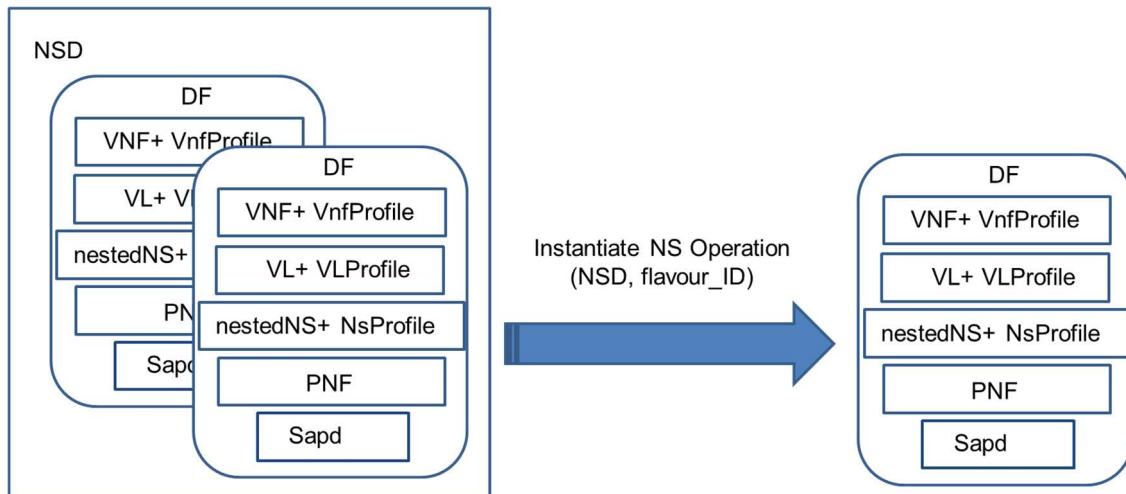


Figure A.1.3-1: General principle for a NS deployment flavour design

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.

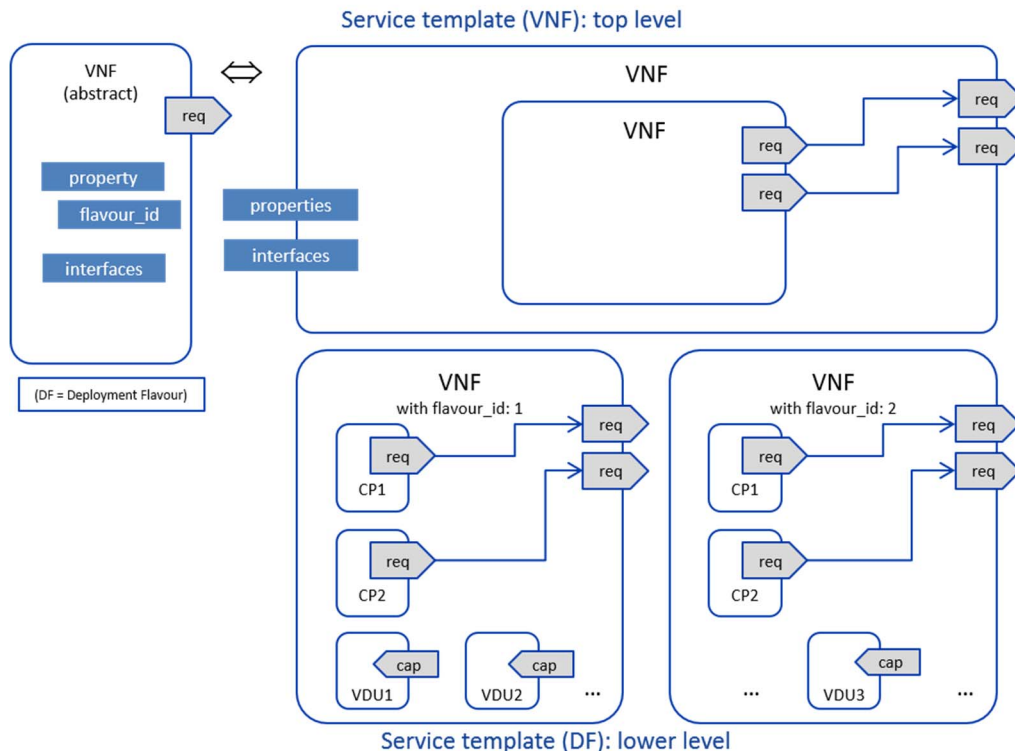


Figure A.2-1: VNFD overview with deployment flavour

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'
    vnf_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: [ equal: '0:MyCompany-1.0.0' ]
      default: [ '0:MyCompany-1.0.0' ]
  requirements:
  - virtual_link:
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.relationships.nfv.VirtualLinksTo
      occurrences: [ 0, 0 ]
  - virtual_link_backend:
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.relationships.nfv.VirtualLinksTo
      occurrences: [ 0, 1 ]
  - virtual_link_service:
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.relationships.nfv.VirtualLinksTo
      occurrences: [ 0, 1 ]
  interfaces:
    Vnflcm:
      type: toasca.interfaces.nfv.Vnflcm
      operations:
        instantiate:
          inputs:
            additional_parameters:
              type: MyCompany.datatypes.nfv.VnfInstantiateAdditionalParameters

```

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".

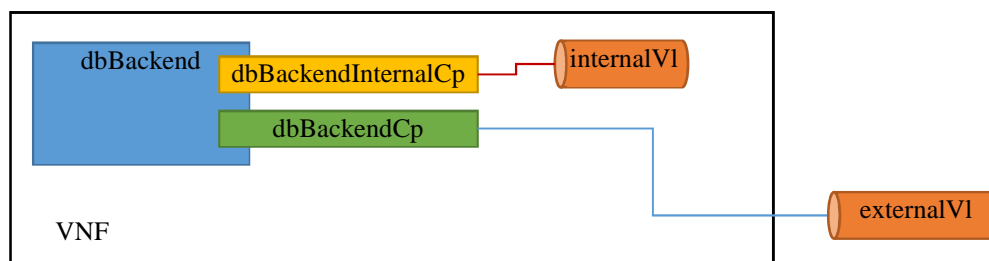


Figure A.2-2: SunshineDB (simple): Lower level

```

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: toasca.nodes.nfv.Vdu.VirtualBlockStorage
  properties:
    virtual_block_storage_data:
      size_of_storage: 100 GB
      rdma_enabled: true
# ..
artifacts:
  sw_image:
    type: toasca.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: toasca.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: toasca.nodes.nfv.VduCp
  properties:

```

```

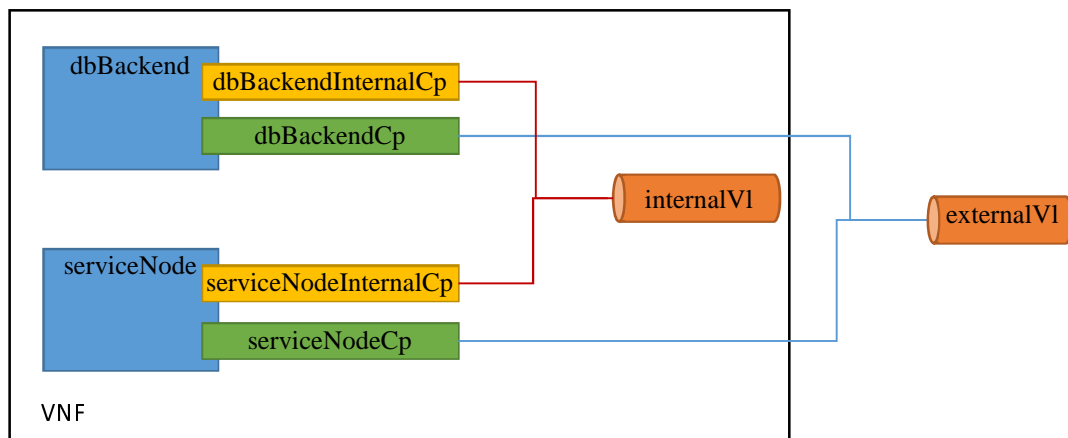
layer_protocols: [ ipv4 ]
role: leaf
description: Internal connection point on an VL
protocol: [ associated_layer_protocol: ipv4 ]
trunk_mode: false
requirements:
- virtual_binding: dbBackend
- virtual_link: internalVl

internalVl:
type: toasca.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: toasca_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_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: toasca.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: toasca.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: toasca.nodes.nfv.Vdu.VirtualBlockStorage
  properties:
    virtual_block_storage_data:
      size_of_storage: 100 GB

```

```
rdma_enabled: true
artifacts:
  sw_image:
    type: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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.

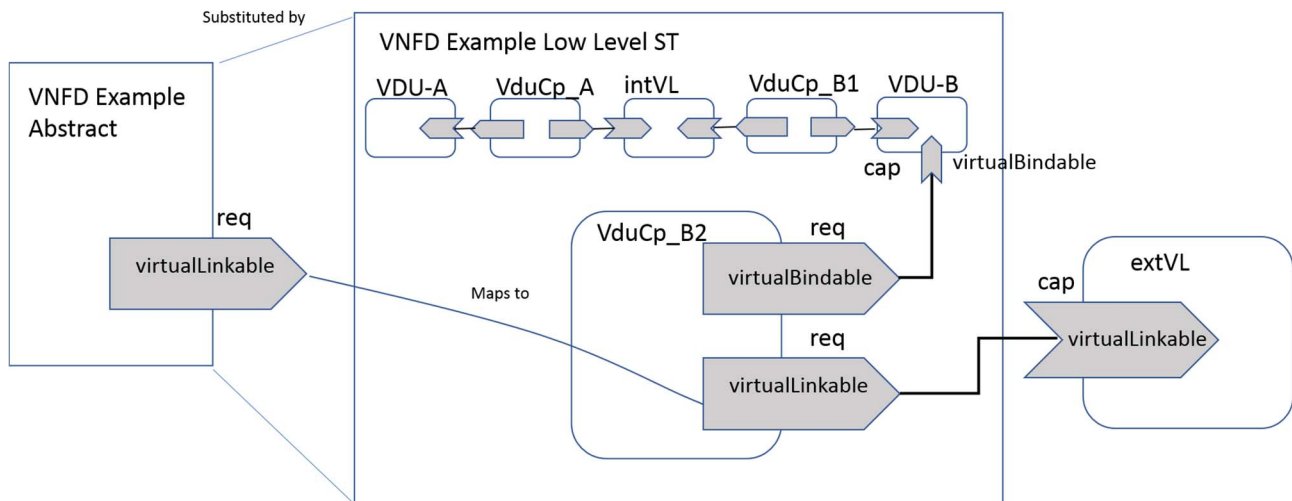


Figure A.3.2-1: VNFD with an VDU connection point acting as VnfExtCp

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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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:

```

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: [ equal: '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: toasca.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.

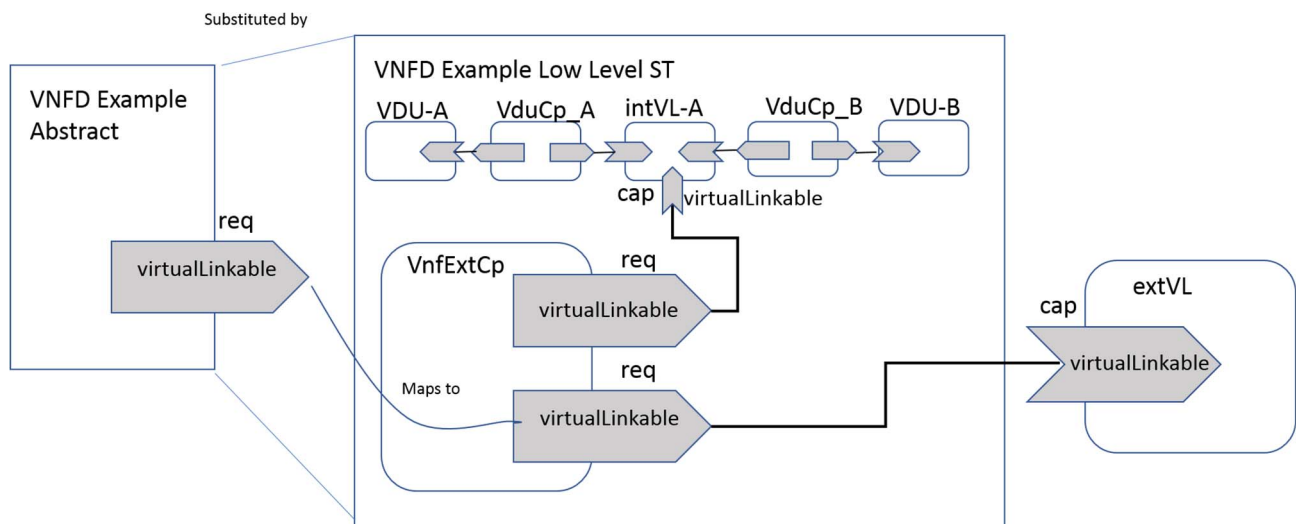


Figure A.3.3-1: VNFD with a VnfExtCp connected to an internal virtual link

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: toasca_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: toasca.nodes.nfv.exampleVNF
  substitution_filter:
    properties:
      - flavour_id: { equal: simple }
  requirements:
    virtual_link: [myMRFExtCp, external_virtual_link]

node_templates:
  ExampleVNF:
    type: toasca.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 VNFD descriptor contains three VDUs, which are interconnected by two virtualLinks.

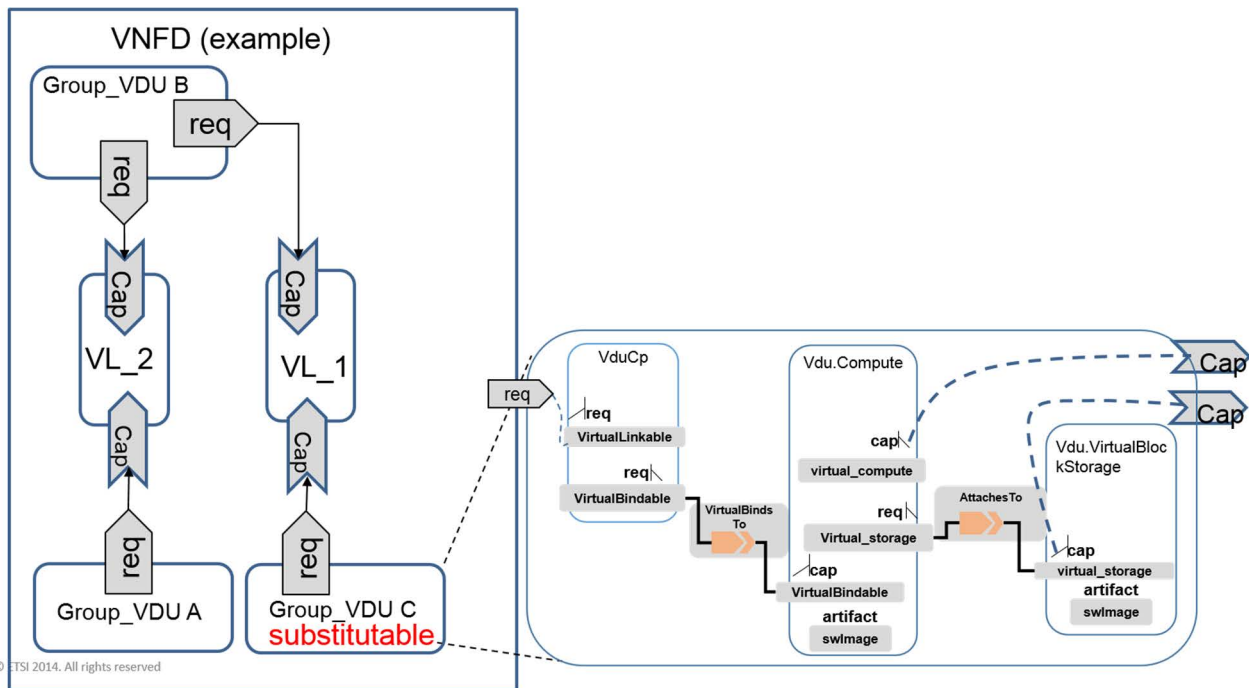


Figure A.4-1: Example of using substitution mapping for the VNFD design

In this example, a separate service template is used to describe the composition of Vdu.Compute, Vdu.VirtualBlockStorage and Vdu.Cp, 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: toska_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: toska.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: toska.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

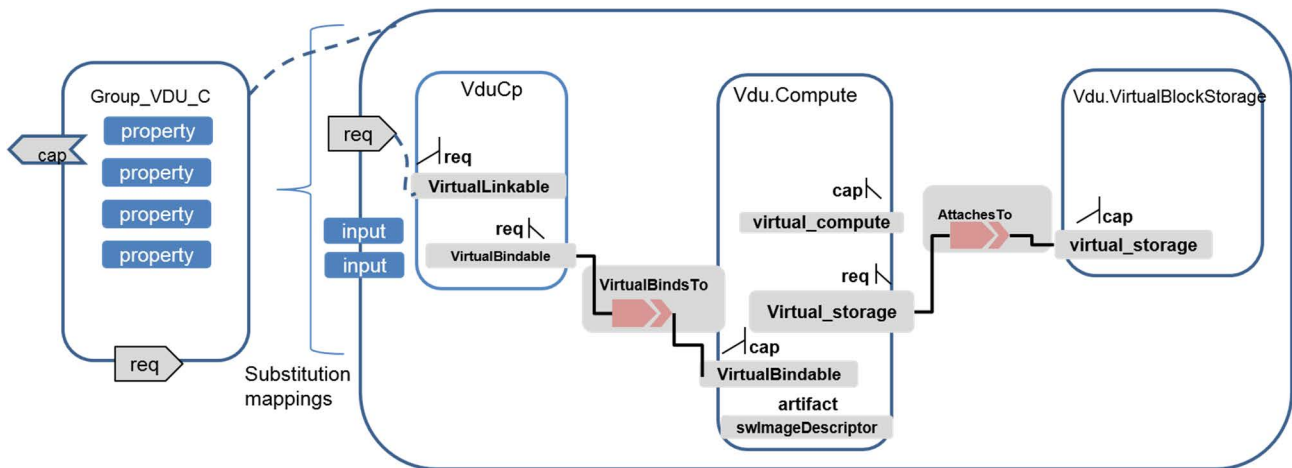
Group_VDU_C:
  type: toasca.nodes.nfv.groupVDU_C # the description of this type is described
                                     # in another service template.

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: toasca.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: toasca.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.



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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: toasca.nodes.nfv.Vdu.VirtualBlockStorage
  properties:
    virtual_block_storage_data:
      size_of_storage: 2 GB
    # other properties omitted here for brevity

internalCpd:
  type: toasca.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.

```

tosca_definitions_version: toasca_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: toasca.nodes.Root
  capabilities:
    virtual_compute:
      description: Describes virtual compute resources capabilities.
      type: toasca.capabilities.nfv.VirtualCompute
    virtual_storage:
      description: Defines the capabilities of virtual_storage.
      type: toasca.capabilities.nfv.VirtualStorage
  requirements:
    - virtual_link:
      description: Describes the requirements for linking to virtual link.
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.relationships.nfv.VirtualLinksTo
      node: toasca.nodes.nfv.VnfVirtualLink
      occurrences: [ 1, 1 ]

tosca.nodes.nfv.groupVDU_A:
  description: Abstract group VDU A.
  derived_from: toasca.nodes.nfv.groupVDU

tosca.nodes.nfv.groupVDU_B:
  description: Abstract group VDU B.
  derived_from: toasca.nodes.nfv.groupVDU
  requirements:
    - virtual_link1:
      description: Describes the requirements for linking to virtual link.
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.relationships.nfv.VirtualLinksTo
      node: toasca.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".

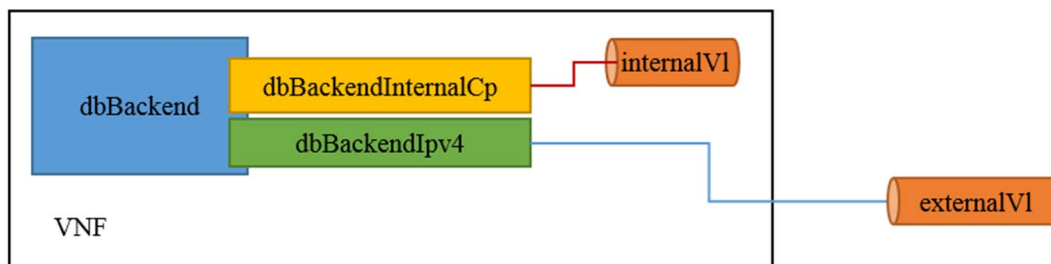


Figure A.5-1: SunshineDB (simple)

```
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: [ equal: '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
        #terminate:

MyCompany.nodes.nfv.Vdu.Aux:
    derived_from: toasca.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: toasca.nodes.nfv.Vdu.VirtualBlockStorage
  properties:
    virtual_block_storage_data:
      size_of_storage: '200 GB'
      rdma_enabled: true
  artifacts:
    sw_image:
      type: toasca.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: toasca.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: toasca.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: toasca.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.

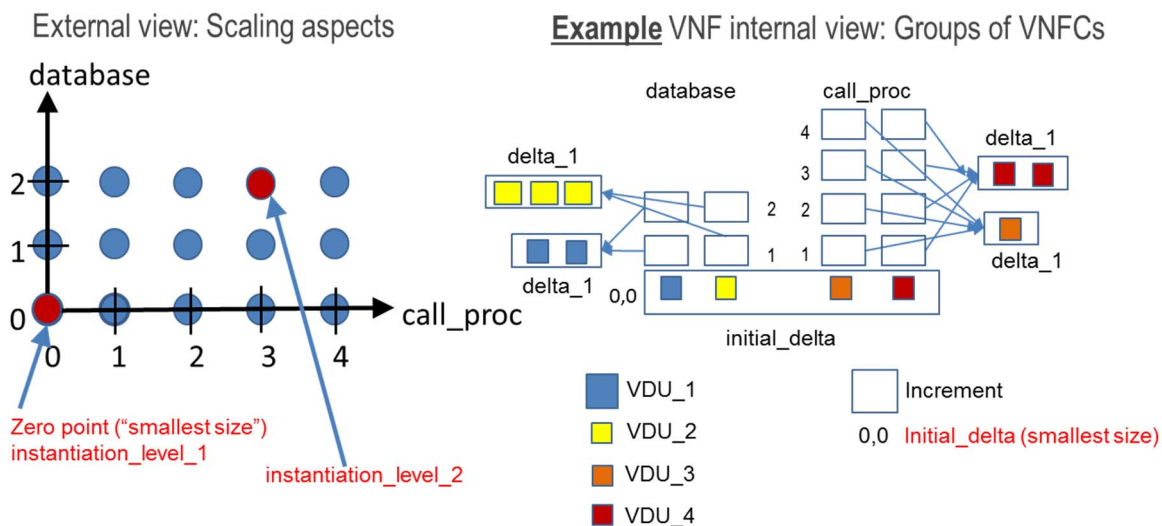


Figure A.6.1-1: Complex scaling example with uniform delta

Example 1

```

tosca_definitions_version: toasca_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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.nodes.nfv.VnfVirtualLink
  properties:
    connectivity_type:
      layer_protocols: [ ipv4 ]
    vl_profile:
      min_bitrate_requirements:
        root: 1000000
      max_bitrate_requirements:
        root: 2000000

vl_2:
  type: toasca.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: toasca.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: toasca.policies.nfv.VduInitialDelta
  properties:
    initial_delta:
      number_of_instances: 1
  targets: [ vdu_1 ]

- vdu_1_scaling_aspect_deltas:
  type: toasca.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: toasca.policies.nfv.VduInitialDelta
properties:
  initial_delta:
    number_of_instances: 1
  targets: [ vdu_4 ]

- vdu_4_scaling_aspect_deltas:
  type: toasca.policies.nfv.VduScalingAspectDeltas
  properties:
    aspect: call_proc
    deltas:
      delta_1:
        number_of_instances: 2
  targets: [ vdu_4 ]

- vl_2_bitrate_initial_delta:
  type: toasca.policies.nfv.VirtualLinkBitrateInitialDelta
  properties:
    initial_delta:
      bitrate_requirements:
        root: 1000000
  targets: [ vl_2 ]

- vl_2_bitrate_scaling_aspect_deltas:
  type: toasca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas
  properties:
    aspect: call_proc
    deltas:
      delta_1:
        bitrate_requirements:
          root: 1000000
  targets: [ vl_2 ]

- instantiation_levels:
  type: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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.

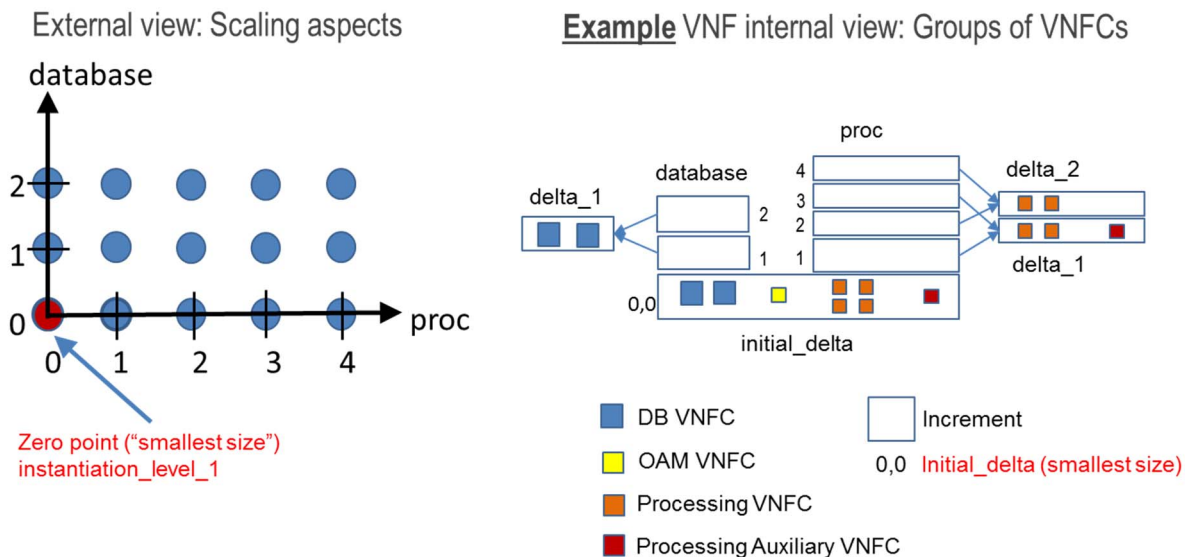


Figure A.6.2-1: Complex scaling example with non-uniform delta

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: toasca_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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.policies.nfv.VduInitialDelta
  properties:
    initial_delta:
      number_of_instances: 2
  targets: [ db ]
- db_scaling_aspect_deltas:
  type: toasca.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: toasca.policies.nfv.VduInstantiationLevels
  properties:
    levels:
      instantiation_level_1:
        number_of_instances: 1
  targets: [ oam ]

- processing_instantiation_levels:
  type: toasca.policies.nfv.VduInstantiationLevels
  properties:
    levels:
      instantiation_level_1:
        number_of_instances: 4
  targets: [ processing ]

- processing_auxiliary_instantiation_levels:
  type: toasca.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.

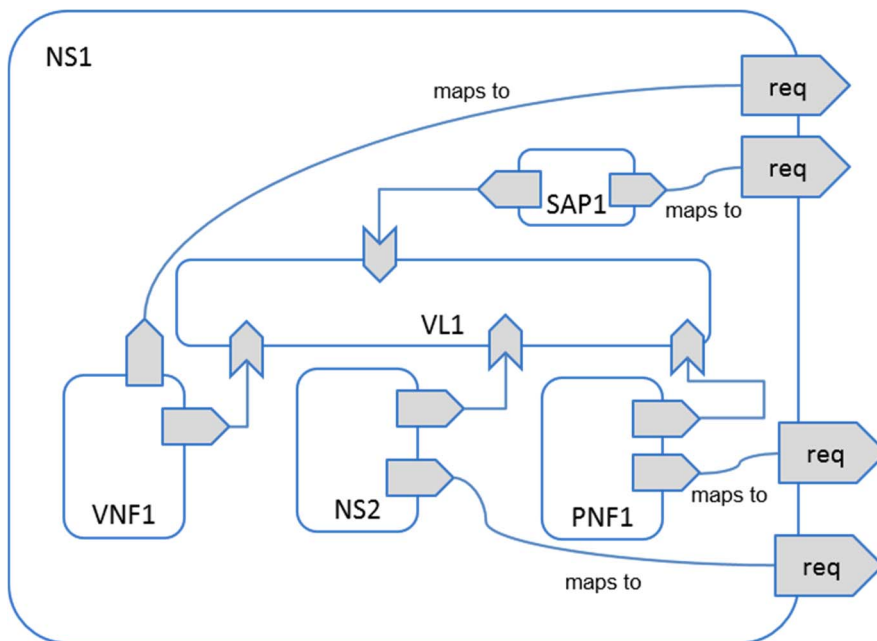


Figure A.7.1-1: Overview of SAP options

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 toasca.nodes.nfv.Sap, but the functionality of it is provided by a VNF external connection point.

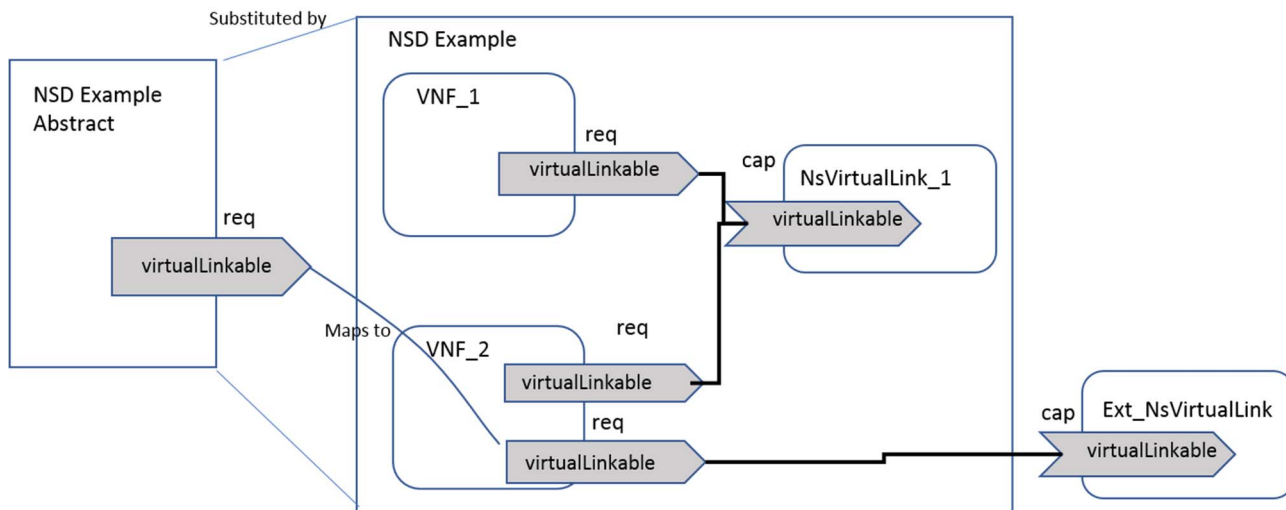


Figure A.7.2-1: VNF_2 External connection point (VnfExtCp) exposed as a Sap

The following snippet shows the relevant part of the NS service template:

```
tosca_definitions_version: toasca_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_VNF2.yaml
```

```

node_types:
  toska.nodes.nfv.exampleNS:
    derived_from: toska.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: toska.capabilities.nfv.VirtualLinkable
            relationship: toska.relationships.nfv.VirtualLinksTo
#...

topology_template:
#...

substitution_mappings:
  node_type: toska.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: toska.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: toska.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.

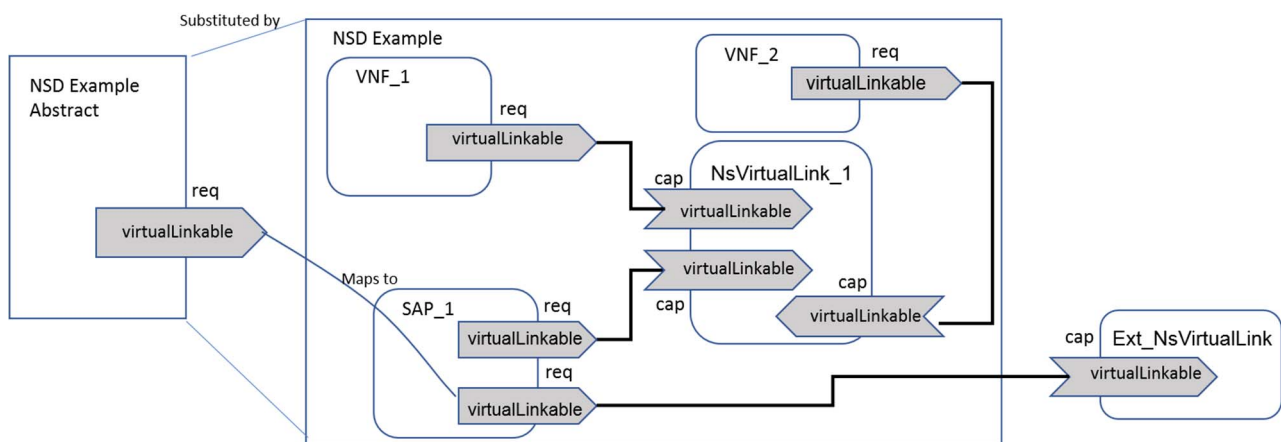


Figure A.7.3-1: SAP_1 exposed as new CP on an internal virtual link

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.

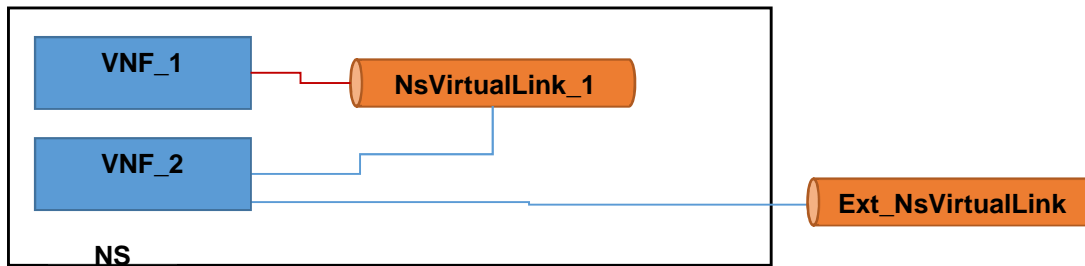


Figure A.8-1: example_NS (simple)

```

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_VNF1.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_VNF2.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: toasca.interfaces.nfv.Nslcm
      operations:
        instantiate:
          inputs:
            additional_parameters:
              type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters

topology_template:
  substitution_mappings:
    node_type: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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: toasca.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 <code>tosca.nodes.nfv.VnfExtCp</code> or <code>tosca.nodes.nfv.VduCp</code> or <code>tosca.nodes.nfv.VipCp</code>
VnfLcmOperationsConfiguration (clause 7.1.5)	property of VNF node type with data type <code>tosca.datatypes.nfv.VnfLcmOperationsConfiguration</code> and/or inputs <code>additional_parameters</code> of the corresponding operation in the <code>Vnflcm</code> interface with type <code>tosca.datatypes.nfv.VnfOperationAdditionalParameters</code>

ETSI GS NFV-IFA 011 [1] information element	TOSCA concept
Vdu (clause 7.1.6)	node template with type <code>tosca.nodes.nfv.Vdu.Compute</code>
VLd (clause 7.1.7)	node template with type <code>tosca.nodes.nfv.VnfVirtualLink</code>
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 <code>tosca.datatypes.nfv.VduProfile</code>
VirtualLinkProfile (clause 7.1.8.4)	property of VnfVirtualLink node type with data type <code>tosca.datatypes.nfv.VIProfile</code>
VirtualLinkDescFlavour (clause 7.1.8.5)	Only qos attribute in VirtualLinkDescFlavour has been defined as property of the VIProfile data type
InstantiationLevel (clause 7.1.8.7)	policy with type <code>tosca.policies.nfv.InstantiationLevels</code>
VduLevel (clause 7.1.8.9)	policy with type <code>tosca.policies.nfv.VduInstantiationLevels</code>
LocalAffinityOrAntiAffinityRule (clause 7.1.8.11)	policy with type <code>tosca.policies.nfv.AffinityRule</code> or <code>tosca.policies.nfv.AntiAffinityRule</code>
AffinityOrAntiAffinityGroup (clause 7.1.8.12)	policy with type <code>tosca.policies.nfv.AffinityRule</code> or <code>tosca.policies.nfv.AntiAffinityRule</code>
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 <code>tosca.nodes.nfv.Vdu.VirtualBlockStorage</code>
VirtualStorageDesc with ObjectStorageData (clause 7.1.9.4.4)	node template with type <code>tosca.nodes.nfv.Vdu.VirtualObjectStorage</code>
VirtualStorageDesc with FileStorageData (clause 7.1.9.4.5)	node template with type <code>tosca.nodes.nfv.Vdu.VirtualFileStorage</code>
ScalingAspect (clause 7.1.10.2)	policy with type <code>tosca.policies.nfv.ScalingAspects</code>
ScalingDelta (clause 7.1.10.4)	policy with type <code>tosca.policies.nfv.VduScalingAspectDeltas</code> and/or <code>tosca.policies.nfv.VirtualLinkBitrateScalingAspectDeltas</code>
VnfIndicator (clause 7.1.11.2)	interface with type <code>tosca.interfaces.nfv.VnfIndicator</code> 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 <code>tosca.datatypes.nfv.VnfConfigurableProperties</code>
LifeCycleManagementScript (clause 7.1.13)	interface with type <code>tosca.interfaces.nfv.Vnflcm</code> or <code>tosca.interfaces.nfv.ChangeCurrentVnfPackage</code>
VnfInfoModifiableAttributes (clause 7.1.14)	property of VNF node template with data type <code>tosca.datatypes.nfv.VnfInfoModifiableAttributes</code>
VnfPackageChangeInfo (clause 7.1.15)	policy with type <code>tosca.policies.nfv.VnfPackageChange</code> , and <code>tosca.interfaces.nfv.ChangeCurrentVnfPackage</code> or <code>tosca.interfaces.nfv.Vnflcm</code>

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 <code>tosca.nodes.nfv.Sap</code> or the <code>virtual_link</code> requirement in the <code>substitution_mapping</code>
MonitoredData (clause 6.2.6)	policy with type <code>tosca.policies.nfv.VnfMonitoring</code> and <code>tosca.policies.nfv.NsMonitoring</code>
VnfIndicatorData (clause 6.2.7)	interface with type <code>tosca.interfaces.nfv.NsVnfIndicator</code> and related attributes of the NS node type.
LifeCycleManagementScript (clause 6.2.9)	Interface with type <code>Nslcm</code>
NsDf (clause 6.3)	lower level service template(s) in the NSD file structure

ETSI GS NFV-IFA 014 [2] information element	TOSCA concept
VnfProfile (clause 6.3.3)	property of VNF node template with data type <code>tosca.datatypes.nfv.VnfProfile</code>
VirtualLinkProfile (clause 6.3.4)	property of NsVirtualLink node template with data type <code>tosca.datatypes.nfv.VIPProfile</code>
AffinityOrAntiAffinityGroup (clause 6.3.5)	policy with type <code>tosca.policies.nfv.NsAffinityRule</code> or <code>tosca.policies.nfv.NsAntiAffinityRule</code>
NsVirtualLinkConnectivity (clause 6.3.7)	requirement and capability between PnfExtCp or VnfExtCp and NsVirtualLink node templates
NsLevel (clause 6.3.9)	policy with type <code>tosca.policies.nfv.NsInstantiationLevels</code>
NsProfile (clause 6.3.11)	property of NS node template with data type <code>tosca.datatypes.nfv.NsProfile</code>
Dependencies (clause 6.3.12)	dependency requirements
Vnffgd (clause 6.4.2)	group with type <code>tosca.groups.nfv.VNFFG</code>
Nfpd (clause 6.4.3)	node template with type <code>tosca.nodes.nfv.NFP</code>
NfpPositionElement (clause 6.4.6)	node template with type <code>tosca.nodes.nfv.NfpPositionElement</code>
NfpPositionDesc (clause 6.4.5)	node template with type <code>tosca.nodes.nfv.NfpPosition</code>
NsVirtualLinkDesc (clause 6.5.2)	node template with type <code>tosca.nodes.nfv.NsVirtualLink</code>
VirtualLinkDf (clause 6.5.4)	Only the serviceAvailabilityLevel and qos attributes in VirtualLinkDf have been defined as properties of the NsVIPProfile 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 <code>tosca.nodes.nfv.PnfExtCp</code>
NsScalingAspect (clause 6.7.2)	policy with type <code>tosca.policies.nfv.NsScalingAspects</code>
VnfToLevelMapping (clause 6.7.4)	policy with type <code>tosca.policies.nfv.VnfToLevelMapping</code> and <code>tosca.policies.nfv.VnfToInstantiationLevelMapping</code>
VirtualLinkToLevelMapping (clause 6.7.5)	policy with type <code>tosca.policies.nfv.VirtualLinkToLevelMapping</code> and <code>tosca.policies.nfv.VirtualLinkToInstantiationLevelMapping</code>
NsToLevelMapping (clause 6.7.6)	policy with type <code>tosca.policies.nfv.NsToLevelMapping</code> and <code>tosca.policies.nfv.NsToInstantiationLevelMapping</code>

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.

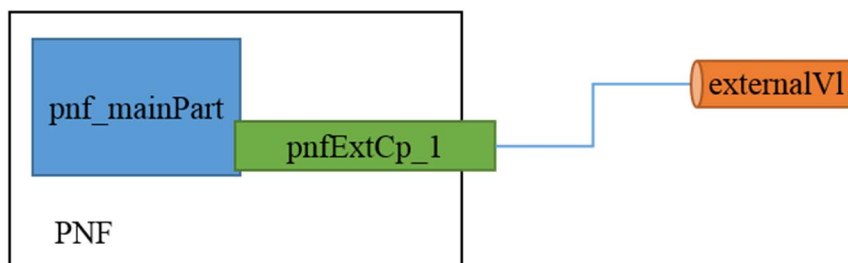


Figure A.10-1: examplePnf

```
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: toasca.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
        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: toasca.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: toasca.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.

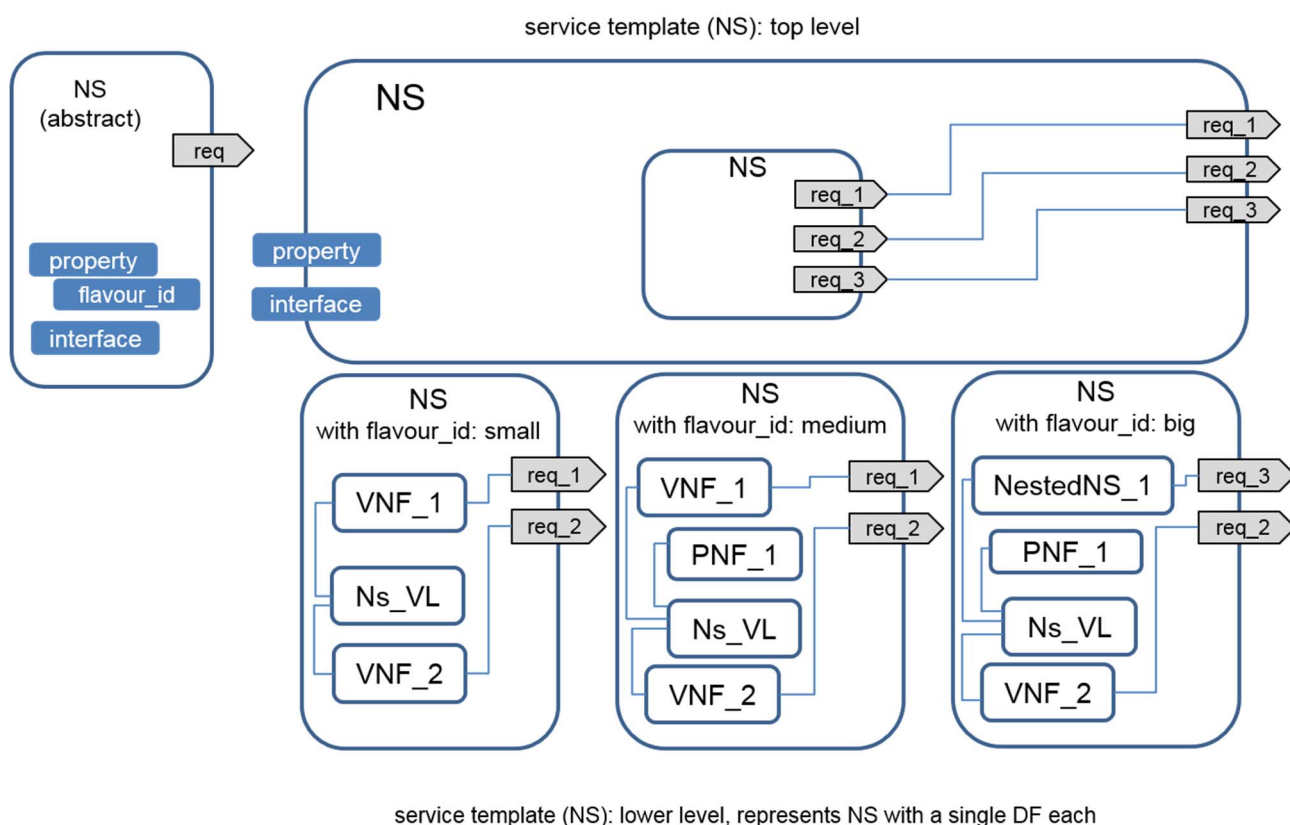


Figure A.11-1: NSD overview with multiple deployment flavour

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: toska_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: toska.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: toska_simple_yaml_1_3

description: type definition of toska.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: toska.datatypes.nfv.NsOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: true
        default: value_1
      parameter_2:
        type: string
        required: true
        default: value_2

node_types:
  toska.MyExampleNS:
    derived_from: toska.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.

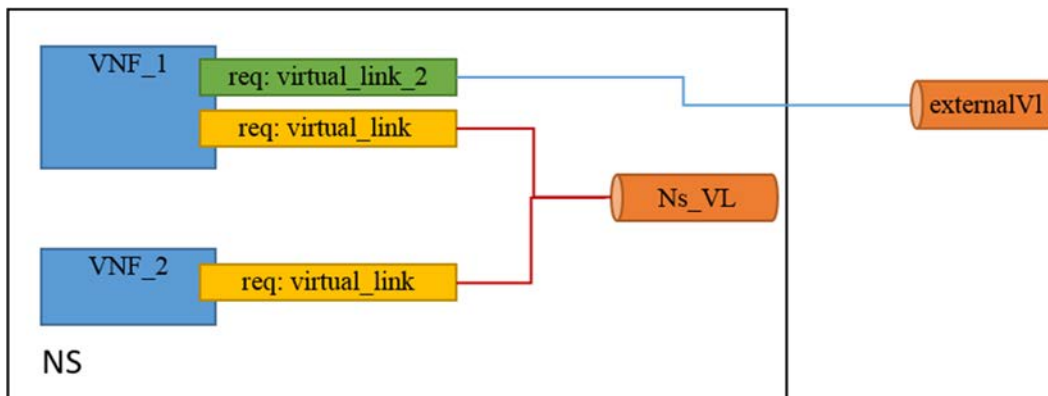


Figure A.11-2: MyExampleNs (simple): Lower level

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: toasca.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: toasca.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.

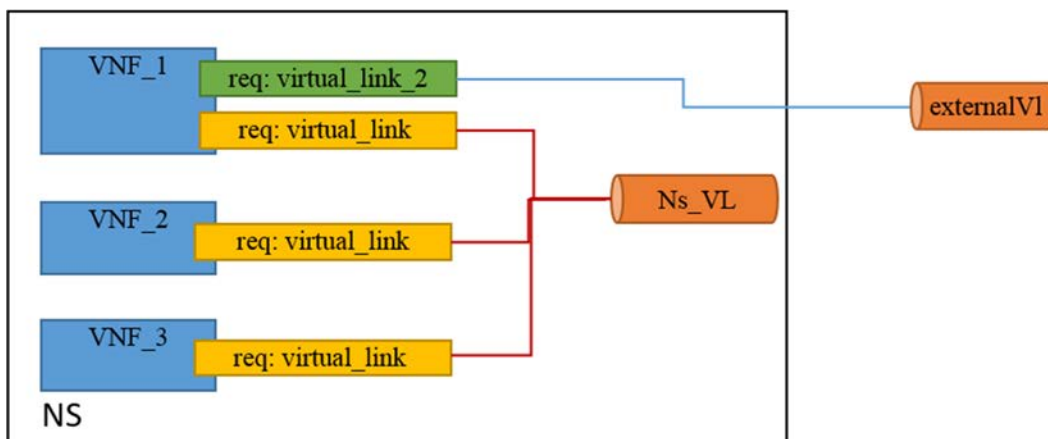


Figure A.11-3: MyExampleNs (big): Lower level

MyExampleNs_big.yaml

```

tosca_definitions_version: toasca_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:
    #
    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: toasca.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: toasca.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).

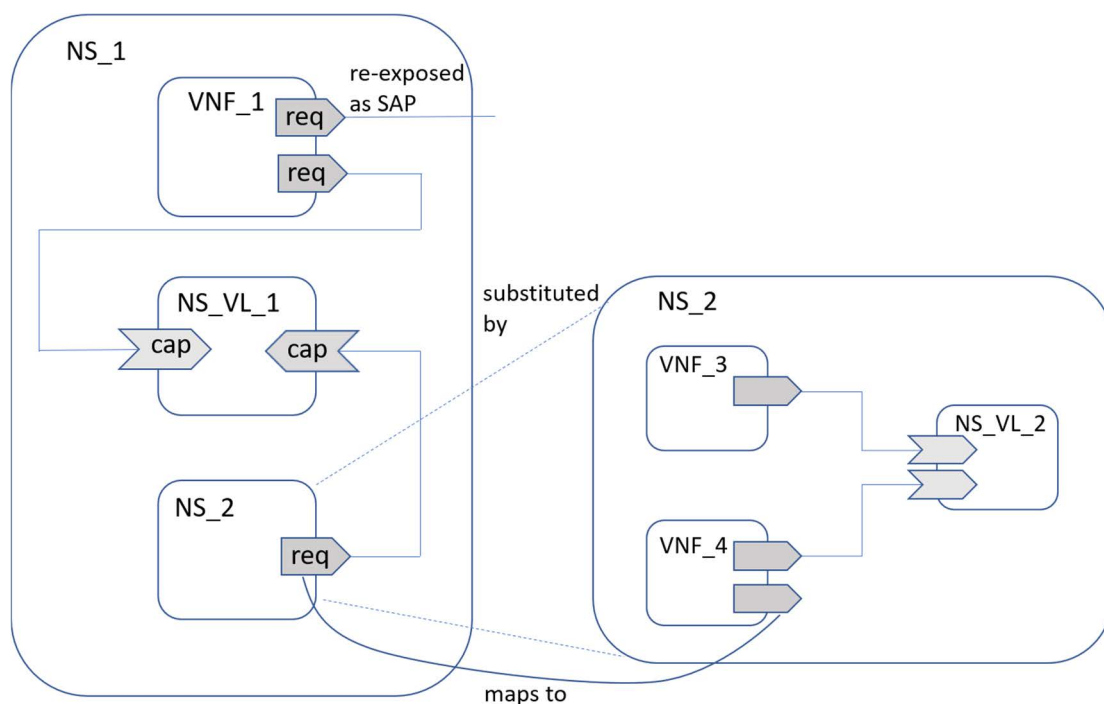


Figure A.12-1: Example of a network service containing a nested network service

```

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
      invariant_id: aaaa-bbbb-cccc-dddd
    ns_profile:
      ns_instantiation_level: level_1
      min_number_of_instances: 1
      max_number_of_instances: 3
      flavour_id: simple

```

```

NS_VL_1:
  type: toska.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: toska_simple_yaml_1_3

description: type definition of toska.MyExampleNS

imports:
  - etsi_nfv_sol001_nsd_types.yaml # all of TOSCA types as defined in ETSI
  GS NFV-SOL 001

node_types:
  toska.MyExampleNS:
    derived_from: toska.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: toska.capabilities.nfv.VirtualLinkable
          relationship: toska.relationships.nfv.VirtualLinksTo
    interfaces:
      Nslcm:
        type: toska.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: toasca.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: toasca.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: toasca.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 etsi_nfv_example_vnf4.yaml. Template fragments for etsi_nfv_example_vnf1.yaml, etsi_nfv_example_vnf2.yaml and etsi_nfv_example_vnf3.yaml are available in clause A.14.

```

tosca_definitions_version: toasca_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:
    toasca.nodes.nfv.example_VNF4:
        derived_from: toasca.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: [ equal: '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.

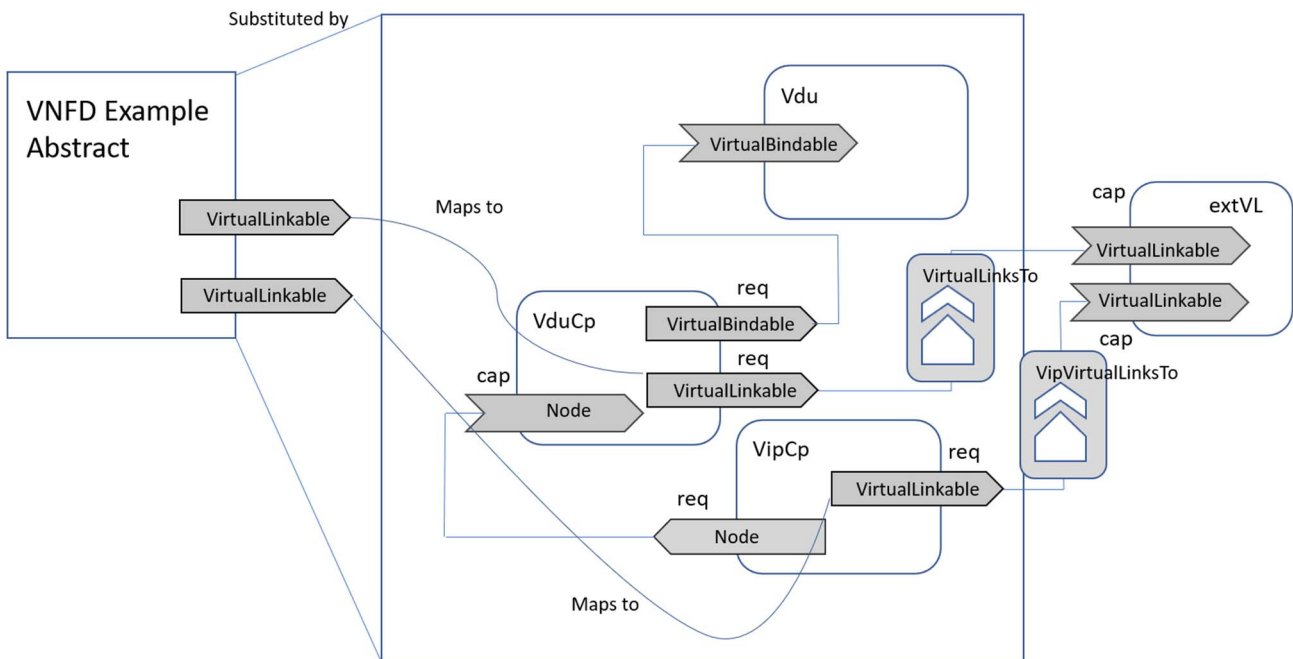


Figure A.13-1: VNFD with a VDU connection point acting as VnfExtCp and sharing a virtual IP address

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: toska_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: toska.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: [ equal: '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: toasca.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: toasca.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.

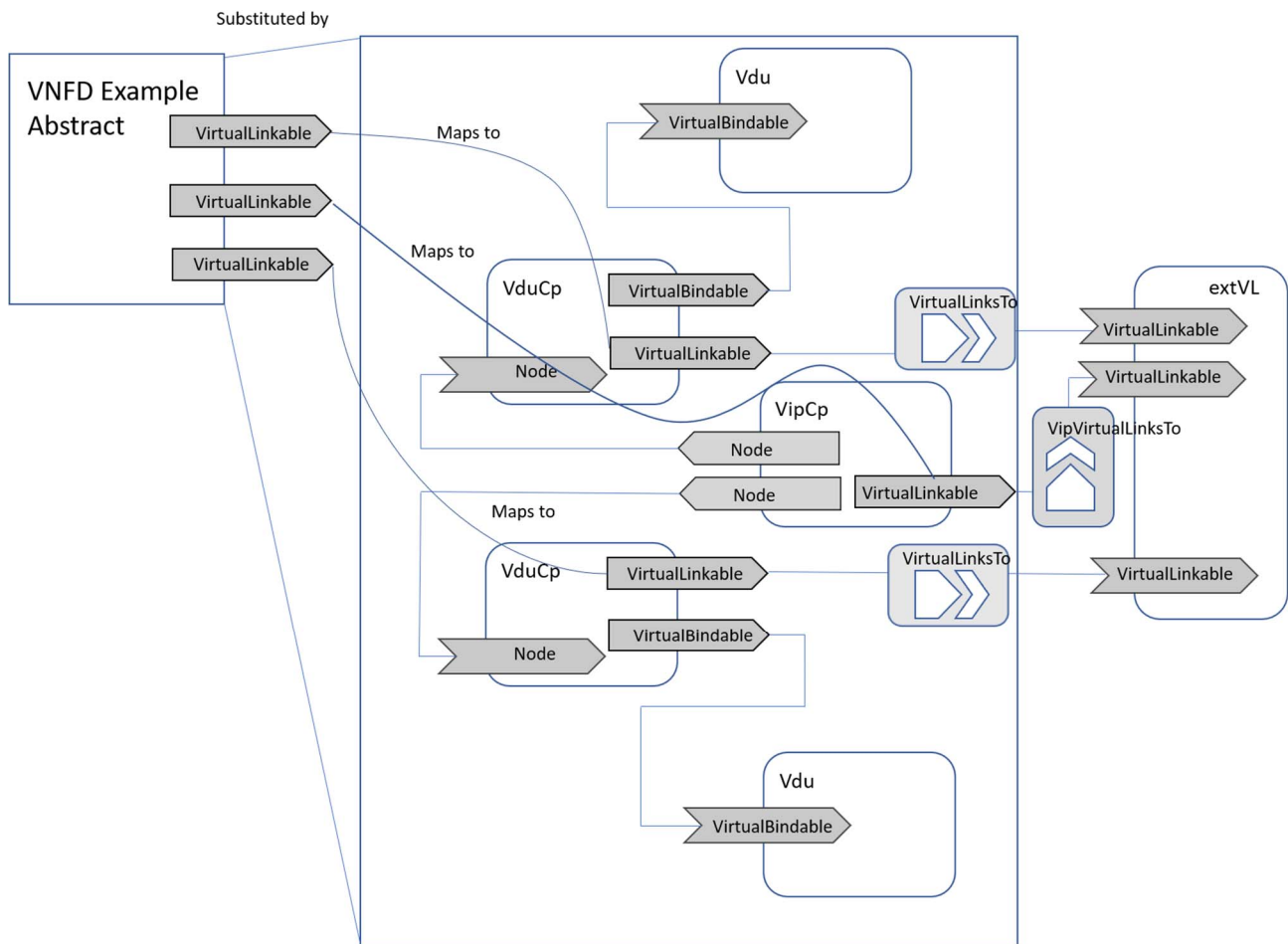


Figure A.13-2: VNF with two VDU connection points acting as VnfExtCps and sharing a virtual IP address

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 VNF definition corresponding to figure A.13-2. For simplicity, a single deployment flavour VNF is assumed.

```
tosca_definitions_version: toska_simple_yaml_1_3
description: Relational database, simple
imports:
  - etsi_nfv_sol001_vnfd_types.yaml # all of TOSCA VNF types as defined in ETSI
    GS NFV-SOL 001 for a VNF

node_types:
  MyCompany.SunshineDB.1_0.1_0:
    derived_from: toska.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: [ equal: '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: toasca.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: toasca.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: toasca.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: toasca.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 toasca.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.

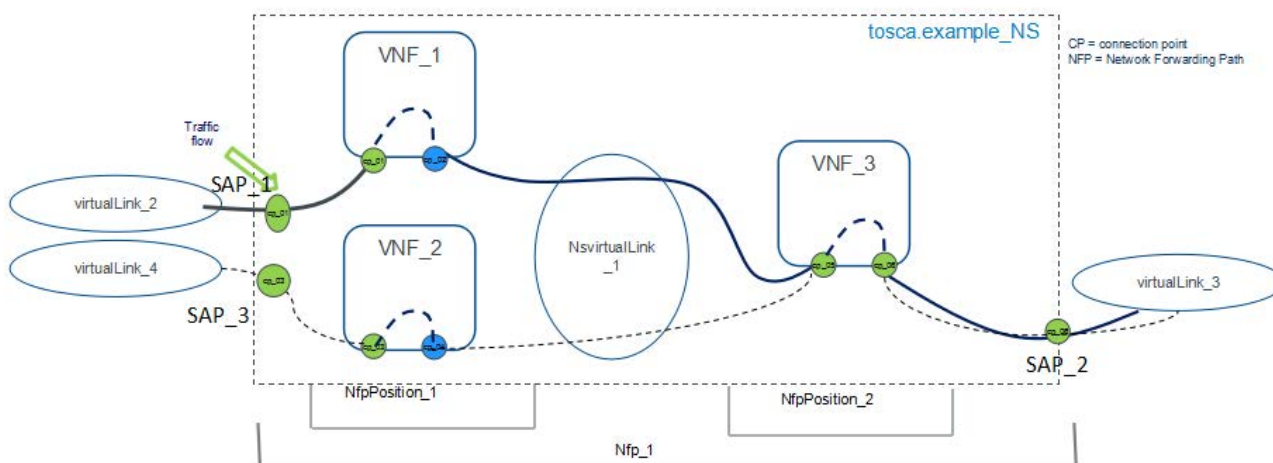


Figure A.14-1: Example Network Forwarding Path

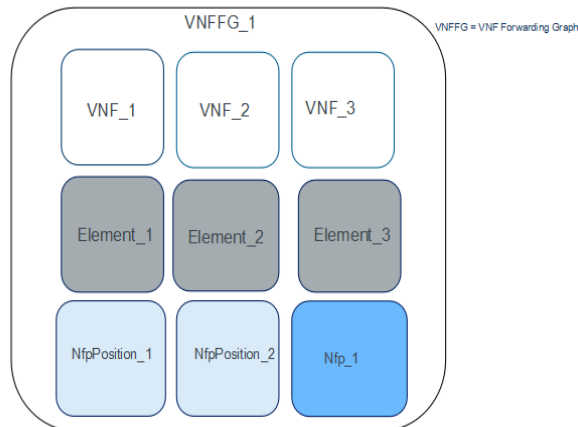


Figure A.14-2: Example VNFFG_1 group with constituent elements

```

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
  requirements:
  - virtual_link:
      capability: tosca.capabilities.nfv.VirtualLinkable
      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, virtual_link ] # the requirement of SAP_1
        virtual_link_3: [ VNF_3, virtual_link_3 ] # the requirement of SAP_2
        virtual_link_4: [ VNF_2, virtual_link_4 ] # 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: toasca.nodes.nfv.example_VNF1
  properties:
    descriptor_id: b1bb0ce7-2222-4fa7-95ed-4840d70a1179
    descriptor_version: "1.0.0"
    # . . .
  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: toasca.nodes.nfv.Forwarding

VNF_1_forward_2:
  type: toasca.nodes.nfv.Forwarding
  requirements:
    - virtual_link: NsVirtualLink_1

VNF_2:
  type: toasca.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: toasca.nodes.nfv.Forwarding

VNF_2_forward_4:
  type: toasca.nodes.nfv.Forwarding
  requirements:
    - virtual_link: NsVirtualLink_1

VNF_3:
  type: toasca.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: toasca.nodes.nfv.Forwarding
  requirements:
    - virtual_link: NsVirtualLink_1

VNF_3_forward_6:
```

```
    type: toasca.nodes.nfv.Forwarding

# NfpPositionElement (Service Function) for VNF_1
Element_1:
  type: toasca.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: toasca.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: toasca.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: toasca.nodes.nfv.NfpPosition
  properties:
    forwarding_behaviour: lb
  requirements:
    - element: Element_1
    - element: Element_2

# NfpPosition_2 with Element_3 as constituents
NfpPosition_2:
  type: toasca.nodes.nfv.NfpPosition
  properties:
    forwarding_behaviour: all
  requirements:
    - element: Element_3

Nfp_1:
  type: toasca.nodes.nfv.NFP
  requirements:
    - nfp_position: NfpPosition_1
    - nfp_position: NfpPosition_2

policies:
  - NfpRule_1:
```

```

type: toasca.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: toasca.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: toasca_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:
  toasca.nodes.nfv.example_VNF1:
    derived_from: toasca.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: [ equal: '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: toska_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:
  toska.nodes.nfv.example_VNF2:
    derived_from: toska.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: ""
    vnf_info:
      type: list
      entry_schema:
        type: string
        constraints: [ equal: '0:MyCompany-1.0.0' ]
        default: [ '0:MyCompany-1.0.0' ]
    requirements:
      - virtual_link_1:
          capability: toska.capabilities.nfv.VirtualLinkable
          relationship: toska.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_2:
          capability: toska.capabilities.nfv.VirtualLinkable
          relationship: toska.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]
      - virtual_link_4:
          capability: toska.capabilities.nfv.VirtualLinkable
          relationship: toska.relationships.nfv.VirtualLinksTo
          occurrences: [ 0, 1 ]

```

```

topology_template:
  substitution_mappings:
    node_type: toasca.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: toasca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . . . .
      requirements:
        - internal_virtual_link: intVL-A
    cp_04:
      type: toasca.nodes.nfv.VnfExtCp
      properties:
        layer_protocols: [ ipv4 ]
        # . . . . .
      requirements:
        - internal_virtual_link: intVL-A

    intVL-A:
      type: toasca.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: toasca_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:
  toasca.nodes.nfv.example_VNF3:
    derived_from: toasca.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: [ equal: '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: [ 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 notification indicating the attribute modified by the output of the notification.
- A VNF specific auto_scale and auto_heal policy definitions of tosca.nfv.policies.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: toasca.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: [ equal: '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: toasca.datatypes.nfv.VnfOperationAdditionalParameters
    properties:
      parameter_1:
        type: string
        required: false
policy_types:
  MyCompany.policies.nfv.VnfIndicator:
    derived_from: toasca.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: toasca.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: toasca.policies.nfv.VnfIndicator
    properties:
      source: vnf
    triggers:
      scale_out:

```

```

    event: toasca.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: toasca.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: toasca.policies.nfv.VnfIndicator
  properties:
    source: vnf
  triggers:
    red:
      event: toasca.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: toasca.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: toska.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 toska.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: toska_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_VNF1.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_VNF2.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: toska.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: toska.interfaces.nfv.NsVnfIndicator
    notifications:
      utilization:
        description: this notification is used to received asynchronous information of
value change of the utilization_vnf_indicator

node_types:
  toska.example_NS:
    derived_from: toska.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: toska.interfaces.nfv.Nslcm
    operations:

```

```

    instantiate:
      inputs:
        additional_parameters:
          type: MyCompany.datatypes.nfv.NsInstantiateAdditionalParameters
    NsVnfIndicator:
      type: MyCompany.nfv.interfaces.NsVnfIndicator
    notifications:
      utilization: {}

topology_template:
  substitution_mappings:
    node_type: toska.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: toska.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: toska.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: toska.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: toasca.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: toasca.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: toasca.policies.nfv.NsAutoScale
#   properties:
#     # none
  triggers:
    scale_out:
      event: toasca.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: toska.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_VNF1.yaml file with the VNF_1 node type definition are as follows:

```

tosca_definitions_version: toska_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: toska.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:
  toska.nodes.nfv.example_VNF1:
    derived_from: toska.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: [ equal: '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_VNF2.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:
  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:
  toska.nodes.nfv.example_VNF2:
    derived_from: toska.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: MyCompany ]
        default: MyCompany
      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: [ equal: '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 ]
  requirements:
    - virtual_link_1:
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.relationships.nfv.VirtualLinksTo
      occurrences: [ 1, 1 ]
    - virtual_link_2:
      capability: toasca.capabilities.nfv.VirtualLinkable
      relationship: toasca.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.

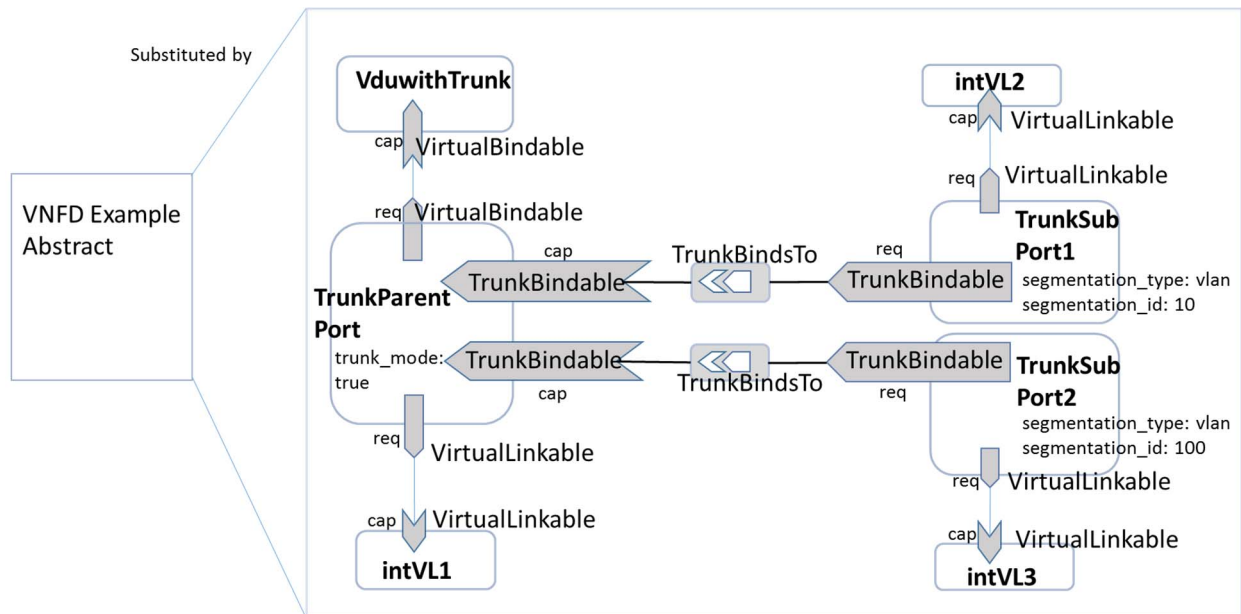


Figure A.16-1: VNFD with a VDU has three connection points group as trunk

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 annex 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 VNFs 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.

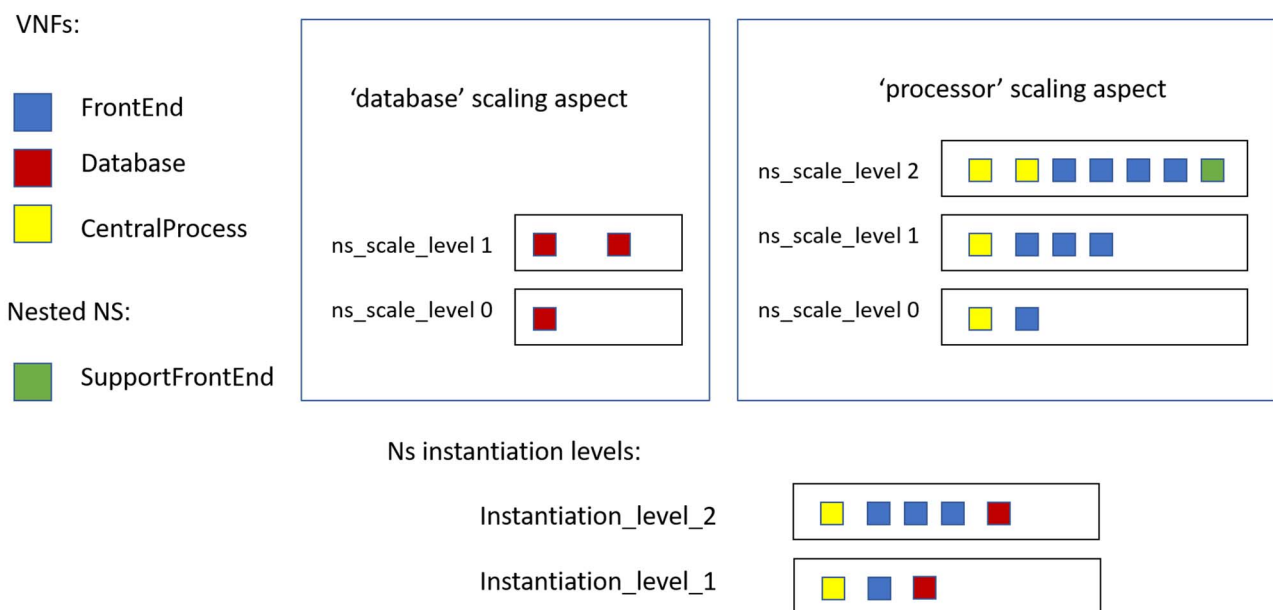


Figure A.17-1: NS scaling aspects and instantiation levels

```
tosca_definitions_version: toska_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
    flavour_id: simple
  requirements:
    - virtual_link_1: NS_VL_1

```

NS_VL_1:

```

  type: toasca.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: toasca.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: toska.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 of archive gs_nfv-sol001v030501p0.zip which accompanies the present document.

This file is also available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.5.1/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 of archive gs_nfv-sol001v030501p0.zip which accompanies the present document.

This file is also available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.5.1/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` of archive `gs_nfv-sol001v030501p0.zip` which accompanies the present document.

This file is also available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.5.1/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` of archive `gs_nfv-sol001v030501p0.zip` which accompanies the present document.

This file is also available at the following URL:

- https://forge.etsi.org/rep/nfv/SOL001/raw/v3.5.1/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 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	Modify VNF Information (see SOL002 and SOL003)
		VnfInfoModifications	
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNoti fication -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
		VnfPkgInfo	Create VNF package (see SOL005) Query/Read VNF Package Info (see SOL003 and SOL005)
		VnfPackageOnboardingNotificati on	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)
		NsLcmOperationOccurrenceNotifi cation -> 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	VnflInstance	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 -> VnflInstance	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	VnflInstance	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 -> VnflInstance	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	VnflInstance	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 -> VnflInstance	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 -> descriptor_version	(Version) vnfdVersion	VnflInstance	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)
		VnfInfoModifications	Modify VNF Information (see SOL002 and SOL003)
		VnfLcmOpOcc -> VnfInfoModifications	Get Operation Status (see SOL002 and SOL003)
		VnfLcmOperationOccurrenceNoti fication -> 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) vnfConfigurableProperti es	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)
		VnfLcmOperationOccurrenceNoti fication -> 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	VnflInstance -> instantiatedVnflInfo -> 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 -> VnflInstance -> instantiatedVnflInfo -> ScaleInfo	Query NS (see SOL005)
tosca.datatypes.nfv.ScaleInfo ->scale_level	(Integer) scaleLevel	VnflInstance -> instantiatedVnflInfo -> 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 -> VnflInstance -> instantiatedVnflInfo -> ScaleInfo	Query NS (see SOL005)
Node template name of type tosca.nodes.nfv.VnfExtCp	(IdentifierInVnfd) cpdId	VnflInstance -> instantiatedVnflInfo -> 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 -> VnflInstance -> instantiatedVnflInfo -> 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	VnflInstance -> instantiatedVnflInfo -> ExtManagedVirtualLinkInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnflInstance -> instantiatedVnflInfo -> 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 -> VnflInstance -> instantiatedVnflInfo -> ExtManagedVirtualLinkInfo	Query NS (see SOL005)
		NsInstance -> VnflInstance -> instantiatedVnflInfo -> VnfVirtualLinkResourceInfo	Query NS (see SOL005)
	(IdentifierInVnfd) vnfVirtualLinkDescId	UpdateNsRequest -> InstantiateVnfData -> ExtManagedVirtualLinkData	Update NS (see SOL005)
tosca.datatypes.nfv.VnfMonitoringParameter	(IdentifierInVnfd) id	VnflInstance -> instantiatedVnflInfo -> MonitoringParameter	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnflInstance -> instantiatedVnflInfo -> MonitoringParameter	Query NS (see SOL005)
tosca.datatypes.nfv.VnfMonitoringParameter ->name	(String) name	VnflInstance -> instantiatedVnflInfo -> MonitoringParameter	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnflInstance -> instantiatedVnflInfo -> MonitoringParameter	Query NS (see SOL005)
tosca.nodes.nfv.VNF ->localization_languages	(String) localizationLanguage	VnflInstance -> instantiatedVnflInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		NsInstance -> VnflInstance -> instantiatedVnflInfo	Query NS (see SOL005)
Node template name of type tosca.nodes.nfv.VduCompute	(IdentifierInVnfd)vduId	VnflInstance -> instantiatedVnflInfo -> VnfcResourceInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnflInstance -> instantiatedVnflInfo -> 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 -> VnflInstance -> instantiatedVnflInfo -> VnfcResourceInfo	Query NS (see SOL005)
	(IdentifierInVnfd) vnfdVirtualComputeDescId	Grant -> vimAssets -> VimComputeResourceFlavour	Grant Lifecycle Operation (see SOL003)
Node template name of type tosca.nodes.nfv.VduCp	(IdentifierInVnfd) cpId	VnflInstance -> instantiatedVnflInfo -> VnfcResourceInfo -> vnfcCplInfo	Create VNF Identifier (see SOL002 and SOL003) Query VNF (see SOL002 and SOL003)
		VnflInstance -> instantiatedVnflInfo -> VnfExtCplInfo 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)
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
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)
		VnfLcmOperationOccurrenceNoti fication -> VnfInfoModifications	Notify about VNF LCM (see SOL002 and SOL003)
		ChangeCurrentVnfPkgRequest	Change current VNF package (see SOL002 and SOL003)
tosca.policies.nfv.Instantia tionLevel ->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.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs 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])!
Properties of tosca.datatypes.nfv.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs in the inputs of the 'change external vnf connectivity' operation of the Vnflcm interface See note 2	(KeyValuePairs) additionalParams	ChangeExtVnfConnectivityReque st	Change External VNF Connectivity (see SOL002 and SOL003)
Properties of tosca.datatypes.nfv.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs 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.VnfOp erationAdditionalParamete rs in the inputs of the Change current VNF operation of the Vnflcm or ChangeCurrentVnfPackag e 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.Com pute Node template name of type tosca.nodes.nfv.Vdu.Virtu alBlockStorage	(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)
		VnfIndicatorValueChangeNotifica tion	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	VnfIndicatorValueChangeNotifica tion	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)
		VnfIndicatorValueChangeNotifica tion	Notify about VNF indicator value change (see SOL002 and SOL003).
Node template name of type tosca.nodes.nfv.Vdu.Com pute Node template name of type tosca.nodes.nfv.Vdu.Virtu alBlockStorage	(IdentifierInVnfd) vnfdSoftwareImageId	Grant -> vimAssets -> VimSoftwareImage	Grant Lifecycle Operation (see SOL003)
tosca.datatypes.nfv.VnfPa ckageChangeSelector -> destination_descriptor_id	(Identifier) vnfdId	ChangeCurrentVnfPkgRequest	Change current VNF package (see SOL002 and SOL003)
tosca.policies.nfv.LcmCoo rdinationsForLcmOperatio n ->actions -> referenced_coordination_ actions	coordinationActionName	LcmCoordRequest LcmCoord	CoordinateLcmOperation for VNF LCM (see SOL002)
tosca.policies.nfv.LcmCoo rdinationsForLcmOperatio n ->actions -> referenced_coordination_ actions	coordinationActionName	LcmCoordRequest LcmCoord	CoordinateLcmOperation for Change current VNF package (see SOL002)
Properties of tosca.datatypes.nfv.Input OpCoordParams See note 2	inputParameters	LcmCoordRequest	CoordinateLcmOperation for VNF LCM and Change current VNF package (see SOL002)
Properties of tosca.datatypes.nfv.Output OpCoordParams See note 2	outputParameters	LcmCoord	CoordinateLcmOperation for VNF LCM and Change current VNF package (see SOL002)
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.			

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)
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.			

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	NsdmSubscription -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
		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)	
(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)

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 NsdmSubscription -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
tosca.nodes.nfv.NS -> designer	(String) nsdDesigner	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdmSubscriptionRequest -> NsdmNotificationsFilter NsdmSubscription -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
tosca.nodes.nfv.NS -> invariant_id	(Identifier) nsdInvariantId	NsdInfo	Create NSD Update NSD Query/read NSD (see SOL005)
		NsdmSubscriptionRequest -> NsdmNotificationsFilter NsdmSubscription -> NsdmNotificationsFilter	Subscription about NSD management (see SOL005)
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.NsVirtual Link	(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.NsVIP profile") See note 2	(IdentifierInNsd) nsVirtualLinkProfileId	NsInstance -> NsVirtualLinkInfo	Create NS Query NS Delete NS (see SOL005)
	(IdentifierInNsd) vIProfileId	NsLcmOperationOccurrenceNotification -> AffectedVirtualLink	Notification about NS LCM (see SOL005)
See note 2	(IdentifierInNsd) nsInstantiationLevel Id	InstantiateNsRequest	Instantiate NS (see SOL005)
	(IdentifierInNsd) instantiationLevelId	UpdateNsRequest -> ChangeNsFlavourData	Update NS (see SOL005)
	(IdentifierInNsd) nsInstantiationLevel	ScaleNsRequest -> ScaleNsData -> ScaleNsToLevelData	Scale NS (see SOL005)
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)

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)
		InstantiateNsRequest -> NsAffinityOrAntiAffinityRule	Instantiate NS (see SOL005)
		InstantiateNsRequest -> ParamsForVnf	
		InstantiateNsRequest -> VnfLocationConstraint	
		InstantiateNsRequest -> VnfInstanceData	
		ScaleNsRequest -> ScaleNsData	Scale NS (see SOL005)
		ScaleNsRequest -> VnfLocationConstraint	
		ScaleNsRequest -> ScaleNsData	
		ScaleNsRequest -> 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
		PnfdOnboardingFailureNotification	(see SOL005)
		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)
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) pnfdProfileId	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)

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)
		UpdateNsRequest -> AddPnfData	Update NS (see SOL005)
Node template name of type toasca.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 toasca.groups.nfv.VNFFG	(IdentifierInNsd) vnffgId	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)
		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 toasca.nodes.nfv.Sap	(IdentifierInNsd) sapId	NsInstance -> SapInfo	Query 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)
		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: toska.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: toska.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: toska.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: toasca.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: toasca.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
                - create_VNF_2

# 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:
        - instantiate_end_step_1
# . . .

    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_1
            - 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_end_step_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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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

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 <i>editHelp</i> 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> – 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	<p>Implemented NFVSOL(19)000727r1_SOL001Ed271_Miscellaneous_corrections, NFVSOL(19)000642r1_SOL001ed271_Annex_Mapping_table_for_SOL_API_NSD_relat ed_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_occurance_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_Editor s_Notes, NFVSOL(19)000607r2_SOL001ed271_VNFFG_clause_6_8_2_6_Editor_s_note_handli ng, NFVSOL(19)000608r2_SOL001ed271_VNFFG_clause_7_8_2_6_Editor_s_note_handli ng, NFVSOL(19)000609r2_SOL001ed271_VNFFG_clause_7_8_5_1_Editor_s_notes_handli ng, 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</p>
2019.11	2.6.7	<p>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</p>
2020.02	3.0.1	<p>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</p>
2020.02	3.0.2	<p>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</p>
2020.04	3.0.3	<p>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_princi ple_in_annex, NFVSOL(20)000242_SOL001ed331_updating_annex_C, NFVSOL(20)000285_SOL001ed331_VNF_specific_types_naming_rules</p> <p>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</p>

Date	Version	Information about changes
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_suppom, 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
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

Date	Version	Information about changes
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
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_auto_scale, 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_template
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

History

Document history		
V3.3.1	September 2020	Publication
V3.5.1	July 2021	Publication