



GROUP SPECIFICATION

Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Architectural Framework Specification

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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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Introduction

Network Functions Virtualisation (NFV) adds new capabilities to communications networks and requires a new set of management and orchestration functions to be added to the current model of operations, administration, maintenance and provisioning. In legacy networks, the Network Function (NF) implementations are often tightly coupled with the infrastructure they run on.

NFV decouples software implementations of NFs from the physical resources offered by the hardware they use, such as computation, storage, and networking. The virtualisation insulates the NFs from those physical resources through a virtualisation layer which partitions them to create virtualisation containers, defined in ETSI GR NFV 003 [i.1].

The software and infrastructure decoupling exposes a new set of entities, the Virtualised Network Functions (VNFs), and a new set of relationships between them and the NFV Infrastructure (NFVI). The VNFs can be chained with other VNFs and/or Physical Network Functions (PNFs) to realize a Network Service (NS).

The virtualisation principle stimulates a multi-vendor ecosystem where the different components of the NFVI, the VNF software, and their management and orchestration functions are likely to follow different lifecycles (e.g. on procurement, upgrading, etc.). This requires interoperable standardized interfaces and proper resource abstraction among them.

The present document focuses on the management aspects introduced by the NFV technology and describes the architecture of the management and orchestration subset of the NFV architectural framework.

1 Scope

The present document describes the high-level functional architectural framework for the Management and Orchestration part of the NFV architectural framework.

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 010: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Functional Requirements Specification".

2.2 Informative references

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

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

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

- [i.1] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".
- [i.2] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".
- [i.3] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Network Service Templates Specification".
- [i.4] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".
- [i.5] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".
- [i.6] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".
- [i.7] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Ve-Vnfm reference point -Interface and Information Model Specification".
- [i.8] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; VNF Descriptor and Packaging Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

3.2 Symbols

Void.

3.3 Abbreviations

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

4 Management and orchestration aspects

4.1 NFV-MANO constructs

4.1.1 NFV Network Service (NS)

An NFV Network Service (NS) is a composition of Network Functions (NF) arranged as a set of functions and/or NSs. As illustrated in figure 4.1.1-1, the NS construct, as used by the NFV Management and Orchestration (NFV-MANO) functions to deploy an NS instance, includes several possible constituent objects:

- Virtualised Network Function (VNF);
- Physical Network Function (PNF);

NOTE: NFV-MANO manages only the connectivity aspects of the PNF(s).

- Nested Network Service(s) (NS);
- Virtual Link(s) (VL).

From management and orchestration perspective, the NFV-MANO uses the NS descriptor (NSD) defined in ETSI GS NFV-IFA 014 [i.3] to manage the lifecycle of an NS.

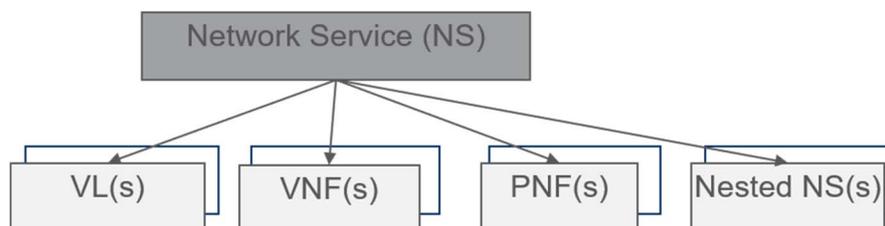


Figure 4.1.1-1: NS constituents overview

4.1.2 Virtualised Network Function (VNF)

The Virtualised Network Function (VNF) construct is defined in ETSI GR NFV 003 [i.1] and represents an NF implementation that can be deployed on a virtualised infrastructure. The VNF construct is agnostic to the functionality of the NF it represents.

From the NFV-MANO perspective, the deployment and operational behaviour requirements of each VNF are captured in a VNF Descriptor (VNFD), which is on-boarded as part of a file archive known as a VNF Package, specified in ETSI GS NFV-IFA 011 [i.8]. The VNFD describes the attributes and requirements necessary to realize an instance of the VNF and captures, in an abstracted manner, the requirements to manage its lifecycle.

NFV-MANO performs the lifecycle management of a VNF instance based on the requirements in the VNFD defined in ETSI GS NFV-IFA 011 [i.8].

4.1.3 Virtualised Network Function Forwarding Graph (VNFFG)

The Virtualised Network Function Forwarding Graph (VNFFG) construct is defined in ETSI GR NFV 003 [i.1] and is used to specify a set of forwarding rules known as Network Forwarding Paths (NFP) applicable to the traffic relayed over a set of Connection Points (CPs) and/or Service Access Points (SAPs) attached to the various NS constituents, where at least one of the constituents is a VNF.

From management and orchestration perspective, NFV-MANO uses the VNFFG descriptor (VNFFGD) defined in ETSI GS NFV-IFA 014 [i.3].

An example showing a VNFFG is depicted in figure 4.1.3-1.

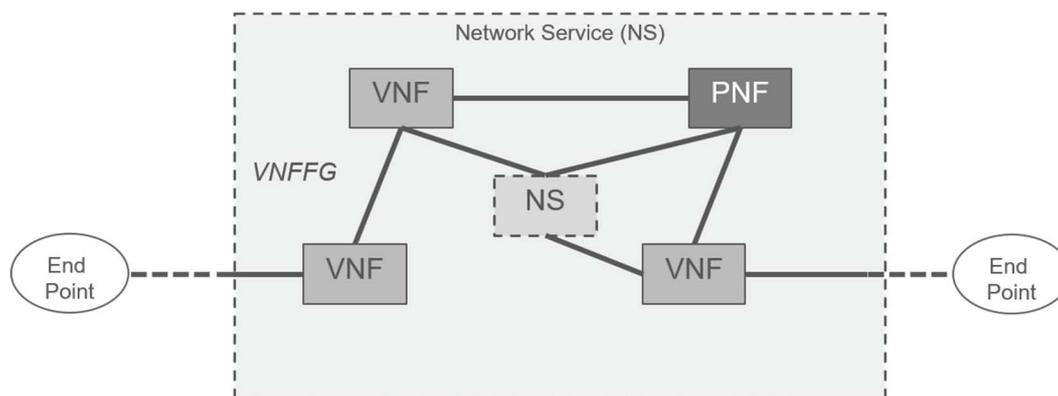


Figure 4.1.3-1: Depiction of a VNF Forwarding Graph

4.1.4 Virtual Link (VL)

The Virtual Link (VL) construct is defined in ETSI GR NFV 003 [i.1]. It abstracts the connectivity type and properties between any two or more of the following: VNF Components (VNFCs), VNFs, PNFs, and nested NSs. From management and orchestration perspective, the NFV-MANO uses the VNF VL descriptor (VLD) defined in ETSI GS NFV-IFA 011 [i.8] and NS VL descriptor defined in ETSI GS NFV-IFA 014 [i.3].

A VL can span across one or more Wide Area Networks (WANs) when the connectivity requirements are fulfilled between different sites, also known as NFVI-PoPs as defined in ETSI GR NFV 003 [i.1].

4.1.5 Physical Network Function (PNF)

The Physical Network Function (PNF) construct is defined in ETSI GR NFV 003 [i.1] and represents a software workload tightly coupled with the hardware it is deployed on. When a PNF is part of an NS, NFV-MANO uses the PNF Descriptor (PNFD) specified in ETSI GS NFV-IFA 014 [i.3] to manage the PNF connectivity with the other constituents of this NS instance. The PNFD is on-boarded as part of a file archive known as the PNFD archive.

The functional requirements on PNF archive and how a PNF is handled as part of the NS resources, are described in ETSI GS NFV-IFA 010 [1].

5 NFV-MANO Architectural Framework

5.1 General architecture overview

The NFV-MANO architectural framework is composed of functional blocks and reference points described in the present document.

The following functional blocks shall be part of the NFV-MANO architectural framework and shall fulfil the functional requirements defined in ETSI GS NFV-IFA 010 [1]:

- Network Functions Virtualisation Orchestrator (NFVO);
- Virtualised Network Function Manager (VNFM);
- Virtualised Infrastructure Manager (VIM).

Additional functional blocks represented in the NFV architectural framework, which interact with the NFV-MANO functional blocks are:

- Element Management (EM);
- Virtualised Network Function (VNF);
- Operation Support System (OSS) and Business Support System functions (BSS);
- NFV Infrastructure (NFVI).

The NFV-MANO architectural framework shall comprise the following reference points:

- Os-Ma-nfvo, a reference point between OSS/BSS and NFVO;
- Or-Vnfm, a reference point between NFVO and VNFM;
- Or-Vi, a reference point between NFVO and VIM;
- Ve-Vnfm-em, a reference point between EM and VNFM;
- Ve-Vnfm-vnf, a reference point between VNF and VNFM;
- Vi-Vnfm, a reference point between VIM and VNFM;
- Nf-Vi, a reference point between NFVI and VIM.

5.2 Architecture diagram

The NFV-MANO architectural framework defined in the present document is illustrated in figure 5.2-1.

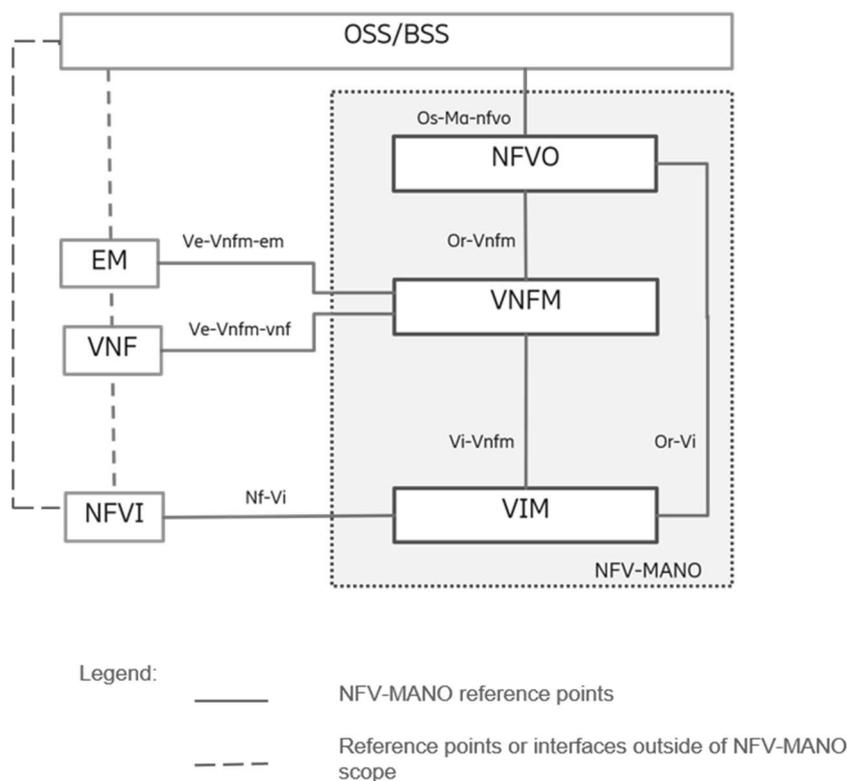


Figure 5.2-1: NFV-MANO architectural framework

The subsequent clauses define the functional blocks and the reference points which are composing the NFV-MANO architectural framework.

5.3 Functional Blocks

5.3.1 NFV Orchestrator (NFVO)

The NFVO is a functional block with a definition provided in ETSI GR NFV 003 [i.1]. Its main functions are:

- NS orchestration, including:
 - handling the lifecycle management of NSs (NS LCM) and their constituents;
- NOTE 1: In the present document, the management of the composite and nested NSs is provided within the same NFVO.
 - NS Performance Measurements (PM) and NS fault management (FM);
 - on-boarding and management of NSDs;
 - on-boarding and management of PNFD archives;
 - on-boarding and management of VNF Packages;
 - management of software images.
- orchestration of NFVI resources managed by one or more VIMs used for the realization of the NSs and their constituents, including:
 - VIM resources allocation and availability tracking;
 - virtual resources granting;

- resource reservation management;
- quota and resource capacity management;
- resource performance management;
- resource fault management;
- resource information management;
- permitted allowance management.

NOTE 2: The interaction of the NFVO with a WAN infrastructure manager (WIM), to realize NS connectivity requirements across NFVI-PoPs via a WAN, is out of scope for the present document.

5.3.2 VNF Manager (VNFM)

The decoupling of Network Functions (NFs) from the physical infrastructure resulted in a new set of management functions focused on the creation and lifecycle management of the VNF, handled by the VNF Manager (VNFM).

The VNFM is a functional block with a definition provided in ETSI GR NFV 003 [i.1].

The VNFM main functions are to provide:

- VNF lifecycle management (LCM);
- VNF configuration management of the configuration parameters of a VNF/VNF Component (VNFC);
- VNF information management for the value changes of VNF related indicators;
- VNF Performance Management (PM);
- VNF Fault Management (FM).

In addition, the VNFM can gather and offer information on the VNF behaviour in the form of VNF indicators. VNF indicators are information supplied by the VNF or the EM.

In order to realize these functions, the VNFM consumes interfaces offered by other NFV-MANO functional blocks. The VNFM maintains the mapping between virtual resources and the VNF instance using them. The VNFM acts upon the virtualised resources that support the VNF functionality, but without interfering with it.

5.3.3 Virtualised Infrastructure Manager (VIM)

The Virtualised Infrastructure Manager (VIM) is a functional block with a definition provided in ETSI GR NFV 003 [i.1]. It is responsible for controlling and managing the NFVI virtual resources used by the VNFs and the VLs: compute, storage and network resources, usually within one Infrastructure Domain (e.g. all resources within an NFVI-PoP, resources across multiple NFVI-PoPs, or a subset of resources within an NFVI-PoP).

The VIM northbound interfaces expose one or more of the following: management of NFVI virtualised compute, storage, and networking resources. In order to achieve that, the VIM interacts with the virtualisation layer of the NFVI and this interaction is out of scope of the present document.

A VIM can be specialized in handling a certain type of NFVI resource (e.g. compute-only, storage-only, network-only), or may be capable of managing multiple types of NFVI resources.

The VIM provides the following functionality:

- Software image management;
- Virtualised resources management (compute, storage, network):
 - Fault Management (FM), Performance Management (PM), configuration management, reservation management, quota management, capacity management, resource information management and Network Forwarding Path (NFP) management.

- Infrastructure resource fault and performance management;
- NFV acceleration capabilities management:
 - Some VNFs can have acceleration requirements specified in their VNFD. The VIM has the capability to expose and perform NFV acceleration management on acceleration resources offered by the NFVI.

5.3.4 Functional blocks interacting with NFV-MANO

5.3.4.1 OSS/BSS

The OSS/BSS are the combination of the operator's other operations and business support functions that are not otherwise explicitly captured in the present architectural framework but are expected to have information exchanges with functional blocks in the NFV-MANO architectural framework.

The NFV-MANO interacts with other OSS entities and with BSS, which are consolidated under the OSS/BSS Functional Block (FB) in the NFV-MANO architectural framework.

The OSS/BSS includes the collection of systems and management applications that service providers use to operate their business, besides NFV-MANO functions like e.g. NFVO, VNFM. Within OSS, these include the other OSS management and orchestration functions which are consuming the NFV-MANO interfaces in order to deliver their own services. These exclude OSS management functions which have a more specialized role in their interaction with NFV-MANO, such as the EM.

The OSS/BSS interacts with NFV-MANO by communicating with the NFVO, via the Os-Ma-nfvo reference point specified in ETSI GS NFV-IFA 013 [i.2].

5.3.4.2 Element Management (EM)

The Element Management (EM) represents the consolidation of all management entities performing the FCAPS management for the application functions of the VNF.

NOTE: The term "Element Manager" is also used in some other documents referred in the present document.

The EM interacts with NFV-MANO by communicating with the VNFM, via the Ve-Vnfm-em reference point specified in ETSI GS NFV-IFA 008 [i.7].

The EM consumes the VNF LCM, VNF PM and VNF FM functionality exposed by the VNFM over Ve-Vnfm-em.

The EM exposes information on the VNF behaviour (VNF indicators) to be reported to the VNFM.

5.3.4.3 Virtualised Network Function (VNF)

The VNF is the entity managed by the VNFM and has an associated VNFD which provides deployment and operational information to manage its lifecycle. The NFV-MANO interacts with the VNF via the Ve-Vnfm-vnf reference point specified in ETSI GS NFV-IFA 008 [i.7].

The VNF consumes the VNF LCM, VNF PM and VNF FM functionality exposed by the VNFM over Ve-Vnfm-vnf and exposes interfaces enabling VNF Configuration and enabling reporting VNF Indicators to the VNFM.

5.3.4.4 Network Function Virtualised Infrastructure (NFVI)

The NFVI definition is available in ETSI GR NFV 003 [i.1]. The NFVI encompasses all the underlying components of the infrastructure, the hardware and the software, which are used to host VNFs. The NFVI exposes the infrastructure resources as virtualised resources to be used by the VNFs and NSs: virtual compute, virtual storage and virtual network resources.

The VIM is the NFV-MANO entity that manages the NFVI, resources used by the VNFs and NSs, via the Nf-Vi reference point.

5.4 Reference points

5.4.1 Interfaces approach

NFV-MANO interfaces are defined focusing on the function they expose. The collection of the interfaces exposed by an NFV-MANO functional block and consumed by another NFV-MANO functional block is mapped into an NFV-MANO reference point. An NFV-MANO Interface can be exposed by an NFV-MANO producer on more than one NFV-MANO reference point, where applicable. In such a case, the exposure of the same NFV-MANO interface on different NFV-MANO reference points might lead to certain differences in terms of functionality (e.g. set of allowed operations) or exchanged information (e.g. different sets of operation input/output parameters). The NFV-MANO producer and consumer are described in the present document for each of the NFV-MANO reference points.

While reference points are a way to identify peer-to-peer relationships between functional blocks, descriptions of the interfaces provide a deeper understanding of how capabilities provided by a producer functional block are exposed to other consumer functional block(s).

5.4.2 Os-Ma-nfvo reference point

The reference point Os-Ma-nfvo is used for information exchanges between the OSS/BSS and the NFVO. The interfaces associated with the Os-Ma-nfvo reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [1] for the NFVO functional block.

The Os-Ma-nfvo reference point and its interfaces are specified in ETSI GS NFV-IFA 013 [i.2].

Os-Ma in short, is also used as a more generalized indication of the interfaces exposed by NFV-MANO to OSS/BSS.

5.4.3 Or-Vnfm reference point

The Or-Vnfm reference point enables the information exchanges between the NFVO and the VNFM. The interfaces associated with the Or-Vnfm reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [1] for the NFVO and the VNFM functional blocks.

The Or-Vnfm reference point and its interfaces are specified in ETSI GS NFV-IFA 007 [i.6].

5.4.4 Ve-Vnfm reference points

Ve-Vnfm is a composition of the reference points between VNFM and EM, and between VNFM and VNF:

- The reference point Ve-Vnfm-em enables information exchanges between the VNFM and the EM.
- The reference point Ve-Vnfm-vnf enables information exchanges between the VNFM and the VNF.

The functionality provided over the Ve-Vnfm reference points are based on the functional requirements specified in ETSI GS NFV-IFA 010 [1] for the VNFM Functional Block (FB).

The Ve-Vnfm reference point and its interfaces are specified in ETSI GS NFV-IFA 008 [i.7].

5.4.5 Or-Vi reference point

The Or-Vi reference point enables the information exchanges between the NFVO and the VIM. The interfaces associated with the Or-Vi reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [1] for the VIM and NFVO functional blocks.

The Or-Vi reference point and its interfaces are specified in ETSI GS NFV-IFA 005 [i.4].

5.4.6 Vi-Vnfm reference point

The Vi-Vnfm reference point enables the information exchanges between the VNFM and the VIM. The interfaces associated with the Vi-Vnfm reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [1] for the VIM and VNFM functional blocks.

The Vi-Vnfm reference point and its interfaces are specified in ETSI GS NFV-IFA 006 [i.5].

5.4.7 Nf-Vi reference point

The reference point Nf-Vi enables the external interaction of NFV-MANO with the NFVI.

Nf-Vi is a representation of the information exchanges between the NFVI and the management and orchestration functions in the VIM.

6 NFV-MANO reliability considerations

The reliability of NFV-MANO functional blocks is outside the scope of NFV Release 2. However, the services provided by NFV-MANO functional blocks include some considerations for the reliability of VNFs and NSs.

For example, fault management interfaces produced by the different NFV-MANO functional blocks and consumed by other NFV-MANO functional blocks, as well as by non-MANO functional blocks (such as EM, VNF and OSS/BSS), allow transferring information about alarms in the form of notifications. In cases of e.g. resource failures, the consumer functional blocks can further trigger appropriate actions to maintain the VNF and NS availability levels, e.g. perform a healing.

Likewise, the NFV-MANO descriptors include information that can be used for reliability and availability purposes. Such examples include:

- an indication on whether VNF auto-healing can be triggered by the VNFM;
- the possibility to include anti-affinity constraints used by NFV-MANO for making resource placement decisions, i.e. setting an anti-affine relation between instances of the same object reduces the risk that they all fail at the same time within the scope of that constraint.

7 NFV-MANO security considerations

Security aspects corresponding to NFV-MANO capabilities concentrate on:

- protection of the information exchanges over the reference points via:
 - a) authentication and authorization; and
 - b) message encryption and integrity.
- integrity protection of the VNF Package, PNF archive file and the NSD archive file. Additional confidentiality protection of the VNF Package artifacts can also be done at onboarding, based on the service provider security policies.

Security requirements specified in ETSI GS NFV-IFA 010 [1] cover authentication, authorization, encryption and integrity protection of the data exchanges, within the NFV-MANO architectural framework as well as with external functional blocks.

Annex A (informative): Change History

Date	Version	Information about changes
February 2020	0.0.1	First draft, introducing the document skeleton and introduction based on: <ul style="list-style-type: none"> NFVIFA(20)00070r2_NFV006_Skeleton NFVIFA(20)000107r1_NFV006_Introduction
March 2020	0.0.2	Incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(20)000108r2_NFV006_clause_4_NS NFVIFA(20)000111r1_NFV006_clause_4_VNF NFVIFA(20)000112r1_NFV006_clause_5_Interfaces
May 2020	0.0.3	Incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(20)000283r2_NFV006_clause4_VNFFG NFVIFA(20)000317r1_NFV006_NFV-MANO_architecture_overview NFVIFA(20)000323r2_NFV006_NFVO_FB_clause5_3_1 NFVIFA(20)000362r1_NFV006_VNFM_FB_clause5_3_2 NFVIFA(20)000364r1_NFV006_VIM_FB_clause5_3_3 NFVIFA(20)000363r3_NFV006_architecture_figure_5_2
July 2020	0.0.4	Incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(20)000398r1_NFV006_OSS_BSS_FB_new_clause NFVIFA(20)000486r2_NFV006_VL_description NFVIFA(20)000488r1_NFV006_VNF_FE_new_clause NFVIFA(20)000489r1_NFV006_PNF_description NFVIFA(20)000490r1_NFV006_NFVI_FE_new_clause
September 2020	0.0.5	Incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(20)000487r3_NFV006_EM_FE_new_clause NFVIFA(20)000506r1_NFV006_OsMa_rp_new_clause NFVIFA(20)000507r1_NFV006_OrVnfm_rp_new_clause NFVIFA(20)000508r1_NFV006_VeVnfm_rps_new_clause NFVIFA(20)000509_NFV006_OrVi_rp_new_clause NFVIFA(20)000510r1_NFV006_ViVnfm_rp_new_clause NFVIFA(20)000511r2_NFV006_NfVi_rp_new_clause NFVIFA(20)000513r2_NFV006_NFV-MANO_security_new_clause
September 2020	0.0.6	Stable draft, incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(20)000512r2_NFV006_NFV-MANO_reliability_new_clause Editorials: <ul style="list-style-type: none"> Removed empty Annexes
November 2020	0.0.7	Final draft, incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(20)000686_NFV006_stable_draft_review_with_editorial_changes NFVIFA(20)000700r1_NFV006_Normative_language_comments NFVIFA(20)000704r2_NFV006 - Editorial Review NFVIFA(20)000705r2_NFV006 - Small technical enhancements Editorials: <ul style="list-style-type: none"> Aligned the numbering for the informative references throughout the document

History

Document history		
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