



Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architectural Framework Specification

Disclaimer

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

Reference

RGS/NFV-006ed451

Keywords

architecture, management, MANO, NFV

ETSI

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

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

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from:

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

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

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

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

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

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

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

If you find a security vulnerability in the present document, please report it through our
Coordinated Vulnerability Disclosure Program:

<https://www.etsi.org/standards/coordinated-vulnerability-disclosure>

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

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

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

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

© ETSI 2024.
All rights reserved.

Contents

Intellectual Property Rights	5
Foreword.....	5
Modal verbs terminology.....	5
Introduction	5
1 Scope	7
2 References	7
2.1 Normative references	7
2.2 Informative references.....	7
3 Definition of terms, symbols and abbreviations.....	8
3.1 Terms.....	8
3.2 Symbols.....	8
3.3 Abbreviations	8
4 Management and orchestration aspects.....	9
4.1 NFV-MANO constructs	9
4.1.1 NFV Network Service (NS).....	9
4.1.2 Virtualised Network Function (VNF)	9
4.1.3 Virtualised Network Function Forwarding Graph (VNFFG)	9
4.1.4 Virtual Link (VL)	10
4.1.5 Physical Network Function (PNF).....	10
4.1.6 Container Infrastructure Service cluster (CIS cluster).....	10
4.1.7 Managed CIS Cluster Object (MCCO).....	10
4.1.8 Managed Container Infrastructure Object (MCIO).....	11
5 NFV-MANO Architectural Framework.....	11
5.1 General architecture overview.....	11
5.2 Architecture diagram.....	13
5.3 Functional Blocks.....	15
5.3.1 NFV Orchestrator (NFVO).....	15
5.3.2 VNF Manager (VNFM)	15
5.3.3 Virtualised Infrastructure Manager (VIM)	16
5.3.4 Functional blocks interacting with NFV-MANO	16
5.3.4.1 OSS/BSS	16
5.3.4.2 Element Management (EM).....	17
5.3.4.3 Virtualised Network Function (VNF)	17
5.3.4.4 Network Function Virtualised Infrastructure (NFVI)	17
5.3.5 WAN Infrastructure Manager (WIM).....	17
5.4 Reference points	18
5.4.1 Interfaces approach	18
5.4.2 Os-Ma-nfvo reference point.....	18
5.4.3 Or-Vnfm reference point	18
5.4.4 Ve-Vnfm reference points	18
5.4.5 Or-Vi reference point.....	18
5.4.6 Vi-Vnfm reference point.....	19
5.4.7 Nf-Vi reference point.....	19
5.4.8 Or-Wi reference point.....	19
5.4.9 Or-Or reference point.....	19
5.4.10 Cm-Vnfm reference point.....	19
5.5 Functions	19
5.5.1 Container Infrastructure Service Management (CISM).....	19
5.5.2 Container Image Registry (CIR).....	20
5.5.3 CIS Cluster Management (CCM)	20
5.5.4 Management Data Analytics Function (MDAF).....	20
5.5.5 Intent Management (IM).....	20
5.5.6 Certificate Management Function (CMF).....	20

5.5.7	PaaS Services Management (PSM)	20
5.5.8	PaaS Services Repository (PSR).....	20
5.6	Service interfaces	21
5.6.1	Interfaces approach	21
5.6.2	OS container workload management service interface	21
5.6.3	OS container compute management service interface	21
5.6.4	OS container storage management service interface	21
5.6.5	OS container network management service interface	21
5.6.6	OS container configuration management service interface.....	21
5.6.7	CIS instance management service interface.....	21
5.6.8	CIS MCCO management service interface	21
5.6.9	CIS cluster lifecycle management service interface	21
5.6.10	CIS cluster fault management service interface.....	22
5.6.11	CIS cluster configuration management service interface.....	22
5.6.12	CIS cluster performance management service interface	22
5.6.13	CIS cluster security management service interface	22
5.6.14	Data analytics service interface	22
5.6.15	Intent management service interface.....	22
5.6.16	Certificate Management interface.....	22
6	NFV-MANO reliability considerations	22
7	NFV-MANO security considerations.....	23
Annex A (informative): Change History		24
History		26

Intellectual Property Rights

Essential patents

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

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

Trademarks

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

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

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

Modal verbs terminology

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

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

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 4; 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 4; 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 4; Management and Orchestration; Network Service Templates Specification".
- [i.4] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".
- [i.5] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".
- [i.6] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".
- [i.7] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Ve-Vnfm reference point -Interface and Information Model Specification".
- [i.8] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification".

- [i.9] ETSI GS NFV-IFA 032: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Interface and Information Model Specification for Multi-Site Connectivity Services".
- [i.10] ETSI GS NFV-IFA 030: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Multiple Administrative Domain Aspect Interfaces Specification".
- [i.11] ETSI GS NFV-IFA 040: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification".
- [i.12] ETSI GS NFV-IFA 036: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for container cluster management and orchestration specification".
- [i.13] ETSI GR NFV-REL 012: "Network Functions Virtualisation (NFV); Reliability; Report on availability and reliability under failure and overload conditions in NFV-MANO".
- [i.14] ETSI GS NFV-IFA 047: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Management data analytics Service Interface and Information Model Specification".
- [i.15] ETSI GS NFV-IFA 050: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Intent Management Service Interface and Information Model Specification".
- [i.16] ETSI GS NFV-IFA 033: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Reference points related to Security Manager and Certificate Management Function - Interface and Information Model Specification".
- [i.17] ETSI GS NFV-IFA 026: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architecture enhancement for Security Management 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] and the following apply.

NOTE: An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in ETSI GR NFV 003 [i.1].

CMF Certificate Management Function

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.

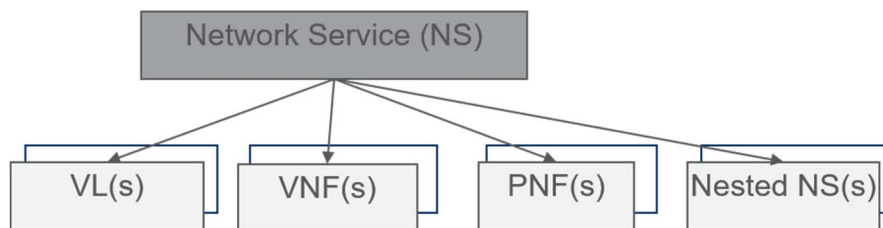


Figure 4.1.1-1: NS constituents overview

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.

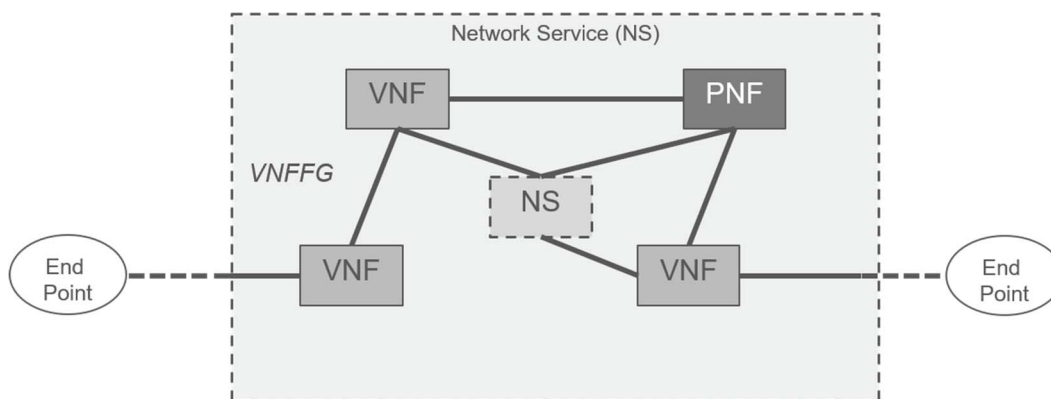


Figure 4.1.3-1: Depiction of a VNF Forwarding Graph

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].

4.1.6 Container Infrastructure Service cluster (CIS cluster)

The Container Infrastructure Service cluster (CIS cluster) construct is defined in ETSI GS NFV-IFA 036 [i.12] and represents a set of CIS instances and CISM instances hosted on one or multiple CIS cluster nodes. CIS cluster nodes can be realized as virtual machines or as bare-metal servers.

From the NFV-MANO perspective, the deployment and operational behaviour requirements of the CIS cluster are captured in a CIS Cluster Descriptor (CCD) as specified in ETSI GS NFV-IFA 036 [i.12], which is on-boarded to the CCM and used by the CCM to manage the lifecycle of a CIS cluster.

The CCD references one or multiple CIS Cluster Node Descriptors (CCND) for describing characteristics of CIS cluster nodes that the CIS cluster is hosted on. The CCND references a CIS Cluster Node Resource Descriptor (CCNRD) for describing the CIS cluster node's resource characteristics and necessary information for the basic instantiation of the CIS cluster. Both the CCND and the CCNRD are specified in ETSI GS NFV-IFA 036 [i.12].

4.1.7 Managed CIS Cluster Object (MCCO)

The Managed CIS Cluster Objects (MCCO) construct is defined in ETSI GS NFV-IFA 036 [i.12] and represents an abstract NFV object for CIS Cluster Management characterized by its configuration, state, requested and allocated infrastructure resources and applicable operational policies.

From the NFV-MANO perspective, the CCM uses the MCCO declarative descriptor as specified in ETSI GS NFV-IFA 036 [i.12] to deploy and manage the lifecycle of the MCCOs.

4.1.8 Managed Container Infrastructure Object (MCIO)

The Managed Container Infrastructure Objects (MCIO) construct is defined in ETSI GS NFV-IFA 040 [i.11] and represents an abstract NFV object for container infrastructure service management characterized by the desired and actual state of a containerized workload or subset of it, including the requested and allocated infrastructure resources and applicable operational policies.

From the NFV-MANO perspective, the CISM uses the MCIO declarative descriptor as specified in ETSI GS NFV-IFA 040 [i.11] to deploy and manage the lifecycle of containerized workloads. The aggregate of information objects including MCIO declarative descriptors and configuration files forms a Managed Container Infrastructure Object Package (MCIOP).

The VNF Package contains both the VNFD and MCIOPs, in which the VNFD of a containerized VNF has references to one or multiple MCIOPs that contain declarative descriptors and configuration files for MCIOs consumed by the containerized VNF.

5 NFV-MANO Architectural Framework

5.1 General architecture overview

The NFV-MANO architectural framework is composed of functional blocks and functions realizing management and orchestration capabilities.

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);
- Wide area network Infrastructure Manager (WIM).

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

- Element Management (EM);
- Virtualised Network Function (VNF);
- Operation Support System (OSS) and Business Support System functions (BSS);
- NFV Infrastructure (NFVI), including the CIS and WAN;
- Certificate Management Function (CMF).

NOTE: Allocation of CMF in relation to NFV-MANO is not specified by the present document version. Such a relation can be reflected in future versions of the present document.

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;
- Or-Or, a reference point between NFVOs in different administrative domains;
- Or-Wi, a reference point between an NFVO and a WIM.

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

- Container Infrastructure Service Management (CISM);
- Container Image Registry (CIR);
- Container Infrastructure Service Cluster Management (CCM);
- Management Data Analytics Function (MDAF);
- Intent Management (IM);
- PaaS Services Management (PSM); and
- PaaS Services Repository (PSR).

A series of management service interfaces are exposed by the CISM, CIR, CCM, MDAF, IM, CMF, PSM and PSR functions, which are invoked by consumers within NFV-MANO and/or consumers outside NFV-MANO. The consumers within NFV-MANO include:

- The NFVO consumes management service interfaces produced by the CISM.
- The VNFM consumes management service interfaces produced by the CISM.
- The NFVO consumes management service interfaces produced by the CIR.
- The VNFM consumes management service interfaces produced by the CIR.
- The NFVO consumes management service interfaces produced by the CCM.
- The NFVO consumes management service interfaces produced by the MDAF.
- The VNFM consumes management service interfaces produced by the CMF (only applicable for the CMF in "delegation-mode" as described in ETSI GS NFV-IFA 026 [i.17]).
- The NFVO consumes management service interfaces produced by the PSM.
- The NFVO consumes management service interfaces produced by the PSR.

The consumers outside NFV-MANO include:

- The OSS/BSS consumes management service interface produced by the IM.

The CCM, CISM, MDAF, IM, CMF, PSR and PSM function also consume management interfaces produced by other functional blocks or functions, which include:

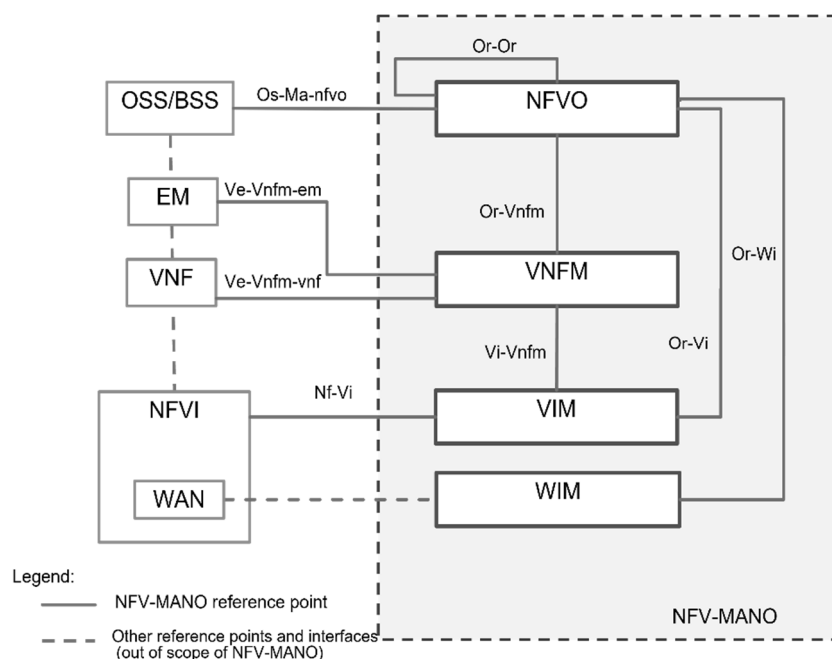
- The CCM consumes management interfaces produced by the NFVO.
- The CCM consumes management interfaces produced by the VIM.
- The CCM consumes management service interfaces produced by the CISM.
- The CISM consumes management interfaces produced by the VIM.
- The MDAF consumes management interfaces produced by the NFVO.
- The MDAF consumes management interfaces produced by the VNFM.

- The MDAF consumes management interfaces produced by the VIM.
- The MDAF consumes management interfaces produced by the CISM.
- The MDAF consumes management interfaces produced by the CCM.
- The MDAF consumes management interfaces produced by the WIM.
- The IM consumes management interfaces produced by the NFVO.
- The CMF consumes management interfaces produced by the VNFM.
- The PSM consumes management interfaces produced by the VNFM, VIM and CISM.
- The PSM consumes management interfaces produced by the PSR.
- The PSR consumes management interfaces produced by the PSM.

5.2 Architecture diagram

The NFV-MANO architectural framework defined in the present document is illustrated in figures 5.2-1 and 5.2-2.

Figure 5.2-1 shows the NFV-MANO architectural framework with the WIM as part of NFV-MANO.



NOTE: The VIM does not manage the whole NFVI, specific parts such as the WAN are managed by the WIM.

Figure 5.2-1: NFV-MANO architectural framework with WIM as part of NFV-MANO

Figure 5.2-2 shows the NFV-MANO architectural framework with the WIM external to NFV-MANO.

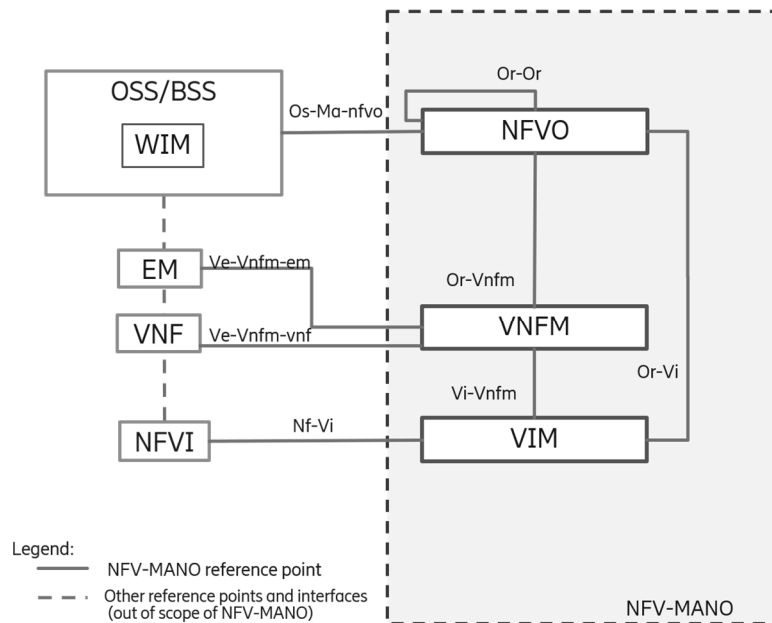


Figure 5.2-2: NFV-MANO architectural framework, WIM external to NFV-MANO

The functions and service interfaces introduced for support of containerized deployments are shown in figure 5.2-3.

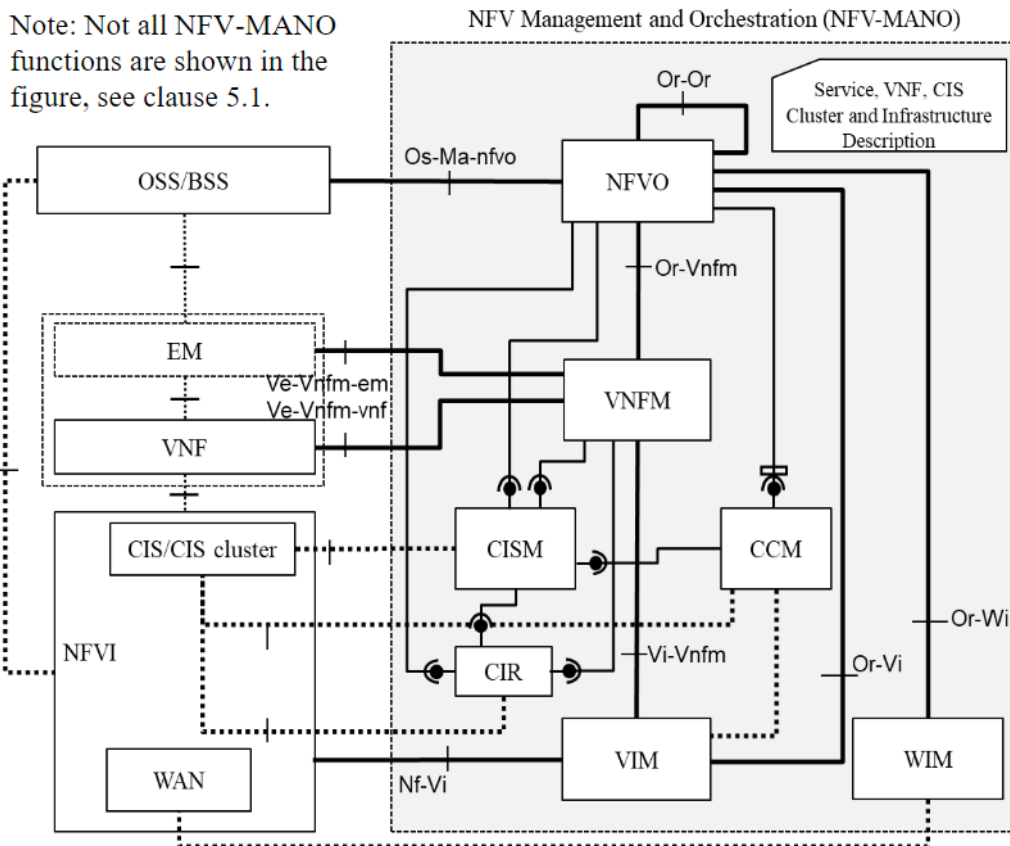


Figure 5.2-3: NFV-MANO architectural framework with support for containers

NOTE 1: The VIM does not manage the whole NFVI, such as the WAN is managed by the WIM, the CIS is managed by the CISM. For the sake of simplicity, this figure only shows the option where the WIM is in NFV-MANO, although the WIM can be external to NFV-MANO.

NOTE 2: There are interactions expected between the CCM and the VIM which are to be specified in a next version of the present document.

The subsequent clauses define the functional blocks, the reference points, the functions and the service interfaces which are composing the NFV-MANO architectural framework. The WIM architecture options are further described in clause 5.3.5.

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: In the present document, the management of the composite and nested NSs is provided by NFVOs that reside in same or different administrative domains, or it can be supported within the same NFVO.
- NS Performance Management (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.
- management of connectivity services, used for the realization of the connectivity between NSs and/or NS constituents deployed over different NFVI-PoPs (sites), including:
 - management of MSCS between multiple sites;
 - management of the WAN capacity and topology information needed for the connectivity between NSs, and/or NS constituents deployed over different NFVI-PoPs, and/or VNFC of a VNF in the case of a multi-site VNF deployment;
 - obtaining MSCS fault management data; and
 - management of the MSCS performance management data.

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, as well as by the CIS clusters, via the Nf-Vi reference point.

The Container Infrastructure Service (CIS) is a service provided by the NFVI and has a definition in ETSI GR NFV 003 [i.1]. It refers to the service that provides runtime environment for one or more container virtualisation technologies. The CIS is exposed by one or multiple CIS clusters. Containerized VNFs are deployed and managed on CIS instances and make use of container cluster networks deployed in the CIS clusters. The Container Infrastructure Service Management (CISM) is the function that manages the CIS.

5.3.5 WAN Infrastructure Manager (WIM)

The WAN Infrastructure Manager (WIM) is a functional block which provides management of Multi-Site Connectivity Services (MSCS). The WIM establishes the connectivity between NFVI-PoP connectivity service endpoints (e.g. offered by a network gateway) in different NFVI-PoPs using MSCS which abstracts the details of the connections between the NFVI-PoPs on the transport network/WAN.

When considering connectivity between NFVI-PoPs realized over transport network/WAN to fulfil NS level connectivity, a multi-site NS VL encompasses virtual networks in each of the involved NFVI-PoP provided by the WIM and MSCS on the transport/WAN provided by the WIM.

The NFV-MANO architectural framework supports the integration of the WIM with the following two options:

- the WIM may be part of the NFV-MANO; or

- the WIM may be external to NFV-MANO, e.g. under control or part of other OSS/BSS systems.

Annex G of ETSI GS NFV-IFA 010 [1] provides additional information about WIM integration options.

When the WIM is part of the NFV-MANO, it exchanges information with the NFVO using the Or-Wi reference point.

5.4 Reference points

5.4.1 Interfaces approach

NFV-MANO interfaces are defined focusing on the capability 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.

5.4.8 Or-Wi reference point

The reference point Or-Wi enables the information exchanges between NFVO and the WIM. A detailed specification of the interfaces supported over the Or-Wi reference point is available in ETSI GS NFV-IFA 032 [i.9].

The reference point Or-Wi offers the WIM capabilities to the NFVO via the following interfaces:

- MSCS Management interface;
- WAN Capacity Management interface;
- MSCS Fault Management interface; and
- MSCS Performance Management interface.

5.4.9 Or-Or reference point

The reference point Or-Or is used for information exchanges between the NFVOs handling NSs in a hierarchical relationship (i.e. composite NS and nested NS) across multiple NFV administrative domains. The interfaces associated with the Or-Or reference point are based on the functional requirements specified in ETSI GS NFV-IFA 010 [1] for the NFVO functional block.

The Or-Or reference point and its interfaces are specified in ETSI GS NFV-IFA 030 [i.10].

5.4.10 Cm-Vnfm reference point

The reference point Cm-Vnfm is used for information exchanges between the CMF and VNFM. The interfaces associated with the Cm-Vnfm reference point are based on the functional requirements specified in ETSI GS NFV-IFA 026 [i.17] for the CMF.

The Cm-Vnfm reference point and its interfaces are specified in ETSI GS NFV-IFA 033 [i.16].

5.5 Functions

5.5.1 Container Infrastructure Service Management (CISM)

The CISM is a function specified in ETSI GS NFV-IFA 040 [i.11] and ETSI GS NFV-IFA 036 [i.12]. Its main capabilities are the handling of:

- OS container workload management.
- OS container compute management.
- OS container storage management.
- OS container network management.

- OS container configuration management.
- CIS instance management.
- CIS storage management.
- Managed CIS Cluster Objects (MCCO) management.

5.5.2 Container Image Registry (CIR)

The CIR is a function specified in ETSI GS NFV-IFA 040 [i.11]. Its main capabilities are the handling of:

- OS container image management.

5.5.3 CIS Cluster Management (CCM)

The CCM is a function specified in ETSI GS NFV-IFA 036 [i.12]. Its main capabilities are the handling of:

- CIS cluster lifecycle management.
- CIS cluster configuration management.
- CIS cluster performance management.
- CIS cluster fault management.

5.5.4 Management Data Analytics Function (MDAF)

The MDAF is a function specified in ETSI GS NFV-IFA 047 [i.14]. Its main capabilities are the handling of:

- Data analytics.

5.5.5 Intent Management (IM)

The IM is a function specified in ETSI GS NFV-IFA 050 [i.15]. Its main capabilities are the handling of:

- Intent management.

5.5.6 Certificate Management Function (CMF)

The CMF is a function specified in ETSI GS NFV-IFA 033 [i.16]. Its main capabilities are the handling of:

- Certificate Management.

5.5.7 PaaS Services Management (PSM)

The PSM is a function specified in ETSI GS NFV-IFA 010 [1]. The main capabilities of the PSM are the handling of:

- Lifecycle management of PaaS Services.

5.5.8 PaaS Services Repository (PSR)

The PSR is a function specified in ETSI GS NFV-IFA 010 [1]. The main capabilities of the PSR are the handling of:

- registration of PaaS Services;
- inventory of PaaS Service instances; and
- management of PaaS Service Descriptors.

5.6 Service interfaces

5.6.1 Interfaces approach

The concept of service interface is introduced in the NFV architectural framework from Release 4. It specifies an interface from the viewpoint of the producer of the interface (i.e. an NFV-MANO function). The requirements describing the relationship between a consumer and its consumed service interfaces are specified in ETSI GS NFV-IFA 010 [1].

5.6.2 OS container workload management service interface

The OS container workload management service interface produced by the CISM provides the capability to a consumer to manage OS container workloads. The interface associated to OS container workload management service is based on the service interface requirements specified in ETSI GS NFV-IFA 040 [i.11].

5.6.3 OS container compute management service interface

The OS container compute management service interface produced by the CISM provides the capability to a consumer to manage Compute MCIOs. The interface associated to OS container compute management service is based on the service interface requirements specified in ETSI GS NFV-IFA 040 [i.11].

5.6.4 OS container storage management service interface

The OS container storage management service interface produced by the CISM provides the capability to a consumer to manage Storage MCIOs. The interface associated to OS container storage management service is based on the service interface requirements specified in ETSI GS NFV-IFA 040 [i.11].

5.6.5 OS container network management service interface

The OS container network management service interface produced by the CISM provides the capability to a consumer to manage Network MCIOs. The interface associated to OS container network management service is based on the service interface requirements specified in ETSI GS NFV-IFA 040 [i.11].

5.6.6 OS container configuration management service interface

The OS container configuration management service interface produced by the CISM provides the capability to a consumer to manage configurations related to OS containers. The interface associated to OS container configuration management service is based on the service interface requirements specified in ETSI GS NFV-IFA 040 [i.11].

5.6.7 CIS instance management service interface

The CIS instance management service interface produced by the CISM provides the capability to a consumer to manage CIS instances. The interface associated to CIS instance management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.8 CIS MCCO management service interface

The CIS MCCO management service interface produced by the CISM provides the capability to a consumer to manage MCCOs. The interface associated to CIS MCCO management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.9 CIS cluster lifecycle management service interface

The CIS cluster lifecycle management service interface produced by the CCM provides the capability to a consumer to manage the lifecycle of CIS clusters. The interface associated to CIS cluster lifecycle management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.10 CIS cluster fault management service interface

The CIS cluster fault management service interface produced by the CCM provides the capability to a consumer to request fault management related to CIS clusters. The interface associated to CIS cluster fault management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.11 CIS cluster configuration management service interface

The CIS cluster configuration management service interface produced by the CCM provides the capability to a consumer to request configuration management related to CIS clusters. The interface associated to CIS cluster configuration management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.12 CIS cluster performance management service interface

The CIS cluster performance management service interface produced by the CCM provides the capability to a consumer to request performance management related to CIS clusters. The interface associated to CIS cluster performance management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.13 CIS cluster security management service interface

The CIS cluster security management service interface produced by the CCM provides the capability to a consumer to request security management related to CIS clusters. The interface associated to CIS cluster security management service is based on the service interface requirements specified in ETSI GS NFV-IFA 036 [i.12].

5.6.14 Data analytics service interface

The data analytics service interface produced by the MDAF provides the capability to a consumer to manage data analytics processes. The interface associated to data analytics service is based on the service interface requirements specified in ETSI GS NFV-IFA 047 [i.14].

5.6.15 Intent management service interface

The intent management service interface produced by the IM provides the capability to a consumer (e.g. OSS/BSS) to manage intents. The interface associated to intent management service is based on the service interface requirements specified in ETSI GS NFV-IFA 050 [i.15].

5.6.16 Certificate Management interface

The certificate management service interface produced by the CMF provides the capability to a consumer to manage certificates. The interface associated to certificate management services is based on the interface requirements specified in ETSI GS NFV-IFA 033 [i.16].

6 NFV-MANO reliability considerations

The reliability of NFV-MANO is studied in ETSI GR NFV-REL 012 [i.13]. Furthermore, 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)000070r2_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: 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: Aligned the numbering for the informative references throughout the document
August 2021	3.0.1	Initial draft for Release 3, based on the approved Release 2 specification version. The references to Release 2 are replaced with Release 3.
January 2022	3.0.2	Incorporated approved contributions: <ul style="list-style-type: none"> NFVIFA(21)0001083r1 NFVIFA(21)0001091r1 NFVIFA(21)0001095 NFVIFA(21)0001096r1 NFVIFA(22)000017r1
February 2022	3.0.3	Incorporated approved contributions: <ul style="list-style-type: none"> NFVIFA(21)0001084r3
April 2022	3.0.4	Incorporated approved contribution: <ul style="list-style-type: none"> NFVIFA(22)000219r1_NFV006rel3_Architecture_figure_EN
April 2022	3.0.5	Final draft ed361, incorporates approved contributions: <ul style="list-style-type: none"> NFVIFA(22)000271r1_NFV006ed361_Multiple_clauses_review_of_WIM_aspects NFVIFA(22)000272_NFV006ed361_Multiple_clauses_review_of_multi-domain_aspects NFVIFA(22)000273_NFV006ed361_Annex_A_Bringing_back_contribution_history

Date	Version	Information about changes
June 2022	4.0.1	Initial draft version for NFV Rel-4 (ed441) based on the published version of NFV006ed361
Sept 2022	4.0.2	Incorporate approved contributions: <ul style="list-style-type: none"> NFVIFA(22)000421r2_NFV006ed441_General_architecture_overview_extension NFVIFA(22)000439r4_NFV006ed441_Architecture_diagram_update NFVIFA(22)000440r1_NFV006ed441_Add_function_description NFVIFA(22)000523r1_NFV006ed441_Add_CIS_description NFVIFA(22)000525r1_NFV006ed441_Add_CISM_and_CCM_related_managed_objects_and_dec NFVIFA(22)000526r1_NFV006ed441_Add_service_interface_description NFVIFA(22)000563r1_NFV006ed441_Add_interfaces_approach_for_service_interfaces NFVIFA(22)000564_NFV006ed441_EN_s_resolution_for_Figure_5_2-3_in_NFVIFA_22_00 NFVIFA(22)000597_NFV006ed441_EN_s_resolution_for_synchronizing_with_I FA036_fi
October 2022	4.0.3	Incorporate approved contributions: <ul style="list-style-type: none"> NFVIFA(22)000701r1_NFV006_two_review_comments
October 2022	4.0.4	Incorporate approved contributions: <ul style="list-style-type: none"> NFVIFA(22)000708r1_NFV006_add_description_of_Vi-Cc_reference_point
November 2022	4.0.5	Incorporate approved contributions: <ul style="list-style-type: none"> NFVIFA(22)000694r1_NFV006_-_Review_Comments_-_Miscellaneous_improvements NFVIFA(22)000775r4_NFV006ed441_Consistency_fix_on_figure_and_708_N WI.docx Final draft for ISG approval for ed441.
November 2022	4.0.6	Two editorials in clause 4.1.6 and 5.3.4.4 that were missed from: <ul style="list-style-type: none"> NFVIFA(22)000694r1_NFV006_-_Review_Comments_-_Miscellaneous_improvements
January 2024	4.4.2	Incorporate approved contributions: <ul style="list-style-type: none"> NFVIFA(23)000729r2_NFV006ed451_Add_MDAF_related_architectural_specification NFVIFA(23)000831r2_NFV006ed451_Add_IM_related_architectural_specification
February 2024	4.4.3	Incorporate approved contributions: <ul style="list-style-type: none"> NFVIFA(24)000053r1_NFV006ed451_FEAT21_Adding_PaaS_Services_management NFVIFA(24)000046r3_NFV006ed451_Add_CMF_related_architectural_specification
March 2024	4.4.4	No technical changes, only correction of versioning in the Change History table.

History

Document history		
V4.4.1	December 2022	Publication
V4.5.1	May 2024	Publication