ETSI GR NFV 007 V4.4.1 (2023-11)

Network Functions Virtualisation (NFV);
Release Description;
Release 4

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Foreword

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

Modal verbs terminology

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

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

1 Scope

The present document describes the NFV Release 4 and in particular its version 4.4.1. It lists and defines the features forming this release and their relation to work items. It also documents the versions of the related published specifications and reports. The present document provides an overview of version 4.4.1 and is intended to help the user as an entry point to ETSI NFV documentation.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

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

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

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

[i.1] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".

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

[i.3] ETSI GR NFV 007 (V3.7.1): "Network Functions Virtualisation (NFV); Release Description; Release 3".

[i.4] ETSI NFV: "Feature tracking: ENH01 Security enhancements".

[i.5] ETSI NFV: "Feature tracking: ENH02 Special technical enhancements".

[i.6] ETSI GS NFV-PER 001: "Network Functions Virtualisation (NFV); NFV Performance & Portability Best Practises".

[i.7] ETSI GR NFV-REL 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on NFV-MANO software modification".

[i.8] ETSI GR NFV-EVE 010: "Network Functions Virtualisation (NFV) Release 3; Licensing Management; Report on License Management for NFV".

[i.9] ETSI GR NFV-IFA 034: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on Architectural enhancement for VNF License Management support and use of VNF licenses".

[i.10] ETSI GR NFV-TST 006: "Network Functions Virtualisation (NFV); Testing; Report on CICD and DevOps".

NOTE: The release description includes tables, figure and lists of documents to define the versions of the documents comprising the release. In these cases the documents are not listed as references in this clause.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

capability: ability of an item to perform an action under given internal conditions in order to meet some demand

feature: functionality which represents added value to the system for a defined set of users

NOTE: A user could be a network operator, service provider, VNF provider, or some other defined actor.

function: the abstract concept of a particular piece of functionality in a device, entity or service

functionality: sum of actions or any aspect an item can do

NOTE: Functionality can be associated to diverse items, including devices, entities, services and/or features.

release: set of deliverables that specify a well-defined, stable and internally consistent set of functions

NOTE: A Release differs from the previous Release by having added and/or improved functionality introduced as a result of standardization work.

release definition: ensemble of Features of a particular Release

release description: description of specification outputs delivered by the Release

3.2 Symbols

None.

3.3 Abbreviations

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

GR	Group Report
GS	Group Specification
ISG	Industry Specification Group

4 Release overview

4.1 Introduction

ETSI ISG NFV Release 4 (hereinafter referred also as Release 4 or the present Release) builds on top and leverages the results of ETS ISG NFV documents published as part of the Release 3. The Release 4 introduces new features on top of the specified capabilities and features in previous Releases.

A high-level description of the main outcomes of the Release 4 are provided in clause 5. A high-level definition for each of the features which are considered during the development of current Release 4 work is also provided in Annex C. Clause 4.2 provides a statistical summary of the Release 4 in terms of number of specifications and reports published to date. Clause 4.3 summarizes the capabilities and features that have been specified in past Releases and clause 4.4 summarizes the specification work state at each of the specification stages. Clause 6 lists the published GR and GS comprising Release 4, while clause 7 lists the ongoing work items.

4.2 Overview

At the time the present Description document version is delivered, the Release 4 is comprised of the following number of published deliverables:

- 31 Group Specifications, among which:
  - 6 new specifications.
  - 25 specifications evolved from Release 3.
- 7 Group Reports, among which:
  - 5 new reports.
  - 2 reports evolved from Release 3.

4.3 Summary of past Releases

The Release 3 was built upon the capabilities and features specified as part of the NFV Release 2. The Release 2 specified requirements, information models, data models and interface protocols to enable interoperable implementations of the NFV Architectural Framework (see ETSI GS NFV 002 [i.1]). The Release 3 added the following major architectural changes:

- Addition of the Or-Or reference point in between two NFVO (Feature "NFV-MANO admin domains").
- Exposure by the NFV-MANO functional blocks of new interfaces for policy management (feature "Policy management framework").
- Exposure by the NFV-MANO functional blocks of new interfaces for the management of NFV-MANO functional blocks (feature "Management of NFV-MANO").
- Definition of the Wide Area Infrastructure Management (WIM) and exposure of interfaces for multi-site network connectivity management (feature "Management and connectivity of multi-site services").

ETSI GR NFV 007 V3.7.1 [i.3] provides details about the capabilities that had been specified in the Release 3 and also contains details about the capabilities that had been specified in the Release 2 in its annex C.

4.4 Specification work state

Table 4.4-1 summarizes the status of the specification work at different stages. Annex B describes the meaning of the "state" of the specification work.

Table 4.4-1: Specification work state within the present Release

Stage	Meaning	State	Additional notes
Informative (stage 0)	Informative work within a Release used to study new use cases and technical features.	Closed	None
Stage 1/2	Normative work: Service and business requirements Architecture, interfaces and information models.	Open	None
Stage 3	Normative work on protocols and data models. Informative work on studying potential profiling of existing solutions.	Open	None
Stage 4	Normative work on testing specifications for protocols and data models.	Open	None

NOTE: Testing efforts, e.g. normative work on testing specifications for protocols and data models, are not covered in the present document version.

5 Release 4 features

5.1 Overview

The features introduced as part of the Release 4 are listed in Table 5.1-1.

The table also lists the status of the specification of normative provisions concerning protocols and data models (stage 3).

Table 5.1-1: Release 4 features

Feature name	Acronym	FEAT id	Stage 3 status
NFV-MANO upgrades	**SWUP-MANO**	**FEAT01**	**Not started.**
Host reservation	**HOSTRSV**	**FEAT04**	**Ongoing. See note 5.**
Management and connectivity of multi-site services	**NFVWAN (MCMSS)**	**FEAT10**	**Ongoing. See note 1.**
MEC in NFV	**MECinNFV**	**FEAT12**	**Completed. See note 4.**
Licensing management	**LIC**	**FEAT13**	**Completed. See note 6.**
Cloud-native VNFs and Container Infrastructure management	CNNFV	FEAT17	Ongoing. See note 2.
Security management and monitoring for NFV	SECMM	FEAT18	Ongoing
Network connectivity integration and operationalization for NFV - container networking	NFV-Connect-container	FEAT19a	Completed
NFV-MANO automation and autonomous networks	Auto	FEAT20	Not started.
NFV enhancements for 5G	5GNFV	FEAT21	Ongoing. See note 3.
Multi-tenancy enhancements for NFV-MANO	M-Tenant	FEAT22	Postponed to Release 5.
SBA for NFV-MANO	MANO-SBA	FEAT23	Postponed to Release 5.
VNF generic management functions	VNF-OAM	FEAT24	Not started.
Continuous VNF integration	VNF-CI	FEAT25	Not started.
Policy management models	Policy-model	FEAT26	Not started.

NOTE 1: The feature was not completed in the previous release. Some parts were carried over to the present release. See clause 5.2.3 for details.
NOTE 2: Enhancements about the support of OS container management and orchestration for containerized VNF has been completed as part of the version V4.3.1 of related specifications.
NOTE 3: Enhancements related to NSD processing and flexible constituents handling have been completed as part of the version V4.3.1 of related specifications.
NOTE 4: The feature has been completed in Release 3, see ETSI GR NFV 007 V3.7.1 [i.3].
NOTE 5: The feature was not completed in the previous release. Some parts were carried over to the present release. See clause 5.2.2 for details.
NOTE 6: Changes have been introduced in V4.4.1 of related specifications.

Table 5.1-2 lists the Release 4 enhancement features (specific technical or security enhancements) whose specification has been completed with normative provisions at least from an architecture, functional and information model perspective (stage 2). The table also lists the status of the specification of normative provisions concerning protocols and data models (stage 3).

Table 5.1-2: Release 4 enhancement features

Feature name	ENH id	Stage 3 status
NFV-MANO enhancement with SDN-based networking	ENH02.01	Completed
NFV-MANO enhancement for NS feasibility check	ENH02.02	Completed. See note.
Data flow mirroring	ENH02.03	Completed
Invariant identification of NSD constituents	ENH02.04	Completed. See note.
Flexibility with scalable VNF/NS instantiation	ENH02.05	Completed. See note.

NOTE: Core of the specification is completed. Additional work for NFV-MANO procedures can be performed.

5.2 Functional features

5.2.1 NFV-MANO upgrades (SWUP-MANO, FEAT01)

The feature was started in Release 3 as FEAT01.

The scope of the feature covers the following areas:

- Update and upgrade of NFV-MANO software components in an NFV context (or environment).
- Identification of use cases for update and upgrade of NFV-MANO.
- Identification of the required set of update/upgrade controlling functions to facilitate software updates/upgrades.
- Specification of requirements for software update/upgrade controlling functions.

The feature was studied in ETSI GR NFV-REL 011 [i.7]. There are no normative provisions for the feature in Version 4.4.1.

5.2.2 Host reservation (HOSTRSV, FEAT04)

5.2.2.1 Description

The feature was started in Release 3 as FEAT04 but was not completed.

The feature adds the capability to the NFV-MANO architectural framework to support the reservation of compute hosts (see clause 3.1 in ETSI GS NFV-PER 001 [i.6]) in the NFVI. The feature allows the network operator to guarantee that the allocation of some of the virtualised resources takes place on certain hosts isolated from others, e.g. under certain security enclaves, or to guarantee the availability of resources at the host level.

Compute host reservation is supported in Release 3 by query operations on capacity using the Virtualised Compute Resources Capacity Management Interface. Query operations on capacity using descriptor based resource management are not described in Release 3 but carried over to Release 4.

5.2.2.2 Architecture scope

The feature concerns the following main functional blocks and references points, described already in Release 3, see ETSI GR NFV 007 V3.7.1 [i.3]:

- Functional blocks: NFVO, VNFM, VIM.
- Reference points: Or-Vi, Vi-Vnfm, Os-Ma-nfvo.

5.2.2.3 Specification results

The Release 4 additions to the feature have been specified in the specifications listed in table 5.2.2.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.2.3-1: Specification results of feature "Host Reservation"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-SOL 003	Stage 3	Removed 3 attributes. Modified semantics of one attribute. Change on the supported policies.

5.2.3 Management and connectivity of multi-site services (NFVWAN/MCMSS, FEAT10)

5.2.3.1 Description

FEAT10 has not progressed fast enough to be completed in Release 3.

The following specification items have been postponed to be realized in Release 4 documentation:

- The normative profiling of the protocols and data models for the interfaces produced by the WIM about management of multi-site connectivity services on the WAN resources.
- Updates to the data models exposed by the VIM regarding the information and management of NFVI-PoP gateways enabling the connectivity to/from multi-site connectivity services.

5.2.3.2 Architecture scope

The feature introduced in release 3 enhancements on the following main functional blocks, references points and artefacts:

- Functional blocks: WIM (new), and NFVO, VNFM, and VIM.
- Reference points: Os-Ma-nfvo, Or-Vi, Or-Vnfm.
- Artefacts: NSD.

In release 4 no additional architectural changes are introduced but the management of the new functional block of the WIM is further specified.

5.2.3.3 Specification results

The Release 4 additions to the feature have been specified in the specifications listed in table 5.2.3.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.3.3-1: Specification results of feature "Management and connectivity of multi-site services"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-SOL 003	Stage 3	3 new attributes. Modified semantics of 5 attributes.

5.2.4 MEC in NFV (MECinNFV, FEAT12)

Although a candidate to postpone from Release 3 to Release 4, this work has been completed in Release 3, see ETSI GR NFV 007 V3.7.1 [i.3].

5.2.5 Licensing management (LIC, FEAT13)

5.2.5.1 Description

The feature was started in Release 3 as FEAT13, based on ETSI GR NFV-EVE 010 [i.8].

The scope of the feature covers the following areas:

- NFV license management framework aspects to ensure Service Providers can deploy VNFs quickly without customizing the licensing mechanisms for each VNF and each VNF Provider.

The feature specification work scope encompasses:

- Develop use cases related to license management.

- Derive requirements from license management use cases.
- Identify what NFV Architectural Framework support and enhancements are needed to cover license management requirements.

The feature was studied in ETSI GR NFV-IFA 034 [i.9].

5.2.5.2 Architecture scope

In release 4 no architectural changes are introduced.

5.2.5.3 Specification results

The feature small impacts on the specifications and reports listed in table 5.2.5.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.5.3-1: Specification results of feature "Licensing management"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 011	Stage 2	The presence of license terms information is made optional in the VNF Package.
ETSI GS NFV-SOL 004	Stage 3	The presence of license terms information is made optional and is clarified in the VNF Package.

5.2.6 Cloud-native VNFs and container infrastructure management (CNNFV, FEAT17)

5.2.6.1 Description

The feature enhances the NFV architectural framework to support VNFs which follow "cloud-native" design principles and the NFV-MANO to support capabilities for container and container infrastructure management and orchestration.

Regarding the container management and orchestration new NFV-MANO functions, the Container Infrastructure Services Management (CISM) and Container Image Registry (CIR), are defined, exposing a new set of service interfaces:

- OS container workload management service interface, produced by the CISM;
- OS container compute management service interface, produced by the CISM;
- OS container storage management service interface, produced by the CISM;
- OS container network management service interface, produced by the CISM;
- OS container configuration management service interface, produced by the CISM; and
- OS container image management service interface, produced by the CIR.

Regarding the CIS cluster management a new NFV-MANO function, the CIS Cluster Management (CCM), as well as extensions to the CISM are defined exposing a new set of service interfaces:

- CIS cluster lifecycle management service interface, produced by the CCM;
- CIS cluster fault management service interface, produced by the CCM;
- CIS cluster configuration management service interface, produced by the CCM;
- CIS cluster performance management service interface, produced by the CCM;
- CIS cluster security management service interface, produced by the CCM;
- CIS instance management service interface, produced by the CISM; and

- CIS MCCO management service interface, produced by the CISM.

5.2.6.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO, VNFM, CISM (new), CIR (new), CCM (new).
- Reference points and interfaces: Os-Ma-nfvo, Or-Vnfm, CISM service interfaces, CIR service interface, CCM service interface, Vi-cc.
- Artefacts: VNFD, VNF package, CCD.

5.2.6.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.2.6.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.6.3-1: Specification results of feature "Cloud-native VNFs and container infrastructure management"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV 006	Stages 1 and 2	NFV-MANO architectural framework updated to include new functional entities CISM, CIR and CCM and their interworking.
ETSI GS NFV-IFA 010	Stages 1 and 2	Functional requirements for the NFVO and VNFM to support the capability to consume CISM and CIR produced interfaces for OS container management and orchestration of container-based VNF. Functional requirements of the CISM to and CIR related to OS container management and orchestration. Functional requirements for the NFVO to support the capability to consume CCM produced interfaces for CIS cluster management. Functional requirements of the CISM and CCM related to CIS cluster management. Add CISM notification subscription requirements Adding CCM into NFV-MANO mgmt.
ETSI GS NFV-IFA 007	Stage 2	Extensions to the VNF Lifecycle Management interface to support the exposure of runtime information regarding container-based VNF. Extension to the VNF lifecycle operation granting interface to handle container related resource definitions and namespaces information.
ETSI GS NFV-IFA 008	Stage 2	Extensions to the VNF Lifecycle Management interface to support the exposure of runtime information regarding container-based VNF.
ETSI GS NFV-IFA 011	Stage 2	Addition of attributes and new information elements to support the design of container-based VNF. Addition of requirements to handle additional artifacts in the VNF package related to container-based VNF. Support floating IP address for containerized VNFCs.
ETSI GS NFV-IFA 013	Stage 2	Extensions to the NS Lifecycle Management interface to support the exposure of runtime information regarding container-based VNF.
ETSI GS NFV-IFA 014	Stage 2	Extensions for the affinity/anti-affinity values to support container-based VNF deployments.
ETSI GS NFV-IFA 031	Stage 2	Updates to interface requirements, interface modelling and information model to enable the management of CISM, CIR and CCM as new managed NFV-MANO entities. Specification of applicable performance measurements related to CISM and CIR.

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 036	Stage 2	Description and concepts of CIS cluster management and CCM function. Specification of the object model for the management of CIS clusters. Functional requirements of CIS cluster management service interfaces produced by CCM and CISM.
ETSI GS NFV-IFA 040	Stage 2	Description of CISM and CIR services and relationship of container-based VNF with NFV models. Functional requirements of OS container compute, network, storage, configuration management service interfaces. Functional requirements of OS container workload management service interface. Functional requirements of OS container image management service interface.
ETSI GS NFV-SOL 001	Stage 3	Addition of node and data types to support the design of container-based VNF. Support_of_floating_IP_address_for_containerized_VNFCs.
ETSI GS NFV-SOL 002	Stage 2	Extensions to the VNF Lifecycle Management API to support the exposure of runtime information regarding container-based VNF.
ETSI GS NFV-SOL 003	Stage 3	Extensions to the VNF Lifecycle Management API to support the exposure of runtime information regarding container-based VNF. Extension to the VNF lifecycle operation granting API to handle container related resource definitions and namespaces information. Enhance information model for containerized VNFs both using bare metal or nested virtualization technologies.
ETSI GS NFV-SOL 005	Stage 3	Extensions to the NS Lifecycle Management API to support the exposure of runtime information regarding container-based VNF. Enhance information model for containerized VNFs.
ETSI GS NFV-SOL 006	Stage 3	Addition of node and data types to support the design of container-based VNF.
ETSI GS NFV-SOL 009	Stage 3	Updates to APIs to enable the management of CISM, CIR and CCM as a new managed NFV-MANO entity.
ETSI GS NFV-SOL 018	Stage 3	API and interface profiling specification for OS container and containerized workload management produced by the CISM based on KubernetesI API and Helm™ APIs, and OS container image management produced by the CIR based on OCI™ Distribution Specification API. API and interface profiling for CIS MCCO management and CIS Instance management.

5.2.7 Network connectivity integration and operationalization for NFV - container networking (NFV-Connect-container, FEAT19a)

5.2.7.1 Description

The feature enhances the NFV architectural framework to provide support for multiple networks connectivity for OS container-based VNF.

More precisely, the feature enhances the NFV descriptors and NFV-MANO functional blocks/functions and exposed interfaces to enable the management of secondary container cluster networks, and connectivity of OS container-based VNF to such networks.

5.2.7.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO, VNFM, CISM.
- Reference points and interfaces: Os-Ma-nfvo, Or-Vnfm, CISM service interfaces.
- Artefacts: VNFD.

5.2.7.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.2.7.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.7.3-1: Specification results of feature "Network connectivity integration and operationalization for NFV - container networking"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 010	Stages 1 and 2	Functional requirements for the NFVO to support requesting the creation of secondary container cluster network management and providing information about such networks in VNF LCM procedures to the VNFM. Functional requirements for the VNFM to support processing resource requirements related to network resources for secondary container cluster networks. Functional requirements for the VNFM to support requesting attachment of groups of one or more OS containers of container-based VNF to secondary container cluster networks. Functional requirements for the CISM to support the capabilities to management the attachment to secondary container cluster networks.
ETSI GS NFV-IFA 007	Stage 2	Additional attributes in VNF Lifecycle Management interface to signal information about network attachment definition resources used to signal the attachment to secondary container cluster networks, and exposure of relevant runtime information.
ETSI GS NFV-IFA 008	Stage 2	Additional attributes in VNF Lifecycle Management interface to signal information about network attachment definition resources used to signal the attachment to secondary container cluster networks, and exposure of relevant runtime information.
ETSI GS NFV-IFA 040	Stage 2	Add secondary networks.
ETSI GS NFV-SOL 002	Stage 3	Additional data type attributes in VNF Lifecycle Management API to signal information about network attachment definition resources used to signal the attachment to secondary container cluster networks, and exposure of relevant runtime information.
ETSI GS NFV-SOL 003	Stage 3	Additional data type attributes in VNF Lifecycle Management API to signal information about network attachment definition resources used to signal the attachment to secondary container cluster networks, and exposure of relevant runtime information.
ETSI GS NFV-SOL 018	Stage 3	Add secondary networks.

5.2.8 NFV-MANO automation and autonomous networks (Auto, FEAT20)

5.2.8.1 Description

The scope of the feature covers the following areas:

- NFV-MANO support for managing autonomous networks.
- Enabling higher level of automation for NFV-MANO.
- Intent-based principles for external exposure network services management.

5.2.8.2 Architecture scope

The feature concerns the following main functional blocks (or functions) and service interfaces:

- Functional blocks and functions: NFVO, MDAF (new).
- Service interfaces: MDAF service interfaces.

5.2.8.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.2.8.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.8.3-1: Specification results of feature "NFV-MANO automation and autonomous networks"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 010	Stages 1 and 2	Add functional requirements for the MDAF. Add functional requirements for the NFVO, related to MDAF.
ETSI GS NFV-IFA 047	Stage 2	Specify the service requirements for the Management Data Analytics (MDA) Function (MDAF), corresponding service interfaces produced by the MDAF, and related information elements.

5.2.9 NFV enhancements for 5G (5GNFV, FEAT21)

5.2.9.1 Description

The feature enhances the NFV architectural framework to further support 5G network deployments.

The feature comprises several types of enhancements including:

- Enhancements to the NSD processing and flexible handling of NS constituents (e.g. version dependencies) to support the deployment and continuous update of 5G services delivered by constituent VNFs.

5.2.9.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO.
- Reference points and interfaces: Os-Ma-nfvo.
- Artefacts: NSD, VNFD.

5.2.9.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.2.9.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.9.3-1: Specification results of feature "NFV enhancements for 5G"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 010	Stages 1 and 2	Functional requirements for the NFVO to process and maintain information about version dependencies in NSD constituents.
ETSI GS NFV-IFA 013	Stage 2	Extensions to the NS Lifecycle Management interface to support the provisioning and handling of versions dependencies between NSD constituents. Enhancement of the related interface and information model specification, including runtime information.
ETSI GS NFV-IFA 014	Stage 2	Extensions to the NSD information modelling to support the indication of version dependencies between NSD constituents and information to determine the constraints of onboarding of packaging associated to the constituents.
ETSI GS NFV-SOL 001	Stage 3	Extensions with new properties in datatypes and node types of the NSD data model to support the indication of version dependencies between NSD constituents and information to determine the constraints of onboarding of packaging associated to the constituents.
ETSI GS NFV-SOL 005	Stage 3	Extensions to the NS Lifecycle Management API to support the provisioning and handling of versions dependencies between NSD constituents. Enhancement of the related interface and information model specification, including runtime information.

5.2.10 Multi-tenancy enhancements for NFV-MANO (M-Tenant, FEAT22)

The feature is postponed to release 5.

5.2.11 SBA for NFV-MANO (MANO-SBA, FEAT23)

The feature is postponed to release 5.

5.2.12 VNF generic management functions (VNF-OAM, FEAT24)

5.2.12.1 Description

The feature enhances the NFV architectural framework to further support VNF Generic OAM functions.

The feature analyses and defines the type of OAM functions for VNFs that can be generalized and be provided as a "generic function" supporting the provisioning, connectivity, configuration, testing and monitoring of VNFs on a virtualized platform.

The feature will also determine possible solutions to realize such generic OAM functions, e.g. by leveraging PaaS capabilities, the interfaces exposed by the VNF generic OAM functions and the relevant information elements.

The result will include, if necessary, recommendations for requirements and architectural enhancements.

5.2.12.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFV-MANO.
- Reference points and interfaces: all.
- Artefacts: PSD, VNFD.

5.2.12.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.2.12.3-1.

Table 5.2.12.3-1: Specification results of feature "VNF Generic OAM functions"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 049	Stage 2	Definition of interfaces and information elements, description of the VNF generic OAM functions architectural model.

5.2.13 Continuous VNF integration (VNF-CI, FEAT25)

The feature was studied in ETSI GR NFV-TST 006 [i.10]. There are no normative provisions for the feature in version 4.4.1.

5.2.14 Policy management models (Policy-model, FEAT26)

5.2.14.1 Description

The feature defines the models necessary for policy management, while the architectural enhancements for the introduction of the policy framework and the specification of a policy engine, with its procedures, interfaces and handling of the input events, goals and output/actions is not in scope of this feature.

The scope of the feature covers the following areas:

- Analyse existing policy information and data models and identify solutions that potentially could be applied to NFV-MANO.
- Clarify the main alternative for policy management (between NFV-MANO and OSS/BSS).
- Determine the objectives and management alternatives for policy management applicable to NFV-MANO.

- Identify policy expression information model applicable to NFV-MANO.
- Identify policy expression data model applicable to NFV-MANO.

5.2.14.2 Architecture scope

The feature does not introduce architectural changes. The main functional block affected by the feature is the NFVO.

5.2.14.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.2.14.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.2.14.3-1: Specification results of feature "NFV enhancements for 5G"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 048	Stage 2	Specifies the structure and content of the NFV-MANO policy information model
ETSI GS NFV-IFA 005	Stage 2	Specify enhancements according to the policy information model
ETSI GS NFV-IFA 006	Stage 2	Specify enhancements according to the policy information model
ETSI GS NFV-IFA 007	Stage 2	Specify enhancements according to the policy information model
ETSI GS NFV-IFA 008	Stage 2	Specify enhancements according to the policy information model
ETSI GS NFV-IFA 013	Stage 2	Specify enhancements according to the policy information model
ETSI GS NFV-SOL 012	Stage 3	Specifies the structure and content of the NFV-MANO policy information model

5.3 Enhancement features

5.3.1 NFV-MANO enhancement with SDN-based networking (ENH02.01)

5.3.1.1 Description

The enhancement feature enhances the NFV-MANO functionality regarding the virtualised network management, lifecycle management and template information model to support the integration of SDN-based network in the framework of NFV-MANO by exposing a new type of routing resource and the capability to handle affinity/anti-affinity requirements for determining the needed resources for the connectivity of NS.

5.3.1.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO, VIM.
- Reference points and interfaces: Os-Ma-nfvo, Or-Vi.
- Artefacts: NSD.

5.3.1.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.3.1.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.3.1.3-1: Specification results of enhancement feature "NFV-MANO enhancement with SDN-based networking"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 010	Stages 1 and 2	Updates to the functional requirements of NFVO to request management of routing resources against the VIM and to consider affinity/anti-affinity rules for network resources needed for the connectivity of NS.
ETSI GS NFV-IFA 005	Stage 2	Extensions in the virtualised network resource management interfaces to model and manage routing resources.
ETSI GS NFV-IFA 014	Stage 2	Extending the scope of affinity/anti-affinity to consider L2 network isolation to guide NFV-MANO determining the needed routing resources.
ETSI GS NFV-SOL 001	Stage 3	Adding new L2 network scopes in NS affinity/anti-affinity rules.

5.3.2 NFV-MANO enhancement for NS feasibility check (ENH02.02)

5.3.2.1 Description

The enhancement feature adds the capability of feasibility check of Network Service to the lifecycle management. The capability allows for a consumer of the NS LCM to request to NFV-MANO to determine the availability of network constituents.

5.3.2.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO.
- Reference points and interfaces: Os-Ma-nfvo.

5.3.2.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.3.2.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.3.2.3-1: Specification results of enhancement feature "NFV-MANO enhancement for NS feasibility check"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 010	Stages 1 and 2	New functional requirements for the NFVO to support the capability to handle feasibility check and reserve resources needed during the feasibility check. Add error information related to NS feasibility check.
ETSI GS NFV-IFA 013	Stage 2	Extensions to the NS Lifecycle Management interface to support the capability to perform feasibility check as part of NS instantiation and NS update. Add error information related to NS feasibility check.
ETSI GS NFV-SOL 005	Stage 3	Extensions to the NS Lifecycle Management API to support the capability to perform feasibility check as part of NS instantiation and NS update.

5.3.3 Data flow mirroring (ENH02.03)

5.3.3.1 Description

The enhancement feature enhances the NFV-MANO functionality to enable data flow mirroring management. The feature adds the support to manage intra NFVI-PoP data flow mirroring jobs, which can be derived based on requirements expressed in the NSD or provided by the OSS/BSS to the NFVO via the Os-Ma-nfvo reference point interfaces.

5.3.3.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO, VIM.
- Reference points and interfaces: Os-Ma-nfvo, Or-Vi.
- Artefacts: NSD.

5.3.3.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.3.3.3-1.

Table 5.3.3.3-1: Specification results of enhancement feature "Data flow mirroring"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 005	Stage 2	New "Data flow mirroring management" interface provided by the VIM, with operations and respective information modelling enabling the creation, deletion, update and query of information about data flow mirroring jobs.
ETSI GS NFV-IFA 010	Stage 1 and 2	Addition of functional requirements to the NFVO and VIM to support the management of data flow mirroring jobs. Addition of use cases illustrating the data flow mirroring management driven by NSD and through the NS LCM interface produced by the NFVO.
ETSI GS NFV-IFA 013	Stage 2	Addition of interface requirements and updates to the NS LCM update operation to management the creation, deletion and update of data flow mirroring jobs. Specification of information elements related to data flow mirroring.
ETSI GS NFV-IFA 014	Stage 2	Addition to the VirtualLinkProfiles the capability to describe design-time requirements for data flow mirroring associated to the NS instances created based on the NSD. Specification of corresponding information elements.
ETSI GS NFV-SOL 001	Stage 3	Added new policies and data types for data flow mirroring description in NSD.
ETSI GS NFV-SOL 005	Stage 3	Added new attributes in NS runtime information about data flow mirroring. Added capability in NS update operation to manage data flow mirroring jobs.

5.3.4 Invariant identification of NSD constituents (ENH02.04)

5.3.4.1 Description

The enhancement feature adds the capability to identify the VNFDs, nested NSDs and PNFDs of an NSD by invariant identities as an alternative option to the defined descriptor identifiers. Such a capability avoid having to change and create a new NSD when its components (VNFDs, PNFDs or nested NSDs) are replaced by another version and this replacement does not require changes in the rest of the NSD.

5.3.4.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO.
- Reference points and interfaces: Os-Ma-nfvo.
- Artefacts: VNFD, NSD.

5.3.4.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.3.4.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.3.4.3-1: Specification results of enhancement feature "Invariant identification of NSD constituents"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 010	Stages 1 and 2	Addition of functional requirements for the NFVO to support the capability to use invariant identifiers when creating or adding constituents to the NS instances.
ETSI GS NFV-IFA 011	Stage 2	Addition of new attribute to the VNFD to identify a VNFD in a version independent (invariant) manner.
ETSI GS NFV-IFA 013	Stage 3	Additional interface requirement for the NS Lifecycle Management interface to support providing invariant descriptor identifiers for constituents to be instantiated or added to the NS. Updates to the functional and information model descriptor of the Instantiate and Update NS operations to support the use of invariant descriptor identifiers.
ETSI GS NFV-IFA 014	Stage 2	Addition of attributes to VNF, PNF and NS profiles to use invariant identifiers for VNF, PNF and NS constituents in the NSD. Addition of new attribute to the NSD to identify a NSD in a version independent (invariant) manner. Addition of new attribute to the PNFD to identify a PNFD in a version independent (invariant) manner.
ETSI GS NFV-SOL 001	Stage 3	Addition of properties to VNF, NS and PNF types to use invariant identifiers for VNF, PNF and NS constituents in the NSD.
ETSI GS NFV-SOL 003	Stage 3	Addition of attribute for Invariant Identification.
ETSI GS NFV-SOL 005	Stage 3	Updates to the NSD and VNF Package management APIs with new runtime information about invariant identification of NSD constituents. New attributes in NS Lifecycle Management API operations, NS Instantiate and Update NS operations, to support the use of invariant descriptor identifiers.

5.3.5 Flexibility with scalable VNF/NS instantiation (ENH02.05)

5.3.5.1 Description

The enhancement feature adds the capability to indicate scale levels as input during instantiation to support flexible scalable VNF/NS instantiation. The VNFs/NSs supporting flexible instantiations are identified with VNFD/NSD level attribute(s). This enhancement provides flexibility for the service providers to adjust instantiation level when instantiating a VNF and supports instantiate a VNF with required size in one single operation.

5.3.5.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks and functions: NFVO, VNFM.
- Reference points and interfaces: Os-Ma-nfvo, Or-Vnfm, Ve-Vnfm.
- Artefacts: VNFD, NSD.

5.3.5.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.3.5.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.3.5.3-1: Specification results of enhancement feature "Flexibility with scalable VNF/NS instantiation"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 007	Stage 2	Extending the VNF lifecycle operation granting interface to signal target scale level for VNF instantiation. Extension to the VNF Lifecycle Management interface to support signalling target scale level during VNF instantiation and change VNF flavour operations.
ETSI GS NFV-IFA 008	Stage 2	Extension to the VNF Lifecycle Management interface to support signalling target scale level during VNF instantiation and change VNF flavour operations.
ETSI GS NFV-IFA 011	Stage 2	Updating the attributes that affect the invocation of VNF instantiation to indicate the support for signalling target scale levels.
ETSI GS NFV-IFA 013	Stage 2	Extensions to the NS Lifecycle Management interface to support the signalling of VNF target scale levels during NS instantiation and NS update.
ETSI GS NFV-IFA 014	Stage 2	Updates to the VNF and NS profiles to indicate the target scale levels for instantiation.
ETSI GS NFV-SOL 001	Stage 3	Adding properties to the VNF instantiation operation configuration datatypes to indicate the support for signalling target scale levels. Update the VNF and NS profiles to indicate the target scale levels for instantiation. Update NsScaleInfo_in_NsProfile.
ETSI GS NFV-SOL 002	Stage 3	Modified semantics of attributes related to instantiation level and added new ones to signal target scale levels in VNF instantiation and change VNF flavour operations of the VNF Lifecycle Management API.
ETSI GS NFV-SOL 003	Stage 3	Modified semantics of attributes related to instantiation level and added new ones to signal target scale levels in VNF instantiation and change VNF flavour operations of the VNF Lifecycle Management API. Added and modified relevant attributes in the VNF lifecycle operation granting API to signal target scale level for a VNF.
ETSI GS NFV-SOL 005	Stage 3	Extensions and modification to the NS Lifecycle Management API to support the signalling of target NS and VNF scale levels in NS instantiation and change of VNF flavour in NS update operations.

5.4 Security features

5.4.1 Security management and monitoring for NFV (SECMM, FEAT18)

5.4.1.1 Description

The feature concerns to NFV security lifecycle management for the establishment of consistent security policies and uniform enforcement of the policies on virtualised networks. As part of the feature outcomes, enhancements to the architecture are introduced whereby different functional blocks responsible for security monitoring and management interface with other NFV blocks such as NFVI, VNF and NFV-MANO functional blocks.

In addition, the feature considers the needed security requirements for the NFV-MANO functional blocks and the reference points in between and to/from the NFV-MANO functional blocks to reduce the security risks in terms of authenticity, integrity, confidentiality and privacy.

5.4.1.2 Architecture scope

The feature concerns the following main functional blocks and references points:

- Functional blocks: Security Manager (SM), NFVO, VNFM, VIM.
- Reference points:
  - Security reference points Sc-Vi, Sc-Vnfm, and Sc-Or for security monitoring and management.

5.4.1.3 Specification results

The feature has been specified in the specifications and reports listed in table 5.4.1.3-1. Refer to clause 6 for the latest version available of the referred documents.

Table 5.4.1.3-1: Specification results of feature "Security management and monitoring for NFV"

Document Id.	Stage	Description of the feature specification
ETSI GS NFV-IFA 033	Stage 2	Requirements applicable to the interfaces supported over the Sc-Or, Sc-Vnfm, Sc-Vi reference points as well as the operations invoked over these interfaces, which aim to support the security monitoring and management as specified in ETSI GS NFV-SEC 013.

5.5 Testing

Testing efforts, e.g. normative work on testing specifications for protocols and data models, are not covered in the current version of the present document.

6 NFV Release 4 published deliverables

6.1 Introduction

The present clause 6 lists the published deliverables (Group Specifications and Group Reports) associated to the Release 4. The NFV Release 4 is comprised of multiple specification and reports, which can be categorized according to different specification stages (stage 1, stage 2, etc.) and compliance (normative or informative).

NOTE 1: The versions among the different deliverables may differ, e.g. a deliverable may have been updated and published with a newer version due to maintenance, whereas some other deliverable not. The latest available published version of each deliverable is indicated in the following tables.

NOTE 2: The present clause 6 only lists GS and GR that contain the specification of features listed in clause 5.

6.2 Stage 1 and stage 2 Group Specifications

6.2.1 Newly published Group Specifications

The published new specifications associated to the Release 4 are listed in table 6.2.1-1.

Table 6.2.1-1: Newly published stage 1 and stage 2 Group Specifications

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-IFA 036	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for container cluster management and orchestration specification	FEAT17: Cloud-native VNFs and Container Infrastructure management
ETSI GS NFV-IFA 040	V4.4.1 Old: V4.3.1 V4.2.1 V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification	FEAT17: Cloud-native VNFs and Container Infrastructure management
ETSI GS NFV-IFA 047	V4.4.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Management data analytics Service Interface and Information Model Specification	FEAT20: NFV-MANO automation and autonomous networks
ETSI GS NFV-IFA 048	V4.4.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Policy Information Model Specification	FEAT26: Policy management models
ETSI GS NFV-IFA 049	V4.4.1	Network Functions Virtualisation (NFV) Release 4; Architectural Framework; VNF generic OAM functions specification	FEAT24: VNF generic management functions

6.2.2 Evolved/propagated published deliverables from a previous Release

The published deliverables associated to the Release 4 that have been evolved/propagated from a previous Release are listed in table 6.2.2-1.

Table 6.2.2-1: Published stage 1 and stage 2 deliverables evolved/propagated from a previous Release

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV 006	V4.4.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architectural Framework Specification	FEAT17: Cloud-native VNFs and Container Infrastructure management
ETSI GS NFV-IFA 005	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification	FEAT26: Policy management models ENH02.01: SDN-based networking ENH02.03: Data flow mirroring
ETSI GS NFV-IFA 006	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification	FEAT26: Policy management models
ETSI GS NFV-IFA 007	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT19a: Network connectivity integration and operationalization for NFV - container networking FEAT26: Policy management models ENH02.05: Scalable VNF/NS instantiation

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-IFA 008	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT19a: Network connectivity integration and operationalization for NFV - container networking FEAT26: Policy management models ENH02.05: Scalable VNF/NS instantiation
ETSI GS NFV-IFA 010	V4.4.1 Old: V4.3.1 V4.2.1 V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Functional requirements specification	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT19a: Network connectivity integration and operationalization for NFV - container networking FEAT20: NFV-MANO automation and autonomous networks FEAT21: NFV enhancements for 5G ENH02.01: SDN-based networking ENH02.02: NS feasibility check ENH02.03: Data flow mirroring ENH02.04: Invariant identification of NSD constituents
ETSI GS NFV-IFA 011	V4.4.1 Old: V4.3.1 V4.2.1 V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification	FEAT13: The presence of license terms information is made optional. FEAT17: Cloud-native VNFs and Container Infrastructure management ENH02.04: Invariant identification of NSD constituents ENH02.05: Scalable VNF/NS instantiation
ETSI GS NFV-IFA 013	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Os-Ma-Nfvo reference point - Interface and Information Model Specification	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT21: NFV enhancements for 5G FEAT26: Policy management models ENH02.02: NS feasibility check ENH02.03: Data flow mirroring ENH02.04: Invariant identification of NSD constituents ENH02.05: Scalable VNF/NS instantiation

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-IFA 014	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration Network Service Templates Specification	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT21: NFV enhancements for 5G ENH02.01: SDN-based networking ENH02.03: Data flow mirroring ENH02.04: Invariant identification of NSD constituents ENH02.05: Scalable VNF/NS instantiation
ETSI GR NFV-IFA 024	V4.3.1 Old: V4.2.1	Network Functions Virtualisation (NFV) Release 4; Information Modeling; Report on External Touchpoints related to NFV Information Model	N/A (see note).
ETSI GS NFV-IFA 027	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Performance Measurements Specification	N/A (see note).
ETSI GS NFV-IFA 030	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Multiple Administrative Domain Aspect Interfaces Specification	N/A (see note).
ETSI GS NFV-IFA 031	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements and interfaces specification for management of NFV-MANO	FEAT17: Cloud-native VNFs and Container Infrastructure management
ETSI GS NFV-IFA 032	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Interface and Information Model Specification for Multi-Site Connectivity Services	N/A (see note).
NOTE: The specification has been updated into the present Release 4, but without outcomes of specific Release 4 features (e.g. maintenance performed in Release 3 specification versions).			

6.2.3 Stage 2 publication packages

As indicated in Annex A of ETSI GR NFV 007 V3.7.1 [i.3], ETSI ISG NFV publishes deliverables in rounds, also referred as "drops" or "packages". Some documents are also not re-published if no technical changes or maintenance are performed. Clause A.3.3 describes guidelines and rules related to version alignments and inter-stage relationships.

The present clause lists the "Packages" of stage 2 deliverables to guide the readers and consumers of the specifications about consistently specified sets of deliverables. In the package tables, the tag "Not republished" applies when a deliverable is not republished with a new version and a previously published version is considered to be part of the package.

Release 4 stage 2 Package 1:

Table 6.2.3-1 lists the deliverables that are part of Release 4 stage 2 Package 1 delivered during the 2020H2.

Table 6.2.3-1: Deliverables part of Release 4 stage 2 Package 1

Id.	Version	Publication date (year-month)
ETSI GS NFV-IFA 010	V4.1.1	2020-11
ETSI GS NFV-IFA 011	V4.1.1	2020-11
ETSI GS NFV-IFA 033	V4.1.1	2020-08
ETSI GS NFV-IFA 040	V4.1.1	2020-11

Release 4 stage 2 Package 2:

Table 6.2.3-2 lists the deliverables that are part of Release 4 stage 2 Package 2 delivered during the 2021H1.

Table 6.2.3-2: Deliverables part of Release 4 stage 2 Package 2

Id.	Version	Publication date (year-month)
ETSI GS NFV-IFA 005	V4.2.1	2021-05
ETSI GS NFV-IFA 006	V4.2.1	2021-05
ETSI GS NFV-IFA 007	V4.2.1	2021-05
ETSI GS NFV-IFA 008	V4.2.1	2021-05
ETSI GS NFV-IFA 010	V4.2.1	2021-05
ETSI GS NFV-IFA 011	V4.2.1	2021-05
ETSI GS NFV-IFA 013	V4.2.1	2021-05
ETSI GS NFV-IFA 014	V4.2.1	2021-05
ETSI GR NFV-IFA 024	V4.2.1	2021-05
ETSI GS NFV-IFA 027	V4.2.1	2021-05
ETSI GS NFV-IFA 030	V4.2.1	2021-05
ETSI GS NFV-IFA 031	V4.2.1	2021-06
ETSI GS NFV-IFA 032	V4.2.1	2021-05
ETSI GS NFV-IFA 040	V4.2.1	2021-05

Release 4 stage 2 Package 3:

Table 6.2.3-3 lists the deliverables that are part of Release 4 stage 2 Package 3 delivered during the 2022H1.

Table 6.2.3-3: Deliverables part of Release 4 stage 2 Package 3

Id.	Version	Publication date (year-month)
ETSI GS NFV-IFA 005	V4.3.1	2022-06
ETSI GS NFV-IFA 006	V4.3.1	2022-05
ETSI GS NFV-IFA 007	V4.3.1	2022-06
ETSI GS NFV-IFA 008	V4.3.1	2022-05
ETSI GS NFV-IFA 010	V4.3.1	2022-06
ETSI GS NFV-IFA 011	V4.3.1	2022-06
ETSI GS NFV-IFA 013	V4.3.1	2022-06
ETSI GS NFV-IFA 014	V4.3.1	2022-06
ETSI GR NFV-IFA 024	V4.3.1	2022-06
ETSI GS NFV-IFA 027	V4.3.1	2022-06
ETSI GS NFV-IFA 030	V4.3.1	2022-06
ETSI GS NFV-IFA 031	V4.3.1	2022-06
ETSI GS NFV-IFA 032	V4.3.1	2022-06
ETSI GS NFV-IFA 036	V4.3.1	2022-09
ETSI GS NFV-IFA 040	V4.3.1	2022-05

Release 4 stage 2 Package 4:

Table 6.2.3-4 lists the deliverables that are part of Release 4 stage 2 Package 4 delivered during the 2022H2/2023H1.

Table 6.2.3-4: Deliverables part of Release 4 stage 2 Package 4

Id.	Version	Publication date (year-month)
ETSI GS NFV 006	V4.4.1	2022-12
ETSI GS NFV-IFA 005	V4.4.1	2023-03
ETSI GS NFV-IFA 006	V4.4.1	2023-03
ETSI GS NFV-IFA 007	V4.4.1	2023-03
ETSI GS NFV-IFA 008	V4.4.1	2023-03
ETSI GS NFV-IFA 010	V4.4.1	2023-03
ETSI GS NFV-IFA 011	V4.4.1	2023-03
ETSI GS NFV-IFA 013	V4.4.1	2023-03
ETSI GS NFV-IFA 014	V4.4.1	2023-03
ETSI GS NFV-IFA 027	V4.4.1	2023-03
ETSI GS NFV-IFA 030	V4.4.1	2023-03
ETSI GS NFV-IFA 031	V4.4.1	2023-03
ETSI GS NFV-IFA 032	V4.4.1	2023-03
ETSI GS NFV-IFA 036	V4.4.1	2023-03
ETSI GS NFV-IFA 040	V4.4.1	2023-03
ETSI GS NFV-IFA 047	V4.4.1	2023-03
ETSI GS NFV-IFA 048	V4.4.1	2023-01
ETSI GS NFV-IFA 049	V4.4.1	2023-08

6.3 Stage 3 Group Specifications

6.3.1 Newly published Group Specifications

The published new specifications associated to the Release 4 are listed in table 6.3.1-1.

Table 6.3.1-1: Newly published stage 3 Group Specifications

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-SOL 018	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Model; Profiling specification of protocol and data model solutions for OS Container management and orchestration	FEAT17: Cloud-native and Container Infrastructure management

6.3.2 Evolved/propagated published deliverables from a previous Release

The published deliverables associated to the Release 4 that have been evolved/propagated from a previous Release are listed in table 6.3.2-1.

Table 6.3.2-1: Published stage 3 deliverables evolved/propagated from a previous Release

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-SOL 001	V4.4.1 Old: V4.3.1 V4.2.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on TOSCA specification	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT21: NFV enhancements for 5G ENH02.01: SDN-based networking ENH02.03: Data flow mirroring ENH02.04: Invariant identification of NSD constituents ENH02.05: Scalable VNF/NS instantiation
ETSI GS NFV-SOL 002	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT19a: Network connectivity integration and operationalization for NFV - container networking ENH02.05: Scalable VNF/NS instantiation
ETSI GS NFV-SOL 003	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point	FEAT04: Host reservation FEAT10: Management and connectivity of multi-site services FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT19a: Network connectivity integration and operationalization for NFV - container networking ENH02.04; Invariant identification of NSD constituents ENH02.05: Scalable VNF/NS instantiation
ETSI GS NFV-SOL 004	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; VNF Package and PNFD Archive specification	FEAT13: The presence of license terms information is made optional and is clarified in the VNF Package.
ETSI GS NFV-SOL 005	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Os-Ma-nfvo Reference Point	FEAT17: Cloud-native VNFs and Container Infrastructure management FEAT21: NFV enhancements for 5G ENH02.02: NS feasibility check ENH02.03: Data flow mirroring ENH02.04: Invariant identification of NSD constituents ENH02.05: Scalable VNF/NS instantiation

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-SOL 006	V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on YANG Specification	FEAT17: Cloud-native VNFs and Container Infrastructure management
ETSI GS NFV-SOL 007	V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Network Service Descriptor File Structure Specification	See note.
ETSI GS NFV-SOL 009	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the management of NFV-MANO	FEAT17: Cloud-native VNFs and Container Infrastructure management
ETSI GS NFV-SOL 011	V4.4.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Or-Or Reference Point	See note.
ETSI GS NFV-SOL 012	V4.4.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Policy Management Interface	FEAT26: Policy management models
ETSI GS NFV-SOL 013	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Specification of common aspects for RESTful NFV MANO APIs	N/A (specifies common API matters applicable to all API specs).
ETSI GS NFV-SOL 014	V4.4.1 Old: V4.3.1	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Specification of common aspects for RESTful NFV MANO APIs	See note.
NOTE: The specification has been updated into the present Release 4, but without outcomes of specific Release 4 features (only including e.g. maintenance performed in previous specification versions).			

6.3.3 Stage 3 publication packages

As indicated in Annex A of ETSI GR NFV 007 v3.7.1 [i.3], ETSI ISG NFV publishes deliverables in rounds, also referred as "drops" or "packages". Some documents are also not re-published if no technical changes or maintenance are performed. Clause A.3.3 describes guidelines and rules related to version alignments and inter-stage relationships.

The present clause lists the "Packages" of stage 3 deliverables to guide the readers and consumers of the specifications about consistently specified sets of deliverables. In the package tables, the tag "Not republished" applies when a deliverable is not republished with a new version and a previously published version is considered to be part of the package.

Release 4 stage 3 Package 1:

Table 6.3.3-1 lists the deliverables that are part of Release 4 stage 3 Package 1 delivered during the 2022H1.

Table 6.3.3-1: Deliverables part of Release 3 stage 3 Package 1

Id.	Version	Publication date (year-month)
ETSI GS NFV-SOL 001	V4.2.1	2022-01

Release 4 stage 3 Package 2:

Table 6.3.3-2 lists the deliverables that are part of Release 4 stage 3 Package 2 delivered during the 2022H3.

Table 6.3.3-2: Deliverables part of Release 3 stage 3 Package 2

Id.	Version	Publication date (year-month)
ETSI GS NFV-SOL 001	V4.3.1	2022-08
ETSI GS NFV-SOL 002	V4.3.1	2022-07
ETSI GS NFV-SOL 003	V4.3.1	2022-07
ETSI GS NFV-SOL 004	V4.3.1	2022-07
ETSI GS NFV-SOL 005	V4.3.1	2022-08
ETSI GS NFV-SOL 006	V4.3.1	2022-09
ETSI GS NFV-SOL 007	V4.3.1	2022-07
ETSI GS NFV-SOL 009	V4.3.1	2022-07
ETSI GS NFV-SOL 013	V4.3.1	2022-07
ETSI GS NFV-SOL 014	V4.3.1	2022-07
ETSI GS NFV-SOL 018	V4.3.1	2022-09

Release 4 stage 3 Package 3:

Table 6.3.3-3 lists the deliverables that are part of Release 4 stage 3 Package 3 delivered during the 2023H1.

Table 6.3.3-3: Deliverables part of Release 3 stage 3 Package 3

Id.	Version	Publication date (year-month)
ETSI GS NFV-SOL 001	V4.4.1	2023-01
ETSI GS NFV-SOL 002	V4.4.1	2023-03
ETSI GS NFV-SOL 003	V4.4.1	2023-04
ETSI GS NFV-SOL 004	V4.4.1	2023-03
ETSI GS NFV-SOL 005	V4.4.1	2023-03
ETSI GS NFV-SOL 009	V4.4.1	2023-03
ETSI GS NFV-SOL 011	V4.4.1	2023-03
ETSI GS NFV-SOL 012	V4.4.1	2023-03
ETSI GS NFV-SOL 013	V4.4.1	2023-03
ETSI GS NFV-SOL 014	V4.4.1	2023-03
ETSI GS NFV-SOL 018	V4.4.1	2023-06

6.4 Other Group Specifications

6.4.1 Security specifications

The published new deliverables of Release 4 specifying security aspects are listed in table 6.4.1-1.

Table 6.4.1-1: Published deliverables related to security

Id.	Version(s)	Title	Related feature(s)
ETSI GS NFV-IFA 033	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Sc-Or, Sc-Vnfm, Sc-Vi reference points - Interface and Information Model Specification	FEAT18: Security management

6.4.2 Testing specifications

Testing efforts, e.g. normative work on testing specifications for protocols and data models, are not covered in the present document version.

6.5 Newly published Group Reports

The newly published reports associated to the Release 4 are listed in Table 6.5-1.

Table 6.5-1: Newly published Group Reports

Id.	Version(s)	Title	Related feature(s)
ETSI GR NFV-REL 011	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on NFV-MANO software modification	FEAT01: NFV-MANO upgrades
ETSI GR NFV-EVE 019	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on VNF generic OAM functions	FEAT24: VNF generic management functions
ETSI GR NFV-IFA 034	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on Architectural enhancement for VNF License Management support and use of VNF licenses	FEAT13: Licensing management
ETSI GR NFV-IFA 037	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on further NFV support for 5G	FEAT21: NFV enhancements for 5G
ETSI GR NFV-IFA 038	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on network connectivity for container based VNF	FEAT19a: Network connectivity integration and operationalization
ETSI GR NFV-IFA 041	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on enabling autonomous management in NFV-MANO	FEAT20: NFV-MANO automation and autonomous networks
ETSI GR NFV-IFA 042	V4.1.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on policy information and data models for NFV-MANO	FEAT26: Policy management models

6.6 Evolved/propagated Group Reports

The published group reports associated to the Release 4 that have been evolved/propagated from a previous Release are listed in table 6.5-1.

Table 6.5-2: Updated Group Reports

Id.	Version(s)	Title	Related feature(s)
ETSI GR NFV-IFA 024	V4.2.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on policy information and data models for NFV-MANO	See note.
ETSI GR NFV-IFA 024	V4.3.1	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on policy information and data models for NFV-MANO	See note.
NOTE: The report has been updated into the present Release 4, but without outcomes of specific Release 4 features.			

6.7 Other documentation

ETSI GR NFV 003 [i.2] on "NFV; Terminology for main concepts in NFV" includes terminology used across several NFV Releases. As a result, a number of terms and acronyms used in Release 4 documentation are defined and present in ETSI GR NFV 003. The latest published version (11-2022) is:

- ETSI GR NFV 003 (V1.7.1) "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

The ETSI GS NFV-SOL 015 on "NFV; Protocols and Data Models; Specification of Patters and Conventions for RESTful NFV-MANO APIs" defines patterns and conventions for RESTful NFV-MANO API specifications, gives recommendations on API versioning and provides an API specification template. This document is followed by the ETSI NFV when creating RESTful NFV-MANO API specifications. The latest published version (2020-12) is:

- ETSI GS NFV-SOL 015 (V1.2.1): "NFV; Protocols and Data Models; Specification of Patters and Conventions for RESTful NFV-MANO APIs".

ETSI GR NFV-TST 006 [i.10] on "NFV; Testing; Report on CICD and DevOps" provides guidance and recommendations on how to leverage DevOps and CI/CD techniques. The latest published version (2022-12) is:

- ETSI GR NFV-TST 006 V1.2.1: "Network Functions Virtualisation (NFV); Testing; Report on CICD and DevOps".

6.8 Map of ETSI NFV specifications and the NFV Architectural Framework

NFV Release 4 documentation is, to a great extend, structured according to the NFV Architectural Framework, with some specifications mapping one to one to the reference points and functional blocks identified in the framework. Figure 6.8-1 illustrates a map of ETSI NFV specifications, reports, and ongoing work items to the NFV Architectural Framework.

- specifications with requirements, information models and architecture (as known as Stages 1 and 2) are depicted in red;
- specifications and work items related to protocols and data models (as known as Stage 3) are depicted in green;
- specifications and work items related to security enhancements are depicted in orange.

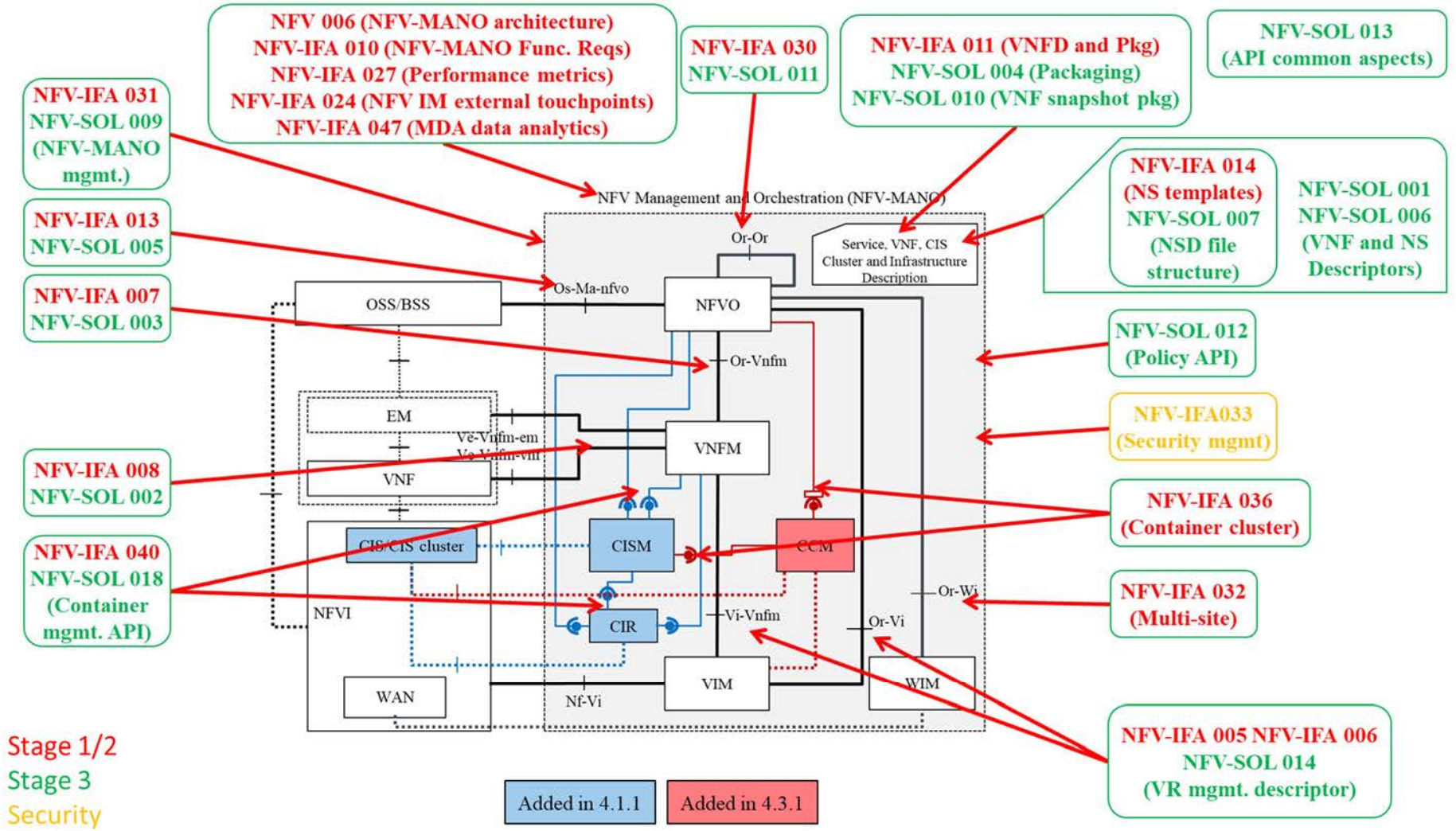

Figure 6.8-1: Map of ETSI NFV specifications, reports, and the NFV Architectural Framework

7 NFV Release 4 active Work Items of unpublished deliverables

7.1 Introduction

The present clause 7 lists the active Work Items associated to the Release 4.

Clause 7.2 lists the Work Items that will produce new specifications and reports (i.e. complete new deliverables). Clause 7.3 lists the Work Items that will produce a new version of a specification or report that has been published in a previous Release and which is evolved/propagated in order to document the needed Release 4 features.

7.2 Work Items producing new specifications or reports

The current Work Items associated to the Release 4 and that will produce new specification or reports are listed in Table 7.2-1.

NOTE: For tracking purposes, Work Items listed in Table 7.2-1 include both informative and normative work. The final list of Release-dependent deliverables will be listed within the Release Description upon publication of the deliverables.

Table 7.2-1: NFV Release 4 Work Items producing new specification or reports

Work Item	Full Title	Type	Related Feature(s)
DGS/NFV-IFA050	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Intent Management Service Interface and Intent Information Model Specification	Specification	FEAT20: NFV-MANO automation and autonomous networks
DGS/NFV-SEC023	Network Functions Virtualisation (NFV) Release 4; Security; Container Security Specification	Specification	FEAT17: Cloud-native and Container Infrastructure management
DGS/NFV-SEC024	Network Functions Virtualisation (NFV) Release 4; Security; Security Management Specification	Specification	FEAT18: Security management
DGS/NFV-SEC025	Network Functions Virtualisation (NFV) Release 4; Security; Secure End-to-End VNF and NS management specification	Specification	FEAT18: Security management
DGS/NFV-SEC026	Network Functions Virtualisation (NFV) Release 4; Security; Isolation and trust domain specification	Specification	FEAT18: Security management
DGR/NFV-SEC027	Network Functions Virtualisation (NFV) Release 4; Security; Report on security assurance of NFVI	Report	N/A
DGS/NFV-SEC028	Network Functions Virtualisation (NFV) Release 4; Security; Security Assurance Specification (SCAS) for NFV-MANO	Specification	FEAT18: Security management

7.3 Work Items evolving/propagating Release 3 specifications and reports

A set of deliverables from Release 3 are evolved/propagated into the Release 4. The corresponding Work Items are listed in table 7.3-1. These Work Items will produce a new version of a previously published specification or report.

Table 7.3-1: NFV Release 4 Work Items of propagated/evolved Release 3 deliverables

Work Item	Full Title	Type	Related Feature(s)
RGS/NFV-IFA 026ed441	Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architecture enhancement for Security Management Specification	Specification	See note 1.
RGS/NFV-SOL016ed441	Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV-MANO procedures specification	Specification	N/A (see note 2).
NOTE 1: Document is related to FEAT18, but specifies architectural enhancements, not features. NOTE 2: Set of corresponding features is to be determined.			

Annex A:
Versioning of published deliverables

A.1 Introduction

The present Annex A provides information about the versioning of the deliverables published by the ETSI ISG NFV. The purpose is to ease the understanding about the version semantics and the alignments/relationships between published deliverables depending on their versions.

A.2 Types of specifications/reports produced by the ETSI ISG NFV

By using the Release process, the ETSI ISG NFV differentiates between four categories of deliverables:

- **Release-dependent GS (normative) deliverable:** this is a specification that contains normative provisions and specifies features that become part of an NFV Release. By making a deliverable Release-dependent, the ISG foresees that such deliverable will be part of an NFV Release. Features are specified consistently across other NFV Release-dependent GS deliverables. The deliverables that are Release-dependent are included in the NFV Release Description.

- **Release-independent GS (normative) deliverable:** this is a specification that contains normative provisions, but is not associated to any specific Release. This can be either because the specification was published as pre-Release (i.e. when a Release system was not established yet), or the specification is used or referred across many different Releases. A GS deliverable that is Release-independent can be included in the NFV Release Description when it is referred or directly used by some other Release-dependent deliverable(s).

- **Release-dependent GR (informative) deliverable:** this is a report that contains informative elements used to document different aspects of a feature or set of features part of an NFV Release. For instance, it fulfils the purposes of documenting use cases and potential solutions to support the feature or set of features. The deliverables that are Release-dependent are included in the NFV Release Description.

- **Release-independent GR (informative) deliverable:** this is a report that contains informative elements used to report about aspects of NFV that are related to features of several NFV Releases, related to future Releases, or independent of Releases. A GR deliverable that is Release-independent can be included in the NFV Release Description when it is referred or directly used by some other Release-dependent deliverable(s).

A.3 Deliverables naming and version semantics

A.3.1 Deliverables naming and numbering

All ETSI ISG NFV GS/GR deliverables follow the following naming and numbering scheme:

ETSI GS NFV[-XXX] YYY

ETSI GR NFV[-XXX] YYY

Where:

- XXX: optionally identifies the working group of the ISG that has produced the deliverable;

- YYY: stands for the chronological number from 000 to 999, which is unique within the namespace of the ISG or the working group identified by XXX;

EXAMPLE: ETSI GS NFV-IFA 001 v1.1.1

A.3.2 Deliverables versioning

All published ISG NFV GS/GR deliverables follow a versioning scheme:

ETSI GS NFV[-XXX] YYY vm.a.b

ETSI GR NFV[-XXX] YYY vm.a.b

The "m.a.b" stands for the version number where:

- "m", or first digit. It identifies a major version, and it is used to identify the Release number of Release-dependent deliverables. The value "m = 1" indicates that the deliverable is Release-independent and/or pre-Release (i.e. set of deliverables published when a Release system was not established yet).
- "a", or second digit. It typically stands for new publication with technical changes, which is incremented every time a (set of) technical change is introduced.
- "b", or third digit. It typically stands for an editorial version, which is incremented every time a (set of) purely editorial change is introduced. The digit is reset to "1" every time "a" is incremented.

Table A.3.2-1 summarizes the deliverable versioning "m.a.b" of published deliverables.

Table A.3.2-1: Summary deliverable versioning

	Type of deliverable	
	Release-dependent	**Release-independent and/or pre-Release**
On first publication	"m" = Release number "a" = 1 "b" = 1 (see note 1)	"m" = 1 "a" = 1 "b" = 1
On subsequent publication after first publication	"m" = Release number "a" = incremented with (expected) technical changes. "b" = 1. (see note 2)	"m" = 1 "a" = incremented with (expected) technical changes. "b" = incremented only with editorial changes.
Specific naming guidelines	The first title uses the tag "Release #", indicating the Release to which the deliverable belongs to.	Not applicable.

NOTE 1: Due the sequencing in the specification work and the inter-stage alignment (e.g. in between stage 2 and stage 3), the second digit "a" of the first publication version can differ from the one indicated in the present table. For instance, if stage 3 specifications already target the first publication providing an alignment with specifications of stage 2 published as V3.3.1, it is recommended that the first publication version of the stage 3 equivalence is also V3.3.1, and not V3.1.1.

NOTE 2: During drafting of subsequent versions of a published deliverable within a Release, the third digit "b" is used to track new draft versions which can include technical and/or editorials changes.

A.3.3 Version alignments and relations

Aiming at identifying the technical alignment between specifications stages, principally stage 2 (architecture, interfaces and information model), stage 3 (protocols and data models) and stage 4 (testing), the following rules and guidelines are followed for determining the target publications versions.

Guideline #1:

As part of the Release development and while the Release feature work is still "open" within a particular specification stage, certain features or technical changes are completed first than others. Furthermore, the ETSI ISG NFV typically publishes documents twice per year. Consequently, for Release-dependent deliverables within a Release, the second digit "a" of the published version of a deliverable denotes the "drop" or publication package.

EXAMPLE 1: Version 3.1.1 of a published deliverable denotes the publication within "drop #1" (version digit "a = 1"). Version 3.2.1 of a published deliverable denotes the publication within "drop #2".

Guideline #2:

Inter-stages specification alignment is important for keeping traceability of requirements across the different specification stages. During the development of the technical features of a Release, different specification publication "drops" can occur. In addition, a feature that has been completed at a specific drop can also be further maintained for corrections, improvements or clarifications, whose outcomes are reflected in subsequent specification publication drops.

To show the correspondence of requirements across different specification stages, higher (or subsequent) stages (e.g. stage 3 compared to stage 2) target same publication version as lower (or prequel) stages.

EXAMPLE 2: Table A.3.3-1 illustrates and example.

Table A.3.3-1: Example 2

Stage 2	Stage 3
Drop #1: publications as V3.1.1 Feature #1 and #2 are completed. Feature #3 is partially completed.	No publication.
Drop #2: publications as V3.2.1 Feature #3 is completed. Feature #4 and #5 are completed. Feature #1 is updated with maintenance	**Package #A: publications as V3.2.1** Feature #1 and #3 is completed. Stage 3 aligns with requirements and maintenance done in stage 2 drop #2 of completed features in this package.
Drop #3: publications as V3.3.1 Feature #6 is completed. No more features are to be specified within the Release. Feature #1, #2 and #5 are updated with maintenance.	**Package #B: publications as V3.3.1** Feature #2, #4, #5 are completed. Stage 3 aligns with requirements and maintenance done in stage 2 drop #3 of completed features in this package.
First round of full maintenance: publications as V3.4.1 Feature #1 and #6 are updated with maintenance.	**Package #C: publications as V3.4.1** Feature #6 is completed. Stage 3 aligns with requirements and maintenance done in the first round of full maintenance in stage 2.
Second round of full maintenance: publications as V3.5.1	**First round of full maintenance: publications as V3.5.1** Stage 3 aligns with requirements and maintenance done in the second round of full maintenance in stage 2.

Guideline #3:

Within a specification stage, all associated Release-dependent deliverables are expected to be published with new version as part of specification publication drops. However, in some cases a deliverable might not be re-published if no technical changes or maintenance are performed. In such a case, differences in the latest published version of a specification can occur among the set of Release-dependent deliverables.

Normative and informative cross-references among deliverables published by the ETSI ISG NFV are typically present in deliverables without specifying a concrete version, only the "Release #". In such a case, the following guideline applies:

- If a deliverable X published with version "m.a.b" contains a reference to a deliverable Y that is published with same version "m.a.b", the applicable referenced version is thus "m.a.b" of deliverable Y.

- If a deliverable X published with version "m.a.b" contains a reference to a deliverable Y that is not published with same version "m.a.b", the applicable reference version is the latest version published of deliverable Y. For instance, the latest published version of deliverable Y might be "m.a-1.b".

Annex B:
Release specification states

B.1 Overview

The meaning of the specification states of the specification stages is provided in table B.1-1.

Table B.1-1: Meanings of specification work states

State	Meaning
Not started	Specification work has not started.
Open	Specification work is ongoing and the specifications/reports are being either newly created or updated to incorporate new technical features or modify existing ones.
Frozen	Specification work to incorporate new technical features or modify existing ones is completed. Only maintenance work can be performed.
Closed	Specification work is completed and the specifications are not further maintained. If corrections are necessary, these are handled on a case by case basis.

The release specification state transitions is as follows:

"Not started" → "Open" → "Frozen" → "Closed"

Release specification states are associated to the specification stages, so while a Release can be in one state at an earlier specification stage, it can be in another state at a later specification stage.

EXAMPLE: Stage 2 specification work can be "frozen" while the stage 3 specification work can be still in development, i.e. "open".

Annex C:
Release definition

C.1 Introduction

The present annex defines the set of features that the ETSI NFV plans to develop as part of the Release 4 work programme. Clause C.2 provides high-level information about the main technical areas envisioned for Release 4. Clauses C.4, C.5 and C.6 list and provide a high-level definition of the features.

C.2 Release 4 technical areas

The ETSI NFV Release 4 aims to specify around the following technical areas.

A) NFVI evolution, focusing on:

A.1) Enhancements to support lightweight virtualization technologies,

A.2) Optimizing NFVI abstraction for reducing the coupling of VNFs to infrastructure, and

A.3) Optimizing networking integration into the infrastructure fabric and ease the connectivity for VNFs and NS.

B) Enhancing NFV automation and capabilities, focusing on:

B.1) Improving life-cycle management and orchestration,

B.2) Simplification of VNF and NS management aspects leveraging virtualization, and

B.3) Handling advances in autonomous networking.

C) Evolving the NFV-MANO framework, focusing on:

C.1) Optimizing internal NFV-MANO capabilities exposure and usage.

D) Operationalization, focusing on:

D.1) Simplification of NFV to ease development and deployment of sustainable NFV based solutions,

D.2) Verification (and certification) procedures and mechanisms, and

D.3) Operationalization, integration and use of NFV with other management and network frameworks.

In addition to the above technical areas, additional aspects about security hardening of NFV (enhancements), and other specific technical enhancements are necessary to maximize the impact of virtualization and future NFV deployments.

Within the areas of work that are introduced above, the following more specific top-level ("umbrella") features are derived as described in the following clauses.

C.3 Overview

The candidate new features introduced as part of the Release 4 are listed in Table C.3-1.

Table C.3-1: Release 4 features and enhancement features

Feature name	Acronym	FEAT id	Notes
NFV-MANO upgrade	SWUP-MANO	FEAT01	Carried over from Release 3.

Feature name	Acronym	FEAT id	Notes
Management and connectivity of multi-site services	NFVWAN (MCMSS)	FEAT10	Late carry over of parts from Release 3.
MEC in NFV	MECinNFV	FEAT12	Carried over from Release 3. Completed in Release 3.
Licensing management	LIC	FEAT13	Carried over from Release 3.
Cloud-native VNFs and Container Infrastructure management	CNNFV	FEAT17	Carried over from Release 3.
Security management	SECMM	FEAT18	Carried over from Release 3.
Network connectivity integration and operationalization for NFV - container networking	NFV-Connect	FEAT19a	New feature.
Network connectivity integration and operationalization for NFV	NFV-Connect	FEAT19b	Carried over to Release 5. See note.
NFV-MANO automation and autonomous networks	Auto	FEAT20	New feature.
NFV enhancements for 5G	5GNFV	FEAT21	New feature.
Multi-tenancy enhancements for NFV-MANO	M-Tenant	FEAT22	New feature.
SBA for NFV-MANO	MANO-SBA	FEAT23	Carried over to Release 5. See note.
VNF generic management functions	VNF-OAM	FEAT24	New feature.
Continuous VNF integration	VNF-CI	FEAT25	New feature.
Policy Management Models	Policy-model	FEAT26	New feature.
NOTE: The work and specification of this feature has been carried over to Release 5. For more information, refer to the Release 5 documentation.			

C.4 Features carried over from Release 3

C.4.1 Overview

This clause introduces areas of work that were not completed in Release 3 timeframe and are included in Release 4.

Minor adaptations on the scope from Release 3 may be done as part of the Release definition.

References to feature identifiers (e.g. FEAT01) are provided referring the Annex B of the NFV Release 3 Definition document.

Clause 7 lists current open work items and published specifications and the specific features that are covered in their scope where available.

C.4.2 NFV-MANO upgrades (SWUP-MANO, FEAT01)

The feature was started in Release 3 as FEAT01.

The scope of the feature covers the following areas:

- Update and upgrade of NFV-MANO software components in an NFV context (or environment).
- Identification of use cases for update and upgrade of NFV-MANO.

- Identification of the required set of update/upgrade controlling functions to facilitate software updates/upgrades.
- Specification of requirements for software update/upgrade controlling functions.

The "technical areas" covered by this feature are: C.1), D.2) and D.3).

C.4.3 MEC in NFV (MECinNFV, FEAT12)

The feature was started in Release 3 as FEAT12.

The scope of the remaining work of the feature covers the following areas:

- Enhancement support for multi-access edge computing (MEC) in NFV deployments
- Support coordination of NFV-MANO with consumers (in particular MEC) for graceful termination / stop support
- Enhancements on the placement and network constraints during resource allocation for network service and VNF instances

The "technical areas" covered by this feature are: B.2), B.3), D.1) and D.3).

C.4.4 Licensing management (LIC, FEAT13)

The feature was started in Release 3 as FEAT13, based on ETSI GR NFV-EVE 010.

The scope of the feature covers the following areas:

- NFV license management framework aspects to ensure Service Providers can deploy VNFs quickly without customizing the licensing mechanisms for each VNF and each VNF Provider.

The feature specification work scope encompasses:

- Develop use cases related to license management.
- Derive requirements from license management use cases.
- Identify what NFV Architectural Framework support and enhancements are needed to cover license management requirements.

The "technical areas" covered by this feature are: B.1), B.3), D.1) and D.3).

C.4.5 Cloud-native VNFs and Container Infrastructure management (CNNFV, FEAT17)

The feature was started in Release 3 as FEAT17, based on ETSI GS NFV-EVE 011 and ETSI GR NFV-IFA 029.

The scope of the feature covers the following areas:

- NFV Architecture support for VNFs which follow "cloud-native" design principles.
- Enhance NFV-MANO capabilities to support container technologies based on ETSI GR NFV-IFA 029.
- Enhance NFV-MANO capabilities for container management and orchestration
- Enhance information model for containerized VNFs both using bare metal or nested virtualization technologies

The "technical areas" covered by this feature are: A.1), A.2), B.2) and C.1).

C.4.6 Security management (SECMM, FEAT18)

The feature was started in Release 3 as FEAT18.

The scope of the feature covers the following areas:

- Security management and monitoring for NFV for planning, enforcement and monitoring targeting at holistic security policies and functions.
- Enhancements to current NFV Architectural for NFV Security Management.
- Secure sensitive components in the NFV framework.
- Secure hosts on which sensitive components will be hosted.
- Secure the broader context in which sensitive components will be hosted.
- Physical, logical and operational measures related to securing sensitive components.
- Provisioning and de-provisioning sensitive components.
- Specification of requirements for sensitive components.

The "technical areas" covered by this feature are: C.1) and D.3).

C.5 New features

C.5.1 Network connectivity integration and operationalization for NFV - container networking (NFV-Connect, FEAT19a)

The scope of the feature covers the following areas:

- The management and orchestration of secondary container cluster networks for the VNF and NS deployments.
- Enhancements to the NFV-MANO to manage the secondary container cluster networks.

The "technical areas" covered by this feature are: A.2), and A.3).

C.5.2 NFV-MANO automation and autonomous networks (Auto, FEAT20)

The scope of the feature covers the following areas:

- NFV-MANO support for managing autonomous networks.
- Enabling higher level of automation for NFV-MANO.
- Intent-based principles for external exposure network services management.

The "technical areas" covered by this feature are: B.1), B.3), and C.1).

C.5.3 NFV enhancements for 5G (5GNFV, FEAT21)

The scope of the feature covers the following areas:

- NFV support for deploying 5G networks, capabilities and associated requirements.
- 5G network capabilities and features interworking and relationship with NFV.
- Determine and profile how NFV can support 5G deployments.

The "technical areas" covered by this feature are: A.1) and D.3).

C.5.4 Multi-tenancy enhancements for NFV-MANO (M-Tenant, FEAT22)

The scope of the feature covers the following areas:

- Multi-tenancy technology to share IT resources securely among multiple tenants that use the cloud.
- Virtualization-based features as a means to isolate tenants.
- Association/disassociation of tenancy and NFV-MANO objects.

The "technical areas" covered by this feature are: B.1), and C.1).

C.5.5 SBA for NFV-MANO (MANO-SBA, FEAT23)

The scope of the feature covers the following areas:

- Service exposure to 3rd party access for selected NFV-MANO services.
- Assess steps in the SBA transformation (different steps have different levels of complexity), such as NFV-MANO service independence, modularization, data separation/split, exposure, dynamic registration and discovery of services.
- Optimal routing of service requests to NFV-MANO service instances, including load balancing and failover management
- Enabling new interface consumers (e.g. policy engines, license managers, AI-based systems, etc.).

The "technical areas" covered by this feature are: B.1) and C.1).

C.5.6 VNF generic management functions (VNF-OAM, FEAT24)

The scope of the feature covers the following areas:

- Definition of a set of common management functions for VNFs to ease their provisioning, connectivity, configuration and monitoring on a virtualized platform.
- Reducing dependencies of the VNF from underlying resources, hosts and network, thus realizing a full network function decoupling from the infrastructure.
- VNFs reusing generic and common management functionality provided as virtualization platform functionalities.
- Leveraging PaaS capabilities as a means for providing common management functions.

The "technical areas" covered by this feature are: A.2), B.2), B3) and D.1).

C.5.7 Continuous VNF integration (VNF-CI, FEAT25)

The scope of the feature covers the following areas:

- Optimization of the VNF Package structure and VNF.
- Test execution of test functions and feedback to VNF provider/developer.
- VNF/VNFC software component update/upgrade supporting continuous development and integration paradigms.

The "technical areas" covered by this feature are: A.2), D.1), and D.2).

C.5.8 Policy management models (Policy-model, FEAT26)

The scope of the feature covers the following areas:

- Analyse existing policy information and data models and identify solutions that potentially could be applied to NFV-MANO.
- Clarify the main alternative for policy management (between NFV-MANO and OSS/BSS).
- Determine the objectives and management alternatives for policy management applicable to NFV-MANO.
- Identify policy expression information model applicable to NFV-MANO.
- Identify policy expression data model applicable to NFV-MANO.

NOTE 1: The specification of a policy engine, with its procedures, interfaces and handling of the input events, goals and output/actions is not in scope of this feature.

NOTE 2: The specification of interfaces as part of the policy framework is part of the Release 3.

The "technical areas" covered by this feature are: B.1), B.3), and D.3).

C.6 Enhancement features

C.6.1 Introduction

This clause introduces areas of work in which specific technical and security enhancements are expected to be specified.

C.6.2 NFV security hardening (enhancements) (ENH01)

The scope of the feature covers different technical working areas to enhance the ETSI NFV specifications and the already specified past Releases features/capabilities with the required security levels.

NOTE: The list of possible security enhancements is not determined in the present Release definition. Updates and tracking of this type of enhancements are available on the feature tracking wiki pages [i.4].

C.6.3 Specific technical enhancements (ENH02)

The scope of the feature covers different technical working areas to enhance the ETSI NFV specifications and the already specified past Releases features/capabilities with specific technical enhancements which are considered of low complexity and not addressed already by other Release 4 features.

NOTE: The list of possible technical enhancements is not determined in the present Release definition. Updates and tracking of this type of enhancements are available on the feature tracking wiki pages [i.5].

Annex D:
Change history

Document history		
Version	**Date**	**Changes**
0.1.0	June 2021	First draft reusing the Release 4 Definition v0.3.0 as baseline and to be uploaded to the Portal.
0.2.0	September 2021	- Clause 4.2: update the number of completed deliverables. - Clause 5.3.1.3: document the feature specification work of IFA033. - Clause 6.5: update the list of newly published group reports. Update the corresponding table in clause 7.2. - Clause 7.3: added all the newly opened work items propagating stage 3 specs from Release 3. - Annex B: new annex providing a reference to information about deliverables versioning documented in the Release 3 Description document.
0.3.0	November 2021	- Feature FEAT19 split into two: FEAT19a for container networking, and FEAT19b for "connectivity integration and operationalization". - Annex A.4: features FEAT22, FEAT23 and FEAT19b are deleted from the document because of carrying over them into Release 5.
0.3.1	December 2021	- Updated the completion of IFA037 and IFA038, thus moved the entries from table 7.2-1 to table 6.5-1. - Clause 4.4: marked the informative (stage 0) as closed. - Clause 4.2: updated the number of published/completed documents.
0.4.0	May 2022	- Clause 5.1: updated the list of completed enhancement features from stage 2 pov. - Clause 5.2.1.3: added the SOL001 to the list of published deliverables specifying part of the FEAT17. - Clause 5.2.6 (new): documentation of the data flow mirroring enhancement feature. - Clause 6.3.2: updated the list of completed deliverables, i.e. SOL001 v4.2.1. - Clause 7.3: deleted the SOL001ed421, since a first version has been completed and published (see clause 6.3.2). - Clause 6.2.2: updated latest version of published deliverables, basically IFA v4.3.1 specs. - Clause 7.2: added the new stage 2 work items of Release 4 features FEAT20, FEAT24 and FEAT26, i.e. IFA047, IFA048, IFA049 and IFA050.
0.5.0	September 2022	Changes mostly to reflect specification status after completion of ed431. - Clause 4.2: updated the statistics of number of specifications comprising the Release 4. - Clause 5.1: updated the tables to describe the specification status of features and enhancement features. Marked the Release 4 enhancement features as completed with appropriate notes, where applicable. - Clause 5.2.1: updated the description of the feature to describe the completion of the CIS cluster management parts. Updated the list of specifications including also stage 3 specs. - Clauses 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.6: updated the list of specifications including the stage 3 specs that have been completed. - Clause 5.2.7: added description of parts of the FEAT21 (5GNFV) that have been completed. - Clause 5.2.8: added description of completed FEAT19a (NFV-Connect-container). - Table 6.2.1-1: added IFA036 to the list of completed specs. - Table 6.2.2-1: updated the entries in the table with the association to the related features. - Table 6.3.1-1 and table 7.2-1 updates: add the SOL018 as newly published specification. - Table 6.3.2-1 and table 7.2-1 updates: add all newly published versions of evolved Release 3 documents. - Clause 6.3.3: added description about the first Release 3 stage 3 package corresponding to the development until 2022H1. - Table 7.2-1: added new work item SEC028. - Table 7.3-1: added the NFV006ed441. Deleted entries of work items whose drafts have been completed and published as indicated in clause 6. - Clause 6.6: new clause to describe other document (similar approach as in the Release 3 Description document). - Clause 6.7: new clause to map specifications onto the NFV architectural framework (similar approach as in the Release 3 Description document). Figure is not provided, and an editor's note is placed to indicate adding it once the NFV006ed441 is completed.

Document history		
Version	**Date**	**Changes**
0.6.0	November 2022	Add FEAT10 which was carried over partly from Release 3 Added empty clauses for remaining features, restructured in clause 5 sorting by feature numbering. Changes to reflect specification status after completion of SOLed431. Add publication of IFA048 in FEAT26. Add publication of NFV006.
0.7.0	January 2023	Editorial changes to prepare transformation to a GR. Copied Annex A and B from NFV007ed371 to avoid strange reference from the present document to its own predecessor. Table 7.3-1: updated SOL011, SOL012, SOL014 and SOL016 to ed441 and added notes.` add recent publication of IFA048 and NFV006 (IFA048 is RC approved, but publication pending) add FEAT04 because of planned postponing of a part from Release 3. List all features in 5.1. Overview Provide feature description information in clause 5 for FEAT01, FEAT04, FEAT12, FEAT13, FEAT18, FEAT26, Enh01.01 Add Editor's notes to indicate missing information. Add clause on release 2 publication packages Add IFA024 and TST006 Remove SOL014 in clause 7, since there is a publication Restored info on FEAT22 and FEAT23 in release definition Add publication date for IFA048
0.8.0	February 2023	Correct references to wiki Resolve Editors note in FEAT01 Correct a few Editors notes Provide description for FEAT04 Provide clause for FEAT20 Add updates for FEAT26 Add Version 441 documents: IFA005, IFA006, IFA007, IFA008, IFA010, IFA011, IFA013, IFA014, IFA027, IFA030, IFA031, IFA032, IFA036, IFA040 Add new IFA047
4.3.2	March 2023	Transformed into ETSI GR NFV007ed441 Added many editor's notes indicating missing contents, including feature mapping of SOLed441 documents. Add description and progress of FEAT24 in clause 5.2.12 Updated Statistics in clause 4.2 Added placeholder for Enh02.06 Added publication date for IFAed441 Added table for SOLed441 publication Added FEAT reference for SOLed publications Added SOLed441 versions in clause 6.3.2
4.3.3	July 2023	NFVTSC(23)000063 NFV007 Add SOLed441 publication dates, etc.
4.3.4	July 2023	NFVTSC(23)000067r1 NFV007ed441 Resolve editors notes and update some features NFVTSC(23)000068 NFV007ed441 update for FEAT20
4.3.5	August 2023	NFVTSC(23)000074r1 NFV007ed441 Editorial Correction NFVTSC(23)000076 NFV007ed441 some more corrections NFVTSC(23)000078 NFV007ed441 Correction on diagram
4.3.6	September 2023	NFVTSC(23)000087 NFV007ed441 Add publication of IFA049 Declared stable draft as agreed in TSC#275.
V4.3.6	October 2023	Pre-processing done before TB approval E-mail: edithelp@etsi.org

History

Document history		
V4.4.1	November 2023	Publication