ETSI ISG NFV: Work program and Releases overview

Presented by: **Joan Triay (ETSI NFV Technical Manager, DOCOMO Euro-Labs)**

For: **SDN & NFV World Congress**

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Outline

- PART 1: ETSI ISG NFV Overview
  - ETSI NFV Releases overview
  - ETSI NFV ongoing work

- PART 2: NFV Release 2
  - What does it contain?
  - Maintenance, API development, etc.

- PART 3: NFV Release 3
  - Overview
  - Features and specification work.

Part 1: ETSI
ISG NFV
overview

ETSI NFV Releases overview

Release 1

- Focus: the feasibility of NFV.
- Delivered the baseline studies and specifications.
- Set the NFV Architecture:
  - Infrastructure (NFVI),
  - Virtualized network functions (VNF),
  - Integration of the VNFs into Network Services (NS), and
  - NFV Management and Orchestration (NFV-MANO) aspects at different layers.

Release 2

- Focus: interoperability of NFV solutions.
- Details requirements and specification of interfaces and descriptors.
- Realizes the interoperability of solutions based on the NFV Architecture, detailing
  - VNF Package and VNF and NS Descriptors,
  - Acceleration,
  - Internal and external NFV-MANO interfaces.

Release 3

- Focus: feature enriching the NFV Architectural Framework, readying NFV for deployment and operation.
- Interfaces, modeling, etc. to support new features such as (not exhaustive list):
  - Policy framework,
  - VNF snapshot,
  - NFV-MANO management,
  - Licensing,
  - Multi-site,
  - Cloud-native, etc.

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ETSI NFV ongoing work

Release 2 maintenance:

- Third round (1H2018) was completed.

- Fourth round (2H2018) is underway.

Release 2 ongoing work for new specifications:

- Some stage 3 specification, e.g., VNFD and NSD descriptors, NSD file structure.

- Specific technical gaps, such as security enhancements for VNF Packaging and APIs.

- Testing specifications, including API conformance testing.

Release 3 features work:

- Few remaining informative/study works.

- Most of the stage 2 normative specification. Based on a feature set, whereby features may deliver new specifications or evolve current Release 2 specifications.

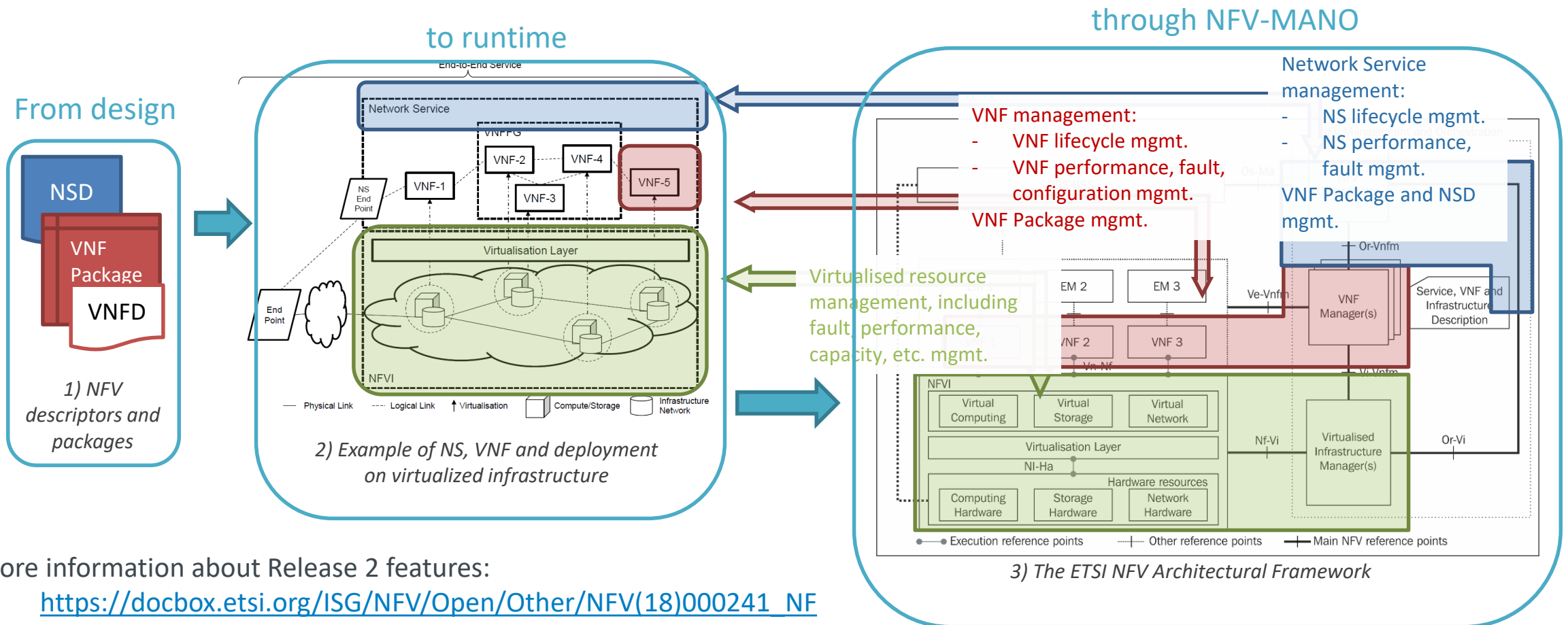- Several features completed at stage 2 level.
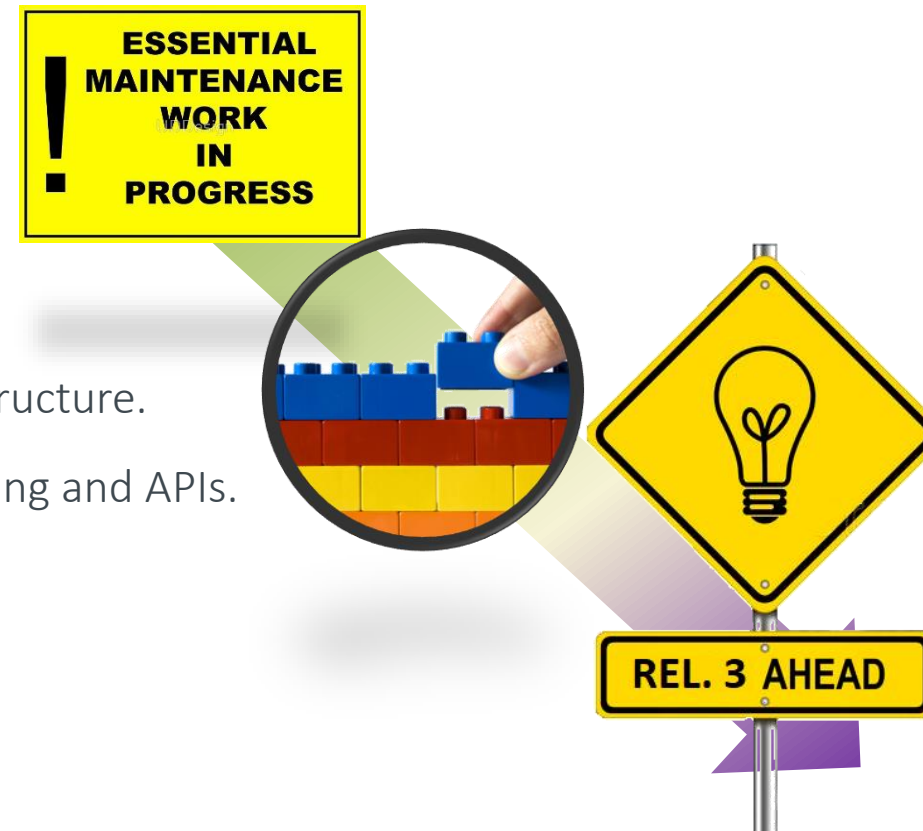
Part 2: NFV Release 2

Release 2: what does it contain?

Release 2 specifications set up the NFV framework with essential capabilities related to NS, VNF and VR management.

through NFV-MANO

to runtime

From design

1) NFV descriptors and packages

2) Example of NS, VNF and deployment on virtualized infrastructure

Network Service management:
- NS lifecycle mgmt.
- NS performance, fault mgmt.
VNF Package and NSD mgmt.

VNF management:
- VNF lifecycle mgmt.
- VNF performance, fault, configuration mgmt.
VNF Package mgmt.

Virtualised resource management, including fault, performance, capacity, etc. mgmt.

3) The ETSI NFV Architectural Framework

More information about Release 2 features:
https://docbox.etsi.org/ISG/NFV/Open/Other/NFV(18)000241_NFV_Release_2_Description_v17.pdf

Release 2: maintenance work (1/2)

3 rounds completed (1H2017, published as v2.3.1; 2H2017, published as v2.4.1; and 1H2018, published as v2.5.1).

2H2018 maintenance is ongoing (targeting publication of affected specifications as v2.6.1).

▿ Focus is on stage 3 specifications (NFV-SOL specs), and stage 2 specifications closely related to unfinished Rel. 2 stage 3 specifications (NFV-IFA011/014).

Main aspects addressed (so far) as part of maintenance:

▿ Correction of bugs.

▿ Feedback received from deployments and development: remove ambiguities, enhance certain APIs, etc.

▿ Alignment in between Stage 2 and 3 specifications.

▿ Feedback from open source projects, e.g., OpenStack gap analysis and alignment to NFV-IFA005 and NFV-IFA006, OSM information model feedback to NFV-IFA011 and NFV-IFA014, contributions to NFV-IFA011 and NFV-SOL 004 by companies participating in ONAP providing feedback, etc.

Release 2: maintenance work (2/2)

Capability changes and enhancements developed during maintenance (not an exhaustive list) since first published version:

- Adding support for compute flavour management.

- Merging of VNF and NS lifecycle change notifications into VNF and NS LCM interfaces, respectively.

- Merging of VNF configuration and instance information mgmt. into VNF LCM interface.

- Adding support for changing the external VNF connectivity.

- Enhancements and consistency to alarm management within the fault management interfaces.

- Enhancements in the information and data modelling of network connectivity.

Release 2:
API standardization process

The content of the NFV-SOL APIs is based on the related NFV-IFA specifications.

The NFV-SOL specifications are implementable representations of the design defined in the stage 2 specifications, not alternative solutions.

OpenAPI descriptions publically available for all APIs specified in GS NFV-SOL 002/003 (version 2.4.1) https://nfvwiki.etsi.org/index.php?title=API_specifications#OpenAPIs

SOL API conventions

Stage 2: Requirements and information model

NFV-IFA 007 (Or-Vnfm)
NFV-IFA 008 (Ve-Vnfm)
NFV-IFA 013 (Os-Ma-nfvo)
NFV-IFA 011 (VNF Package, VNFD)
NFV-IFA 014 (NSD)

Mapping information model to data model

Defining protocol machinery for the operations specified in stage 2

Closing gaps left open in stage 2 (e.g. error handling, technical details)

Stage 3: Protocols and data model

NFV-SOL 003 (Or-Vnfm)
NFV-SOL 002 (Ve-Vnfm)
NFV-SOL 005 (Os-Ma-nfvo)
NFV-SOL 004 (VNF Packaging)
NFV-SOL 001 (VNFD, NSD) (in progress)

Latest published versions: NFV-SOL002/003/004/005 v2.5.1 (Sep. 2018)

Testing: Benchmarking, interop, conformance

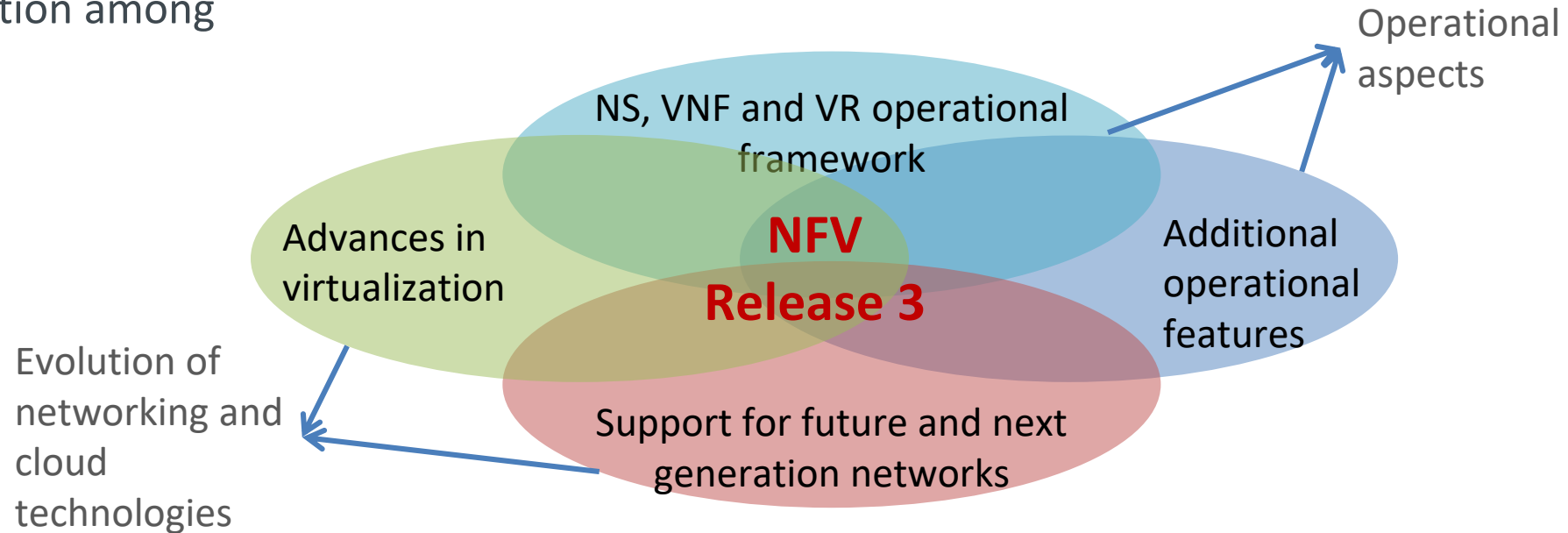NFV-TST 007 (testing guidelines)
NFV-TST 010 (API conformance)

Part 3: NFV Release 3

Release 3: overview

Main focus:

- Enriching the NFV Architectural Framework, readying NFV for expansive deployment, enhanced operation, taking into account the evolution of networking and cloud technologies.

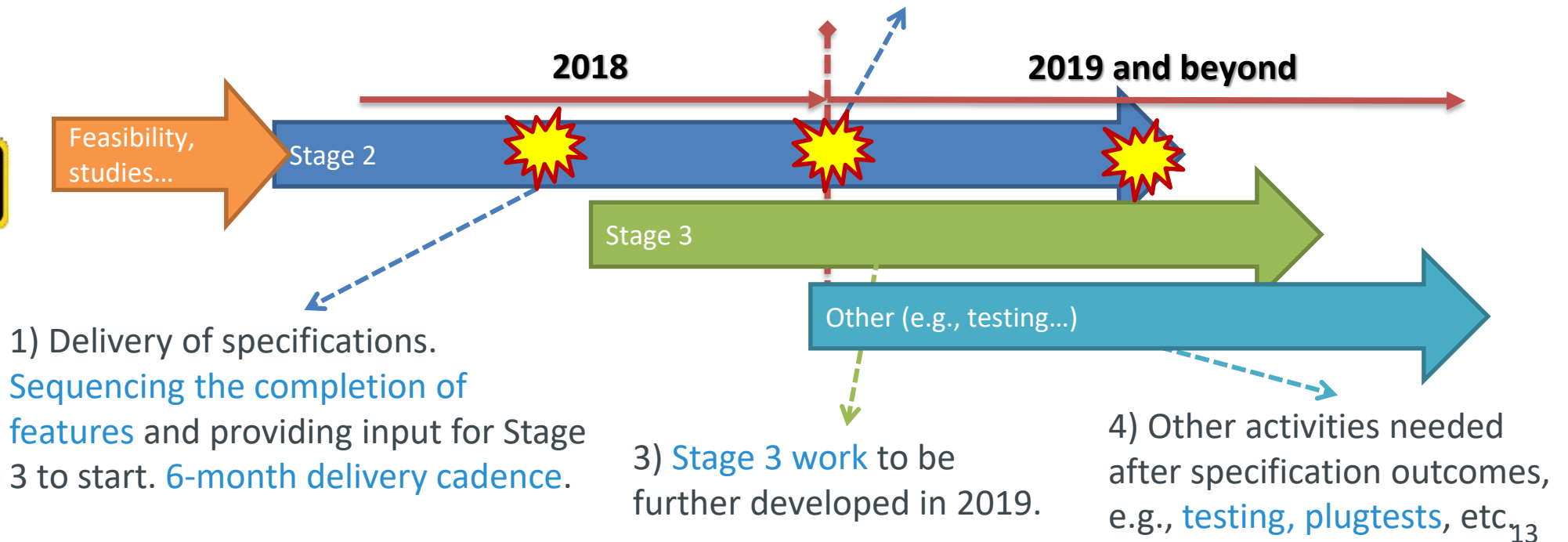- In commercial deployments, operational aspects are critical!

The intersection among

Operational aspects

NS, VNF and VR operational framework

Advances in virtualization

NFV Release 3

Additional operational features

Evolution of networking and cloud technologies

Support for future and next generation networks

Release 3:
feature-based specification and next steps

Release specification progress and plans are publicly available on the NFV Public Wiki. List of features is available in the Release 3 Definition (periodically updated, latest v0.11.0 Sep. 2018). See also backup slides.

- Following a feature-based specification approach.
- 17+ candidate features (see backup slides).
- "stage 2 level" specification is well underway, and now transitioning into "stage 3 work.

2) Stage 2 level specification is expected to be completed in 2018 and 2019.

2018

2019 and beyond

REL. 3 AHEAD

Feasibility, studies...

Stage 2

Stage 3

Other (e.g., testing...)

1) Delivery of specifications. Sequencing the completion of features and providing input for Stage 3 to start. 6-month delivery cadence.

3) Stage 3 work to be further developed in 2019.

4) Other activities needed after specification outcomes, e.g., testing, plugtests, etc.

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Release 3:
stage 1&2 completed features

ⓥ Compute Host Reservation

ⓥ NFV-MANO Policy Management Framework

ⓥ VNF Snapshots

ⓥ Management of NFV-MANO

ⓥ Network Service (NS) across multiple administrative domains

More information on the following slides

ⓥ Enhancement of acceleration related features:

    ⓥ Hardware-independent acceleration

    ⓥ Network acceleration for VNF

ⓥ Virtualization technologies:

    ⓥ Hypervisor-based virtualisation

    ⓥ Hardware environment for NFV

Release 3 features:
Compute Host Reservation

Objective: Enable reservation of physical hosts in the NFVI by „authorized consumers of NFVI administration".

Use cases:

- Secure NFVI resource availability during maintenance processes.
- Hardware interoperability requirements (see ETSI GS NFV-EVE 007).
- Security regulations (see ETSI GS NFV-SEC 012).
- See also OPNFV's Promise project: wiki.opnfv.org/display/promise/

Specification outcomes:

- Requirements and interface specification in ETSI GS NFV-IFA 010 and ETSI GS NFV-IFA 005 (versions v3.1.1).

Other information:

- Aligned with (Resource reservation service): https://docs.openstack.org/blazar/ which supports reservation of virtual compute(s) and physical compute host(s).

Performance is critical! We need a dedicated host!

I need guaranteed resources on host to migrate VNF during NFVI maintenance.

Our security process requires a host with "Trusted Platform Module"!

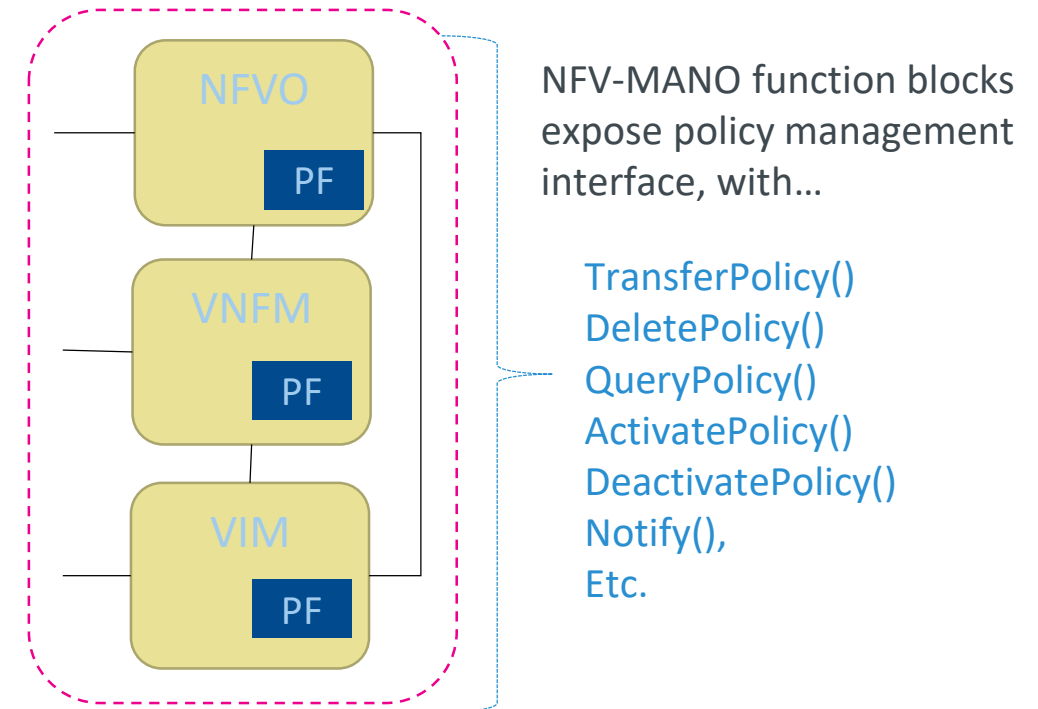# Release 3 features: NFV-MANO Policy Management Framework

Objective: Create a policy management framework to further enhance the flexibility in NFV Management and Orchestration.

Use cases:

- Change the behaviour of VNF, NS and VR lifecycle and orchestration based on policies.
- See also use cases documented in the published report ETSI GR NFV-IFA 023.

Specification outcomes:

- NFV-MANO FB (i.e., NFVO, VNFM and VIM) act as Policy Functions (PF) to enforce policies. NFV-MANO FB can also act as Policy Administration Points (PAP).
- A new policy management interface is added for each reference point, which includes operations of policy transfer, deletion, query, activation and deactivation. Specified in v3.1.1 versions of ETSI GS NFV-IFA 010/005/006/007/008/013.

NFV-MANO function blocks expose policy management interface, with…

TransferPolicy()
DeletePolicy()
QueryPolicy()
ActivatePolicy()
DeactivatePolicy()
Notify(),
Etc.

Other information:

- RESTful protocol and data model solution (stage 3) work expected to start soon (work item proposal currently under ISG approval).
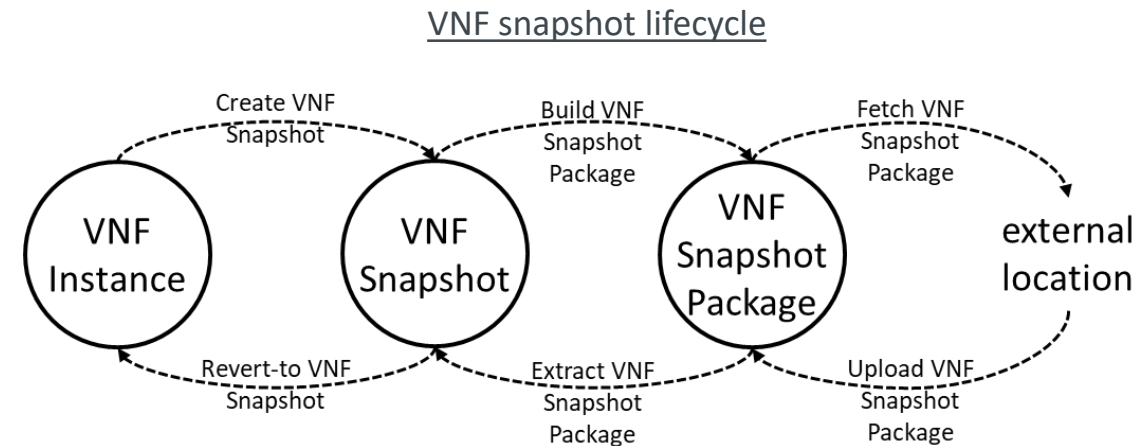
Release 3 features:
VNF Snapshots

Objective: Solution to manage, store and transfer a snapshot of a VNF.

Use cases:
- Testing, troubleshooting, as fall-back in LCM procedures, e.g., quick VNF recovery.
- See also use cases documented in the published report ETSI GR NFV-TST 005.

Specification outcomes:
- Extending VNF and NS lifecycle management interfaces with new operations to create and revert to snapshots. Specified in ETSI GS NFV-IFA 010/007/008/013.
- A new VNF Snapshot Package Management interface, for building/extracting packages from/to VNF/C snapshots. Specified in ETSI GS NFV-IFA 007/008/013.

VNF snapshot lifecycle

Other information:
- Data model (stage 3) work for the VNF Snapshot Packages just started (work item DGS/NFV-SOL010).
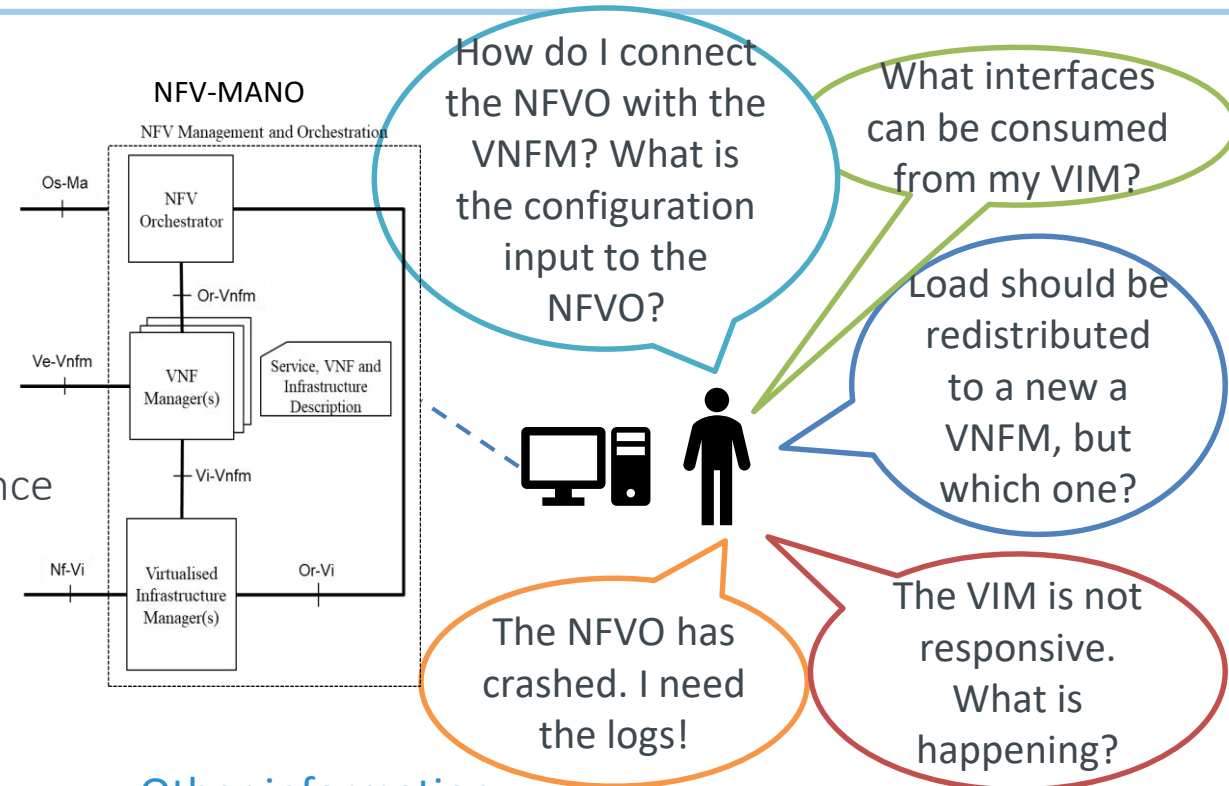
Release 3 features: Management of NFV-MANO

Objective: Create a framework for flexible NFV-MANO management to ease the integration/interworking of NFV-MANO system with network operators support systems.

Use cases:
- NFV-MANO functions need to be configured for interworking, and monitored against fault and performance issues.
- See also use cases documented in the published report ETSI GR NFV-IFA 021.

Specification outcomes:
- Set of requirements, interfaces and information model for the operation, management and maintenance of NFV-MANO (see also ETSI GS NFV-IFA 031).

Other information:
- RESTful protocol and data model solution (stage 3) work just started (work item DGS/NFV-SOL009).

NFV-MANO

NFV Management and Orchestration

Os-Ma — NFV Orchestrator
Or-Vnfm
Ve-Vnfm — VNF Manager(s) — Service, VNF and Infrastructure Description
Vi-Vnfm
Nf-Vi — Virtualised Infrastructure Manager(s) — Or-Vi

How do I connect the NFVO with the VNFM? What is the configuration input to the NFVO?

What interfaces can be consumed from my VIM?

Load should be redistributed to a new a VNFM, but which one?

The NFVO has crashed. I need the logs!

The VIM is not responsive. What is happening?

Fault management | Configuration management | Performance management | State management | Log management

Release 3 features:
# NS across multiple administrative domains

Objective: Enable different business models where the NFV infrastructure or Network Services are provided by another administrative domain.

Use cases:

ᐁ NS provisioning and lifecycle management require coordination between two NFVOs in different administrative domains.

ᐁ See also use cases documented in the published report ETSI GR NFV-IFA 028.

Specification outcomes:

ᐁ Enable a new reference point Or-Or with the functionality mainly referencing to the existing ETSI GS NFV-IFA 013 operations. Developed in the ETSI GS NFV-IFA 030.
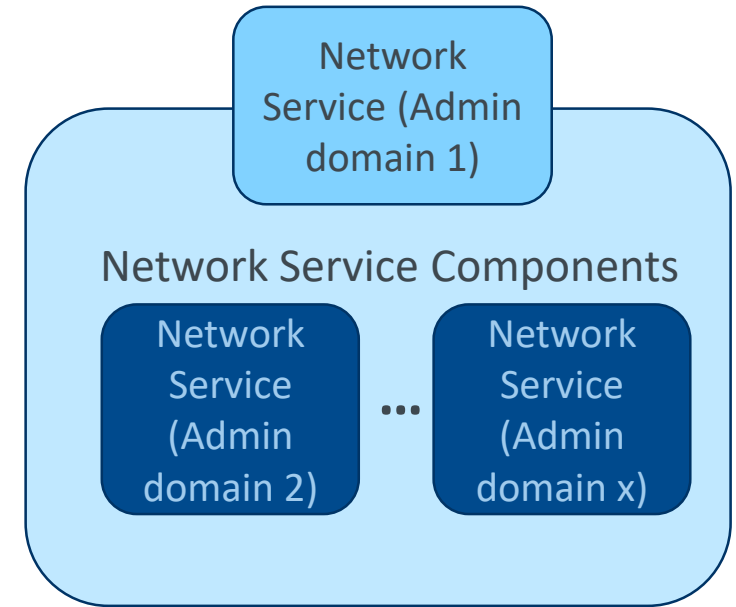
Other:

ᐁ RESTful protocol and data model solution (stage 3) work just started (work item DGS/NFV-SOL011).

Conclusion

Conclusion

Release 2 documentation is almost fully complete.

◊ Only few stage 3 and testing specifications are remaining.

◊ Maintenance has been performed since 2017, and it will continue (focusing particularly on protocols and data model specifications) until Release 3 is completed.

Release 3 specification work is progressing well.

◊ Few informative/study work items are remaining.

◊ Focus is mostly on stage 2 normative specification. A pipeline of features being delivered every 6 months.

◊ Stage 3 work has just started on a set of features completed at stage 2 level in the summer 2018.

◊ Work will continue through 2018 and 2019.

More information

NFV Technology Page
(information)
http://www.etsi.org/nfv

NFV Portal (working area)
http://portal.etsi.org/nfv

NFV Proofs of Concept
(information)
http://www.etsi.org/nfv-poc

NFV Plugtest (information &
registration)
http://www.etsi.org/nfvplugtest

Open Area:

- Published Docs: https://docbox.etsi.org/ISG/NFV/Open/Publications_pdf

- Working Drafts http://docbox.etsi.org/ISG/NFV/Open/Drafts/

- Issue tracker http://nfvwiki.etsi.org/index.php?title=NFV_Issue_Tracker

- Detailed Release 3 specification progress can be found at:
  https://nfvwiki.etsi.org/index.php?title=Feature_Tracking

http://nfvwiki.etsi.org/index.php?title=NFV_Issue_Tracker
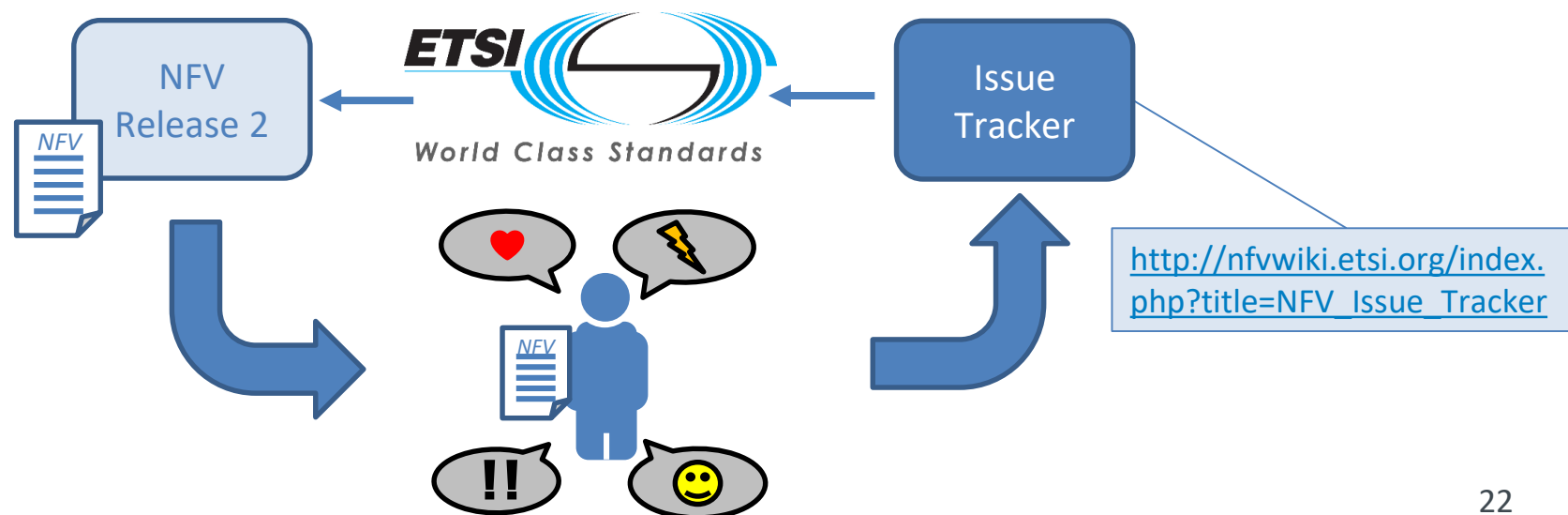
Backup slides

Release 2: specification summary

Published documents

Release 2, published documentation (22): 17 Group Specification (GS) and 5 Group Report (GR).

- 13 Stage 2 GS (11 from IFA, 1 from TST).

- 4 Stage 3 GS (SOL).

- 4 Stage 2 GR (IFA).

- 1 testing GR (TST).
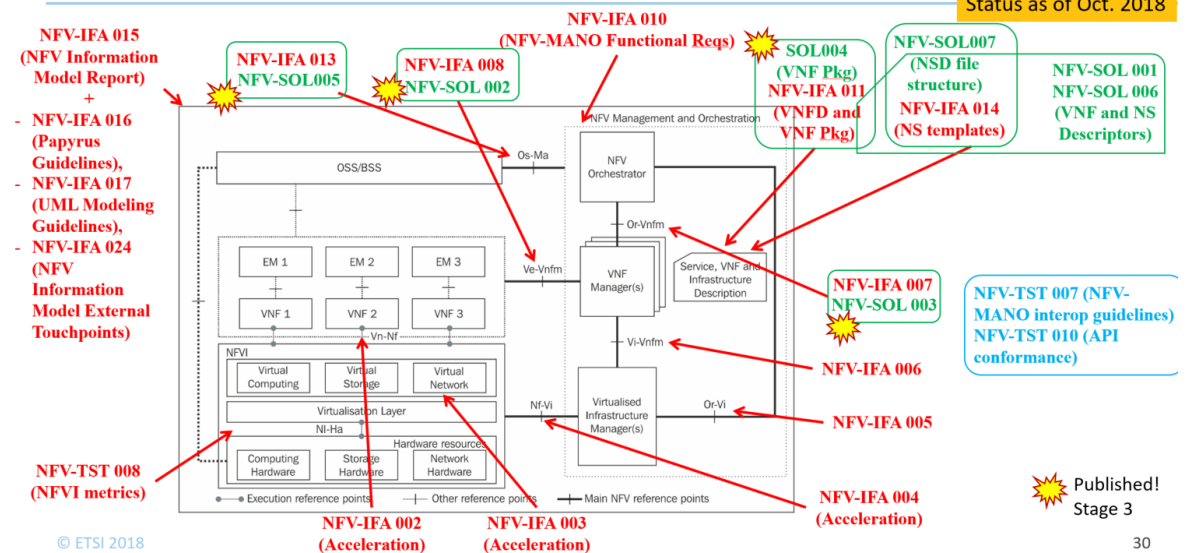
Active work items

Currently, 6 ongoing unpublished active WI:

- 3 Stage 3 GS drafts (NFV-SOL001/006/007).

- 2 GS drafts related to security (NFV-SEC021/022).

- 1 GS draft on conformance testing (NFV-TST010).

Refer to continuous updates on the Release 2 Description (latest version v1.7, Sep 2018).

Release 2: specification summary

Status as of Oct. 2018

NFV-IFA 015 (NFV Information Model Report) + NFV-IFA 016 (Papyrus Guidelines), NFV-IFA 017 (UML Modeling Guidelines), NFV-IFA 024 (NFV Information Model External Touchpoints)

NFV-IFA 013 NFV-SOL005

NFV-IFA 008 NFV-SOL 002

NFV-IFA 010 (NFV-MANO Functional Reqs)

SOL004 (VNF Pkg) NFV-IFA 011 (VNFD and VNF Pkg)

NFV-SOL007 (NSD file structure) NFV-IFA 014 (NS templates)

NFV-SOL 001 NFV-SOL 006 (VNF and NS Descriptors)

NFV-IFA 007 NFV-SOL 003

NFV-TST 007 (NFV-MANO interop guidelines) NFV-TST 010 (API conformance)

NFV-IFA 006

NFV-IFA 005

NFV-TST 008 (NFVI metrics)

NFV-IFA 002 (Acceleration)

NFV-IFA 003 (Acceleration)

NFV-IFA 004 (Acceleration)

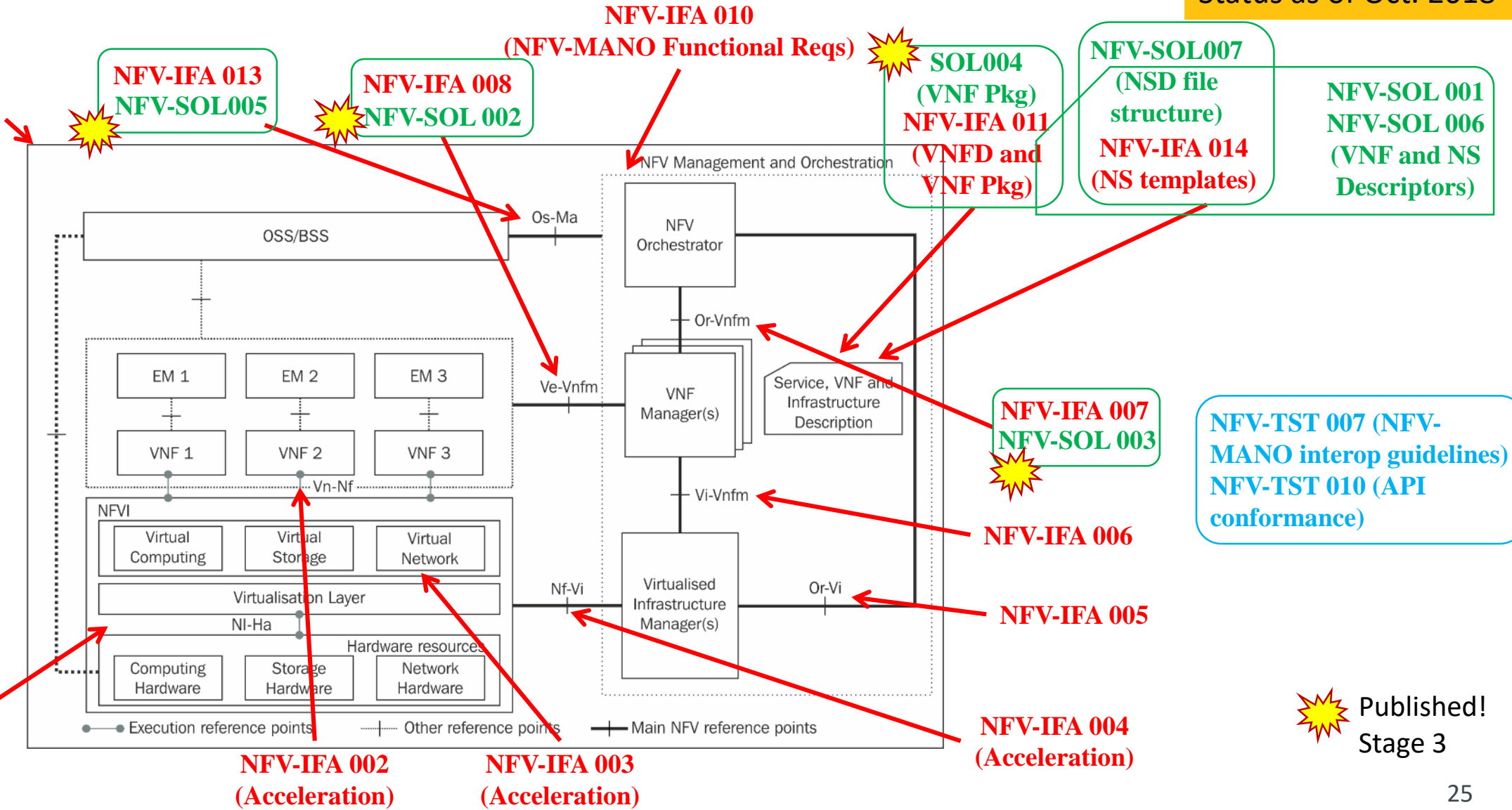Published! Stage 3

© ETSI 2018

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3 rounds of maintenance have been completed (1H2017, 2H2017, and 1H2018), and 1 round is now ongoing for 2H2018:

- Versioning: First round: v2.3.1; Second round: v2.4.1; Third round: v2.5.1 (some specs without maintenance remain in v2.4.1); and Fourth round: v2.6.1 (target).

Release 2: specification summary

Status as of Oct. 2018

NFV-IFA 015 (NFV Information Model Report) + - NFV-IFA 016 (Papyrus Guidelines), - NFV-IFA 017 (UML Modeling Guidelines), - NFV-IFA 024 (NFV Information Model External Touchpoints)

NFV-IFA 013 NFV-SOL005

NFV-IFA 008 NFV-SOL 002

NFV-IFA 010 (NFV-MANO Functional Reqs)

SOL004 (VNF Pkg) NFV-IFA 011 (VNFD and VNF Pkg)

NFV-SOL007 (NSD file structure) NFV-IFA 014 (NS templates)

NFV-SOL 001 NFV-SOL 006 (VNF and NS Descriptors)

NFV-IFA 007 NFV-SOL 003

NFV-TST 007 (NFV-MANO interop guidelines) NFV-TST 010 (API conformance)

NFV-IFA 006

NFV-IFA 005

NFV-TST 008 (NFVI metrics)

NFV-IFA 004 (Acceleration)

NFV-IFA 002 (Acceleration)

NFV-IFA 003 (Acceleration)

Published! Stage 3

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Release 2:
stage 2 published documents (for reference)

ID	Title
Functional requirements	
ETSI GS NFV-IFA 010 v2.5.1	MANO; Functional requirements specification
Acceleration (with interfaces)	
ETSI GS NFV-IFA 002 v2.4.1	Acceleration Technologies: VNF Interfaces Specification
ETSI GS NFV-IFA 003 v2.4.1	Acceleration Technologies; vSwitch Benchmarking and Acceleration Specification
ETSI GS NFV-IFA 004 v2.4.1	Acceleration Technologies; Management aspects Specification
NFV-MANO reference points and interfaces	
ETSI GS NFV-IFA 005 v2.5.1	MANO; Or-Vi reference point - Interface and Information Model Specification
ETSI GS NFV-IFA 006 v2.5.1	MANO; Vi-Vnfm reference point - Interface and Information Model Specification
ETSI GS NFV-IFA 007 v2.5.1	MANO; Or-Vnfm reference point - Interface and Information Model Specification
ETSI GS NFV-IFA 008 v2.5.1	MANO; Ve-Vnfm reference point - Interface and Information Model Specification
ETSI GS NFV-IFA 013 v2.5.1	MANO; Os-Ma-Nfvo reference point - Interface and Information Model Specification

Release 2:
stage 2 published documents (for reference)

ID	Title
Descriptors and artefacts	
ETSI GS NFV-IFA 011 v2.5.1	MANO; VNF Descriptor and Packaging Specification
ETSI GS NFV-IFA 014 v2.5.1	MANO; Network Service Templates Specification
Information modeling	
ETSI GR NFV-IFA 015 v2.5.1	MANO; Report on NFV Information Model
ETSI GR NFV-IFA 016 v2.5.1	IM; Papyrus Guidelines
ETSI GR NFV-IFA 017 v2.5.1	IM; UML Modeling Guidelines
ETSI GR NFV-IFA 024 v2.1.1	IM; Report on External Touchpoints related to NFV Information Model
Metrics, measurements	
ETSI GS NFV-TST 008 v2.5.1	Testing; NFVI Compute and Network Metrics Specification
ETSI GS NFV-IFA 027 v2.4.1	MANO; Performance Measurements Specification

Release 2:
stage 3 published documents (for reference)

Status as of Oct. 2018

ID	Title
NFV-MANO APIs	
ETSI GS NFV-SOL 002 v2.5.1	Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point
ETSI GS NFV-SOL 003 v2.5.1	Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point
ETSI GS NFV-SOL 005 v2.5.1	Protocols and Data Models; RESTful protocols specifications for the Os-Ma-nfvo Reference Point
Artefacts	
ETSI GS NFV-SOL 004 v2.5.1	Protocols and Data Models; VNF Package specification

Release 2:
other published documents (for reference)

ID	Title
Testing	
ETSI GR NFV-TST 007 v2.5.1	Testing; Guidelines on Interoperability Testing for MANO

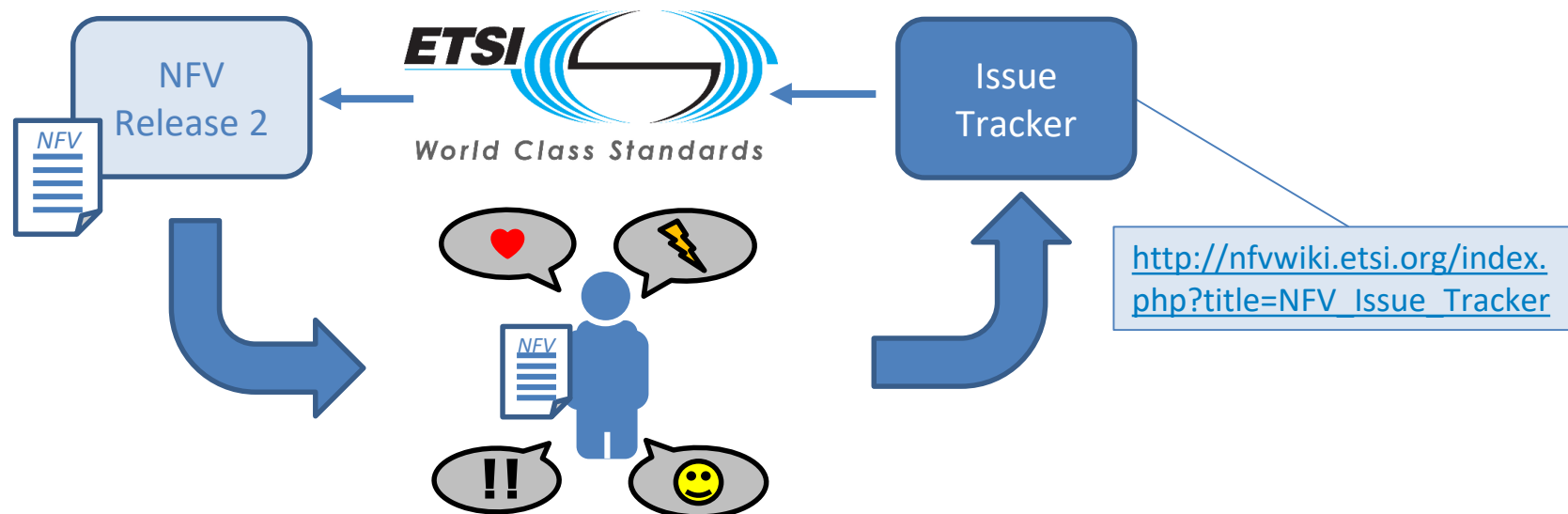# Release 2:
more information and feedback

More information about Release 2 features:

▽ https://docbox.etsi.org/ISG/NFV/Open/Other/NFV(18)000241_NFV_Release_2_Description_v17.pdf

Ongoing work (drafts) publicly available here:

▽ https://docbox.etsi.org/ISG/NFV/Open/Drafts/

http://nfvwiki.etsi.org/index.php?title=NFV_Issue_Tracker

Release 3:
specification summary

Published documents

Release 3, published documentation (30): 19 Group Specification (GS) and 11 Group Report (GR).

- 3 Stage 1/2 GS (NFV-EVE001, NFV-EVE007, NFV-REL006)

- 4 Stage 2 GS (NFV-IFA018, NFV-IFA019, NFV-IFA030, NFV-IFA031).

- 9 Stage 2 GS evolved from Release 2 (NFV-IFA005/006/007/008/010/011/013/014 and NFV-TST008) and 3 GR (NFV-IFA015/016/017).

- 3 GS on security (NFV-SEC012, NFV-SEC013, NFV-SEC014).

- 8 GR (NFV-EVE008/010/012, NFV-IFA021/022/023/028, NFV-TST005).

Refer to continuous updates of the Release 3 Definition (latest version v0.11.0 Sep 2018).

Active work items

Release 3, ongoing unpublished work items (refer to Release 3 Definition): 20 WI.

- 2 Stage 1/2 GS draft (NFV-EVE011, NFV-REL009).

- 3 Stage 2 GS draft (NFV-IFA026/032/033).

- 4 GR draft (NFV-IFA012/029/034, NFV-REL010).

- 1 GS draft on testing/benchmarking (NFV-TST009).

- 2 GS drafts on security (NFV-SEC019, NFV-SEC020).

- Evolved Rel. 2 deliverables from stage 2 and 3: 5 GS (NFV-IFA002, and NFV-SOL002/003/004/005).

- 3 GS drafts on newly stage 3 (NFV-SOL009/010/011).

Release 3, ongoing "continuation and maintenance work": 11 WI.

- Propagated/evolved Rel. 2 deliverable drafts: 9 Stage 2 GS (NFV-IFA005/006/007/008/010/011/013/014, NFV-TST008).

- Newly added by Release 3: 2 Stage 2 GS (NFV-IFA030/031).

Release 3: feature-based specification

17 candidate features, including Release 3 definition features and small enhancements.

Approach:

- 6-month delivery cadence.

- Main workload is still on stage 2 level specifications.

- But stage 3 work has started.

- Release 3 specification progress and plans are publicly available on the NFV Public Wiki.

Refer also to Release 3 Definition Annex B for a summary of work, impacted specifications and tracking about the considered features.

First version of Release 3 Description will be made publicly available soon.

Release 3 Definition (continuously updated, latest version v0.11.0 Sep. 2018).

5.2.7 Policy management framework (POLICY)

As part of the feature, a new interface applicable to multiple reference points (see clause 5.2.7.2) is introduced. The interface allows to invoke policy management operations towards the corresponding NFV-MANO functional block. The interface defines the follow operations: transfer, delete, query, activate and deactive policy. The interface also exposes the subscription and notification mechanism for issuing notifications concerning policy handling.

5.2.7.2 Architecture scope

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

- Functional blocks: NFVO, VNFM, VIM.

- Reference points: Os-Ma-nfvo, Or-Vnfm, Or-Vi, Vi-Vnfm, and Ve-Vnfm.

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 document.

Table 5.2.7.3-1: Specification results of feature "policy management framework"

Document Id.	Stage	Description of the feature specification
ETSI GR NFV-IFA 023	Stage 0	Feasibility study of the feature. Use cases related to the introduction of policy usage and management into NFV-MANO.
ETSI GS NFV-IFA 010	Stage 1 and 2	Functional requirements for NFV-MANO functional blocks (NFVO, VNFM and VIM) to support the capability to manage NFV-MANO policies. Definition of scope and category of policies applicable to the different reference points (informative).
ETSI GS NFV-IFA 005	Stage 2	Functional requirements of the Policy Management interface on the Or-Vi reference point. Functional and information model description of the Policy Management interface.
ETSI GS NFV-	Stage 2	Functional requirements of the Policy Management interface on the Vi-

Table 5.1-1: Release 3 features

Feature title	Acronym	Id (from the Definition document)
Hardware-independent acceleration	ACCEL	R02.CAP12
Network Acceleration for VNF	FASTSWITCH	R03.F07
Hypervisor-based virtualisation	HYPER	R03.F16
Hardware environment for NFV	HWENV	R03.F13
Management of NFV-MANO	NFV_M&Ms	R03.F04
VNF Snapshotting	VNF_PHOTO	R03.F11
Policy management framework	POLICY	R03.F14
NFV-MANO admin domains	MANOMD	R03.F18

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Release 3:
work items and features from stage 1&2 perspective

Network Service LCM and Descriptor (NFV-IFA013/014)

VNF LCM, Packaging and Descriptor (NFV-IFA007/008/011)

Virtualised Resource management (NFV-IFA005/006)

Information Modeling (NFV-IFA015/016/017)

Metrics and Performance (NFV-IFA027, NFV-TST008)

framework, evolved with...Rel. 2:
base operational and automation

1) Advances in virtualization

Cloud-native VNF (NFV-EVE011)

PaaS support for cloud-native, and containers (NFV-IFA029)

NFVI aspects: Hardware environment (NFV-EVE007)

Hypervisor (NFV-EVE001)

Acceleration (NFV-IFA018/IFA019)

2) Support for future network technologies

Network Slicing to NFV concepts (NFV-EVE012/NFV-REL010, **)

MEC in NFV (**)

3) Additional operational features

NFV-MANO management (NFV-IFA021/031, **)

Security management (NFV-IFA026/033)

NFV software update and upgrade (NFV-REL006, **)

Policy management framework (NFV-IFA023, **)

Multi administrative NFV-MANO (NFV-IFA028/030, **)

VNF snapshotting (NFV-TST005, **)

Charging, billing and accounting (NFV-EVE008, **)

Connectivity for multi-site (NFV-IFA022/032, **)

Service availability (**)

NFV licensing (NFV-EVE010, NFV-IFA034, **)

Host reservation (**)