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ETSI

World Class Standards

ETSI NFV ARCHITECTURE & INTERFACES

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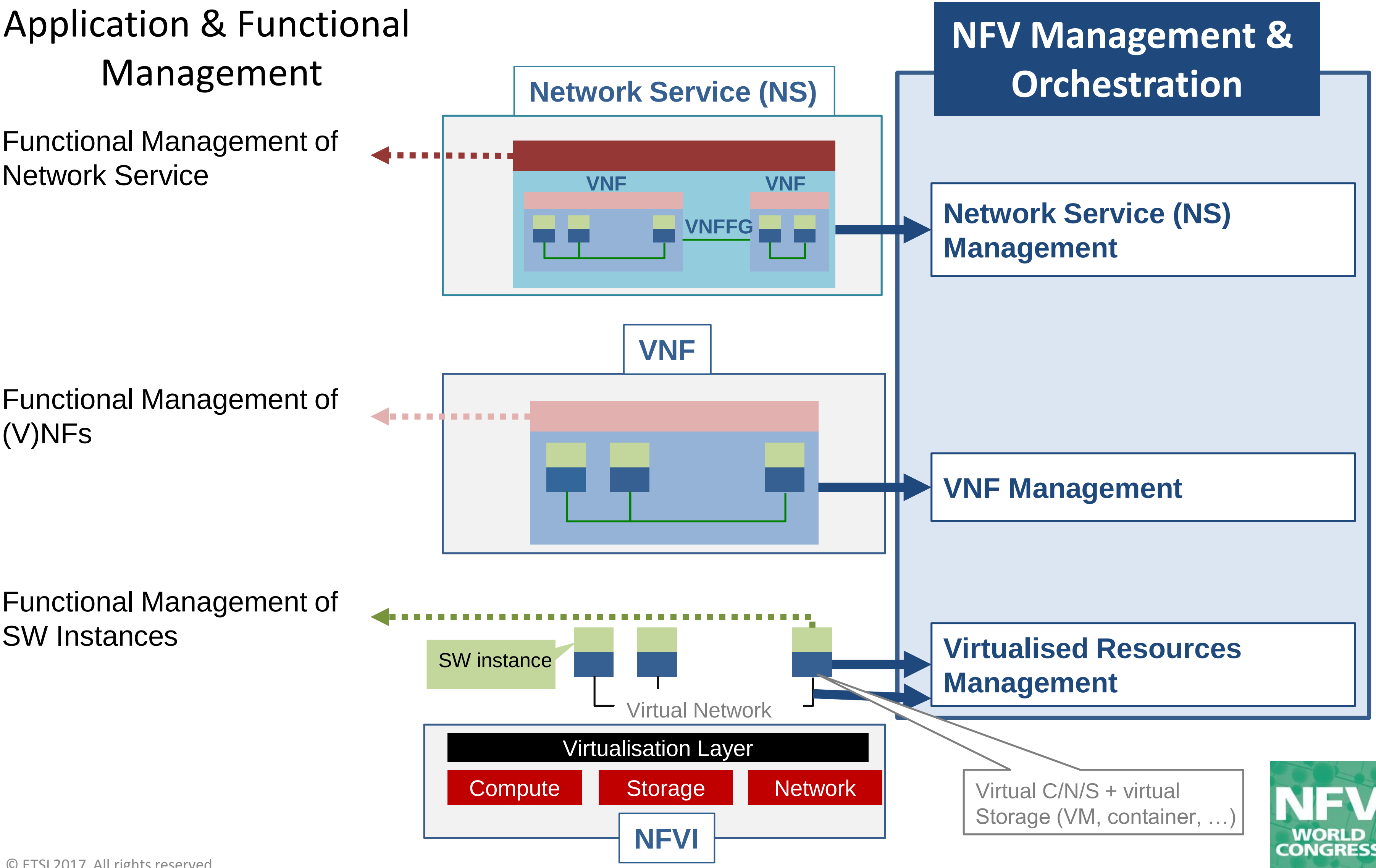
NFV WORLD CONGRESS

Agenda

- ETSI NFV Concepts and IFA Specifications
  - NFV architectural framework
  - Main Management and Orchestration concepts
- VNF lifecycle management: drilling down into IFA007, IFA008, and IFA011
  - What is a VNF?
  - Packaging a VNF
  - Managing the VNF lifecycle
- Conclusion

PART 1
ETSI NFV CONCEPTS AND IFA SPECIFICATIONS

Network Functions Virtualisation: Management of NFV Components

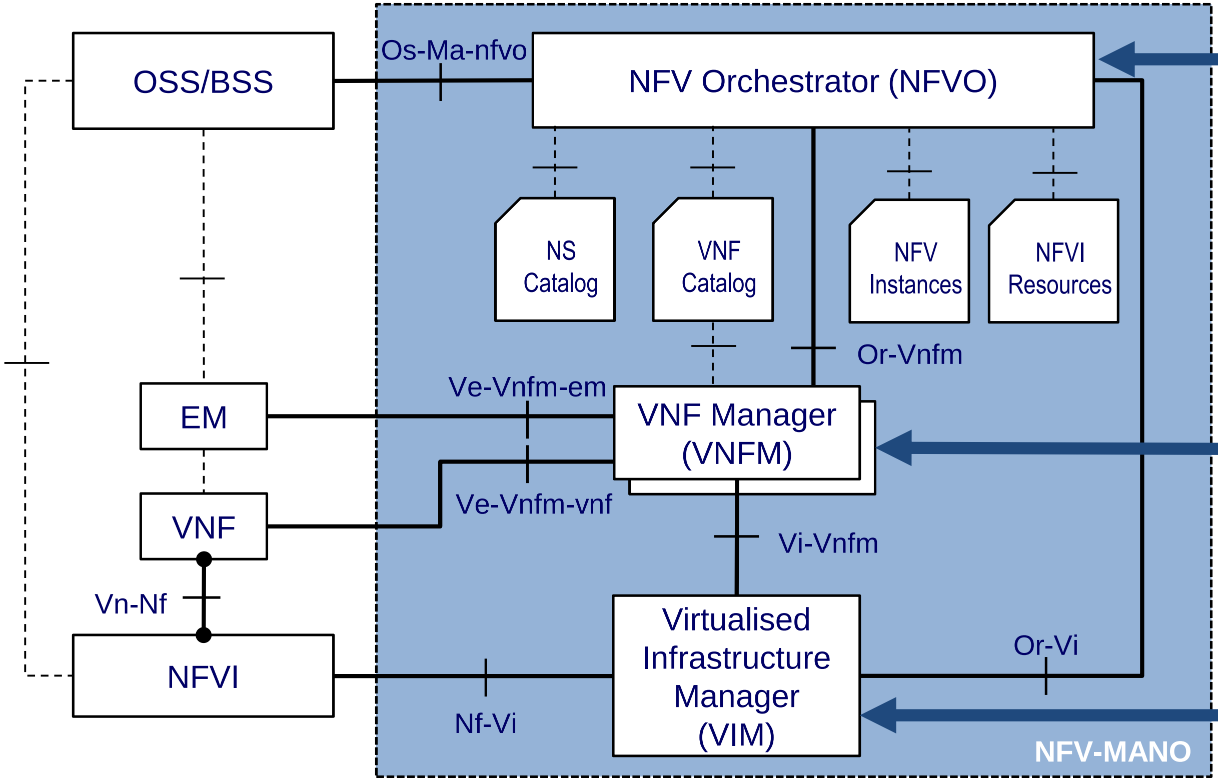


Application & Functional Management
Functional Management of Network Service
Functional Management of (V)NFs
Functional Management of SW Instances
Network Service (NS)
VNF
VNF
VNFFG
VNF
SW instance
Virtual Network
Virtualisation Layer
Compute
Storage
Network
NFVI
NFV Management & Orchestration
Network Service (NS) Management
VNF Management
Virtualised Resources Management
Virtual C/N/S + virtual Storage (VM, container, …)

ETSI NFV Architecture, and NFV-MANO

NFV Management & Orchestration

(Specified in ETSI GS NFV-MAN 001)



Network Service Management

→ Manage combinations of connected VNFs

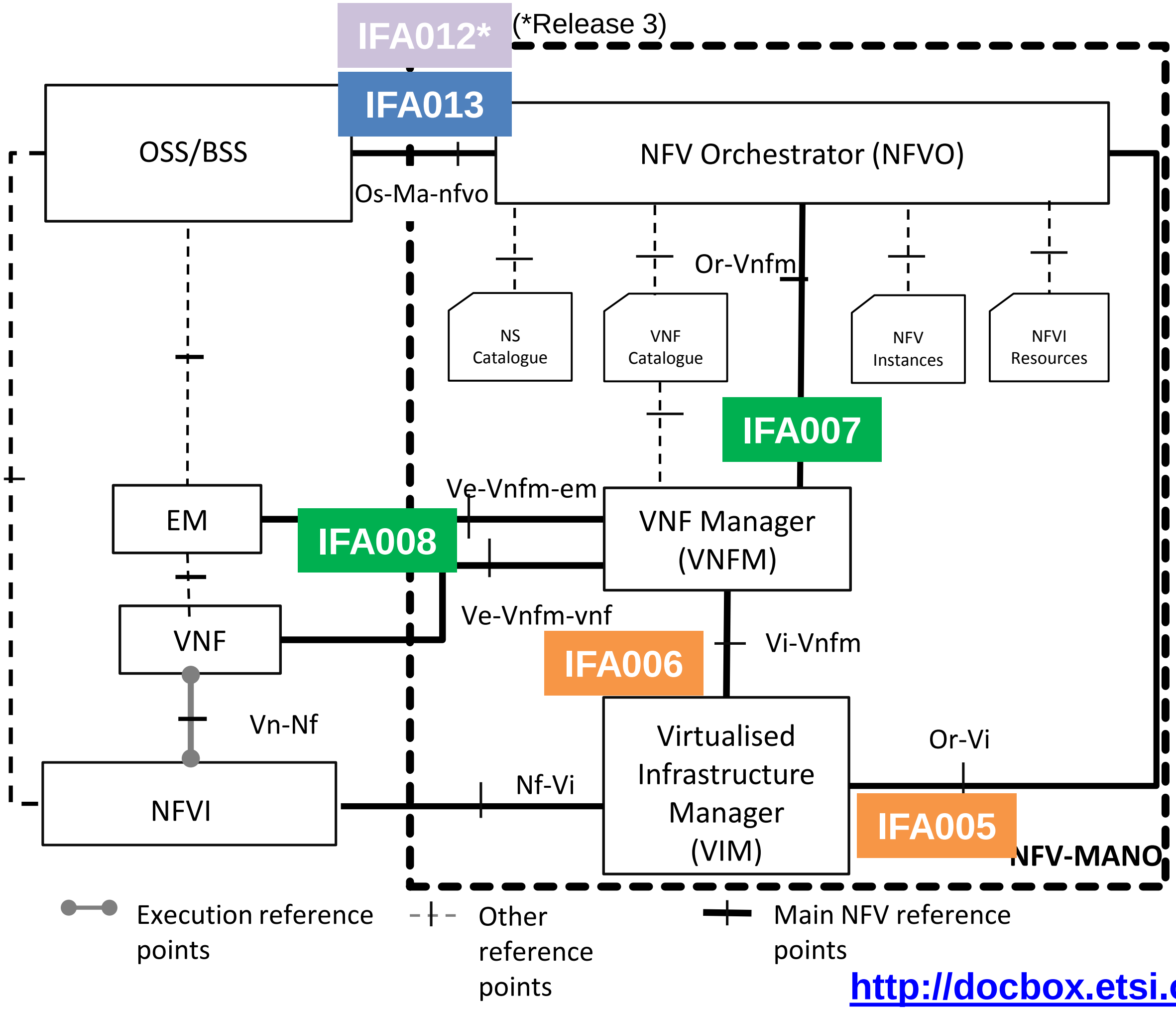
VNF Management

→ Manage individual VNFs

Virtual Resource Management

→ Manage the use of NFVI resources

ETSI NFV IFA WG Group Specifications related to NFV-MANO interfaces and IM



IFA010	Functional Requirements
IFA011	VNF Package & VNFD
IFA014	NS Descriptor
IFA015	NFV Information Model (GR)

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

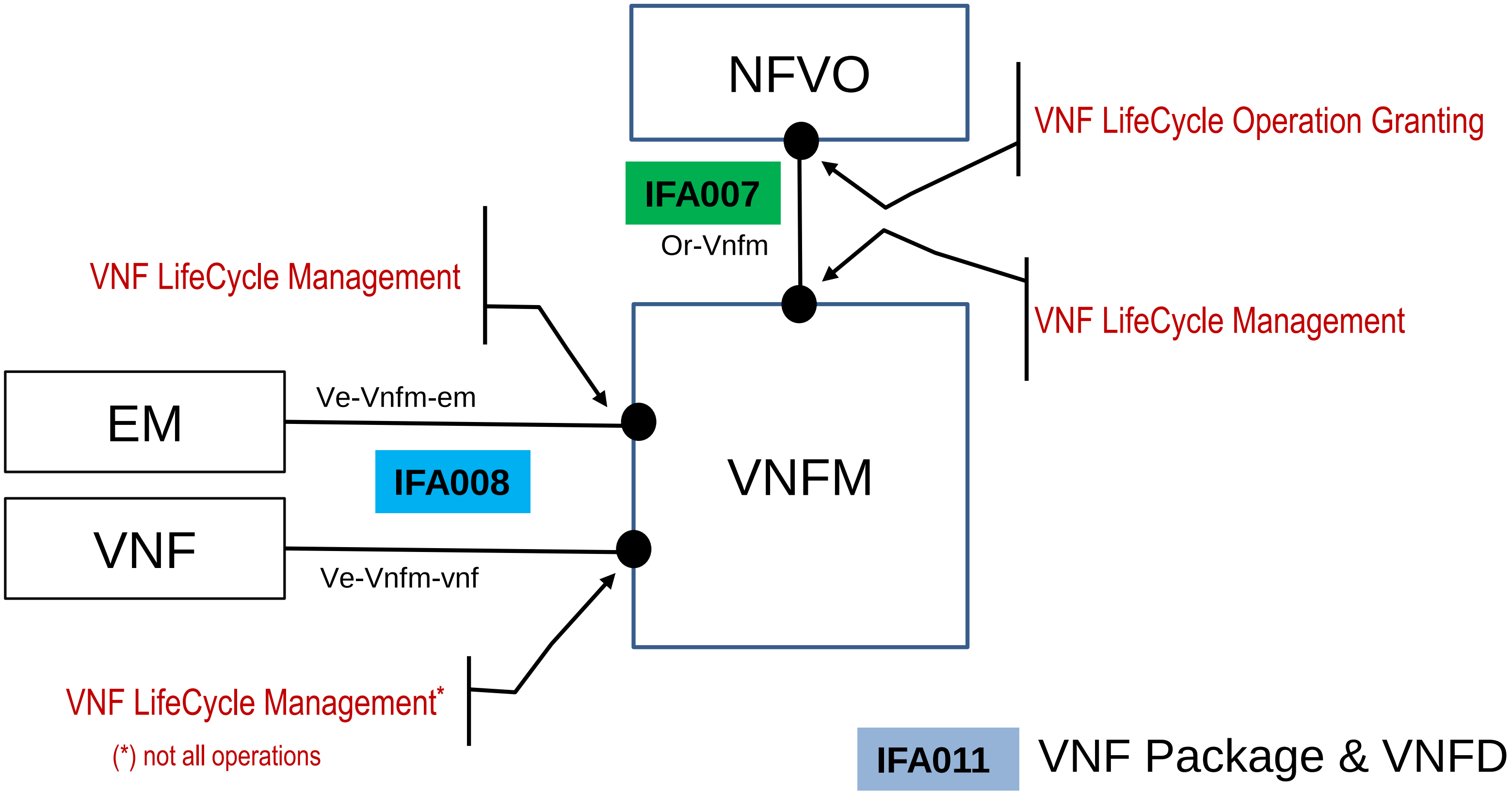
http://www.etsi.org/nfv

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

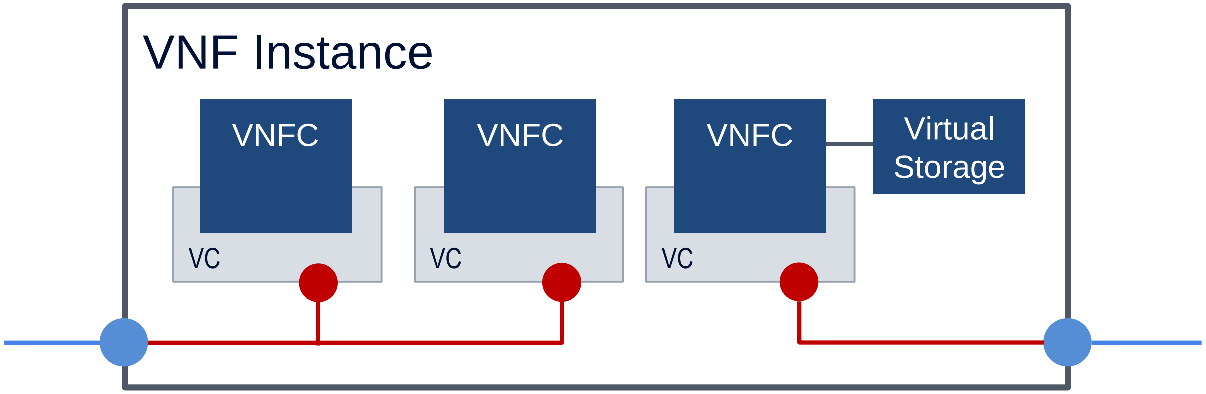
PART 2
VNF LIFECYCLE MANAGEMENT

VNF lifecycle management

VNF lifecycle management requires the VNF Descriptor (IFA011) and a number of interfaces defined in IFA007 and IFA008.



What is a VNF?
A look inside

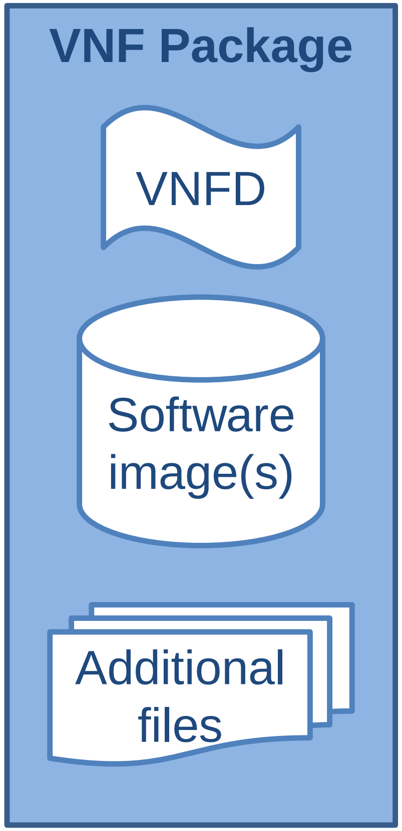


- 🔵 External Connection Point
- 🔴 Internal Connection Point
- — External Virtual Link (Virtual Network)
- — Internal Virtual Link (Virtual Network)

- VNF instance uses virtualized resources (Compute, Networking, Storage)
  - VNF Components (VNFCs)
    - Internal components of a VNF, each providing a part of the functionality of a VNF (i.e. a part of the VNF’s application software).
    - Each VNFC instance maps 1:1 to a “Virtualization Container (VC)” (typically a Virtual Machine).
    - Resources are: Virtualised Compute plus optional Virtualised Storage.
  - Internal virtual links (VLs, virtual networking), interconnecting the VNFCs via internal Connection Points (CPs).
- A VNF provides external connection points
  - external CPs allow to connect the VNF via external VLs to other virtual or physical network functions.
  - external VLs are part of the Network Service, not of the VNF.

Packaging a VNF: VNF Package

- The VNF Package contains:
  - the VNF descriptor (VNFD) that defines metadata for package onboarding and VNF management,
  - the software images needed to run the VNF, and
  - (optional) additional files to manage the VNF (e.g. scripts, vendor-specific files, etc.).
- The VNF Package is digitally signed and delivered by the VNF provider as a whole.
  - The VNF Package is immutable (protected from modification).
- The VNF Package is stored in a repository by the NFVO.
- The VNF Package can be accessed by VNFM.



Reference:
- ETSI GS NFV-IFA 011
- ETSI GS NFV-SOL 004

Packaging a VNF:
VNF Package identification and versioning

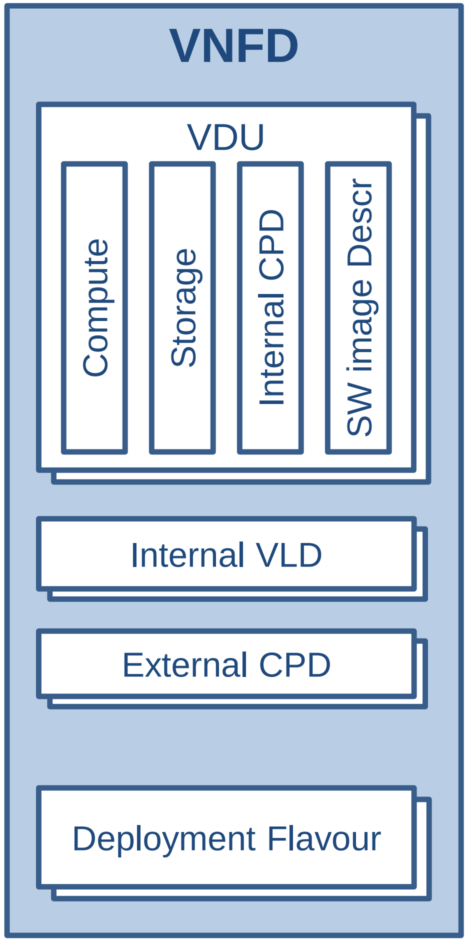
The VNFD in the VNF package contains a set of information elements which allow unique identification of a VNF package (as created by the VNF provider), and keeping track of VNF package versions.

vnfdId	Identifier of the VNFD and the associated VNF Package. This attribute shall be globally unique. It is also used in interfaces.	Global Id
vnfProvider	Provider of the VNF and of the VNFD.	For correlation and versioning
vnfProductName	Name to identify the VNF Product. Invariant for the VNF Product lifetime.	
vnfSoftwareVersion	Software version of the VNF. This is changed when there is any change to the software that is included in the VNF Package.	
vnfdVersion	Identifies the version of the VNFD.	
vnfProductInfoName	Human readable name for the VNF Product. Can change during the VNF Product lifetime.	Info for display
vnfProductInfoDescription	Human readable description of the VNF Product. Can change during the VNF Product lifetime.	

Reference: ETSI GS NFV-IFA 011

Packaging a VNF: VNF Descriptor (VNFD)

- The VNFD defines VNF properties, such as:
  - resources needed (amount and type of Virtual Compute, Storage, Networking),
  - software metadata,
  - connectivity:
    - External Connection Points (described via CP Descriptors, CPD).
    - Internal Virtual Links (described via VL Descriptors, VLD)
    - Internal Connection Points (described via CP Descriptors, CPD)
  - lifecycle management behavior (e.g. scaling, instantiation),
  - supported lifecycle management operations, and their configuration,
  - supported VNF specific parameters, and
  - affinity / anti-affinity rules.



- The VNFD defines deployment flavours (size-bounded deployment configurations, e.g. related to capacity).

Reference:
- ETSI GS NFV-IFA 011
- ETSI GS NFV-SOL 001

Managing the VNF lifecycle: VNF runtime information

- Based on the definitions in the VNFD, VNF instances can be created in the NFVI (aka cloud).
- The runtime information of each VNF instance, VnfInfo, is managed by the VNFM.
- The VnfInfo element includes information such as
  - VNF instance identifier, VNF instance state,
  - scale status (current „size“ of VNF),
  - metadata (version info, pointer to VNFD and VNF package, vendor-specific metadata),
  - virtualised resources used (Virtualised Compute, Storage, Network),
  - list of VNFCs,
  - configurable parameters,
  - external connectivity (external VLs, external CPs), and
  - connectivity to VIM(s) used to manage the resources of the VNF.

Managing the VNF lifecycle:
VNF lifecycle management (LCM) overview

- VNF lifecycle management operations can influence the allocation of virtualized resources to a VNF instance, and/or modify the state of the VNF instance.
- The following VNF LCM operations are defined by ETSI GS NFV-IFA 007 and IFA 008. Support of certain operations by a concrete VNF may depend on the capabilities of the VNF itself (e.g., whether a VNF is "scalable").

Operation	Support by VNF	Explanation
Instantiate VNF	Mandatory	Allocate virtualised resources, configure them, start the application, trigger configuration of the application.
Scale VNF	Optional	Change the amount of virtualised resources allocated to a VNF.
Query VNF	Mandatory	Obtain runtime information about the VNF instance (VnfInfo).
Terminate VNF	Mandatory	Terminate the VNF, and release the virtualised resources.
Change VNF flavour	Optional	Change the deployment flavor of the VNF, which typically includes changing the amount of virtualised resources, and the topology.
Heal VNF	Optional	Virtualisation-related corrective actions to repair a faulty VNF, and/or its VNFC instances and internal VNF Virtual Link(s).
Operate VNF	Optional	Start or stop the VNF software.
Modify VNF Info	Mandatory	Change certain items of the VNF runtime information (VnfInfo).
Auto-Scale and Auto-Heal	Optional	Variants of Scale VNF and Heal VNF, triggered automatically in the VNFM, by monitoring the VNF

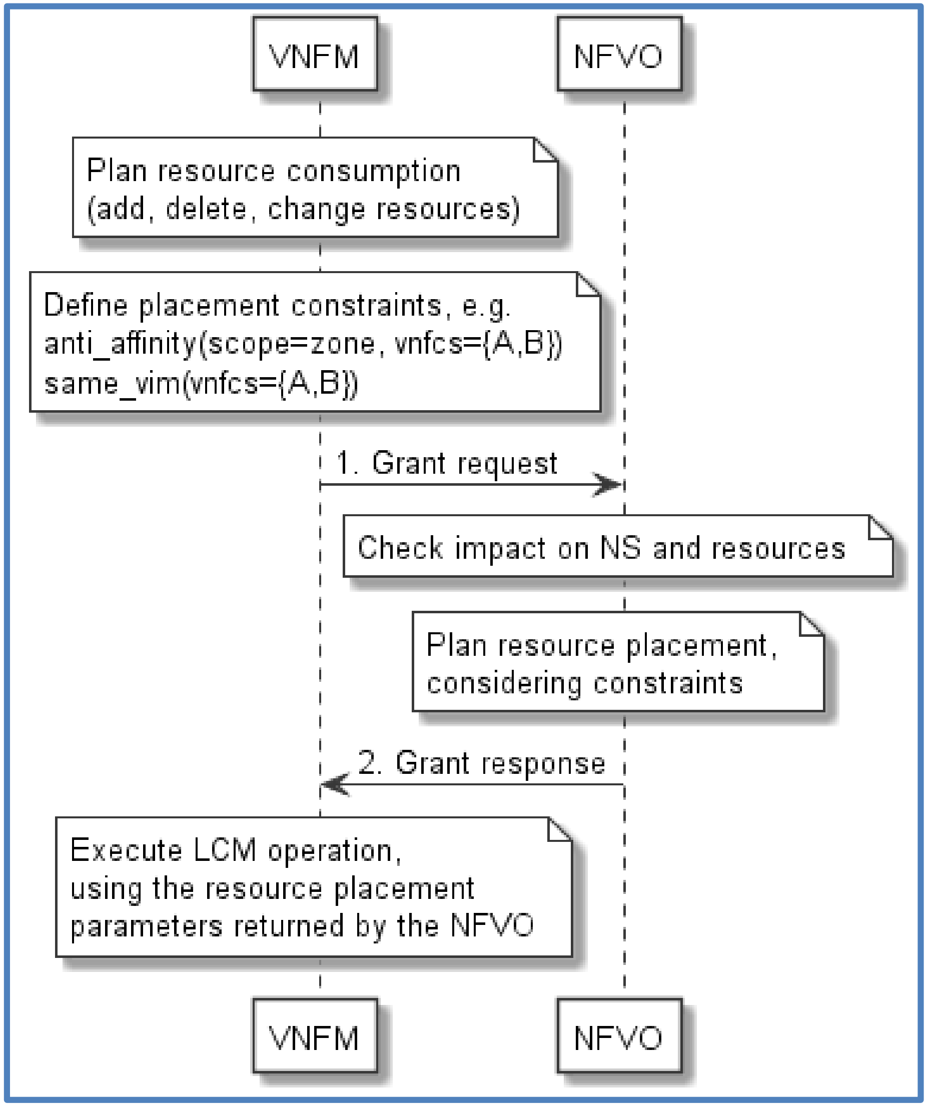
Managing the VNF lifecycle: How VNF LCM operations work

- Typically, LCM operations are long-running operations (minutes, hours)
  → tracking is essential.

- Therefore, each individual VNF LCM operation occurrence
  - can be identified (for correlation),
  - has a status (e.g. ongoing, error, success) that can be queried.

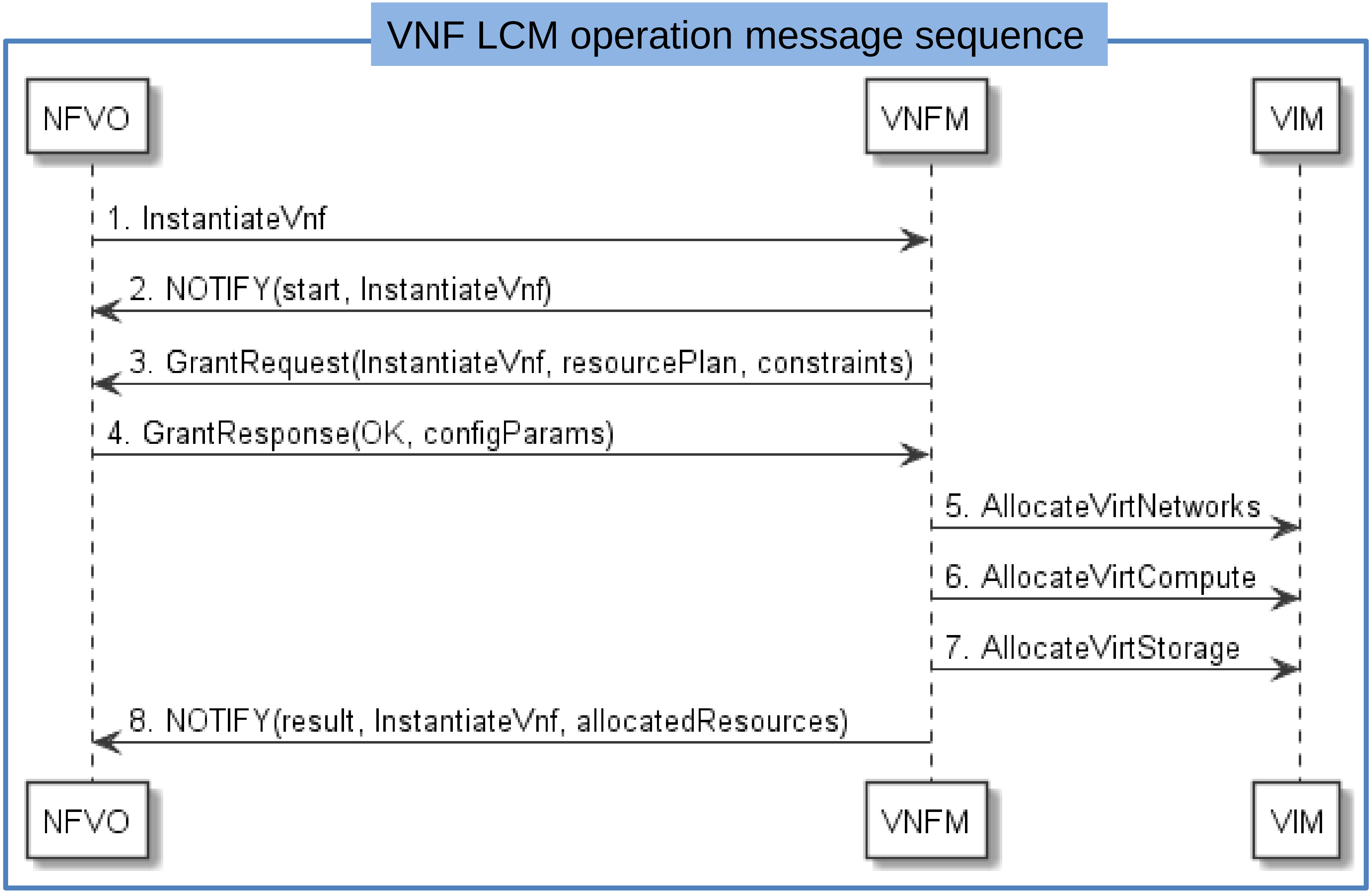
- VNFM will notify start and completion of each operation
  - notification sent to subscribed functional blocks (e.g. NFVO, EM),
  - each notification identifies the affected VNF and applied operation occurrence,
  - “completion” notification contains information about the changes to the VNF’s consumption of virtualised resources (success case), and
  - “completion” notification communicates error information (error case).

Managing the VNF lifecycle:
Lifecycle Operation Granting: Ask the Orchestrator!


VNFM
NFVO
Plan resource consumption
(add, delete, change resources)
Define placement constraints, e.g.
anti_affinity(scope=zone, vnfcs={A,B})
same_vim(vnfcs={A,B})
1. Grant request
Check impact on NS and resources
Plan resource placement,
considering constraints
2. Grant response
Execute LCM operation,
using the resource placement
parameters returned by the NFVO
VNFM
NFVO

- NFVO is responsible for Network Service Orchestration and Resource Orchestration
  - VNFM has therefore need to obtain permission for LCM operations, and
  - NFVO needs to tell the VNFM in which part of the NFVI (data center, zone) the resources can be allocated.
- Solution: granting exchange.

Managing the VNF lifecycle: Putting it together (an example)

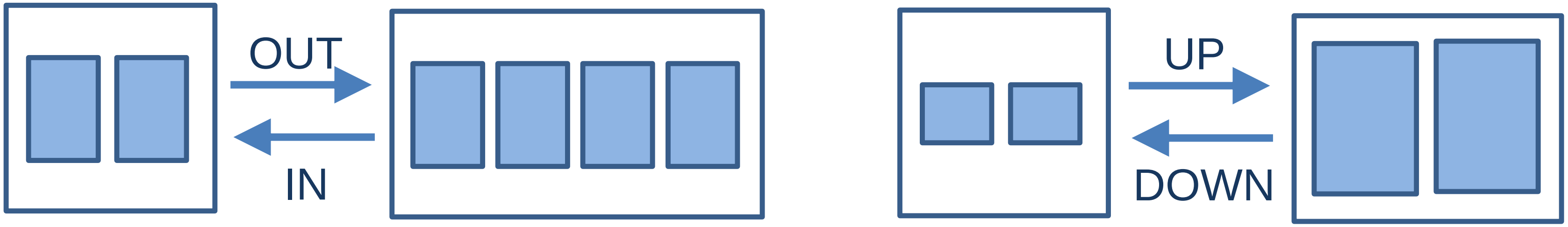


VNF LCM operation message sequence

1. InstantiateVnf
2. NOTIFY(start, InstantiateVnf)
3. GrantRequest(InstantiateVnf, resourcePlan, constraints)
4. GrantResponse(OK, configParams)
5. AllocateVirtNetworks
6. AllocateVirtCompute
7. AllocateVirtStorage
8. NOTIFY(result, InstantiateVnf, allocatedResources)

Managing the VNF lifecycle: Scaling a VNF

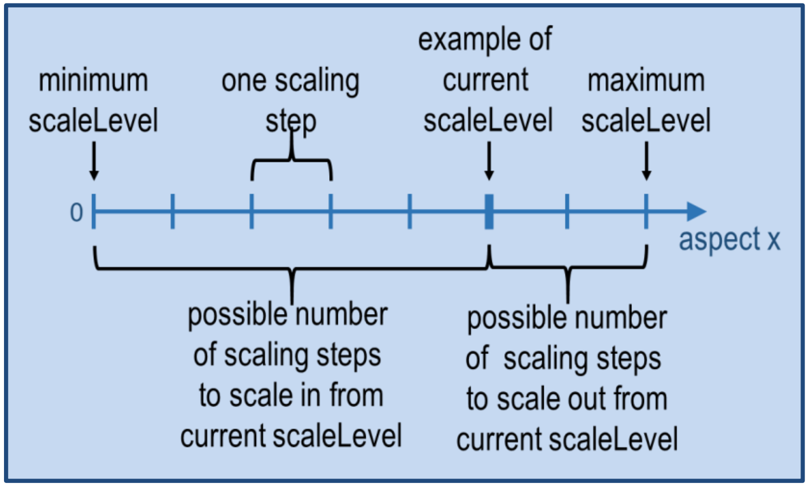
- Basic idea: Elasticity
  A VNF’s resource consumption (e.g. number of VNFCs) changes with load.
- VNF scaling shall be non-service disruptive.
- Modes:
  - Horizontal scaling (scale in/out) → Add/remove virtualised resources (e.g. VNFCs)
  - Vertical scaling (scale up/down) → Reconfigure the capacity / size of existing virtualised resources (e.g., VM flavor, storage size)
  - In the ETSI NFV current release <u>only horizontal scaling</u> of the VNFs is supported



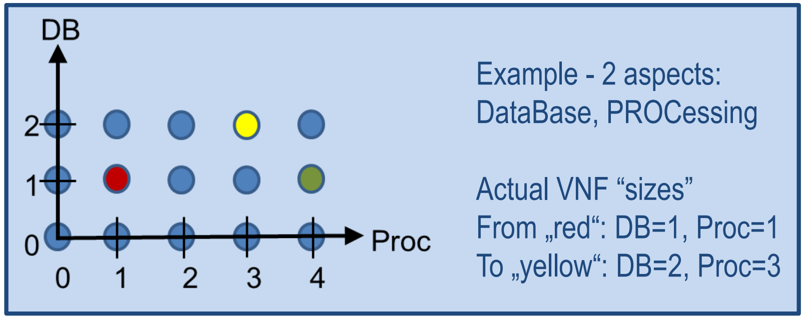
- Scaling triggers
  - on demand (Scale VNF LCM operations), and
  - automatically by the VNFM when certain performance figures cross a threshold.

Managing the VNF lifecycle: Scaling a VNF, the model

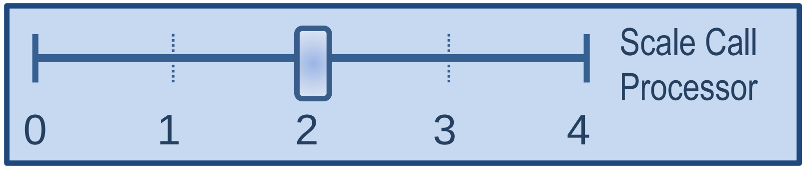
One scaling aspect with scale levels


minimum scaleLevel
one scaling step
example of current scaleLevel
maximum scaleLevel
0
aspect x
possible number of scaling steps to scale in from current scaleLevel
possible number of scaling steps to scale out from current scaleLevel

The scaling space (all scaling aspects)


DB
2
1
0
0
1
2
3
4
Proc
Example - 2 aspects: DataBase, PROCessing
Actual VNF "sizes"
From „red": DB=1, Proc=1
To „yellow": DB=2, Proc=3

Operating experience



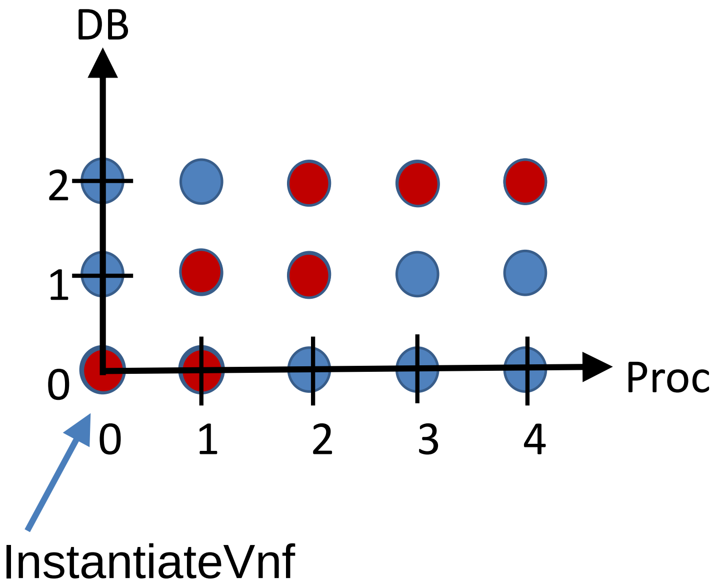
- Requirement from VNF designs:
  A VNF may be scaled in multiple independent aspects (e.g. scale database storage capacity independent from call processing capacity).

- Scaling aspect
  - Also known as "scaling dimension". Describes in an abstracted manner what "property" of the VNF to scale.
  - Each scale level of a scaling aspect defines a valid size of the VNF w.r.t that aspect.
  - Scaling takes place in discrete steps, changing the size from one level to another one.
  - Operating experience: E.g. slider model.

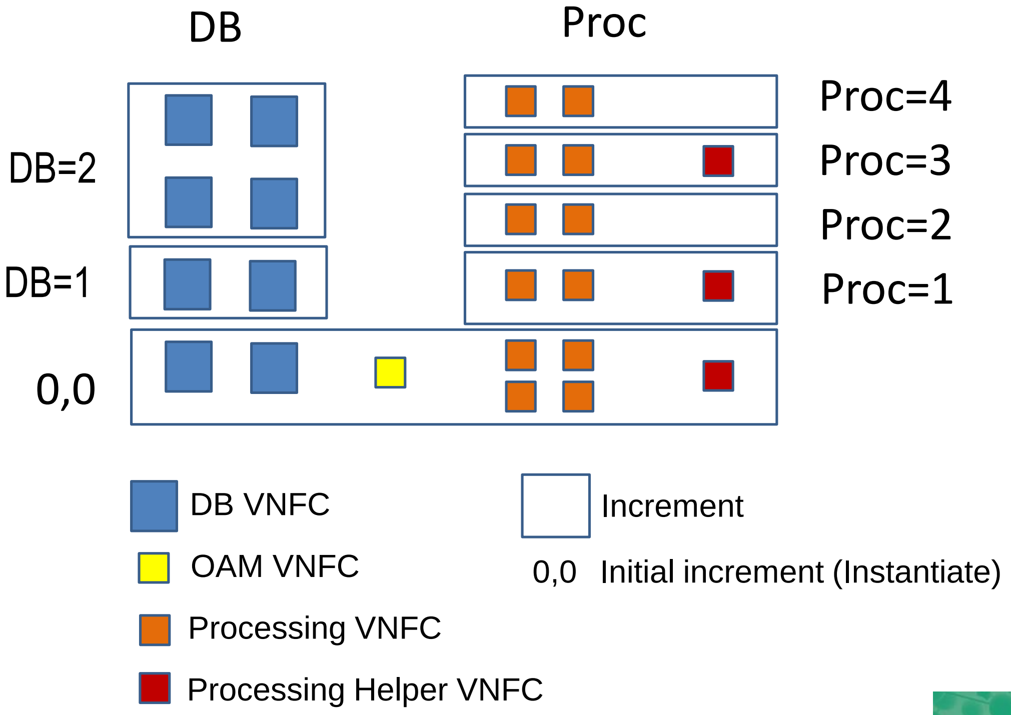
Managing the VNF lifecycle:
Illustration of VNF instantiation and scaling

Scaling aspects abstract the internal composition of the VNF, allowing unified fine-granular control and a good operating experience.

External view: Scaling aspects

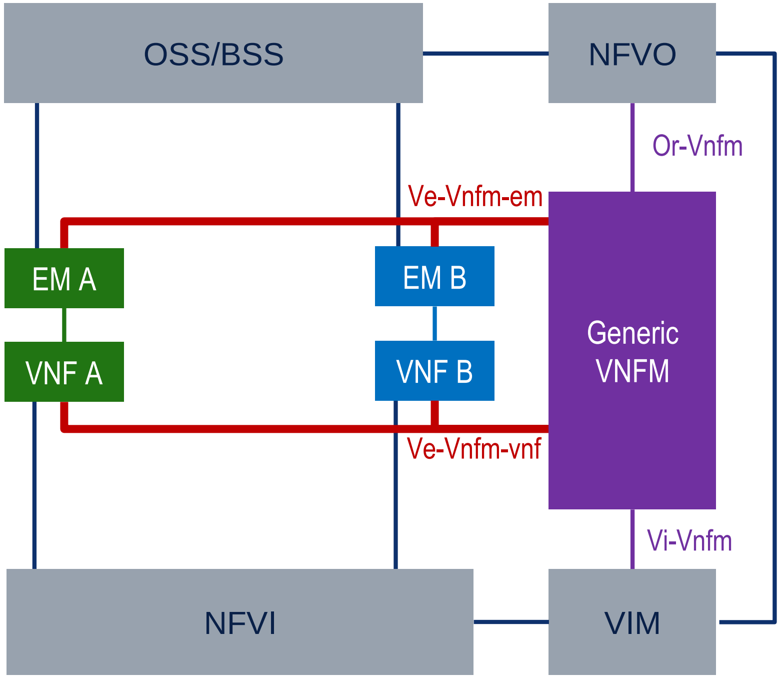


Example VNF internal view: Groups of VNFCs



Managing the VNF lifecycle: Generic VNFM

- One VNFM for all VNFs (from multiple vendors).
- VNF-related Multivendor integration interface: Ve-Vnfm (IFA008).
- Provides standard basic management capabilities to all VNFs.
- Additionally, if required, VNF-specific management functionality is covered „lifecycle management scripts" that are defined by the VNF vendor and included with the VNF package
  - Standardization of a universal scripting language for such scripts is future work.
  - Near-term Generic VNFM implementations may support a few existing scripting languages selected by the VNFM vendor, and VNF vendors have to adapt their VNFs to use one of the available languages.

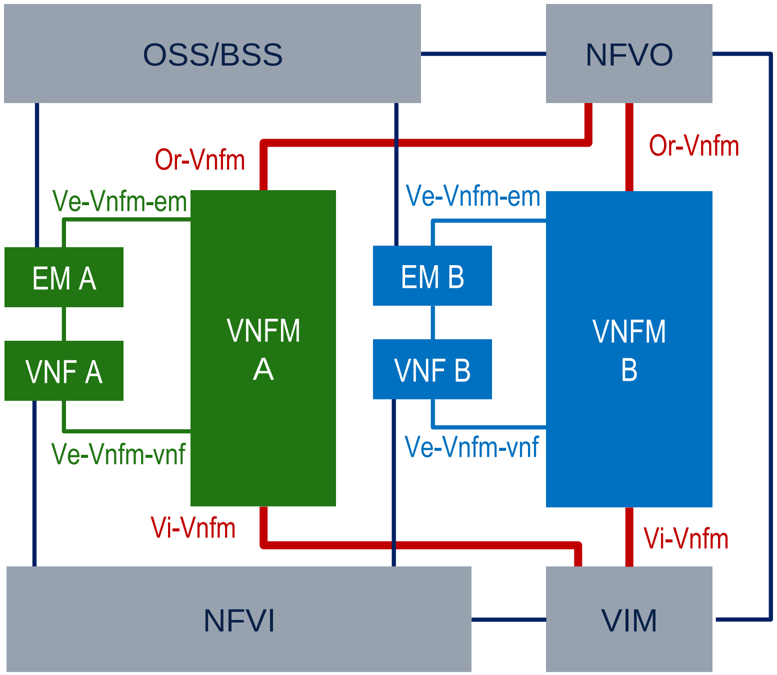


Source: ETSI GS NFV-IFA 009

Managing the VNF lifecycle: VNFM specific to a set of VNFs

- A VNFM that can manage a particular set of VNFs.
- Typically, delivered by the VNF vendor together with the VNF.
- VNF-related multivendor integration interfaces: Vi-Vnfm (IFA006) towards VIM, Or-Vnfm (IFA007) towards NFVO. Interface towards VNF and EM may be proprietary or based on IFA008.
- Allows the VNF vendor to encapsulate in a VNFM particular VNF-specific, complex or advanced lifecycle management procedures.

NOTE: IFA-specified interfaces and operations do not differentiate whether the VNFM is generic or specific, and thus applicable to all types of VNFM.



Source: ETSI GS NFV-IFA 009

CONCLUSION

Conclusion

This tutorial has …

… provided an overview of the main NFV concepts, MANO architecture, interfaces and functional blocks, and the work items of the ETSI NFV IFA working group,

… outlined what a VNF is, how a VNF is structured and packaged, what the role and composition of the VNF descriptor is and how the descriptions in it relate to the management of the lifecycle of a VNF,

… introduced how the lifecycle of a VNF is managed by its VNF Manager, which are the main lifecycle management operations, and what the typical call flow of a lifecycle management operation looks like, and

… briefly touched the different deployment options of the VNF Manager.

World Class Standards

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:

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

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

BACKUP

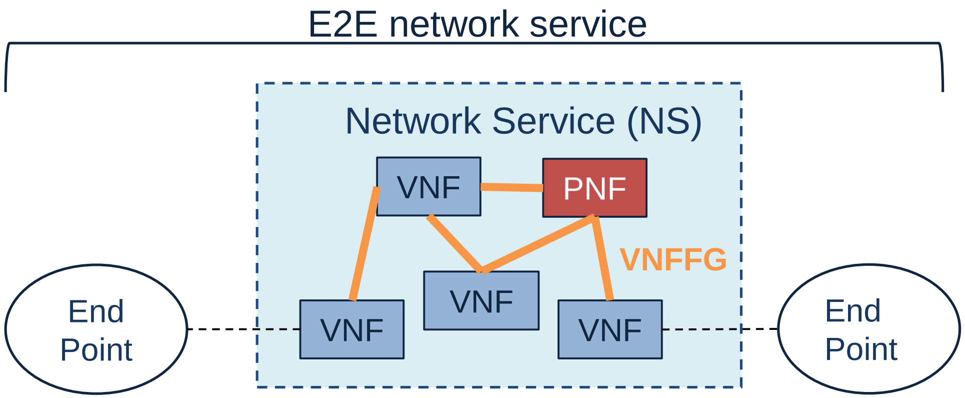
ETSI NFV ISG Interfaces and Architecture (IFA) Working Group

Dec ‘13	• ETSI NFV Architectural Framework v1.1.1 published
Nov ‘14	• ETSI NFV MANO WG Closed • **ETSI NFV IFA WG created** • **NFV Release 2 work starts**
Jan ‘15	• ETSI NFV Architectural Framework v1.2.1 published • MAN001 - ETSI NFV Management and Orchestration Report published
Apr ’16	• First IFA WG Release 2 specifications published • **NFV Release 3 work starts**
Sep ’16	• Completion of Release 2 work on requirements, interfaces and information model
Nov ’16	• Publication of IFA WG Release 2 specifications
Now	• Maintenance of IFA Release 2 specifications • Completing reports about Release 3 features

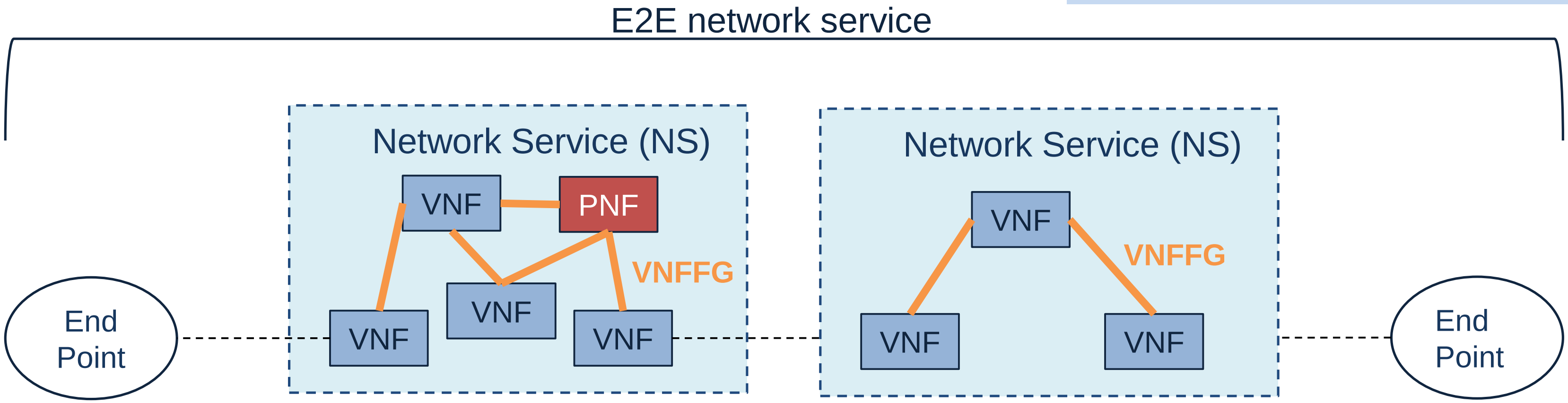
IFA WG Scope

- **Specification of functional requirements and Interfaces**
- **Specification of NFV Information Modeling**
- **Specification of NFV Descriptors**
- **Reporting and specification of Acceleration Use cases**
- **Reporting and specification of new features evaluating interface and architecture enhancements**

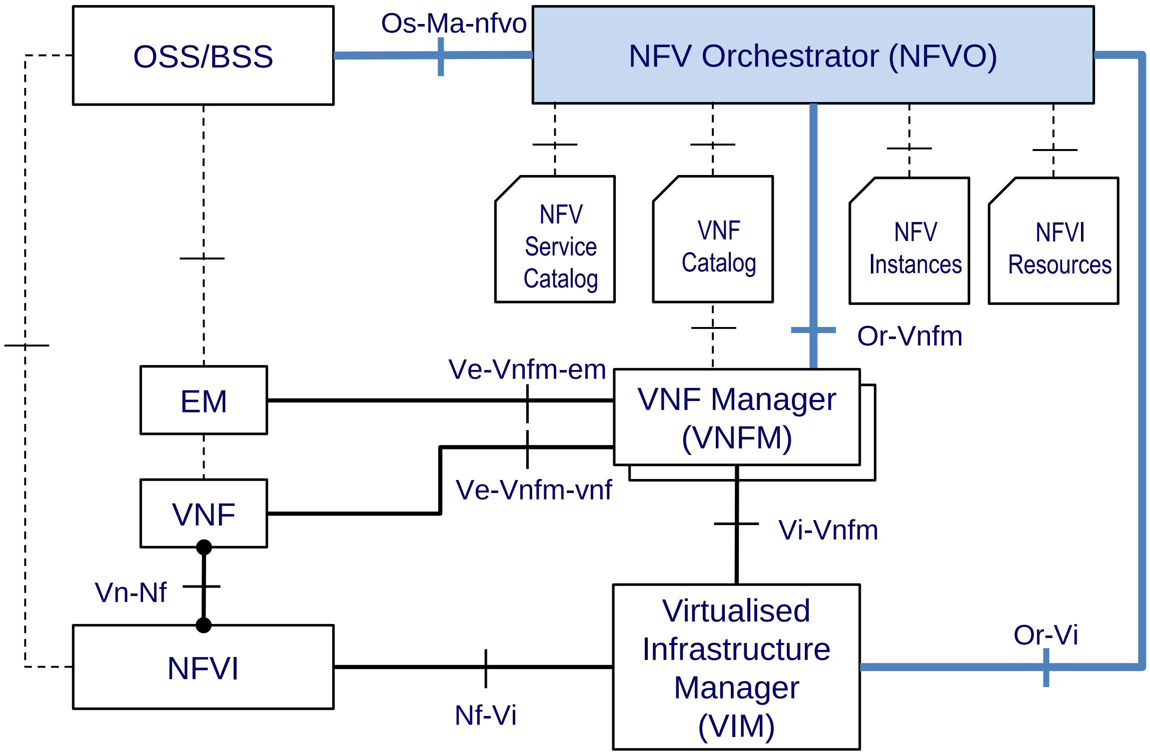
Network Functions Virtualization: VNFs, NS and E2E Network Service



The NFV Idea:
Decoupling network functions functionality from infrastructure and relocating the network functions from dedicated appliances to pools of resources leveraging commodity-of-the-shelf (COTS) hardware.
Softwarization of the network enabling automation of deployment and operations.

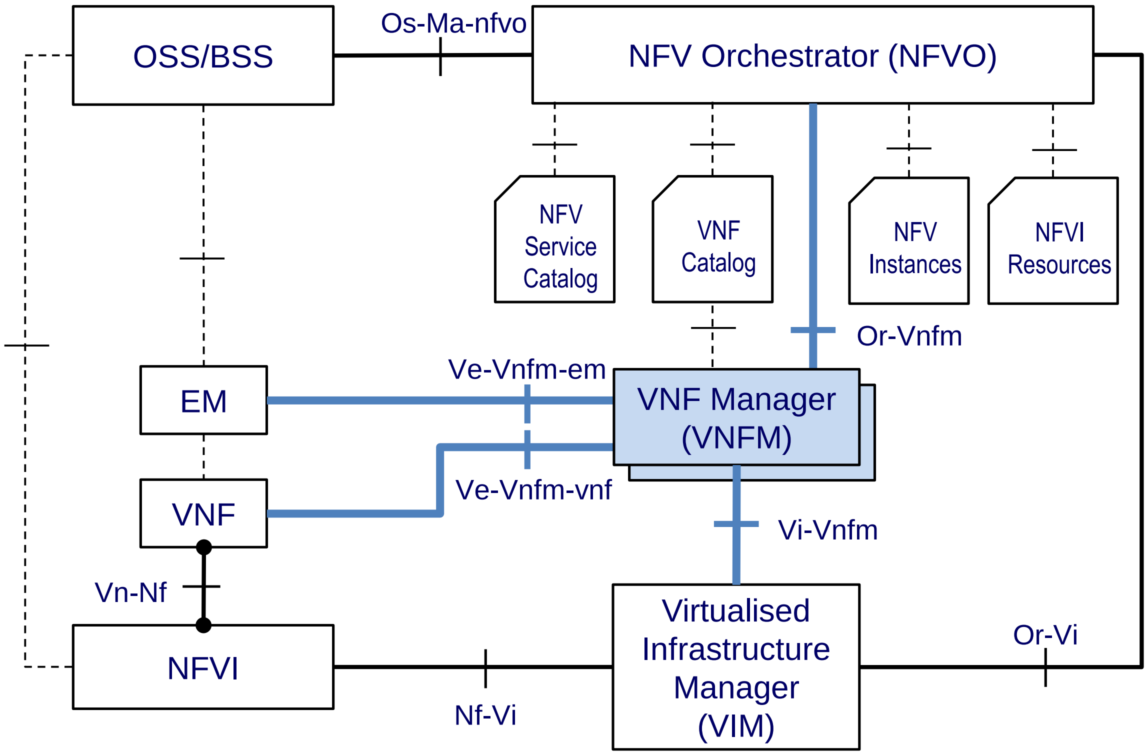


NFVO – NFV Orchestrator



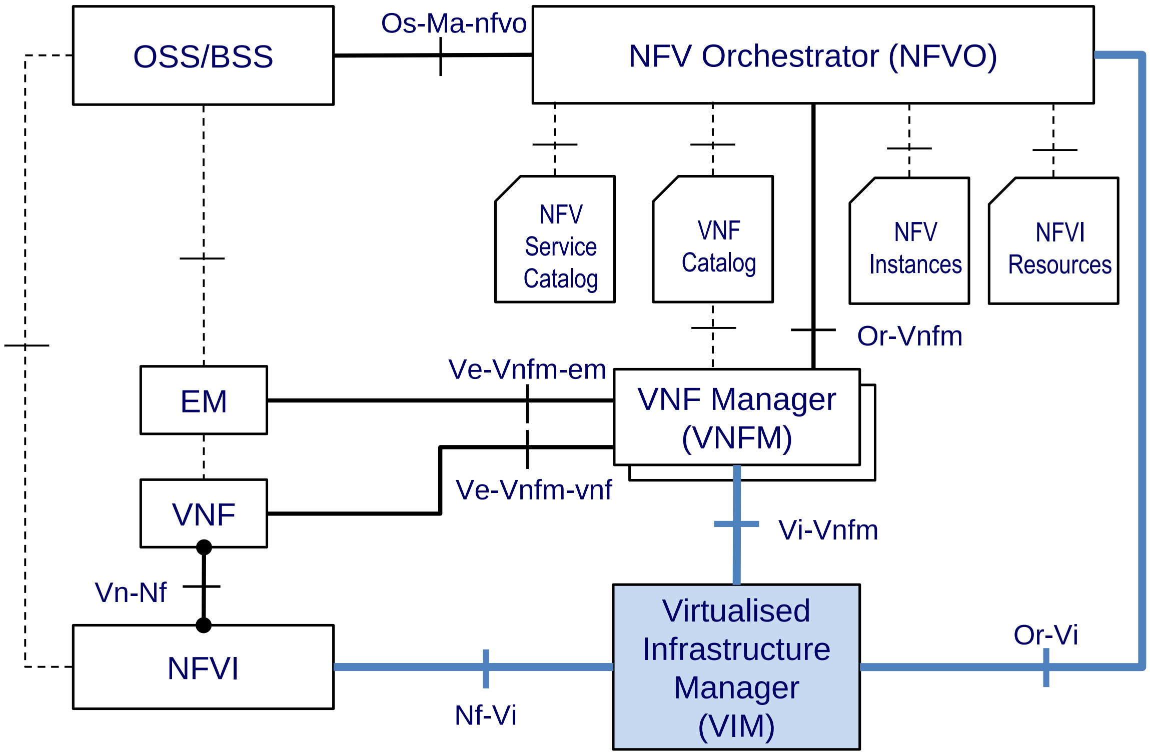
- Manages the lifecycle of NS
- Exposes NS lifecycle management interfaces to the OSS/BSS
- Sends NS lifecycle management notifications to the OSS/BSS
- Exposes virtualized resource management interfaces to the VNFM
- Sends virtualized resource management notifications to the VNFM
- Manages the VNF lifecycle via the interfaces exposed by the VNFM
- Manages virtualized resources via the interfaces exposed by the VIM.

VNFM – VNF Manager



- **Manages the lifecycle of VNFs**
- **Manages virtualized resources associated to the VNF** it manages via the interfaces exposed by the VIM or NFVO
- Exposes VNF lifecycle management interfaces/APIs to the VNF, EM and NFVO.
- Sends VNF lifecycle management notifications to the VNF, EM and NFVO
- **Manages VNF initial configuration** via the interfaces exposed by the VNF.

VIM – Virtualised Infrastructure Manager



- **Manages the NFV infrastructure resources** (compute, network and storage) in one or more NFVI-PoPs.
- Exposes virtualized resource management interfaces/APIs to the VNFM and NFVO
- Sends virtualized resource management notifications to the VNFM and the NFVO

IFA WG deliverables:
Acceleration Reports and Specifications

GS: Group Specification (normative)
GR: Group Report (informative)

- GR IFA001 – Acceleration Overview & use Cases
- GS IFA002 – VNF acceleration interface specifications
- GS IFA003 – vSwitch Requirements
- GS IFA004 – Acceleration Management Aspects
- (In progress) GS IFA018 – Resource Management Acceleration
- (In progress) GS IFA019 – Acceleration Interface

http://docbox.etsi.org/ISG/NFV/Open/Drafts/
http://www.etsi.org/nfv
http://nfvwiki.etsi.org/index.php?title=NFV_Issue_Tracker

IFA WG deliverables:
Other Reports and Specifications

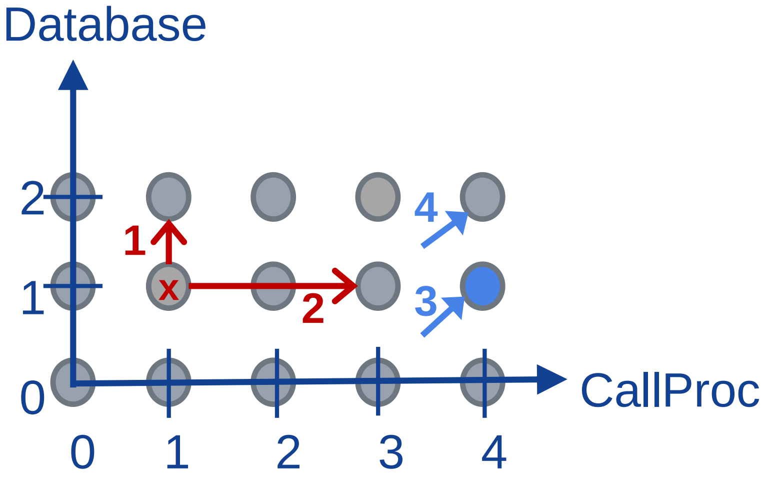
GS: Group Specification (normative)
GR: Group Report (informative)

- GR IFA009 – Architectural Options
- GR IFA015 – NFV Information Model
- GR IFA016 – Papyrus Guidelines
- GR IFA017 – UML Modeling Guidelines
- (In progress) GR IFA020 – NFVO Decomposition Options (Release 3)
- (In progress) GR IFA021 – MANO and Automated Deployment (Release 3)
- (In progress) GR IFA022 – Multi Site Services (Release 3)
- (In progress) GR IFA023 – Policy Management in MANO (Release 3)
- (In progress) GR IFA024 – External Touchpoints related to NFV Information Model
- (In progress) GR IFA025 – Real-time/ultra-low latency aspects in NFV related to service and network handling
- (In progress) GS IFA026 – Architecture enhancements for security management
- (In progress) GS IFA027 – Performance measurements
- (In progress) GR IFA028 – Architecture options to support multiple administrative domains (Release 3)
- (In progress) GR IFA029 – Enhancements of the NFV architecture towards cloud native and PaaS (Release 3)

http://docbox.etsi.org/ISG/NFV/Open/Drafts/
http://www.etsi.org/nfv
http://nfvwiki.etsi.org/index.php?title=NFV_Issue_Tracker

How is a VNF managed?
Two operations to scale a VNF

- ScaleVnf: Incremental scaling
  - Changes one aspect only at a time
  - Semantics: apply a delta (how many steps) based on current level of aspect to scale
  - Two options: Scale from the current position by one scaling step (1) or by multiple scaling steps (2)
- ScaleVnfToLevel: Go to target
  - Typically changes multiple aspects at once
  - Semantics: Specify a new target in scaling space (where do you want to go)
  - The target may be a pre-defined instantiation level (3) or any arbitrary target in scaling space (4)

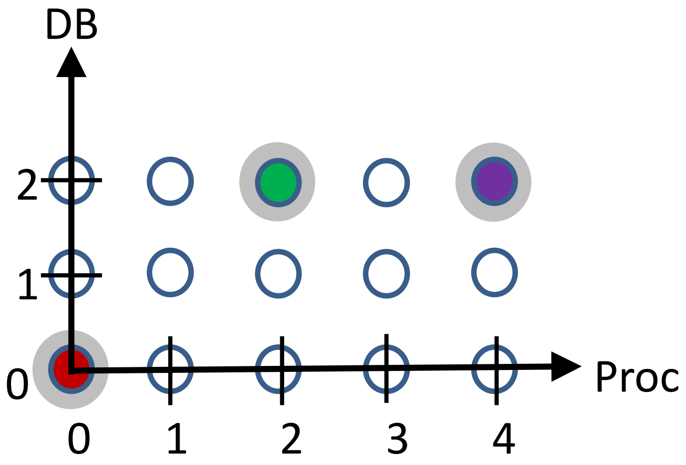


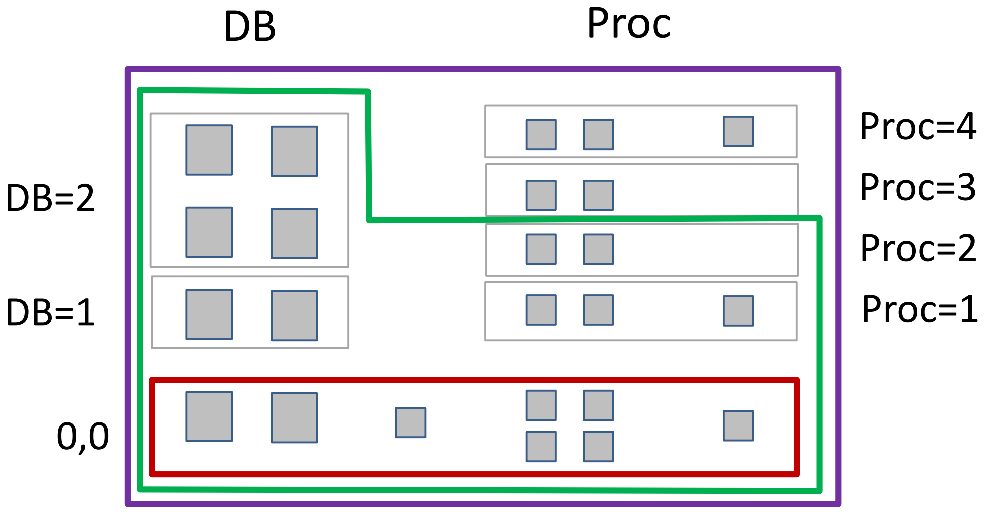
1 ScaleVnf(Database, out)
2 ScaleVnf(CallProc, out, 2)
3 ScaleVnfToLevel(„blue“)
4 ScaleVnfToLevel((Database,2), (CallProc,4)

Most VNFs only support a subset of these.

Support for the different scaling modes can be defined by the VNF provider in the VNFD.

How is a VNF managed?
Different VNF instantiation sizes





- Use case: Operator does not want to always instantiate the VNF at minimum size, but rather, e.g.
  - At minimum size
  - At some intermediate size(s)
  - At maximum size
- Solution: Instantiation level is a tool that allows the VNFM to instantiate different sizes, using the defined scaling space.